

The Syntax of Simultaneity*

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Although language utterances primarily consist of *sequences* of phonemes, morphemes and words, language is not limited to linearity. There are many linguistic phenomena that show a certain degree of *simultaneity*: cases in which two (or more) meaningful elements are realized at the same time. Typical cases include intonation contours to mark e.g. focus, topic, questions, etc. While it may be argued that such examples are marginal from the perspective of syntax and can therefore be safely ignored, the same cannot be said for sign languages. Sign languages make extensive use of simultaneity, using it even for negation and adverbial modification, phenomena that are generally considered to be syntactic. Trying to analyze simultaneous constructions syntactically, we run into the problem that under standard assumptions, all terminal elements in a syntactic tree have a unique position in the linear string (*Exclusivity & Nontangling Conditions*, Partee et al. 1993). The sign language examples obviously violate these conditions. In order to account for these data, we need to extend ideas behind *prosodic morphology* to syntax: not only morphemes but also syntactic elements can map onto prosodic forms in phonology. Standard principles of the syntax/phonology interface and of the phonological module then apply to construct the simultaneous expression.

Keywords: Syntax/phonology interface; simultaneity; sign language; prosodic morphology

1 Simultaneity

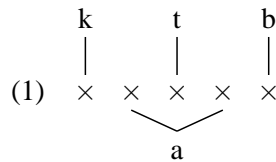
Language is linear. A linguistic utterance consists of a temporally ordered sequence of meaningful units (“words”), which in turn consist of a temporally ordered sequence of non-meaningful units (phonemes).

Although this statement is not false, it is not entirely true either. Language is indeed linear, but it would be wrong to say that meaningful elements are all sequentially ordered. Many languages

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use intonation contours to mark things such as focus, topic, questions, etc. While the actual intonation contour is generally not considered to be a syntactic element, it cannot be denied that it is meaningful in some sense.

Similarly, prosodic morphology shows non-linear aspects. Take the well-known Arabic example of *kataba* ‘he wrote’ (cf. McCarthy, 1981, 1986):



The two morphemes «ktb» (verb root) and «a» (perfective) are not sequentially ordered with respect to each other. Obviously, the phonemes are sequentially ordered, but the phonemes are not the meaning-bearing units.

It may be argued that such examples are marginal from the perspective of syntax and can therefore be safely ignored, because they may tell us something about the morphology module of language but not about the syntax module.¹ There are natural languages, however, for which this claim certainly cannot be made.

Bellugi & Fischer (1972) show that while individual (manual) signs in American Sign Language (ASL) generally take longer to produce than words in spoken English,² ASL utterances are generally about as long as spoken English utterances. One way in which sign languages achieve this result is through what is often called *simultaneity*: the simultaneous realization of two or more meaningful elements.

The following example from German Sign Language (DGS) illustrates this:

- (2) **face:** with effort DGS
hands: STUDENT SIGN-LANGUAGE LEARN
 ‘The student learns sign language with difficulty.’
 (Leuninger, 2005)

In this example, the manual sign LEARN is accompanied by a facial expression that expresses the adverbial *with effort, difficulty*. That is, verb and adverb are realized simultaneously.

Note that there are in fact examples of simultaneity in spoken language. For example, Hayes & Lahiri (1991) treat intonational patterns as morphemes, and Akinlabi’s (2011) *featural affixation* can be considered a form of simultaneity as well. Also, certain African languages use tone as a grammatical marker. In Tiv, for example, tone patterns mark tense on verbs (see Goldsmith, 1976, 4.2 and references there) and in Maasai, tone is used to mark case:

¹Unless one assumes that word formation optionally or exclusively takes place in the syntactic module, as argued for by e.g. Halle & Marantz (1993), Ackema (1995), Julien (2002) and others.

²Emmorey (1995) makes a similar claim. Although I am not aware of similar studies on other sign/spoken language pairs, it seems safe to assume that this is a general tendency.

(3) a. *é-dól embártá*
 3-see horse.ACC
 ‘He sees the horse.’

b. *é-dól embartá*
 3-see horse.NOM
 ‘The horse sees him’

(Tucker & Tompo Ole Mpaayei, 1955)

Maasai has four major tone classes in the nominal system, all with subclasses, making about 20 different noun tone classes. The noun *embártá*³ ‘horse’ belongs to a tone class that lowers the high tone on the penultimate vowel in the nominative, as indicated in (3b).

