GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

GOEDOC - Dokumenten- und Publikationsserver der
Georg-August-Universität Göttingen

2014

Parallel Structures

Joost Kremers

Linguistics in Göttingen (LinG) Nr. 1

Kremers, J.: Parallel structures
Göttingen : GOEDOC, Dokumenten- und Publikationsserver der Georg-August-Universität, 2014
(Linguistics in Göttingen 1)

Verfügbar:
PURL: http://resolver.sub.uni-goettingen.de/purl/?webdoc-3930

This work is licensed under a
Creative Commons Attribution-NoDerivatives 4.0 International License.

Bibliographische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie; detaillierte bibliographische Daten sind im Internet über <http://dnb.ddb.de> abrufbar.

Erschienen in der Reihe
Linguistics in Göttingen (LinG)

ISSN: 2199-143X

Herausgeber der Reihe
Seminar für Deutsche Philologie, Philosophische Fakultät der Georg-August-Universität Göttingen

Anja Müller, M.A. und Dr. Joost Kremers

Abstract: The traditional grammar model of generative grammar is a sequential model, in which the derivation starts from the lexicon and proceeds by merging elements and constructing a syntactic structure. At some point, the derivation diverges, continuing in two directions: toward the interface with the conceptual-intentional (C-I) system, often simply LF, and toward the interface with the sensorimotor (SM) system, often simply PF. One property is fundamental to this system: the syntactic derivation is primary, the interface representations for the C-I and SM systems (a semantic and a phonological representation) are derivative. Crucially, there is no feed-back from phonology (or semantics) back into syntax. In this paper, I wish to challenge this idea. I will in fact argue that this interpretation of the relation between the syntactic representation and the semantic and phonological representations is neither necessary from a theoretical point of view, nor desirable from an empirical point of view. In its place, I propose to put a parallel grammar architecture, in which the semantic, syntactic and phonological representations are built in parallel to each other, with information flowing from syntax to semantics and phonology, but also in the other direction, from semantics and phonology back to syntax. Motivations for the proposal both conceptual and empirical. Conceptually, it is argued that the output of the derivation must be a linguistic sign, i.e., an object containing a syntactic, semantic and phonological representation and that the most straightforward way of constructing such an object is to merge smaller linguistic signs. Empirically, there are phenomena that cannot be analysed straightforwardly with a standard sequential model and that would benefit from a parallel model. This paper discusses two such domains, wh-movement and heavy NP shift.

Keywords: grammar architecture, parallel grammar model, phonology-syntax interaction, wh-movement, heavy NP shift

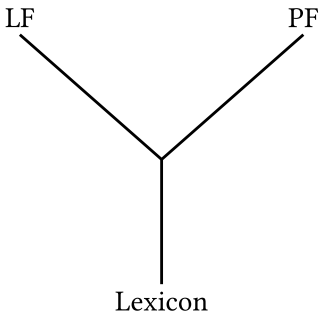
Parallel structures

Joost Kremers

University of Göttingen
joost.kremers@phil.uni-goettingen.de

1. Introduction

The traditional grammar model of generative grammar is sometimes called a Y-model, due to the fact that it resembles a capital Y when represented schematically:

(1)


The idea is that the derivation starts from the lexicon and proceeds by merging elements from the lexicon (or a numeration). At some point, the derivation diverges, continuing in two directions: toward the interface with the conceptual-intentional (C-I) system, often simply LF, and toward the interface with the sensorimotor (SM) system, often simply PF.[1] This split-off point is called *Spell-out*, or *Transfer* in more recent parlance. In phase-based systems (cf. Chomsky, 1995, and subsequent work), the derivation proceeds in phases, with a Transfer (or Spell-out) operation at the end of each phase.

Different iterations of the Principles & Parameters model have known different variants of the Y-shaped model, but one property is fundamental to them all: the syntactic derivation is primary, the interface representations for the C-I and SM

[1] This obviously simplifies to an extreme extent and mixes terminology that strictly speaking does not belong together. While it is still common to speak of PF (less so of LF), it would be more accurate to speak of the sensorimotor interface. For the present paper, such considerations are not relevant, however.

systems (a semantic and a phonological representation) are derivative. Crucially, there is no feed-back from phonology (or semantics) back into syntax.

In this paper, I wish to challenge this idea. I will in fact argue that this interpretation of the relation between the syntactic representation and the semantic and phonological representations is neither necessary from a theoretical point of view, nor desirable from an empirical point of view. In its place, I prospose to put a parallel grammar architecture, in which the semantic, syntactic and phonological representations are built in parallel to each other, with information flowing from syntax to semantics and phonology, but also in the other direction, from semantics and phonology back to syntax.

In fact, in this paper I focus on the relation between syntax and phonology and argue that we need a bidirectional model to describe this relation. I assume (mainly on conceptual grounds) that the same is true for the relation between syntax and semantics, but this lies beyond the scope of the current paper.

In section 2 I discuss the conceptual motivations for moving toward a parallel model. The main point of this section is to argue that a parallel architecture is not contradictory to standard minimalist views. Furthermore, I discuss the main differences between the current proposal and Jackendoff's (2002) parallel grammar architecture. In section 3, I discuss a number of phenomena that provide empirical evidence for the parallel model and show how they can be analysed.

2. Conceptual motivations

2.1. The external systems: C-I and SM

The grammar model in various iterations of (mainstream) generative theory has always been a model in which syntactic structures are built first, after which the semantic and phonological structures are derived from it. At least since Chomsky (1999), it has been assumed that the derivation of semantic and phonological structure takes place not at the end of the syntactic derivation, but after completion of distinct parts of syntactic structure called *phases*.

Although this model seems relatively straightforward and clear, questions arise when we look at the details more closely. The systems that syntax interfaces with are the conceptual-intentional (C-I) and the sensorimotor (SM) systems. These systems are obviously extra-linguistic. What this means is that they do not *generate* semantic and phonological representations on the basis of the syntactic structure, because those are clearly linguistic in nature. Rather, the external systems *interpret* these representations.

Consider for example the sensorimotor system. This system controls the muscles that move the articulators and the lungs, which then generate the speech sound. We may plausibly assume that the phonological structure serves as the basis for the instructions that the SM system generates in order to control the muscles of the speech organs, but it is implausible that the SM system must first generate the phonological structure itself. After all, the phonological structure not only serves as the basis for the SM system to generate its muscle control instructions, it also serves as the target for the auditory system when parsing an incoming speech signal.

The phonological structure is a linguistic representation for the very reason that two completely disparate cognitive systems make use of it. This is not a new observation, of course (cf. Chomsky, 1995), but it is worth pointing out. What this means is that it does not suffice to say that a syntactic structure is sent off to the interfaces. The interfaces do not generate the semantic and phonological structures, they intepret them (and hand their results over to the C-I and SM systems). The question is therefore where and when these structures are generated. The null hypothesis here would seem to be that they are generated together with the syntactic structure. Anything else requires explicit motivation.

To see why this is so, consider the composition of the linguistic representation that is passed to the interfaces. Such as structure is essentially a "linguistic sign", i.e., a structure composed of semantic, morphosyntactic and phonological features. This is acknowledged by Chomsky as early as Chomsky (1965, p. 214 fn. 15), but also in later work, where he often refers to a *structural description* or *structural object*. Given that the interface systems interpret linguistic representations, rather than generate them, as just discussed, the linguistic system needs to generate a structural object of this kind, one that is composed of a semantic, a morphosyntactic and a phonological structure.

If the final output of the linguistic system (i.e., of the generative grammar) is a structural object and the initial objects out of which those structures are built can also be modelled as structural objects, it makes sense to assume that the derivation handles structural objects. Let us therefore assume that what the operation Merge combines are in fact structural objects (linguistic signs) in this sense. That means that when a head is merged into the structure, its semantic and phonological features become immediately available as well. The natural assumption is that they are immediately integrated with the other semantic and phonological features already present in the structure. It would not make sense to assume that their integration is postponed until some later point; such an assumption would be an unwarranted stipulation.

Obviously, this conclusion does not follow inevitably. In Distributed Morphology (DM), for example (cf. Halle & Marantz, 1993), Merge combines morphosyntactic features, not linguistic signs. However, two essential motivations behind DM, doing morphology in syntax and dealing with morphological form alternations without some form of look-ahead (or look-back), through *Late Insertion*, are not incompatible with a parallel model as outlined here. First, adopting the assumption that Merge combines linguistic signs does not entail a lexicalist grammar model: if we understand the term "sign" in a broad sense, such that a morpheme like {PL} ↔ /z/ is also considered a sign, we can do morphology as part of the syntactic component without having to assume "morphology in the privacy of our own lexicon" (cf. Marantz, 1997). Likewise, *Late Insertion* is not a requirement in order to account for the fact that the actual form that realises a particular morphosyntactic feature (bundle) may depend on the context in which said feature (bundle) appears. This, too, can be accounted for in a parallel model if we move the information about the context that is contained in the Vocabulary Item into the relevant sign (cf. Kremers, 2014, for discussion).

Summarising, a parallel model makes sense as a null hypothesis: the linguistic system must generate structural objects consisting of a semantic, a syntactic and a phonological representation. The building blocks of syntactic structure can be described in the same way. Therefore, the minimal assumption is that the derivation is parallel, combining syntactic, semantic and phonological features at the same time, albeit in different modules.

2.2. Modules

At this point, it is helpful to say a few words about what a module is and how this term is to be understood. The classic view of a module in generative grammar is presumably that developed by Fodor (1983), who describes a module as being domain-specific and informationally encapsulated.[2] This view is inspired by the chomskian view of grammar and is indeed a good fit for a sequential grammar model. This view is not challenged in a fundamental way by the parallel model outlined here, although some nuance is necessary. The semantic, syntactic and phonological modules are indeed domain-specific, dealing only with their own kinds of features, and they are informationally encapsulated, in the sense that, e.g., phonology cannot see syntactic information.

There is one difference with Fodor's view: although Fodor did not explicitly entertain the phrenologist position that the modules he talks of are located at very specific positions in the brain, he nonetheless seems to conceive of them as individual machines in an assembly line. One module receives input and yields an output that becomes the input for the next module. What the parallel model changes is this assembly line idea: instead of having just one module active at any specific time, the modules act in parallel, with the connection existing between different pieces of information in different modules being active at all times.[3]

To see what this means, consider the parallel representation of a simple lexical item such as *car*:

(2) CAR ↔ [N,+sg,+count] ↔ /kɑːɹ/

The idea is that the links between the three types of features are stored in the lexicon; when this lexical item is merged in a derivation, the links between the three feature bundles remain extant. Furthermore, the links are subject to a number of principles (as discussed in the next section), so that if syntax remerges an element, the semantic and phonological representations may need to be updated as well.

In other words, all three types of features are integrated into the larger structure at the same time, but the combinatorial principles that apply to them are different in nature. Phonological elements are combined on the basis of phonological

[2] Along with a few other properties that are less relevant here.

[3] Note that this does not say anything about the actual implementation of this parallelism in the so-called "wet-ware". It is in principle possible (though to my mind unlikely) that it is implemented by rapidly switching computation from one module to the next and back again, similarly to how multitasking is implemented in a computer by rapidly switching between processes.

principles, syntactic heads on the basis of syntactic principles, and semantic elements on the basis of semantic principles. In this way, the three types of features can be said to be part of different modules. At the same time, the features are all part of the same head, so they are linked and cannot be separated. Yet, they act separately, in the sense that they are subject to different principles.