The fact that such constructions exist obviously raises many questions, some of which are being addressed in the literature (see especially Vermeerbergen et al. 2007). Some authors have made proposals for representing non-manual elements syntactically (e.g. Neidle et al., 1998; Wilbur & Patschke, 1999; Cecchetto et al., 2009) but no unified proposal exists that attempts to handle the phenomenon of simultaneity in general. The aim of this paper is to propose such an analysis.

The most pressing question that these examples raise regarding syntax is how standard approaches to linearity in syntax can deal with them. Theoretical approaches to syntax generally assume that a syntactic structure uniquely defines a linear order, which they do either as an integral part of syntactic structure (e.g., Government & Binding) or through a separate principle or module that derives linear order from a syntactic tree (GPSG, HPSG, minimalism).

This requirement is formalized as the *Exclusivity Condition* in Partee et al. (1993) (see section 3 below). Kayne (1994) incorporates the same idea in his *Linear Correspondence Axiom* when he says that linear order is *total*. The example in (2), however, do not seem to obey this principle: no linear order is defined between the adverbial and the verb.

While the adverb in (2) may be argued to be a morphological marker, the same cannot be claimed for the negation in (4):

(4) **head:** *neg*
hands: JOHN BUY HOUSE
 ‘John is not buying a house’
 (Neidle et al., 2000, 44ff)

In this example, the negation is expressed through a head shake accompanying the *entire* VP. As such, it cannot be considered a morphological marking of the verb (‘morphological’ in the sense of ‘relating to word structure’). Instead, we seem to be forced to assume a syntactic analysis (also in the sense of ‘related to phrasal structure’). The point is, as syntacticians, we cannot argue that simultaneity is something that we do not need to be concerned about as it only occurs inside words. That being the case, we need to find a way to deal with these phenomena, because, as mentioned, they seem to contradict standard syntactic views on the relation between syntactic structure and phonological form.

³Note that the accusative is the citation form of the noun in Maasai.

The answer is clearly to be sought in the fact that the adverb and the negation in these examples are realized on autosegmental phonological tiers. For this reason, I propose to extend the ideas behind McCarthy & Prince's (1996) model of prosodic morphology to syntax: syntactic heads have the ability to map onto autosegmental phonological forms, which are integrated with the segmental material.

This integration process is controlled by principles of phonology, syntax plays no direct role in it. Obviously, the constituent structure that is constructed in syntax is relevant for the phonological form that is eventually created (if it were not, there would be no such thing as language), but the role of syntax is indirect, because it is mediated by principles governing the mapping from syntax to phonology.

The view of grammar that I adopt is inspired by Beard's (1988) *Separation Hypothesis*, according to which the morphosyntactic and phonological features of an element should be considered separately, and by Jackendoff's (1997; 2002) parallel grammar architecture (as discussed in section 4.1). A central aspect of this model is that the phonological form onto which a given morphosyntactic structure is mapped is essential for the analysis of linguistic phenomena. Phonological structure plays an active role in the formation of linguistic utterances: the hierarchical constituent structure of the negation example in (4) above does not fully determine the phonological form of the utterance, not even its linear order. The phonological form onto which the Neg^o head is mapped is crucial for this.

In this paper, I discuss several simultaneity phenomena in sign language (section 2), focusing on the question how the two (or possibly more) simultaneously realized elements relate to each other in terms of semantics, syntax and phonology. The phenomena discussed by no means exhaust the range of possible simultaneity effects in sign language, but they represent a good cross section of the relevant phenomena. Then, after briefly discussing the problems that simultaneity poses for the Exclusivity and Nontangling Conditions (Partee et al., 1993), I turn to the model that I propose in section 4, arguing that in order to account for the data discussed, we need to consider the whole process of what I term *phonological composition*, which takes its input from morphosyntax and establishes a phonological structure on the basis of this input, a process that is constrained by certain mapping principles of the syntax-phonology interface and by specific phonological principles. In section 5, I discuss how the two mapping principles Linear and Input Correspondence (Ackema & Neeleman, 2004), which are crucial for the analysis of simultaneity data, interact. Finally, in section 6, I discuss some possible directions for future research.

2 Cases of simultaneity

Let us now turn to the data. I discuss adverbials, negation, interrogative marking and topic marking in turn. Note that it is not the purpose of this paper to present an overview and classification of all types of simultaneity that occur in sign languages. Rather, I limit myself to a number of cases that one would at first sight be inclined to analyze syntactically. Admittedly, the inclination to treat these phenomena syntactically is due to a spoken-language bias and we obviously should not expect sign language to express the relevant phenomena syntactically as well. However, choosing such examples makes it somewhat easier to argue for the analysis that I propose, because we know that the relevant phenomena at least *can* be syntactic (since they are

so in spoken languages).

Note, however, that the analysis that I propose for the sign language phenomena to be discussed is not purely syntactic. Rather, it is a combination of a syntactic and a prosodic analysis. The central point of this paper is that we should strictly separate between morphosyntactic and phonological features but that we cannot achieve a descriptively and explanatorily adequate theory unless we consider *both*. The sign language data discussed in this paper makes this point quite clear.

2.1 Adverbials

I already discussed examples of simultaneous adverbs in the introduction. The example in (2) is repeated here as (5):

- (5) **face:** with effort DGS
hands: STUDENT SIGN-LANGUAGE LEARN
'The student learns sign language with difficulty.'
(Leuninger, 2005)

Non-manual adverbs also occur in other sign languages. The following examples are from ASL:

- (6) a. **face:** /mm/ ASL
hands: HER HUSBAND COOK-[dur] DINNER
'Her husband has been cooking the dinner with pleasure'
- b. **face:** /th/
hands: HER HUSBAND COOK-[dur] DINNER
'Her husband has been cooking the dinner inattentively'
(Corina et al., 1999, 310)

/mm/ and */th/* represent different facial expressions, associated with the respective adverbial meanings indicated in the translations. In fact, Anderson & Reilly (1998) identify eleven different facial adverbials for ASL. Similar examples can be found in other sign languages: Kyle & Woll (1985, 86) discuss a number of facial expressions that contribute adverbial (or in some cases adjectival) meaning in British Sign Language (BSL), Meir & Sandler (2008, 173–176) report non-manual adjectives and adverbs for Israeli Sign Language (ISL) and Johnston & Schembri (2007, 150) discuss facial adverbials in Australian Sign Language (Auslan).

The phenomenon is therefore widespread in sign languages. Importantly, as most authors note, the forms and meanings of these facial expressions are conventionalized, they differ from one sign language to the next, and they contribute to the meaning of the utterance: leaving them out changes the meaning of the phrase. That is, as already argued for by (Liddell, 1980), these facial expressions are not mere gestures, they are linguistic and we therefore expect them to be

represented in the syntactic structure underlying the utterance.⁴

Non-manual adverbs may also be expressed in other ways than through facial expressions, and furthermore, they may be combined:

- (7) **body:** exclusive DGS
face: reluctant
hands: APPROACH-EACH-OTHER.Cl_{uprightG}.slow
'two people approach each other slowly, reluctantly, and with hostility
(Leuninger et al., 2005, 331)

This example contains two or possibly three simultaneous adverbs. The manual sign is a two-handed sign, with both hands consisting of an upright G-handshape (stretched index finger). This handshape functions as a classifier for human beings. The two hands move toward each other, expressing the meaning *approach each other*. Two non-manual adverbials are expressed in (7): the upper body of the signer is leaned backwards, a body posture that expresses exclusivity, which is understood as hostility in the current case (cf. Wilbur & Patschke, 1998, who analyze backward tilt body posture as expressing exclusivity). Furthermore, the signer's facial expression expresses the meaning *reluctant*.

Additionally, the movement of the hands is realized more slowly than usual, which expresses the adverbial *slowly*. Because of the obvious iconic nature of this part of the utterance, it is difficult to tell whether it is merely gestural or whether it is truly morphemic. For the present paper, however, this question is not crucial, as the other examples of adverbial modification are clearly morphemic.

One might perhaps argue that these adverbials are morphological, not syntactic (in fact, Sandler & Lillo-Martin 2006, p. 61–63 suggest as much), especially considering the fact that they are realized simultaneously with the verb, not the entire VP. However, although this may be a possible analysis for the non-manual adverbs demonstrated so far, there are non-manual adverbials that cannot be analyzed morphologically. Happ & Vorköper (2006, 363) give the following examples from DGS:

- (8) a. **f/b:** presumably
h: (POSSIBLE) SVEN WORK:3 GO:Perf:3
'Presumably, Sven has gone to work already.'
- b. **f/b:** possible
h: (POSSIBLE) SVEN WORK:3 GO:Perf:3
'Sven has possibly gone to work already.'