It is important to note that the structures being built are linked at every level: the heads present in the structure provide most of these links, but there are also principles that govern the mapping from one module to another, which provide additional links. For example, syntax-phonology interface is governed by a set of principles that correlate syntactic constituents with prosodic constituents (Nespor & Vogel, 1986; Selkirk, 1984; Truckenbrodt, 2007, and much related work). These principles introduce additional links between the syntactic and the phonological structure while the structure is being built.

2.3. Mapping principles

Two principles that are especially important to the present discussion are *Linear* and *Input Correspondence* (Ackema & Neeleman, 2004):[4]

(3) Mapping principles:

a. *Linear Correspondence*
If A is structurally external to B, then Φ(A) is linearly external to Φ(B).

b. *Input Correspondence*
If A selects (a projection of) B, then Φ(A) selects Φ(B).

Linear Correspondence is in essence equivalent to the Nontangling Condition (Partee, ter Meulen, & Wall, 1993). It ensures that two sister nodes in the tree are adjacent in the linear string (more specifically, that the phonological elements associated with them are adjacent).

For Ackema and Neeleman (2004), Input Correspondence is primarily a morphological principle: it says that the phonological exponent of an affix attaches to the phonological exponent of the *head* of the structure it attaches to in syntax. In this way, it becomes possible to account for the fact that for example the English gerund affix *-ing* can attach to a VP or an IP in syntax (cf. Abney, 1987), while still attaching to the verb stem morphologically.

In Kremers (2012b, 2013b) I argue that these two principles are not restricted to morphology but are equally valid for the mapping from syntax to phonology.[5] For Linear Correspondence this is unproblematic, given that it is essentially equivalent to the Nontangling Condition, which is a condition on syntactic trees. For Input Correspondence, on the other hand, this may not be immediately obvious.

[4] But see Sadock (1992) for two very similar principles. The notation Φ(X) refers to the phonological material associated with the syntactic element X. For example, in (2), Φ(N) = /kɑːɹ/.

[5] More precisely, I argue that there is a single generative system responsible for both syntactic and morphological structures.

However, in Kremers (2012b) I argue that Input Correspondence is a secondary mapping principle. Linear Correspondence is the primary principle, but there are cases where adhering to this principle would lead to phonologically illicit structures. Specifically, elements may have phonological requirements that cannot be met if Linear Correspondence were adhered to. Affixes have such a phonological requirement, because they require alignment with the edge of a prosodic word. Because syntactic elements usually do not carry such phonological requirements, Input Correspondence appears restricted to elements that are morphological.

In what is to follow, we will see several cases where Linear and Input Correspondence play a crucial role.

2.4. Jackendoff's parallel architecture

Jackendoff (2002) develops a grammar model that also has a parallel nature. There are some differences between his model and the current proposal, however. Most importantly, Jackendoff assumes that semantics, syntax and phonology are independent generative systems. That is, semantics and phonology generate structures of their own, which are then related to syntactic structures. In the current proposal, syntax is still the sole generative module of the grammar. The semantic and phonological structures are built in parallel to the syntactic structure, but always on the basis of this syntactic structure. It is the syntactic component that merges two heads. The phonological and semantic "merger" operations are dependent on it.

Connected to this is a further difference: in Jackendoff's model, parts of syntactic structures are indexed with parts of semantic and phonological structures. Freidin (2003) argues that these indices violate Full Interpretation and to the extent that they are assumed to be theoretical devices, they do. In the current proposal, no such indices are necessary, because the connections between the syntactic, semantic and phonological features are inherent. They do not need to be established as part of the derivation.[6]

One thing that I do adopt from Jackendoff is the representation for lexical items. A lexical item such as *car* can be represented as in (2), repeated here:

(2) CAR ↔ [N,+sg,+count] ↔ /kɑːɹ/

This lexical entry states that the semantic concept CAR is linked to a syntactic head with the features [N,+sg,+count], which is in turn linked to a phonological string of the form /kɑːɹ/. The double arrows indicate that the three types of features are combined according to different principles. It should be kept in mind, though, that the representation in (2) is really one single linguistic object, not three.

[6] Another difference between Jackendoff and the current proposal concerns the fact that Jackendoff (2002) explicitly proposes a unification-based model. Although the model that I propose is derivational in nature, I do not consider this a very important distinction. I assume that language processing uses methods that can be described using a representational, unification-based grammar model, but the stored structures that Jackendoff's approach uses must be generated following certain principles, which a generative model describe.

3. Empirical motivations

A parallel grammar architecture has one great advantage: it becomes possible to model interactions between syntax and phonology that are not strictly unidirectional.[7] Such effects have been known for a long time (cf. Inkelas & Zec, 1990), but they have rarely been picked up by mainstream generative theory.[8] The point has been made abundantly clear, however, by Richards (2010), who argues quite explicitly that there are cases where syntactic operations take place in order to improve the prosodic structure of the utterance. Richards also notes (in section 3.1.1) that such a conclusion is at odds with standard generative views and that he has no true solution to offer to offer to the questions this raises.

Obviously, a parallel grammar architecture provides us with a way to account for the observed effects. In this section, I discuss several empirical phenomena that display a phonology-syntax interaction and I provide an analysis in terms of the grammar model sketched in the previous section. I start out with a phenomenon that strictly speaking does not show feed-back from phonology to syntax, but which will help to describe the grammar model in some more detail.

3.1. Negation in DGS

Sign languages show a high degree of simultaneity (Vermeerbergen, Leeson, & Crasborn, 2007; Sandler & Lillo-Martin, 2006; Kremers, 2012a). What this means is that they have the ability to express two or more meaningful elements simultaneously, often by involving the face, head or upper body. One example is negation, which in many sign languages can be expressed through a headshake. Take the following example from German Sign Language (*Deutsche Gebärdensprache*, DGS):[9]

(4) **head:** *hs* (spanning BUY (NOT))
hands: MOTHER FLOWER BUY (NOT)
'Mother does not buy a flower.'
(Pfau & Quer, 2002)

In DGS, negation can be expressed with a manual sign NOT. This manual negation is accompanied by a non-manual negation marker consisting of a headshake, indicated as *hs* in (4). This headshake, however, is not limited to the manual sign NOT, it must spread over the predicate (here the verb). Furthermore, the manual sign is optional. That is, negation in DGS can be expressed simply by accompanying the predicate with a headshake.

[7] The same is true for interactions between syntax and semantics, of course, but in this paper I focus on phonology-syntax interactions.
[8] In cases where they have been noted, attempts are usually made to model them by assuming syntactic features that simply encode the relevant phonological information, or by a system of overgeneration in syntax combined with phonological filters. See Büring (2012) for an example of the latter.
[9] Negation in DGS and a few other sign languages is discussed extensively in a series of papers by Pfau (2001; 2002; 2008) and Pfau & Quer (2002; 2007). See also Zeshan (2006) for a typological overview of negation in a number of sign languages. The analysis in this paper is mostly in line with Pfau's, though it is couched in the proposed parallel architecture.

The headshake is not limited to the predicate, however. Occasionally, it may spread over the entire VP:

(5) **head:** *hs* (over FLOWER BUY)
hands: MOTHER FLOWER BUY
'Mother does not buy a flower.'

Here, the headshake accompanies both the object FLOWER and the verb. The meaning of (4) and (5) is the same: both express sentential negation. Note that if negation spreads over the object, it must spread over the *entire* object. It cannot spread over just a part of it:

(6) * **head:** *hs* (over RED BUY)
hands: MOTHER FLOWER RED BUY
'Mother does not buy a red flower.'

Furthermore, the headshake cannot extend over the subject:

(7) * **head:** *hs* (over MOTHER FLOWER BUY)
hands: MOTHER FLOWER BUY
'Mother does not buy a flower'

Interestingly, if the subject is a pronoun, the headshake *can* (and according to Pfau (2008) usually does) spread over the subject:

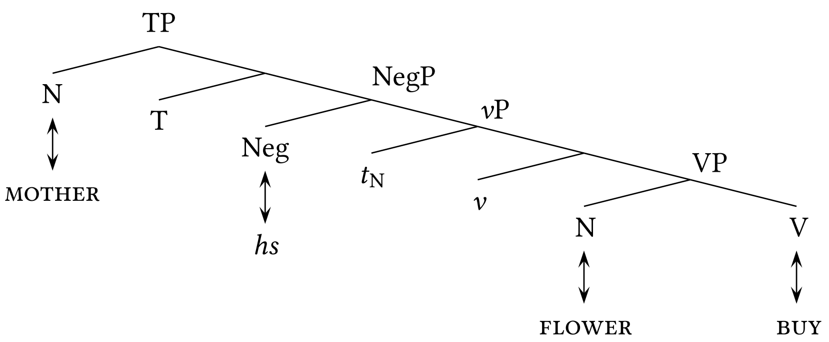
(8) **head:** *hs* (over IX:3 FLOWER BUY)
hands: IX:3 FLOWER BUY
'She does not buy a flower'

Pfau concludes from these facts that the spreading domain of the negation is prosodic. He assumes that the verb and its object together form a phonological phrase (p-phrase) and that this is the domain of headshake spreading.[10] The subject forms its own p-phrase, so that the headshake does not spread over it. A pronominal subject, however, does not form its own p-phrase. Instead, it is incorporated into the p-phrase containing the object and the verb. It then follows that the headshake spreads over the pronominal subject.

Without having to go into the details of DGS clause structure, we may assume that the syntactic structure for the clauses in (4)-(8) is something along the following lines:

[10] Note that the prosodic structure of DGS (and indeed of many sign languages) is still a largely unexplored topic. Pfau's assumption that the object and the verb constitute a p-phrase is not implausible, but it should be noted that there are (spoken) languages that phrase the object separately from the verb. I will nonetheless assume that Pfau's assumption is correct.

(9)



The double arrows in this tree indicate the links to phonology. That is, everything that is below the double arrows is not part of the syntactic structure. Rather, they are the elements that phonology must combine into a licit phonological form. In order to see how this is done, we must focus on the way in which the phonological structure is assembled in parallel with the syntactic structure.

The first step in the syntactic derivation is the merger of the verb and its object, creating the VP. Phonology has to combine the two manual signs BUY and FLOWER. A crucial aspect of this is linearisation, since I assume that syntactic structures are unordered. How exactly linear order is derived is not relevant to the present paper, however, therefore I will largely ignore the matter here. Since DGS is a verb-final language, I have simply drawn the verb to the right in (9), without wanting to imply too much by it.[11]

Phonology orders the two segmental elements (i.e., manual signs), basically because it cannot do anything else (cf. Kremers, 2013a). It also creates a p-phrase out of the two elements, as the syntactic VP corresponds to one.[12] In the next step, the little *v* head is merged. Since this head is phonologically empty — at least, this is what I have assumed in (9) — there is no additional material that the phonological system needs to integrate.

The little *v* head allows the subject to be merged. In phonology, a new segmental sign, MOTHER, is added to the structure. In the structure in (9), the subject has moved to Spec,TP. Obviously, however, at this point, this movement operation has not taken place. Phonology will therefore integrate the sign MOTHER into the structure. Again omitting details of linearisation, the resulting structure is MOTHER $\{$FLOWER BUY$\}_{\varphi}$.

Since *v* is a phase head, current minimalist theories suggest that the complement, i.e., the VP, is transferred to the interfaces. As we will see shortly, it cannot be the case that Φ(VP) is no longer available for phonology, hence it cannot be that transfer really constitutes a complete transferal of all phonological material to the SM interface. At best, we can think of the phase complement as something that syntax has finished with.

[11] I generally assume that linearisation is achieved through linearisation parameters (cf. Kremers, 2009, 2013b), but nothing I say in this paper is dependent on it. The proposed model would be by and large compatible with an antisymmetric approach (Kayne, 1994).