The examples in (8) contain sentential adverbs. Specifically, there are two components to the adverbs: a manual one, POSSIBLE, which is optional, and a non-manual one, a combined

⁴Another interesting cross-linguistic characteristic of these facial adverbials, pointed out by a reviewer, is that they all involve the lower part of the face, in particular the mouth and cheeks. The upper parts of the face tend to mark sentence types and properties such as topic and focus (cf. Wilbur, 2000; Meir & Sandler, 2008, 175).

facial expression and body position.⁵ The two components are independent from each other: the manual component is optional and the two do not need to share the same meaning.⁶

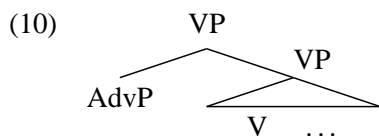
The relevant aspect of these examples is the fact that the non-manual component spreads over the entire clause. As with the VP adverbials above, these non-manual sentential adverbials contribute crucial information to the utterance and their forms are conventionalized. We therefore expect them to be represented syntactically.

Similarly, there are adverbials in ASL that can spread over phrases. In (9), for example, from Sandler & Lillo-Martin (2006, 470), the non-manual adverbial *obviously* spreads over the phrase OBVIOUSLY SMART:

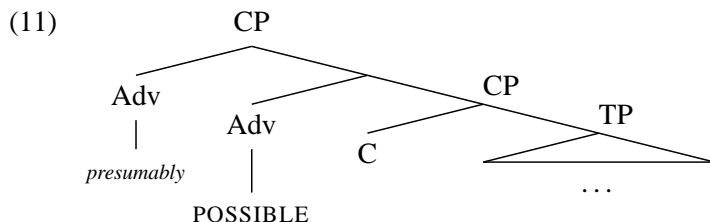
- (9) **face:** whq obv whq
hands: WHO YOU FEEL OBVIOUSLY SMART (WHO IX)
 ‘Who do you think is obviously smart?’

Since morphological analyses are by definition limited to the word/sign, these non-manuals cannot be morphological, as they spread over more than one manual sign.

As regards their syntactic structure, for present purposes it suffices to concentrate on the general constituent structure of the utterances. This means that I will remain agnostic as to the question whether adverbials are adjuncts or specifiers of dedicated functional heads. The VP adverbs in examples such as (7) and (8) can then simply be represented as adjuncts to VP:



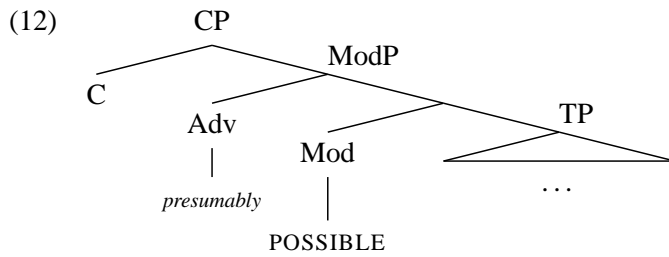
Similarly, sentential adverbs can simply be assumed to be adjoined to the CP. If we separate the manual and non-manual components, we may be dealing with two adjuncts:



Alternatively, we can adopt an analysis along cartographic lines. This provides a different way for dealing with the two components, as it allows us to say that the manual component POSSIBLE is the phonological representation of an adverbial head that has *presumably* in its specifier:

⁵In fact, it is possible that the facial expression and body position contribute independently to the meaning. Such combinatoriality is often assumed for different facial and eye brow configurations (e.g., Wilbur 2000; Dachkovsky & Sandler 2009). Note that even if there is a certain combinatoriality in non-manual components, this system seems to lack the so-called *duality of patterning* of the segmental system, as the independent components all have a specific meaning.

⁶Possibly, the manual component expresses a general modality, which the non-manual component specifies further.



What is relevant here is the fact that the adverbials are part of the syntactic structure in a position c-commanding the element(s) with which they are simultaneously realized. The LCA would therefore predict that they are realized sentence-initially (in the case of sentential adverbs) and preverbally (in the case of VP adverbs) but obviously they are not.

2.2 Negation

Negation in sign language presents us with a similar picture. Different sign languages realize negation in different ways, but most share the ability to realize negation through a simultaneous construction. Here, I will limit myself to negation in DGS.

As Pfau and Pfau & Quer make clear in several papers,⁷ sentential negation in DGS is expressed through the combination of a non-manual and a manual marker, the manual marker being optional:

- (13) **head:** neg DGS
hands: MOTHER FLOWER BUY (NOT)
 ‘Mother does not buy a flower’
 (Pfau & Quer, 2002)

The non-manual marking, here indicated as *neg*, consists of a headshake and is realized together with the verb and the manual negation. If the manual negation is omitted, the headshake accompanies the verb alone. Note that the non-manual negation must always be supported by manual material, it cannot appear on its own.

Pfau & Quer (2002) analyze the DGS data as follows: DGS is a language with split negation, i.e., it has two negative elements that, when realized together, form a single negation, similar to French *ne...pas*. The manual negation NOT is one element, the headshake associated with the verb⁸ is the other. NOT is in Spec,NegP and is lexically associated with a headshake. The headshake is described by Pfau & Quer as a [+neg] feature sitting in the head position Neg°.

Because the [+neg] feature is affixal, the verb moves to Neg° in order to support the headshake phonologically. Note that DGS is an SOV language; Pfau & Quer assume that V and T are head-final, which means that this verb movement is essentially string vacuous.

⁷See Pfau 2001, 2002, 2008 and Pfau & Quer 2002, 2007 for details on negation in DGS, ASL and Catalan Sign Language (LSC); see Pfau 2008 for some discussion of negation in a number of other sign languages; see also Zeshan 2006 for a typological overview of negation in sign languages.

⁸More accurately, with the predicate, as the non-manual negation can also be used to negate copular sentences, which do not contain a verb.

As Pfau (2002, 2008) makes clear, it is also possible for the headshake to spread over the entire VP, even though this is less common:

- (14) **head:** neg DGS
hands: MOTHER FLOWER BUY
 ‘Mother does not buy a flower’
 (Pfau & Quer, 2002)

What is important to note here is that both forms of negation in DGS are sentential, there is no difference in meaning between (13) and (14). Pfau (2008) argues that the spreading of the headshake over the VP is phonological; that is, he analyzes the headshake as an autosegment that may optionally spread over a phonological domain, specifically, the phonological phrase. This analysis seems essentially correct, as indicated by the fact that the headshake may spread even over the subject if this subject is a pronoun and therefore part of the same phonological phrase as the object and the verb:

- (15) **head:** neg DGS
hands: IX:3 FLOWER BUY
 ‘She does not buy a flower’
 (Pfau, 2008)

In this example, the subject of the clause is an indexical, that is, a pronominal element. Unstressed pronouns are cross-linguistically phonologically weak, that is, they usually do not form their own prosodic word and cliticize onto an adjacent prosodic word. Assuming that this is true of the indexical, we predict that spreading of the headshake is possible with indexical subjects. Pfau (2008, 26) argues that this is indeed more common and provides the example in (15) as illustration.

This spreading property of negation in DGS contrasts with negation in certain other sign languages that do not allow the headshake to spread. In Italian Sign Language (LIS), for example, the manual negation is obligatory and is combined with a headshake, but this headshake cannot spread over the verb or the VP (Geraci, 2005). In Pfau’s (2008) analysis, the headshake in DGS is an autosegment, not a manual sign, which entails for him that it is *not* syntactic. The headshake that accompanies the manual negation in LIS is lexically specified and therefore syntactic.⁹

Although I mostly concur with Pfau’s (2008) analysis, I do not adopt this separation between a syntactic (lexical) and a non-syntactic headshake, as it seems to entail that only manual signs are “syntactic” in his terms. I present my alternative analysis in section 4.4; for the moment it suffices to note that negation, which under standard assumptions is represented in syntax by a Neg^o head, can be realized simultaneously with the verb in DGS and other sign languages, violating the Exclusivity Condition.

⁹Note, however, that for Pfau the analysis must be either syntactic or prosodic. With the strict separation between morphosyntactic and phonological features that I assume, however, there is no opposition between a syntactic and a prosodic analysis. Both aspects are relevant.

2.3 Interrogative marking

Another typical phenomenon that is usually expressed non-manually (and hence simultaneously) in sign language is question marking. Interrogatives are normally marked by certain non-manual markers (which can take various forms, depending on the type of interrogative and other factors; see Sandler & Lillo-Martin 2006, 459ff for details and further references). In the case of polar questions, this is usually the only way the utterance is marked as interrogative:

- (16) **face:** Q _____
hands: HE COME
 'Is he coming?'

The interrogative marking extends over the scope of the interrogative but excludes elements that are not in its scope:

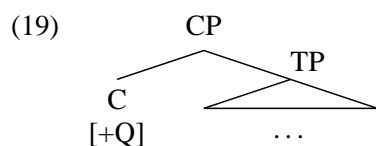
- (17) **eyebrows:** _____ *BSL*
hands: K.I.L.B.Y BEFORE GOOD NOW GOOD
 'Kilby, who was good before, was he good now?'
 (Kyle & Woll, 1985, 156)

As has often been noted, such facial interrogative markers function in much the same way as interrogative intonation in spoken languages:

- (18) a. **int:** Q _____ *English*
segm: Is he coming?
 b. **int:** _____
segm: Kilby, who was so good before, was he good now?