[12] As per the assumption made by Pfau.

After the merger of the subject, Neg is merged in syntax and Φ(Neg) is added to the phonological structure. The relevant question at this point is what form exactly Φ(Neg) has. The negation is phonologically realised as a headshake,[13] which is aligned with a p-phrase. We may represent the lexical entry for the negation as follows:

(10) ¬ ↔ Neg ↔ *hs*
                    |
                    φ

Up until the point where the *v*P is completed, only Linear Correspondence is relevant. When FLOWER and BUY are merged, Linear Correspondence applies vacuously, but when MOTHER is added to the structure, it is responsible for the fact that the resulting structure could never be FLOWER MOTHER BUY. The only two options are those where MOTHER appears either before or after FLOWER BUY. A linearisation principle independent from Linear Correspondence is responsible for selecting the order MOTHER FLOWER BUY.

When Neg is merged, this changes. Φ(Neg) is not a segmental element; rather, it is an autosegment. Being a headshake rather than a manual sign, it is realised on an autosegmental phonological tier (Goldsmith, 1976). Additionally, it has a phonological requirement: the headshake must be associated with a phonological phrase. For these reasons, Linear Correspondence does not apply.

Note that given the autosegmenal nature of Φ(Neg), it makes sense that Linear Correspondence does not apply. Because Φ(Neg) is not segmental, it cannot be linearised with respect to the segmental (manual) signs in the structure. Rather, being autosegmental, it must be realised simultaneously with (some of) the segmental material. In a technical sense, then, it is not linearly external to its sister node: although Neg is structurally external to the VP, the phonological structure is neither Φ(Neg)–Φ(VP) nor Φ(VP)–Φ(Neg), the only two structures permissible under Linear Correspondence.

Although Linear Correspondence does not apply to Neg, Input Correspondence does. Φ(Neg) must therefore be associated with the head of the structure it selects. Neg selects a verbal projection in (9), which means that Input Correspondence requires Φ(Neg) to combine with Φ(V).[14] Phonologically, what happens is that there are two autosegmental tiers, the segmental tier and the head tier, which are associated with each other through Left-to-Right Association.

At this point it becomes clear that it cannot be the case that the VP is completely inaccessible. In order for Left-to-Right Association to be able to associate the headshake with the verb, it needs to be able to access Φ(VP). Furthermore, it is clear

[13] I do not discuss the realisation as a manual sign NOT. Pfau (2008) argues that DGS features split negation and that the manual NOT sign is located in Spec,Neg (the headshake itself being associated with Neg°). NEG is lexically specified for a headshake. I follow this analysis of NEG.

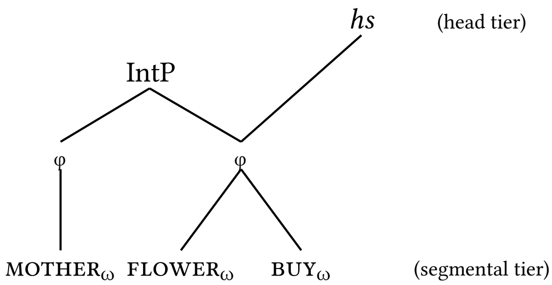
[14] In the implementation here, Neg actually combines with a projection of *v*. There are various ways to ensure that Φ(Neg) combines with Φ(V); I simply assume that since Φ(*v*) is null, Φ(Neg) cannot combine with it, so it combines with the head that *v* selects.

that the links between syntax and phonology must still be present, because Left-to-Right Association must be able to single out Φ(V). If the links between VP and Φ(VP) had been lost, this would not be possible.

Note that Left-to-Right Association is a phonological principle and we probably do not want to dilute it with an ability to look at the syntactic structure. Therefore, we must say that Input Correspondence has the effect of restricting the application of Left-to-Right Association to a part of the phonological structure. That is, Left-to-Right Association associates two phonological tiers and Input Correspondence determines which parts of those tiers are to be considered.

In the current example, Input Correspondence limits application of Left-to-Right Association to Φ(V). Phonology will therefore associate the headshake with BUY. Note, however, that Φ(Neg) is additionally specified for association with a p-phrase, so that even though the headshake is associated with BUY, it spreads to the p-phrase that BUY is contained in. The resulting structure is the following:

(11)

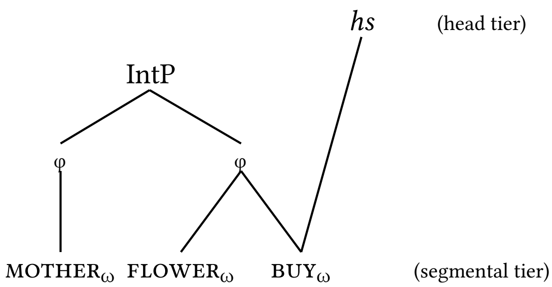


In order to account for the fact that the headshake in DGS can also be restricted to just the verb, we need to assume that there is an alternative lexical entry for the negation:

(12) ¬ ↔ Neg ↔ *hs*
|
ω

In this lexical entry, the headshake is associated with a prosodic word rather than a phonological phrase. When this entry is selected, Left-to-Right Association associates the headshake with BUY, just as before, but now because of the lexical specification, the headshake does not spread over the entire p-phrase. Instead, it remains on the verb and does not extend beyond it:

(13)



This concludes the main part of this section, the analysis of the DGS negation, but there is still one matter to discuss before we move on. In the structure in (9), the subject MOTHER moves from Spec,*v* to Spec,T. In a grammar model in which the phonological structure is built in parallel with the syntactic structure, the phonological aspect of movement needs to be clarified.

When the syntactic module remerges an element X, phonology must recombine Φ(X) with the structure. The simplest assumption is that Φ(X) is taken out of the structure and reinserted in the new location. This of course entails that the phonological structure is not immutable: it cannot be the case that once phonology has combined two elements, they are fixed in that position. As long as the links to the syntactic structure remain, a syntactic operation may result in a rearrangement of the phonological structure.

Obviously, this treatment of movement raises various questions. The copy theory of movement states that a remerge does not involve deletion of the lower copy, but in the analysis sketched here, the phonological part of the lower copy *is* deleted. Perhaps, however, there is something to be said for the assumption that deletion takes place at a later stage, after the phonological structure is complete. This is not entirely impossible, because the structure that phonology builds in parallel with the syntactic structure is not the final structure of the utterance. Postlexical phonological operations take place after the syntactic structure is complete. It could be that trace deletion is part of this component of phonology.

Other relevant questions are for example to what extent rearrangement of the phonological structure is possible. It is conceivable that there are certain restrictions on this process, which may in turn have the effect that certain syntactic movement operations are not possible or are only possible if an additional repair operation is applied.[15] Whether there are restrictions on this rearrangement and whether it has any effect on syntax will have to be determined in future research.

3.2. *Wh*-movement

Richards (2010) argues that *wh*-words are senstive to a specific phonological criterion. They need to share a phonological domain with a (possibly null) *wh*-complementiser:

> "Every language tries to create a prosodic structure for *wh*-questions in which the *wh*-phrase and the corresponding complementiser are separated by as few prosodic boundaries as possible. How languages achieve this varies from language to language, depending on where the complementiser is and on what the basic rules for prosody are" (p. 145).

In the facts that Richards describes, two variables play a role: the position of complementisers (clause-initial vs. clause-final) and the alignment of syntactic and

[15] For example, in Kremers (2013b), I suggest that movement can only apply if the target position is compatible with the type of prosodic constituent that the moved element constitutes. Thus movement of an XP to a head position or vice versa would be ruled out, because the XP constitutes a p-phrase and the head a p-word.

minor phrases (right or left edge).[16] *Wh*-elements, being (noun) phrases, induce a minor phrase boundary either on their left or their right edge, depending on the minor phrasing algorithm of the language (cf. Selkirk, 1984, 1995). Richards discusses four cases, corresponding to four languages: Japanese, Basque, Tagalog and Chicheŵa.

Richards notes that languages generally seem to create a minor phrase encompassing the *wh*-word and the complementiser. This minor phrase can be created by deleting existing minor phrase boundaries. The algorithm for creating the larger minor phrase consists of two steps:

(14) **Prosodic *wh*-domain construction algorithm**

a. For one end of the larger Minor Phrase, use a Minor Phrase boundary that was introduced by a *wh*-phrase.

b. For the other end of the larger Minor Phrase, use any existing Minor Phrase boundary.

In the examples below, the minor phrase boundary introduced by the *wh*-word is marked with an asterisk. This is the boundary that the prosodic *wh*-domain construction algorithm takes as its starting point.

Japanese: Final C, left alignment Japanese has final complementisers and puts a p-phrase boundary at the left edge of XPs. Schematically, this can be represented as in (15a-b):

<table>
<tr><td>(15)</td><td>a.</td><td>[$_{DP}$]</td><td>[$_{whP}$]</td><td>[$_{DP}$]</td><td>V C</td><td></td></tr>
<tr><td></td><td>b.</td><td>|</td><td>|*</td><td>|</td><td></td><td>|</td></tr>
<tr><td></td><td>c.</td><td>|</td><td>|*</td><td></td><td></td><td>|</td></tr>
</table>

The DPs and the *wh*-word introduce minor phrase boundaries to their left. I have indicated the minor phrase boundaries with vertical bars. Those vertical bars that are aligned with square brackets delimiting syntactic phrases are introduced by the prosodic phrasing algorithm that aligns a minor phrase boundary to either the left or right edge of a syntactic phrase. At the beginning and end of an utterance, additional boundaries may be introduced, for obvious reasons. These boundaries are off-set somewhat from the syntactic structure to indicate that they are not directly related to it.

The initial prosodic structure is given in the (b) example of (15). In order to include the *wh*-word and the complementiser in a single minor phrase, the algorithm in (14) can use the boundary introduced by the *wh*-word (indicated with an asterisk) and the boundary after C. The boundary between the *wh*-word and the following DP is deleted, as shown in the (c) example. Since no movement takes place, Japanese is a *wh-in-situ* language.

[16] Richards uses the term *minor phrase* which, for present purposes, can be considered equivalent to *p-phrase*. I use Richards' term when discussing his data, but will otherwise continue to use the term *p-phrase*.

Basque: Final C, right alignment Basque puts a minor phrase boundary at the right edge of XPs. The algorithm in (14) therefore cannot create a larger minor phrase containing the *wh* word and the complementiser. If the intervening minor phrase boundary is deleted, as indicated in (16c), the resulting larger minor phrase still does not encompass both elements, since the *wh* word is, so to speak, on the "wrong" side of the minor phrase boundary it introduces:

(16) a. $[_{DP}$] $[_{whP}$] $[_{DP}$] V C
b. | | *| | |
c. | | *| |

Basque does not have the option of moving the *wh*-word to the right.[17] The language therefore does the next best thing: it tries to minimise the number of minor phrase boundaries between the two elements by fronting material between the *wh*-word and the (clause-final) verb. The verb itself is never fronted, possibly because it does not introduce a minor phrase boundary so that fronting it would not reduce the number of boundaries in any case.

Tagalog: Initial C, left alignment Tagalog is the mirror-image of Basque, as far as the two relevant parameters are concerned. As a result, just like in Basque, the algorithm in (14) could only create a prosodic domain in the wrong direction:

(17) a. C $[_{DP}$] $[_{whP}$] $[_{DP}$]
b. | | |* | |
c. | | |* |

Unlike Basque, however, Tagalog does have the option of *wh*-movement. Therefore, in order to improve the prosodic structure of the clause, the *wh*-word is fronted, creating the following structure:

(18) a. $[_{whP}$] C $[_{DP}$] ~~$[_{whP}$]~~ $[_{DP}$]
b. |* | | |

After *wh*-movement, the prosodic boundary introduced by the *wh*-word is to the left of the complementiser, so that the algorithm in (14) can create a minor phrase encompasing the *wh*-word and the complementiser.