In English, too, question intonation extends over the entire clause in (18a) but only over the second part in (18b). Such intonational patterns are normally considered non-syntactic so that by analogy, a non-syntactic analysis seems preferable for interrogative marking in sign languages as well.

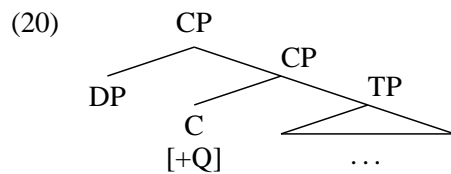
This, however, raises the question in what way interrogative marking is different from negation and facial adverbials. All three phenomena can be expressed non-manually in sign language, so would it not be preferable to have a similar analysis for them? In fact, one thing standing in the way of treating interrogative marking as syntactic is our intuition that syntax deals with the arrangement of words and that words consist of segments, an intuition that is formalized as the Exclusivity Condition. For example, assuming that interrogatives are headed by a [+Q]-marked C head, the basic structure of clauses such as (16) and (18a) is (19):



Given such a tree, the Exclusivity Condition would lead us to expect that if C° is realized phonologically, it is a segmental particle appearing either clause-initially or clause-finally. As I will argue in section 4.2, however, a different view is possible: I assume that the intonational interrogative marking is a reflex of the [+Qh] C° head.¹⁰

In (17) and (18b), the interrogative marking does not extend over the entire utterance, but just over the actual question. The element not marked for [Q] is a left-dislocated topic. In the English example, this topic is taken up by the (resumptive) pronoun *he*. In the BSL example, no pronoun is visible but given that dropped subject and object pronouns are not uncommon in many sign languages (similar to languages such as Chinese), a silent pronoun may be present.

Let us assume that the left-dislocated phrase is adjoined to CP.¹¹ Then the syntactic structure for (17) and (18b) is the following:



Based on this tree, it seems that the interrogative marking extends over the complement of the Q-marked head, i.e., over its c-command domain. In fact, Neidle et al. (2000) make such a claim for negation in ASL. However, as discussed above, Pfau (2008) argues that the relevant spreading domain must be defined phonologically. Similarly, Sandler (2011) argues on the basis of well-know mismatches between syntactic and phonological domains that spreading phenomena of this type are constrained by phonological domains, not by syntactic ones. I adopt this analysis and assume that Q-marking spreads in what is presumably an intonational phrase.¹²

2.4 Topics

Like negation and interrogatives, topics are often marked non-manually in sign language (cf. Sandler & Lillo-Martin 2006, 406–413 and references cited there). The phonological form of topic marking varies depending on the type of topic marking (see Aarons 1994, 156 and Wilbur 1994 for ASL) and (presumably) also varies from one sign language to the next. A typical example from Danish Sign Language is (21):

¹⁰See Neidle et al. (2000), who make this assumption for ASL, and Cheng & Rooryck (2000) who propose that French has a similar “intonation morpheme” that licenses *wh*-in-situ and yes/no questions. Note also that I deliberately keep the analysis simple. There are still many open questions regarding the analysis of interrogatives in sign language, cf. Sandler & Lillo-Martin (2006, 431ff.) for discussion and further references. See also Zeshan (2006) for a typological overview of interrogatives in sign language.

¹¹Nothing really hinges on this assumption, one may also argue that the left-dislocated phrase is in the specifier of some high functional head in the C-domain.

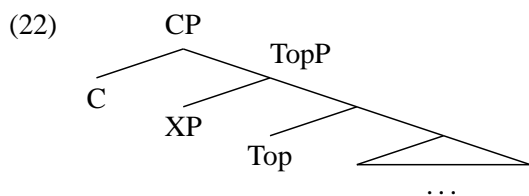
¹²It is standardly assumed that topics constitute separate intonational phrases (cf. Selkirk, 2005; Nespor et al., 2008). It then follows that the domain in which the interrogative marking spreads in the examples in the text is also an intonational phrase.

- (21) **face:** topic
hands: NURSERY *index:3* 1:SEND:3
 ‘I took (her) to the nursery’
 (Engberg-Pedersen, 1994, 75)

DSL

In (21), the signer first introduces the goal argument of the clause and uses an indexical to locate it in signing space. Simultaneously, NURSERY and the indexical are marked non-manually as topic. Next, the signer signs the verb SEND, which is a so-called *agreeing* verb¹³ that agrees with the subject (indicated with ‘1’ for first person) and the goal of the action, which is the nursery. This locative agreement is indicated with the index ‘3’, which refers to the location in signing space that is associated with the nursery.