Chicheŵa: Initial C, right alignment Chicheŵa is the mirror image of Japanese, as far as the two parameters go. This, too, is a language that can simply extend the minor phrase of the *wh*-word to the complementiser, as demonstrated in (19):

[17] This is an option that seems to be generally ruled out in spoken languages. In sign languages, however, things appear to be different. Cecchetto, Geraci, and Zucchi (2009) convincingly show that *wh*-phrases *can* move to the right in Italian Sign Langage (LIS). The gist of Richards' analysis holds in LIS too, however.

(19) a. C $[_{\text{DP}}\ ]$ $[_{\text{whP}}\ ]$ $[_{\text{DP}}\ ]$
b. | | *| |
c. | *| |

Chichewâ is therefore a *wh-in-situ* language: there is no need for *wh*-movement, as it does not improve the prosodic structure of the clause.

In section 3.1.1, Richards notes himself that these facts are problematic for standard views on the architecture of grammar and the interplay of syntax and phonology. He mentions a few possible directions a potential solution might take, leaving a definitive solution to future research.

As pointed out by Richards, one possible solution, treating *wh*-movement as a PF phenomenon, can be eliminated at the outset. There is overwhelming evidence (e.g., inversion in English) that *wh*-movement is syntactic. In section 3.2.5, Richards makes another important point: a language like Japanese could in principle have rightward *wh*-movement, because this, too, would minimise the number of minor phrase boundaries between *wh*-word and complementiser. The fact that such languages do not occur shows that the *syntactic* operation of *wh*-movement only takes place if it improves the *prosodic* structure.[18]

The only feasible account, therefore, seems to be one in which phonology can trigger syntactic operations. Richards does not offer such an account himself. He merely states that languages strive to minimise the number of minor phrase boundaries between the *wh*-word and the complementiser. This, however, is a global condition on representations and therefore hard to implement in a derivational framework. The analysis I present here derives the effects observed by Richards from the interplay of a number of factors: a lexical condition on interrogative C heads, the mapping principle Input Correspondence, and a repair strategy triggered by the phonological system that is employed blindly and that does not always lead to the desired result. These factors are all local, in the sense that they are inevitable steps in the derivation, not aimed at improving the final representation of the structure but only the structure created up to that point.

The first step in the analysis is to determine where exactly the prosodic requirement on *wh*-words and complementisers originates. Smith (2011), who assesses Richards' claims on the basis of the Fukuoka dialect of Japanese (which differs from the Tokyo dialect that Richards takes his data from), concludes that "[...] this phrasing requirement originates with the complementiser, not with the wh element".

The crucial data in Smith's analysis are multiple *wh*-questions an nested *wh*-questions. In multiple *wh*-questions, two *wh*-words appear that are both associated with the same complementiser. Smith's data show that in such cases, only the *wh*-word that is closest to the complementiser (which in Japanese is the second one, since it is a C-final language) is joined into a minor phrase with the complementiser. This shows that a *wh*-words itself does not have this requirement, since although one of the two *wh*-words is not phrased together with C, the structure is grammatical:

[18] As mentioned, Italian Sign Language does have rightward *wh*-movement. The theory predicts that LIS is like Basque and creates minor phrase boundaries to the right of XPs. Otherwise, LIS should behave like Japanese and not allow *wh*-movement at all. See below for some discussion.

(20) { wh_1 ... } { wh_2 ... C }

Nested *wh*-questions lead to essentially the same conclusion. In nested *wh*-questions, two *wh*-words appear, each with their own associated interrogative complementiser. The embedded *wh*-structure (i.e., *wh*-word and complementiser) is linearly contained in the matrix *wh*-structure, along the lines in (21):

(21) { wh_1 ... [wh_2 ... C_2] ... C_1 }

The data show that it structures of this type, the entire matrix *wh*-structure is contained in a single minor phrase. There is no phrase boundary around the embedded *wh*-structure. While this fact alone is not sufficient to conclude that the relevant phrasing requirement originates with the C head, this conclusion does follow when one considers this data in light of the data concerning multiple *wh*-questions.

Smith presents her analysis in terms of Optimality Theory, but the gist of her argument holds independently of this framework. The argument rests on the observation that the requirement that a *wh*-word and its corresponding complementiser are phrased in a single p-phrase can be cancelled by a linearly intervening *wh*-word, but only if the second *wh*-word is associated with the *same* C head, as in (20) but unlike in (21).

If one were to describe the observed data in terms of OT and assume that the requirement originates with the *wh*-word, one would need a constraint requiring that *wh*-questions be phrased together with their associated complementiser. Additionally, one would independently need a constraint that requires a minor phrase boundary at the left edge of a *wh*-word. Crucially, the former constraint would have to be ranked below the latter. This follows from the multiple *wh*-data: both *wh*-words are associated with the same complementiser, but only one is phrased with it. Therefore, the requirement that wh_2 above in (20) above introduces a p-phrase boundary to its left is stronger than the requirement that wh_1 is incorporated into a p-phrase with C.

The problem is that with this relative ranking of the two (hypothetical) constraints, we would expect, contrary to fact, that a minor phrase boundary is placed to the left of the embedded *wh*-word in the embedded *wh*-word example in (21). The reason is again that according to our assumptions the constraint requiring a p-phrase boundary to the left of wh_2 is stronger than the constraint requiring wh_1 to be phrased together with its complementiser.

Since in actual fact there is no boundary preceding the embedded *wh*-word in (21), we can conclude that it is the complementiser that requires phrasing with an associated *wh*-word. On this assumption, the facts follow easily: in the multiple *wh*-question example in (20), the C head requires that it be phrased with an associated *wh*-word. This requirement is met when it is phrase with one of its associated *wh*-words. In the embedded *wh*-word example, however, the matrix C_1 must be phrased with wh_1, which is only possible if the entire embedded clause is also included in the relevant p-phrase. As a result, there are no p-phrase boundaries, not even around the embedded clause.

This actually makes sense from a derivational point of view. When the *wh*-word is merged, the complementiser is not part of the structure yet, therefore there is no way for phonology to rearrange the prosodic structure. The relevant element is simply not there yet. Only when the complementiser is merged, is there enough structure available to make the required rearrangement. It therefore makes sense that it is the C head that carries this prosodic requirement.

3.2.1. Japanese and Chichewâ

Let us consider the structure of the Japanese *wh*-question in some more detail. Take the following example:

(22) Naoya-ga **nani-o** nomiya-de nonda no?
Naoya-NOM what-ACC bar-LOC drank Q
'What did Naoya drink at the bar?'
(Richards, 2010)

The details of Japanese clause structure do not need to concern us here. Up to the point where the TP is completed, the following phonological structure is created:

(23) Naoya-ga **nani-o** nomiya-de nonda
| |* |

When C° is merged in the next step, a constraint is activated that requires Φ(C) to be phrased prosodically with Φ(*wh*). This constraint seems rather complex, as it involves phonological and syntactic information. However, if the syntactic relation between $C_{[+wh]}$ and the *wh*-word is actually a selectional relation, the constraint can be accounted for as an effect of Input Correspondence.

The idea that a C head with a [+*wh*] feature selects a TP that contains a *wh*-word seems plausible enough. Note that I specifically refer to a C head with a *wh*-feature, not to a C head with just an interrogative feature. Although the C head that heads polar questions is essentially the same as the C head that heads constituent questions (in Japanese, for example, both are overtly realised as *ka* or *no*), it must nonetheless be the case that they are differentiated in some way, because only the latter requires prosodic phrasing with an associated *wh*-word.

I therefore assume that the interrogative C head comes in two varieties: one that selects a "normal" TP and turns it into a polar question and one that selects a TP with a *wh*-word, creating a constituent question. In order for $C_{[+wh]}$ to be able to select such a TP, the *wh*-word must project its *wh*-feature up the tree. Since the *wh*-word is obviously not the regular head of the projection, it must be the case that in a merge operation, features from both elements can project, not just features of one of them. We may still maintain the idea that the categorial features come from only one of the two elements, so that in a stricter sense the newly created structure is a projection of that element. But the other element may also contribute features to the newly created structure (cf. Citko, 2008, for a similar proposal).[19]

Assuming that the *wh*-feature is projected up the tree in this manner, C° can select for it. We then have a constellation in which Input Correspondence may become relevant. Let us assume that Φ(C) has something like the following form:

(24) $\begin{bmatrix} \text{C} \\ \textit{WH} \end{bmatrix} \leftrightarrow \begin{matrix} \textit{no} \\ | \\ \varphi \end{matrix}$

To a large extent, this phonological form looks a lot like the phonological form of the DGS negation in (10). There is an important difference, however. In the DGS negation, the element associated with a p-phrase is a headshake, which is an autosegmental element. In the Japanese question marker in (24), the element associated with a p-phrase, *no*, is segmental. That is, when the element in (24) is merged into the structure, the phonological system is given the instruction to associate *no* with a p-phrase.

Note that I assume that p-phrase construction is directional and must start at a p-phrase boundary. That is, the p-phrase construction algorithm does not specify start and end points of a p-phrase, it specifies the starting point and the direction. The p-phrase ends when the next p-phrase boundary or any boundary of a higher category in the prosodic hierarchy is encountered.[20]

So what happens exactly when (24) is merged? Syntactically, C selects TP, both for its category and for the *wh*-feature that was projected up from the *wh*-word. In phonology, *no* is added to the linear string and must be associated with a p-phrase. However, Φ(C) does not introduce a p-phrase boundary itself, so it cannot initiate p-phrase construction. Instead, it must find its p-phrase somewhere else.

Up to this point, Φ(C) is not much different from Φ(Neg) in DGS illustrated in (10). Unlike Φ(Neg), however, Φ(C) has a segmental element and therefore must be linearised as part of the segmental string. In the case of Japanese, it is linearised at the right edge of the string. While Φ(Neg) could be realised on an autosegmental tier and be associated with Φ(V) that way, this is not possible for Φ(C). The only way to fulfill Φ(C)'s prosodic requirement is to find a p-phrase boundary and create a p-phrase from there that includes Φ(C) at the end of the phonological string.

Because Φ(C) has a prosodic requirement that it cannot satisfy itself, Input Correspondence becomes relevant. Specifically, Input Correspondence requires that Φ(C) satisfy its prosodic requirment through association with the head of the element it selects in syntax. $C_{[+wh]}$ selects TP, but Φ(T) is not able to satisfy Φ(C)'s

[19] Upward projection of the *wh*-feature is sometimes thought to be responsible for pied-piping. Obviously, we need a different account of this, because pied-piping of an entire clause is impossible. Pied-piping may be constrained by phase-boundaries or by the maximal extended projection of a lexical category (Grimshaw, 2000).

[20] In fact, as we will see below, p-phrases can in some circumstances also be created "by default". In some situations, there is no p-phrase boundary to trigger p-phrase construction but a p-phrase must nonetheless be constructed. In such cases, the left or right edge of the utterance can function as the start of p-phrase construction.

prosodic requirement, because T is a functional head and therefore cannot introduce a p-phrase boundary (cf. Selkirk, 1996 : "[…] function words (and functional projections) [are invisible] to constraints governing the interface of prosodic structure and morphosyntactic structure", p. 209).

The other feature that $C_{[+wh]}$ selects is the *wh*-feature on TP that was projected up from the *wh*-word in the structure. In this sense, TP is a projection both of the T head and of the *wh*-word. Therefore, Φ(*wh*) is another possible candidate for Φ(C) to satisfy its requirement. As discussed above, the *wh*-word provides a p-phrase boundary and it is this boundary that Φ(C) attempts to construct a p-phrase with.

Consider again the phonological structure that is created up to the point before C is merged:

(25)	Naoya-ga	**nani-o**	nomiya-de	nonda
	|	|*	|	

The segmental part of Φ(C), *no*, is added to the right edge of the structure and additionally, a p-phrase is constructed. This p-phrase is constructed rightward and starts with the p-phrase that Φ(*wh*) introduces. From this boundary, it is possible to constructe a p-phrase that includes *no*, so that Φ(C)'s prosodic requirement is met.

Note that Input Correspondence dictates that for the p-phrase construction that Φ(C) triggers, the phonological system considers only Φ(C) itself and Φ(*wh*). This entails that all intervening material is, so to speak, caught in the middle. Any existing p-phrase boundaries are necessarily deleted, simply because during p-phrase creation for Φ(C), the phonological system does not consider them and after it has constructed the p-phrase, it is too late to salvage them.

In Chichewa̭, the situation is essentially the same as in Japanese, the only difference being the direction of p-phrase alignment and *wh* p-phrase construction. Like Japanese, Chichewa̭ can construct a larger p-phrase encompassing the *wh*-word and the interrogative C head. It does so by starting from the right of the *wh*-word and taking as the final boundary of the p-phrase the boundary introduced at the beginning of the string, preceding (clause-initial) Φ(C). As a result, Chichewa̭ has *wh-in-situ*.

3.2.2. Tagalog

Let us now consider what happens in a language that has *wh*-movement, such as Tagalog. The example clause that Richards (2010) provides is (26):

(26)	Kailan	umuwi	si	Juan?
	when	went.home	the	Juan
	'When did Juan go home?'			

Tagalog is a verb-initial language with a complicated agreement system the details of which do not concern us here. Let us assume that the verb-initial position is derived through verb movement, although nothing in the current analysis really hinges on this. What is relevant to us is that when verb movement has taken place, the *wh*-word, here *kailan* 'when', is still in its base position, inducing a minor phrase boundary to its left:[21]

(27) umuwi si Juan **kailan**
| |* |

In the next step, $C_{[+wh]}$ is merged. Unlike the Japanese interrogative C head, $\Phi(C_{[+wh]})$ in Tagalog does not have segmental material. It does have the requirement that it be associated with a minor phrase (or p-phrase):

(28) $C_{[+wh]} \leftrightarrow \varphi$

As in Japanese, Φ(C) must satisfy this prosodic requirement and Input Correspondence requires that Φ(C) be combined with Φ(*wh*). Unlike Japanese, Tagalog has clause-initial complementisers, which means that the C head is linearised to the left. It may be somewhat surprising that an element without segmental material must be linearised at all, but this is a common assumption in theories on linearisation. Presumably, the linearisation requirement follows from a need to make the element visible phonologically: since Φ(C) in Tagalog consists of *just* a p-phrase,[22] the only way to make it visible is to create a p-phrase that is not already in the structure. Linearising Φ(C) as part of the segmental string is a straightforward way of doing this.

At this point, however, the prosodic requirement of Φ(C) cannot be met. Input Correspondence requires that Φ(C) is associated with Φ(*wh*), i.e., with *kailan*. However, because *kailan* induces a p-phrase boundary to its left it can only construct a p-phrase toward its right. This means that it is impossible to combine Φ(C) and *kailan* into a single p-phrase.

Note that it would be pointless to delete the boundary introduced by *kailan*. Doing so would leave phonology without any p-phrase boundary at all, because due to Input Correspondence it can only consider Φ(C) and Φ(*wh*). If the p-phrase boundary induced by the *wh*-word would be deleted, there would be no prosodic boundary at all and phonology would still not be able to construct a p-phrase.

The result is that phonology is unable to create a p-phrase and cannot satisfy the requirement that Φ(C) carries. In the parallel model sketched here, this does not necessarily lead to a crash, however. In the current case, phonology can try and repair the structure by bringing the two elements closer together. It can do this by triggering a remerge of the *wh*-word with $C_{[+wh]}$. This syntactic operation,

[21] Note that although XPs introduce a minor phrase boundary to their left, the verb is nonetheless phrased with the XP to its right. Richards (2010, sec. 3.3.3) goes to some length to show that this is actually the correct generalisation on prosodic phrasing in Tagalog.

[22] I am ignoring the intonational pattern associated with questions here. I assume for the moment that it is an independent feature not directly associated with the C head, because not all questions have the same intonational pattern. More research is needed to determine the best way to analyse these patterns, however.

triggered by phonology, in turn has an effect in phonology: it triggers a dislocation of Φ(*wh*) to the front of the string.

The structure that emerges is schematically represented in (18), repeated here:

(18) a. [$_{whP}$] C [$_{DP}$] ~~[$_{whP}$]~~ [$_{DP}$]
b. |* | | |

Input Correspondence still requires that C's p-phrase is constructed with Φ(*wh*). After *wh*-movement, however, it becomes possible to constructe a p-phrase that starts at the boundary introduced by Φ(*wh*) and that includes Φ(C).

Note that I explicitly assume that phonology operates blindly here. It attempts to bring the *wh*-word closer to Φ(C) by triggering a syntactic movement, but it has no way of knowing what the effect of that momevent will be. In Tagalog, the effect is positive, but as we will see in the next section, this is not the case in Basque.

3.2.3. Basque

In Basque, things are somewhat different. Initially, it runs into the same problem that Tagalog runs into: the phonological system tries to construct a p-phrase from the right edge of the *wh*-word that includes Φ(C). This is not possible because Φ(C) is at the right edge of the string and p-phrase construction is leftward. As in Tagalog, the phonological system will then try to repair the structure by bringing Φ(*wh*) and Φ(C) closer together. For some reason, it is not possible to move the *wh*-word rightward, to a position where it could construct a p-phrase that includes the complementiser.[23] Instead, Basque does the next best thing: it triggers syntactic movement of all material intervening between Φ(*wh*) and the clause-final verb.[24]

Richards argues that Basque does this in order to minimise the number of p-phrase boundaries between the *wh*-element and the complementiser. In the current analysis, the motivation is different. Minimising the number of p-phrase boundaries between *wh* and C would require foreknowledge of the effect of the movement operations that phonology triggers. Instead, phonology simply tries to bring the two elements that must be associated together by triggering movement. Basically, phonology just identifies the material intervening between Φ(*wh*) and Φ(C) and has syntax move it. It cannot anticipate the result of that movement.

In Tagalog, movement is successful, but in Basque, it is not. Even after all intervening material (except the verb) has been moved out of the way, phonology is still not able to construct a p-phrase that includes both the *wh*-word and Φ(C), because Φ(*wh*) induces a prosodic boundary to its right:

[23] Richards (2010, sec. 3.3.2) suggests that this may be the case because the post-C position in Basque is always associated with radical pitch compression (Elordieta, 1997), which is presumably incompatible with the prosodic requirements on *wh*-phrases.

[24] The verb itself is never moved, which I assume is due to the fact that once C has been merged, the verb is frozen in place: a verb cannot move beyond the C head that closes off the verb's extended projection.

(29) a. [DP] [DP] [whP] ~~[DP]~~ V C
b. | | | *| |

At this point, there is nothing phonology can do to improve the structure further, so that it must give up. A default p-phrase can be constructed starting from the right edge of the string that encompasses Φ(C), but there is no association with Φ(*wh*). In other words, the failure of Basque to enclose the *wh*-word and the complementiser in the same p-phrase is a violation of Input Correspondence.

To recap, what happens in Basque is the following: C is merged and requires a p-phrase. Input Correspondence then specifies that in order to satisfy this prosodic requirement, Φ(C) must be associated with the head of the projection that C selects, i.e., with Φ(*wh*). The first attempt to do so fails, because Φ(*wh*) has a p-phrase boundary on its right. This triggers a repair operation in syntax, which consists of moving everything out of the way that intervenes between the *wh*-word and the complementiser.

After movement has taken place, another attempt is made to satisfy Φ(C)'s prosodic requirement. Again, it is not possible to do so under Input Correspondence, but this time, there is nothing that can be done to bring Φ(*wh*) and Φ(C) closer. At this point, all that can be done is to give up Input Correspondence and create a p-phrase for Φ(C) with whatever is available, which is just the verb.

The current analysis has the advantage that it does not require look-ahead from syntax to phonology in order to determine whether *wh*-movement needs to take place, and there is no look-ahead in phonology to see whether a proposed movement operation will be successful. At every step of the derivation, the system tries to optimise the existing structure without knowing what lies ahead. The movement operations in Basque do not allow the system to create a prosodic domain encompassing both the *wh*-word and the complementiser and could therefore have been skipped. Yet, the system performs it, because at the moment where it is performed, it is the optimal choice.

In other words, unlike Richards' assumption, it is not the case that the grammar tries to minimise the number of p-phrase boundaries between the *wh*-word and the complementiser. Descriptively, that may be what we observe as the result, but it is not what the system is trying to achieve. It is an epiphenomenon, the result of a combination of factors that play a role in the derivation.

Similarly, Richards' observation that interrogative complementisers must form a prosodic domain with an associated *wh*-word is not a principle of grammar. The grammar merely specifies that an interrogative C head must create a p-phrase. It then follows from an independent principle of grammar, namely Input Correspondence, that this p-phrase must include an associated *wh*-word.

3.2.4. Italian Sign Language

To conclude this section on *wh*-phrases, let us take a quick look at Italian Sign Language (*Lingua dei Segni Italiana*, LIS). Cecchetto et al. (2009) argue that *wh*-phrases in LIS move to Spec,CP, which is linearised to the right. That is, *wh*-elements move to the end of the clause. While this is rare to non-existent in spoken languages, Cecchetto et al. argue that because of the different modality, rightward movement of *wh*-elements is possible in sign languages.

The basic data are as follows: LIS is an SOV language, as shown by the simple transitive clause in (30):

(30) Gianni Maria love
'Gianni loves Maria.'

A *wh*-phrase is normally moved to the clause-final position (Cecchetto et al. (2009) provide additional data showing that the *wh*-phrases follows adverbs, negation or the clause-final completion marker done):

(31) a. *wh* (over WHAT)
Gianni *t* buy what
'What did Gianni buy?'

b. *wh* (over WHO)
t house buy who
'Who bought a house?'

If the *wh*-phrase consists of a *wh*-word plus a restrictor (e.g., *which book*), there are two options. Either the whole phrase moves to the clause-final position, or just the *wh*-word does, leaving the restrictor *in situ*:

(32) a. *wh* (over [BOOK WHICH])
Paolo *t* steal [book which]
'Which book did Paolo steal?'

b. *wh* (over WHICH)
[boy *t*] book steal which
'Which boy stole the book?'

According to Cecchetto et al., there is no real difference between the two options, although they note a slight preference for the structure in (32a).

The moved *wh*-elements in (31) and (32) are accompanied by so-called non-manual *wh*-markings. Non-manual markings are facial expressions, head or body positions and other elements not involving the hands that add meaning to the utterance. The headshake expressing negation in the previous section is a typical example, but non-manual markings are also employed to mark topics, relative clauses, and even some adverbials (cf. Sandler & Lillo-Martin, 2006; Vermeerbergen et al., 2007; Kremers, 2012a). In the examples given here, the non-manual *wh*-marking consists of furrowed brows.[25]

[25] Cross-linguistically, furrowed brows often function as *wh*-markers in sign languages. Usually, they contrast with the marking for yes/no-questions, which consists of raised brows.