Views on the syntactic position of topic markers differ. In syntactic approaches that are based on work by Rizzi (1997) and Cinque (1999), topics appear in the specifier position of a dedicated Top° head:



In the structure in (22), the XP would be topic. In languages that have an overt topic marker, the argument goes, this marker is an overt realization of the Top° head. However, if this is indeed the correct structure, the phonological marking of the topic in sign languages (and in spoken languages that use intonation for this purpose) functions in a way that is very different from interrogative marking and negation. Both interrogative marking and negation extend over their complements (or, more precisely, over the phonological domain the complement is embedded in). The same is essentially true for non-manual adverbs: VP adverbs are realized simultaneously with the verb, which is in the c-command domain of the adverb. In the case of topics, however, the phonological marking associated with the Top° head would extend over its specifier.¹⁴

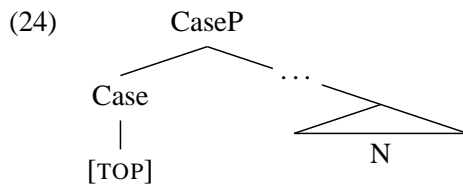
However, there is data to suggest that this cannot be the only source of topic markers. If the topic marker is a Top-head in the verbal projection line, we would expect that a topic marker can co-occur with a case marker on the DP in Spec,TopP. However, this is not always the case. In Japanese, for example, the topic marker *wa* is in complementary distribution with the case markers *ga* (nominative) and *o* (accusative):

¹³Not all verbs in sign languages agree. Those that do can be divided into several different categories. See e.g. Sandler & Lillo-Martin (2006) and references cited there for details.

¹⁴As pointed out by a reviewer, the same would of course also be true of non-manual *wh*-marking that extends over a moved *wh*-phrase in Spec,CP (Neidle et al., 2000).

- (23) a. *taiyō ga noboru*
 sun NOM rise
 ‘the sun rises’
Japanese
- b. *taiyō (*ga) wa noboru*
 sun NOM TOP rise
 ‘the sun rises’

The most straightforward analysis for these data is one in which the topic marker and the case marker (and presumably also prepositions) are reflexes of the same functional head in the nominal projection line, as schematized in (24):



I will assume that the sign language examples under discussion have essentially this structure.¹⁵ On this analysis, the non-manual topic marking would fall in line with the interrogative and negation markers: the topic marker is phonologically realized simultaneously with the element in its scope, i.e., with its *c*-command domain. As above, I assume that the actual domain is defined phonologically: the topic marking spreads over the phonological domain (presumably an intonational phrase, cf. footnote 12) that contains the (phonological form associated with) the N° head.

3 Exclusivity and Nontangling

As already mentioned in the introduction, for standard theories on the relation between hierarchical and linear structure (i.e., in a sense between syntax and phonology), the simultaneity data are problematic. In most theories, syntactic structures are represented as phrase structure trees, which represent the hierarchical relations between the elements in the clause. Phrase structure trees define dominance relations, and in many versions also linear relations.¹⁶ Partee et al. (1993) formulate two conditions on constituent structure trees that regulate the relation between hierarchical and linear structure:

- (25) a. *The Exclusivity Condition:*
 In any well-formed constituent structure tree, for any nodes x and y , x and y stand in

¹⁵The actual category of the head carrying the [TOP]-feature may not be Case° . The label is inspired by the Japanese example, but since sign languages generally do not have case marking, it is probably not the most appropriate label here.

¹⁶Some theories, such as minimalism, HPSG and others, assume that linear order is defined by a principle or by rules that are independent from phrase structure trees. For the remarks in this section, it is immaterial which view of the relation between dominance and linear order one assumes.

the precedence relation P , i.e., either $\langle x, y \rangle \in P$ or $\langle y, x \rangle \in P$, if and only if x and y do not stand in the dominance relation D , i.e., neither $\langle x, y \rangle \in D$ nor $\langle y, x \rangle \in D$.

b. *The Nontangling Condition:*

In any well-formed constituent structure tree, for any nodes x and y , if x precedes y , then all nodes dominated by x precede all nodes dominated by y .

(Partee et al., 1993, 442)

The Exclusivity Condition states that if two nodes do not dominate each other, one of them will precede the other. This guarantees that a linear order is defined between any two terminal nodes. The Exclusivity Condition makes one implicit assumption, which is that terminal nodes are associated with segmental material, or are phonologically null. To the extent that this indeed applies in a given phrase structure tree, the Exclusivity Condition holds.