Such non-manual markings are not restricted to single manual signs. Depending on the type of marking and the construction of the clause, they may spread over more than one manual sign, as in (32a), for example. Initially, it was thought that the spreading domain in such cases is defined syntactically, but Sandler (2011) shows that when syntactic and prosodic structure do not match, non-manual *wh*-marking (and other similar markings) aligns with the prosodic domain, not with the syntactic one.

In other words, the non-manual *wh*-markings in (32) indicate prosodic domains. As mentioned earlier, the prosodic structure of sign languages is still a largely unexplored topic, but given the spoken-language data presented by Richards (2010), we may tentatively assume that the domain with which the *wh*-marking aligns here is a p-phrase. Since LIS has rightward *wh*-movement, we need to assume that it has a clause-final C and that it creates p-phrase boundaries to the right of XPs. That is, it must have the same parameter settings as Basque.

Note that neiter claim can be confirmed with independent data at the moment. Cecchetto et al. (2009) mention that LIS does not have overt subordinators (such elements are generally rare in sign languages), so it is not possible to determine the linearisation of the C head (although given the SOV-structure of LIS, it is not implausible that C is clause-final). They also do not discuss the prosodic structure of LIS in any detail, presumably because the necessary research has not been done yet.

Even though LIS presumably has the same settings as Basque, there is one aspect in which the two languages differ. Contrary to Basque, LIS does have the option of moving the *wh*-phrase rightward in order to improve the prosodic structure of the clause. Cecchetto et al. argue that this is a consequence of the fact that subextraction is rare in LIS: LIS does not use multiply embedded structures (preferring the use of multiclausal structures instead) and subordinate clauses always appear peripheral, rather than center-embedded, as might be expected in an SOV language.

In other words, movement in LIS is generally clause-bound. Interestingly, Ackema and Neeleman (2002) and Abels and Neeleman (2009) argue that rightward movement is necessarily clause-bound for parsing reasons. When parsing an utterance in which movement has taken place, the parser must be able to infer the base position of movement. With rightward movement, this is more difficult than with leftward movement, because in the former, the gap appears before the moved element. If, as is standardly assumed in the parsing literature, the parser closes off certain units as soon as possible and if it only starts looking for a gap when it has identified a moved element, it follows that rightward movement is necessarily clause-bound, whereas leftward movement can jump over clause boundaries.

If this conclusion is correct, a language in which movement is generally clause-bound can (and in the case of LIS does) have rightward movement, while a language such as Basque, which does have subextraction and multiple embedding, cannot.[26] Regardless of the underlying reason that is responsible for this difference between

[26] Obviously, this argumentation assumes that the reason why LIS does not have subextraction and multiple embedding lies elsewhere and that the rightward movement option follows from that. In principle, of course, it is also possible that the causality is reversed: it could be that LIS has rightward movement for some independent reason and that as a result of that, movement is clause-bound.

LIS and Basque, however, the basic LIS data are in line with Richards' observation and with the analysis presented here.

Two questions regarding LIS remain open. First, Cecchetto et al. (2009) explain that when *wh*-movement takes place, the non-manual *wh*-marking may spread toward the base position of the moved *wh*-phrase. So instead of (32a), one may also have (33):

(33) $\overline{\text{\textit{wh}}\qquad\qquad\qquad\qquad\qquad}$

Paolo steal [book which]
'Which book did Paolo steal?'

This seems problematic for Richards' generalisation and the analysis presented here, because if the non-manual *wh*-marker spreads to the base position, there is apparently a prosodic domain that extends from Φ(C) to the gap. However, if it is possible to create such a domain, it should not be necessary to move the *wh*-phrase in the first place.

It is possible, however, that the relevant spreading domain is only created when the phonological system deletes the lower copy of the *wh*-word and inserts the higher copy. As such, the domain is dependent on *wh*-movement and cannot be created as an alternative to it. More research on the prosodic structure of sign languages in general and LIS in particular is needed before these conjectures can be confirmed or denied, however.

The second open question regarding LIS is in fact more general. Cecchetto et al. note that there is a third option for expressing *wh*-questions, which, however, only occurs with discourse-linked *wh*-phrases. In such cases, it is also possible to leave the entire *wh*-phrase *in situ*:

(34) $\overline{\text{\textit{wh}}\qquad\qquad\qquad\qquad\qquad}$

Gianni [book which] steal
'Which book did Gianni steal?'

This structure is obviously reminiscent of the structure of echo questions in English and many other languages that have (leftward) *wh*-movement. As Richards (2010, sec. 3.5.4) notes, echo questions generally exhibit a destressed and flattened intonation contour from the left edge of the utterance up until the *wh*-word, which indicates that there are no p-phrase boundaries in this part of the utterance. This, Richards suggests, may be the result of the fact that all material in echo questions in given information (as it is simply repeated from the clause that the echo question echoes) and that the normal prosodic phrasing algorithms are usually suspended for elements that are given. As a result, the C head's prosodic requirement can be met without movement of the *wh*-word.

This suggestion should work in the current model as well if (as I have implicitly assumed) the prosodic structure is built as part of the phonological structure, i.e., in parallel with syntax. When C is merged, there is no prosodic boundary inhibiting the creation of a prosodic domain encompassing Φ(C) and Φ(*wh*). One requirement for this is that the *wh*-phrase itself does not introduce a p-phrase boundary. Although, as Richards notes, far too litte is known about the prosody of echo questions, this does appear to be the case. In the example that Richards provides, given here in (35), there does not seem to be a p-phrase boundary before the *wh*-word or the phrase it is contained in:

(35) a. John bought a motorcycle.
b. John bought a **WHAT**?

In this example, it is possible to pronounce the «t» of *bought* as an alveolar flap /ɾ/, something that is only possible if the /t/ and the following vowel are part of the same foot (Gussenhoven, 1986). There can therefore be no p-phrase boundary before [a WHAT].[27]

The LIS example in (34), although not strictly an echo question, may be similar: Cecchetto et al. (2009) state that *wh-in-situ* in LIS occurs with D-linked contexts, "[…] namely contexts in which the WH-question asks about a set of entities that are contextually salient" (p. 285). This could mean that the *wh*-phrase counts as given information and does not induce a p-phrase boundary to its right. If so, it would mean that when C is merged, a p-phrase can be formed that incorporates Φ(C) and Φ(*wh*).

Obviously, before any of this can be stated with some certainty, further research into the prosodic structure of echo questions and D-linked questions, and into the prosodic structure of LIS and sign languages in general is needed.

3.2.5. *Wh*-questions: summary and remaining issues

This section started out with an observation made by Richards (2010) that cross-linguistically, *wh*-words share a prosodic domain with a (possibly covert) interrogative C head. Languages that can create such a domain with the *wh*-word *in situ* do not have *wh*-movement. Languages that cannot create a prosodic domain with the *wh*-word *in situ* will try to create it by moving material in the clause. This can be the *wh*-phrase itself, as in Tagalog, or it can be material intervening between the *wh*-word and the complementiser, as in Basque.

Because of the Basque facts, which fail to create a prosodic domain encompassing the *wh*-word and the complementiser, Richards formulates the generalisation as an attempt to minimise the number of minor phrase boundaries between the *wh*-word and the complementiser. Such a formulation is problematic because it would require global computation to implement it in a derivational model. Furthermore, Richards remarks, the data show that there must be some form of look-ahead from syntax to phonology, because *wh*-movement (either of the Tagalog or of the Basque kind) only occurs when it improves the prosodic structure. Such look-ahead is highly controversial in standard generative models.

[27] This of course does not exclude the possibility that there is a p-phrase boundary between *a* and *WHAT*, although this seems unlikely, given the fact that [a WHAT] constitutes a DP. Note, by the way, that echo questions allow *wh*-words in positions in which they normally cannot occur, as demonstrated here.

The analysis presented here assumes a parallel grammar architecture. The syntactic and phonological structures are built in parallel and can influence each other. This allows phonology to trigger a syntactic repair operation in order to satisfy some phonological requirement. Interrogative C heads have such a requirement: they need to be associated with a p-phrase in phonology. Because this is a requirement that Φ(C) cannot satisfy on its own, as it does not introduce a p-phrase boundary, it needs to be associated with another element in the structure. Input Correspondence, one of the basic principles governing the mapping from syntax to phonology, requires that Φ(C) be associated with the head of the structure it selects in syntax. Since $C_{[+wh]}$ selects a projection with a [+*wh*] feature, Φ(C) can be associated with Φ(*wh*).

Φ(*wh*) introduces a p-phrase boundary which can be used to create a p-phrase that encompasses Φ(C). However, this only succeeds when the boundary triggers p-phrase construction in the direction of the complementiser. If p-phrase construction is to the left but C is on the right or vice versa, p-phrase construction fails and Φ(C)'s prosodic requirement cannot be met. In this case, the parallel nature of the grammar allows phonology to trigger syntactic movement operations to bring the *wh*-word and the complementiser closer together.

It is important to note that the phonological system can only trigger movement operations, it cannot foresee their results. In Tagalog, it triggers movement of the *wh*-word, which causes it to be dislocated in the phonological string to a position where it can be linked to the complementiser in a single p-phrase. In Basque, phonology triggers movement operations of all material between the *wh*-word and the complementiser. This movement fails to achieve the desired result, but it is triggered nonetheless.

The analysis does leave open a few questions. First, it is assumed that even if Φ(C) has no segmental form, as is the case in Tagalog, for example, it must nonetheless be linearised as part of the segmental string. Ultimately, it may be some visibility requirement that forces this, as suggested above, but in the derivation, the reason should be more local than that.

Another question that the analysis does not answer is how phonology "knows" that in Tagalog, it must trigger movement of the *wh*-phrase, while in Basque it must trigger movement of the material intervening between the *wh*-phrase and the complementiser. Since phonology cannot know what the effect of a movement operation will be before the movement takes place, it cannot know that in Basque, movement of the *wh*-phrase is not possible.

One option might be that the relevant steps, movement of the *wh*-phrase in Tagalog and of the intervering material in Basque, are simply fixed in the languages' I-grammars, in much the same way that it is fixed that Tagalog is a head-initial language and Basque a head-final language. This raises the question how this is specified in the grammar, but it would avoid the complication of having to decide which step to apply in the derivation.

These questions will obviously have to wait for future research. The main point here is that a parallel grammar architecture has the potential to describe syntax-phonology interactions in a manner that does not make use of global constraints.

Instead, each step of the derivation has consequences for the phonological structure and phonologically illicit structures may trigger repair operations in syntax. Because there is no look-ahead, such operations may or may not yield the desired result, but once they have taken place, they cannot be undone.

3.3. Heavy-NP shift

Heavy-NP shift (HNPS) in English has long been recognised as a phenomenon that involves a phonological constraint. As Zec and Inkelas (1990) argue, an NP can be shifted rightward when it consists of at least two p-phrases:

(36) a. *Mark showed to John (some letters)$_{\varphi}$.
b. Mark showed to John (some letters)$_{\varphi}$ (from Paris)$_{\varphi}$.
c. Mark showed to John (some letters)$_{\varphi}$ (from his beloved city)$_{\varphi}$.

Another fact that points to a phonological constraint rather than a syntactic one is the following pair of sentences:

(37) a. Who did you give the books written by the venerable Prof. Plum to?
b. *Who did you give to the books written by the venerable Prof. Plum?

When *wh*-movement has taken place under stranding of the preposition, it is not possible to shift the heavy object NP *the books written by the venerable Prof. Plum* rightward. Syntactically, this does not seem to make much sense, because the element extracted from (*to who*) is not affected by HNPS. However, we can make sense of this datum if we look at it from a phonological point of view. In (37a), the preposition *to* cliticises onto the proper name *Plum*. In other words, *to* does not constitute a p-phrase of its own, it is part of the p-phrase corresponding to the noun phrase preceding it. As such, we do not expect HNPS to be possible here: there is simply nothing to move the object NP to the right of.[28]

What is important to note is that HNPS does not simply target the right-peripheral position of the clause. Ross (1967) already noted that heavy-NP shift is clause-bound (his so-called *Right-Roof Constraint*):

(38) *John said [that he was going to fix *t*] [to anyone who would listen] [the stove that he found at the dump].

However, it is not even necessarily the case that HNPS targets the edge of the clause that the NP is a constituent of. Culicover and Jackendoff (2005, p. 348) provide the following example:

[28] The crucial test case here would be an example in which the stranded part of a moved constituent still constitutes a p-phrase of its own. However, because constituents larger than prepositions rarely get stranded, it is virtually impossible to construct proper examples that are not ruled out for other reasons.

(39) Richard rolled *t* into the room [the cart with all of the presents on it] using his nose.

Here, the dislocated constituent is placed before the adjunct clause *using his nose*. For Culicover and Jackendoff this is an indication that HNPS is a linearisation effect within the VP.[29] The fact that HNPS licenses parasitic gaps seems to be problematic for such an analysis:

(40) I met *t* on the street, without recognising *e* immediately, [my rich uncle from Detroit].
(Wallenberg, 2010)

Parasitic gaps are generally thought to be licensed by a movement operation elsewhere in the clause. The binding relation created by this movement is co-opted by the parasitic gap. Furthermore, Staub, Clifton, and Frazier (2006) show that in parsing HNPS constructions "[...] evidence of processing difficulty appeared on the material that intervened between the verb and its object when the verb was obligatorily transitive, and on the shifted direct object when the verb was optionally transitive, regardless of transitivity bias" (p. 1). This suggests that the parser needs to do extra work in order to postulate or identify a gap. If HNPS were simply an alternative linearisation, it should not be necessary to posit a gap and we might expect parsing to be unproblematic.

Here, I will assume the simplest possible analysis of HNPS, which is an analysis in terms of rightward movement.[30] There are two possible target sites for HNPS: adjunction to TP and adjunction to VP.[31] For this reason, and for another reason that will become clear shortly, I assume that HNPS-driven movement takes place at the phase level. In phonology, this movement yields a linearisation to the right.[32]

Let us see what happens during the derivation of a straightforward HNPS construction:

(41) Mark showed to John (some letters)$_{\varphi}$ (from his beloved city)$_{\varphi}$.

I assume that the DP *some letters from his beloved city* is constructed in a separate derivation and is merged as an atomic element. The first step in the derivation is the merger of the verb and the indirect object. In phonology, the following structure is created (the vertical bars indicate p-phrase boundaries):

[29] Culicover and Jackendoff develop a syntax model that does not employ movement, but I assume that their proposal means that there is no gap in the canonical direct object position.

[30] Wallenberg (2010), although apparently prefering an antisymmetry analysis for theoretical reasons, nonetheless argues that the rightward movement analysis is the only one that accounts for all the data. The antisymmetric analyses that he discusses all fail to account for some aspects of the data.

[31] Wallenberg (2010) shows that both options are used in English. In fact, Wallenberg argues that the lower option involves adjunction to *v*P, but does not provide arguments in favor of this adjunction site and against VP. Because both TP and VP are phase-complements, I assume that adjunction to VP is more likely.

[32] Although obviously not an antisymmetric analysis, the linearisation part is to a large extent independent from the parallel grammar architecture. The current proposal should be compatible with an antisymmetric analysis.

(42) showed | to John

The PP *to John*, being a maximal lexical projection, introduces a p-phrase boundary to its left. In the next step, the DP *some letters from his beloved city* is merged, which is linearised to the left. The resulting phonological structure is (43):

(43) | some letters | from his beloved city | showed | to John

At the point of merger, the phonological system detects that the element being merged consists of two p-phrases. Based on this fact, the phonological system can then ask syntax to move the phrase. Presumably, the trigger here is not as strong as the trigger in the case of *wh*-movement, because the phonological constraint being violated is not as strong as the lexical constraint that needs to be fulfilled for $C_{[+wh]}$.

Because of the relative weakness of the trigger, syntax may decide not to move the phrase, or to postpone movement. To make this possible, we need to assume that the trigger that phonology places on the constituent remains active during the derivation. In this way, movement may take place at the *v*P-level or at the TP-level, or possibly not at all. Since HNPS, at least descriptively, is not as hard a rule of grammar as *wh*-movement and is influenced by other factors than just phonological weight (e.g., focus, cf. Wallenberg, 2010), the optionality that this weakness provides is desirable.

A slightly different picture emerges when we consider HNPS across an adjunct:

(44) I told John yesterday [everything he needs to know about the software to get started].

Here, the object *everything he needs to know about the software to get started* is moved across the adjunct *yesterday*. On the assumption that *yesterday* is also adjoined to VP, the adjunct is not part of the structure yet when the direct object and the verb are merged. That is, a purely local analysis, such as the one I am attempting to formulate here, seems to run into trouble.

We may nonetheless assume that when the object is merged, a weak movement trigger is put on it, for the sole reason that it consists of more than a single p-phrase. This trigger is not strong enough to actually trigger movement, but because the trigger remains active during the derivation, a situation may arise that strengthens it. When *yesterday* is merged, for example, phonology detects that it is placing a constituent of only one p-phrase after a constituent consisting of multiple p-phrases. This will then strengthen the existing movement trigger on the object.

Given that the adjunction sites for HNPS are TP and VP, it makes sense to assume that movement triggers are evaluated at the phase level. If the trigger is honored, syntax remerges the noun phrase as an adjunct in such a way that phonology linearises the relevant element to the right.[33] Alternatively, syntax may put the noun phrase in the phase edge, in order to later adjoin it to the TP.

[33] We may not even need a special linearisation feature or parameter to ensure that the relevant constituent is linearised to the right. Being a heavy NP, it could be that phonology automatically merges it to the right.

The exact factors that determine whether or not to honor the movement trigger that phonology places on the heavy NP and whether to adjoin to VP or to TP do not concern us here. The main point is that phonology, upon merger of the heavy NP, can put a movement trigger (or perhaps *recommendation*, as the trigger does not have to be followed up on) on the noun phrase and as such can influence syntax.

I assume that it is at the point of first merge of a noun phrase that the decision whether or not to put a movement trigger on it is made, not later. This assumption comes at some cost, since the movement does not happen immediately, it happens later, if at all. The derivation therefore needs to keep this movement trigger active until the phase head is merged and the trigger can be evaluated.[34]

The reason for this assumption is that it keeps the derivation local. The alternative would be to let the phonological system evaluate each phase after it has been completed to determine whether it contains constituents that must be reordered. Such a procedure would seem to be much more complex, however, than the mechanism proposed here, primarily because it does not suffice to examine just the phonological structure to see whether HNPS should be applied. Not every sequence of two p-phrases must be displaced when followed by a single p-phrase; only those that appear postverbally and that constitute a single syntactic constituent are eligible for HNPS.

Evaluation of the movement trigger should be a simple process: it merely evaluates the strength of the trigger. If it is found to be higher than some threshold value, the movement in executed, otherwise it is not. Other factors contributing to HNPS would then simply strengthen the movement trigger on a noun phrase, so that it is more likely to pass the threshold value.

One thing that is probably clear from the discussion is that the analysis is more compatible with a framework that assumes linearisation parameters. In an antisymmetric analysis, deriving HNPS requires moving other elements over the heavy NP.[35] HNPS thus requires a conglomerate of movements that all need to be triggered in concert by the phonological system. A non-antisymmetric analysis seems more parsimonious in this respect.

4. Conclusions

The purpose of this paper is to argue for the need to adopt a parallel grammar model, in which syntactic and phonological structure is built up in parallel, rather than the latter being built on the output of the former. Two kinds of motivations have been discussed for such an approach. The first kind involves conceptual motivations. Because the C-I and SM systems are extra-linguistic systems, they do not generate linguistic structure. Rather, the interfaces to these systems *interpret* linguistic structure, specifically, they interpret the semantic and phonological representations built up by the linguistic system.

[34] This may perhaps be implemented as a feature on the noun phrase, although that would of course raise Full Interpretation issues.

[35] See Wallenberg (2010) for an overview of possible antisymmetric analyses of HNPS.

It follows that the output of the linguistic system is a linguistic sign, a structure composed of three sets of features: semantic, syntactic, and phonological. At the same time, it is feasible to represent the building blocks of the derivation as linguistic signs as well. As such, it makes sense to assume that the derivation deals with such structural objects, not just morphosyntactic features. It also makes sense to assume that all three sets of features become available to the linguistic system as soon as an element is merged. It is therefore unlikely that the grammar should postpone putting the phonological features together until the syntactic component has produced some output. It makes more sense to assume that the phonological (and likewise the semantic) features are assembled simultaneously with the syntactic structure.

The second kind of motivation lies in the ability of such a model to better account for interactions between syntax and phonology where the phonological structure influences syntax. Sequential models, in which the phonological structure is derived from the output of the syntactic structure, can only account for such data through what Büring (2012) calls a *Try-and-Filter Approach*. In such an approach, syntax produces various output options and phonology then filters out the ones that violate prosodic constraints.

What seems undesirable in such an approach is the need for syntax to provide several different structures simultaneously. Furthermore, it would seem that such an approach has difficulty expressing the intuition that there are marked and unmarked structures. Looking at heavy-NP shift, for example, it is obvious that a structure such as SVAdvO is marked in English: it is used only in special circumstances, namely when the object is phonologically heavier than the adverbial. But if syntax generates both structures, how would phonology "know" it must prefer the structure SVOAdv if object and adverbial are of equal phonological weight?

The difficulty of HNPS for a sequential model is that the criteria for movement are phonological in nature, which means that syntax cannot determine whether or not to move an element. At the same time, phonology alone cannot determine where to move a heavy constituent to, as the target for movement is a syntactically defined position. Moreover, it is not clear whether phonology alone could even determine which elements it needs to move. It is not the case that every sequence of two p-phrases constitutes a heavy constituent; only sequences of two (or more) p-phrases that constitute a *single syntactic* constituent is a heavy constituent.

In other words, HNPS is a phenomenon that can only be accounted for by taking both syntactic and phonological structure into account. Consequently, we need a parallel model to describe it properly. The same is true for the other phenomenon discussed in this paper, that of *wh*-movement. Richards (2010) has identified what seems to be a universal prosodic property of *wh*-question formation: a *wh*-complementiser must be phrased together with an associated *wh*-word into a single minor phrase (p-phrase). This is all the more interesting because Büring (2012) makes a clear distinction between "syntactic" types of movement such as *wh*-movement and movement types that are motivated by prosodic structure, such an HNPS. Richards' data suggest that the distinction is not as clear as Büring may assume.

If Richards' data are correct, then *wh*-movement is also driven by prosody. Just as with HNPS, however, this does not mean that we can relegate *wh*-movement to the phonological component altogether. There are syntactic properties to *wh*-movement as well, so here too we need a model that can provide feed-back from phonology to syntax and have syntactic operations act on prosodic cues.

The parallel model described in this paper is a first attempt to provide the necessary bidirectional links between syntax and phonology in a derivational model. The main derivational component of the model is still the syntactic module. A merge operation in the syntactic module immediately entails a phonological merge operation of the phonological features associated with the two syntactic elements being merged.

The phonological merger is subject to phonological rules and principles, but also to principles governing the mapping from syntax to phonology. Most relevant to the current paper is Input Correspondence (Ackema & Neeleman, 2004): a phonological element that carries a prosodic requirement (e.g., association with a prosodic category) must combine phonologically with the head of the structure it selects in syntax. It is this principle that establishes the phonological association of the $C_{[+wh]}$ head with a *wh*-element: the $C_{[+wh]}$ head has the lexical requirement that it must be associated with a p-phrase. Input Correspondence then dictates that this p-phrase must be established with an associated *wh*-word.

Depending on the direction of p-phrase construction, this association either succeeds, in which case *wh in situ* entails, or fails, in which case the phonological system will trigger a syntactic movement operation that should bring the *wh*-element closer to the complementiser in the linear string, which in turn should simplify the creation of a p-phrase encompassing both elements. The phonological system triggers this movement blindly, however. It has no way of knowing if it will indeed yield the desired result. In Basque, it does not, so that in this language, the complementiser and the *wh*-word are not in a single p-phrase. Since at this point, there is nothing else the phonological system can do to rescue the situation, the system must accept a violation of Input Correspondence.

In the case of HNPS, the phonological system puts a movement trigger on a noun phrase that is larger than a single p-phrase. If at some point in the derivation this constituent is followed in the linear string by another constituent that is phonologically lighter, its movement trigger is strengthened. At the phase-level, syntax evaluates the movement trigger and if it is found to exceed a certain value, the noun phrase is moved to an adjunction position, where phonology can then linearise it to the right.

Obviously, the analysis raises a number of important questions that the current paper cannot address for reasons of space. It is not exactly clear, for example, how the phonological system can assess structures and apply constraints to them. It is also not clear what determines whether a phonological constraint violation can be repaired through syntax or whether it needs to be repaired in phonology and similarly, what kinds of syntactic operations phonology can trigger. All of these questions and presumably others will have to be cleared in future research.

In spite of these open questions, however, a parallel model has obvious advantages over a sequential model in accounting for certain phonology-syntax interactions. Although core syntax is quite definitely phonology-free, there are phenomena that can only be accounted for by taking both syntactic and phonological properties into account. The current paper shows that such a model is certainly feasible and can be implemented as a system that performs local computations, without the need for global comparison and filtering of structures.

References

Abels, K. & Neeleman, A. (2009). Universal 20 without the LCA. In J. M. Brucart, A. Gavarro, & J. Sola (Eds.), *Merging features: computation, interpretation, and acquisition* (Chap. 4, pp. 60–79). Oxford: Oxford University Press. Retrieved from http://ling.auf.net/lingBuzz/000279

Abney, S. (1987). *The English noun phrase in its sentential aspect* (PhD Thesis, Cambridge, MA: The MIT Press). MIT Working Papers in Linguistics.

Ackema, P. & Neeleman, A. (2002). Effects of short-term storage in processing rightward movement. In S. Nooteboom, F. Weerman, & F. Wijnen (Eds.), *Storage and computation in the language faculty* (pp. 219–256). Dordrecht: Kluwer.

Ackema, P. & Neeleman, A. (2004). *Beyond morphology: interface conditions on word formation*. Oxford: Oxford University Press.

Büring, D. (2012). Syntax, information structure and prosody. In M. den Dikken (Ed.), *The Cambridge handbook of generative syntax*. Cambridge: Cambridge University Press.

Cecchetto, C., Geraci, C., & Zucchi, S. (2009). Another way to mark syntactic dependencies: the case for right-peripheral specifiers in sign languages. *Language*, *85*(2), 278–320.

Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, MA: The MIT Press.

Chomsky, N. (1995). *The minimalist program*. Cambridge, MA: The MIT Press.

Chomsky, N. (1999). *Derivation by phase*. MIT Occasional Papers in Linguistics 18.

Citko, B. (2008). Missing labels: head movement as *Project Both*. In C. B. Chang & H. J. Haynie (Eds.), *Proceedings of the 26th west coast conference on formal linguistics* (pp. 121–128). Somerville, MA: Cascadilla Proceedings Project. Retrieved from http://www.lingref.com/cpp/wccfl/26/abstract1663.html

Culicover, P. & Jackendoff, R. (2005). *Simpler syntax*. Oxford: Oxford University Press.

Elordieta, G. (1997). Accent, tone, and intonation in Lekeitio Basque. In F. Martinez-Gil & A. Morales-Front (Eds.), *Issues in the phonology and morphology of the major iberian languages* (pp. 3–78). Washington, DC: Georgetown University Press.

Fodor, J. A. (1983). *Modularity of mind*. Cambridge, MA: The MIT Press.

Freidin, R. (2003). Shaky foundations – review of Ray Jackendoff's *Foundations of Language: Brain, Meaning, Grammar, Evolution*. *Glot International*, *7*(7/8), 218–221.

Goldsmith, J. (1976). *Autosegmental phonology* (PhD Thesis, Cambridge, MA: The MIT Press).

Grimshaw, J. (2000). Extended projection. In P. Coopmans, M. Everaert, & J. Grimshaw (Eds.), *Lexical specification and insertion* (pp. 115–134). The Hague: Holland Academic Graphics.

Gussenhoven, C. (1986). English plosive allophones and ambisyllabicity. *Gramma*, *10*, 119–141.

Halle, M. & Marantz, A. (1993). Distributed morphology. In K. Hale & S. J. Keyser (Eds.), *The view from Building 20: essays in linguistics in honor of Sylvain Bromberger* (Chap. 3, Vol. 24, pp. 111–176). Current Studies in Linguistics. Cambridge, MA: The MIT Press.

Inkelas, S. & Zec, D. (Eds.). (1990). *The phonology-syntax connection*. Chicago: University of Chicago Press.

Jackendoff, R. (2002). *Foundations of language: brain, meaning, grammar, evolution*. Oxford: Oxford University Press.

Kayne, R. S. (1994). *The antisymmetry of syntax*. Cambridge, MA: The MIT Press.

Kremers, J. (2009). Recursive linearization. *The Linguistic Review*, *26*(1), 135–166.

Kremers, J. (2012a). Arabic verbal nouns as phonological head movement. In G. Iordăchioaia (Ed.), *Proceedings of jenom 4* (Vol. 9, pp. 73–96). Working Papers of the SFB 732 *Incremental Specification in Context*. Stuttgart University. Retrieved from http://elib.uni-stuttgart.de/opus/volltexte/2012/7639/

Kremers, J. (2012b). The syntax of simultaneity. *Lingua*, *122*(9), 979–1003. doi:10.1016/j.lingua.2012.03.008

Kremers, J. (2013a). Linearization as repair. In P. Brandt & E. Fuß (Eds.), *Repairs: the added value of being wrong* (pp. 207–236). Berlin: Mouton de Gruyter.

Kremers, J. (2013b). *Morphology — like syntax — is in the eye of the beholder*. ms. University of Göttingen.

Kremers, J. (2014). The selection of marked exponents in a parallel grammar. *Lingue e linguaggio*.

Marantz, A. (1997). No escape from syntax: don't try morphological analysis in the privacy of your own lexicon. In A. Dimitriadis (Ed.), *Proceedings of the 21st annual Penn Linguistics Colloquium* (pp. 201–225). UPenn Working Papers in Linguistics 4.2. Retrieved from http://ling.upenn.edu/papers/v4.2-contents.html

Nespor, M. & Vogel, I. (1986). *Prosodic phonology*. Dordrecht: Foris.

Partee, B., ter Meulen, A., & Wall, R. (1993). *Mathematical methods in linguistics*. Dordrecht: Kluwer.

Pfau, R. (2001). Typologische und Strukturelle Aspekte der Negation in Deutscher Gebärdensprache. In H. Leuninger & K. Wempe (Eds.), *Gebärdensprachlinguistik 2000: Theorie und Anwendung* (Vol. 37, pp. 13–31). Internationale Arbeiten zur Gebärdensprache und Kommunikation Gehörloser. Vorträge vom Symposium "Gebärdensprachforschung im deutschsprachigen Raum", Frankfurt a.M., 11.–13. Juni 1999. Hamburg: Signum.

Pfau, R. (2002). Applying morphosyntactic and phonological readjustment rules in natural language negation. In R. Meier, K. Cormier, & D. Quinto-Pozos (Eds.), *Modality and structure in signed and spoken languages* (Chap. 11, pp. 263–295). Cambridge: Cambridge University Press.

Pfau, R. (2008). The grammar of headshake: a typological perspective on German Sign Language negation. *Linguistics in Amsterdam*, *1*, 34–71.
Pfau, R. & Quer, J. (2002). V-to-Neg raising and negative concord in three sign languages. *Rivista di Grammatica Generativa*, *27*, 73–86.
Pfau, R. & Quer, J. (2007). On the syntax of negation and modals in Catalan Sign Language and German Sign Language. In P. M. Perniss, R. Pfau, & M. Steinbach (Eds.), *Visible variation. comparative studies on sign language structure* (pp. 129–161). Trends in Linguistics. Mouton de Gruyter.
Richards, N. (2010). *Uttering trees*. Cambridge, MA: The MIT Press.
Ross, J. R. (1967). *Constraints on variables in syntax* (PhD Thesis, Cambridge, MA: The MIT Press).
Sadock, J. M. (1992). *Autolexical syntax*. Chicago: University of Chicago Press.
Sandler, W. (2011). Prosody and syntax in sign languages. *Transactions of the Philological Society*, *108*(3), 298–328.
Sandler, W. & Lillo-Martin, D. (2006). *Sign language and linguistic universals*. Cambridge: Cambridge University Press.
Selkirk, E. (1984). *Phonology and syntax: the relation between sound and structure* (PhD Thesis, Cambridge, MA: The MIT Press).
Selkirk, E. (1995). Sentence prosody: intonation, stress and phrasing. In J. Goldsmith (Ed.), *The handbook of phonological theory* (pp. 550–569). Cambridge, MA: Blackwell.
Selkirk, E. (1996). The prosodic structure of function words. In J. L. Morgan & K. Demuth (Eds.), *Signal to syntax: bootstrapping from speech to grammar in early acquisition* (pp. 187–214). Mahwah, NJ: Lawrence Erlbaum Associates.
Smith, J. L. (2011). [+wh] complementizers drive phonological phrasing in Fukuoka Japanese. *Natural Language and Linguistic Theory*, *29*(2), 545–559. doi:10.1007/s11049-011-9123-7
Staub, A., Clifton, C., Jr., & Frazier, L. (2006). Heavy NP shift is the parser's last resort: evidence from eye movements. *Journal of Memory and Language*, *54*(3), 389–406. doi:10.1016/j.jml.2005.12.002
Truckenbrodt, H. (2007). The syntax-phonology interface. In P. De Lacy (Ed.), *The Cambridge handbook of phonology* (pp. 435–456). Cambridge: Cambridge University Press.
Vermeerbergen, M., Leeson, L., & Crasborn, O. (Eds.). (2007). *Simultaneity in signed languages: form and function*. Amsterdam/Philadelphia: John Benjamins.
Wallenberg, J. C. (2010). *Antisymmetry and heavy NP shift across Germanic*. ms. University of Iceland.
Zec, D. & Inkelas, S. (1990). Prosodically constrained syntax. In S. Inkelas & D. Zec (Eds.), *The phonology-syntax connection* (pp. 365–378). Chicago: University of Chicago Press.
Zeshan, U. (Ed.). (2006). *Interrogative and negative constructions in sign languages*. Nijmegen: Ishara Press.