The Nontangling Condition ensures that if a node dominating a structure «abc» has a sister node dominating a structure «d», the linear structure will be either «abcd» or «dabc», but not *«adbc» or *«abdc». Like the Exclusivity Condition, the Nontangling Condition makes an implicit assumption, which is that the terminal (phonologically non-null) elements are all realized on the same phonological tier. Again, to the extent that this assumption applies in a given phrase structure tree, the Nontangling Condition holds.

However, in the simultaneity examples discussed in the previous section, it is not the case that every syntactic head corresponds with segmental phonological material, nor is it the case that all phonologically non-null heads are realized on the same tier. In such cases, the Exclusivity and Nontangling Conditions no longer hold. For example, when negation is expressed as a headshake, Neg° and VP are not linearly ordered, but at the same time neither dominates the other. The same is true for the other simultaneity examples.

As already discussed, we cannot look to morphology for a way out. If it were the case that the non-manual negation, for example, could only be associated with the verb, then morphology might have provided us with the means to account for these data. As we have seen, however, the negation can be associated with the entire VP. A similar point can be made for the sentential adverbs and in principle also for the interrogative marking.

Thus, the simultaneity data discussed above present us with a problem. There are certain aspects about the syntax-phonology mapping that do not adhere to the standard view on phrase structure, as formalized in the Exclusivity and Nontangling Conditions. The deeper reason for this problem is the common assumption that as far as syntax is concerned, only a single phonological tier, the one with segmental material, is relevant. What the data in the previous section teach us is that this assumption is not correct.

4 Phonological composition

4.1 Theoretical background

Before I present my analysis of the data, it is necessary to discuss the theoretical background that I assume, because it helps clarify and simplify the discussion. First, let me make explicit what I mean by the term “syntactic analysis” that I have been using above. By this, I mean an

analysis in terms of structures composed of morphosyntactic heads, which are themselves bundles of morphosyntactic features. Phonological features are not part of this syntactic structure (cf. Beard's 1988 Separation Hypothesis). Rather, they are part of the phonological structure, which is built in parallel with but independently from the syntactic structure.

This division of labor is inspired by Jackendoff (2002) and is in fact crucial to the analysis I present here. Simultaneity phenomena do not lend themselves to a purely syntactic analysis that only takes the morphosyntactic features into account. Rather, in order to fully understand them, we need to look at the phonological structure of the relevant elements as well.

For this reason, I adopt a version of the parallel architecture that Jackendoff (1997, 2002) develops. The central idea of Jackendoff's model is that semantic, syntactic and phonological structures are built in parallel. This contrasts¹⁷ with the standard assumption in minimalist theories, which is that syntactic structure is primary and that the phonological and semantic structures are derived from it. Jackendoff proposes a grammar architecture in which each of the modules for semantics, syntax and phonology generate structures independently, which are then co-indexed in order to establish the necessary connections between them.

A lexical entry in this model is represented as illustrated in (26) for the word *car*:

$$(26) \quad \lambda x(\mathbf{car}(x)) \leftrightarrow \left[\begin{array}{l} \mathbf{N, sg} \\ \mathbf{count} \end{array} \right] \leftrightarrow /kaɪ/$$

In this entry, the associations are shown as double arrows rather than with indices. The representation is meant to express the assumption that the semantic, syntactic and phonological features are distinct but linked to each other.

An important part of the analysis of any phenomenon is the establishment of the relevant properties of (the class of) lexical items involved. It will therefore be one of the goals of this paper to establish lexical entries for the elements involved in simultaneity constructions along the lines of (26). However, since semantics is not relevant for our present purpose, the semantic component of a lexical entry is often left underspecified or may be absent altogether.

Unlike common assumptions in minimalist theories, (made explicit in e.g., *Distributed Morphology*, cf. Halle & Marantz 1993), syntactic and phonological features are *not* introduced independently into the derivation. A lexical entry is a bundle of semantic, syntactic and phonological features (cf. Chomsky, 1965, 214, fn. 15), which means that when a syntactic head is introduced into the derivation, its semantic and phonological features become available as well.

That is, when the generative component inserts a lexical item into the derivation, this includes not just the syntactic features, but also the semantic and phonological features. All three systems will then attempt to integrate the new feature bundle into the existing structure. In this sense, the grammar architecture is parallel.¹⁸

¹⁷At least in Jackendoff's opinion, but see Freidin (2003) for a different view.

¹⁸This in fact seems to differ somewhat from Jackendoff's architecture, in which semantic, syntactic and phonological structure are generated separately and then matched through indices. I assume that the different modules can only generate structures in concert, so that there is no need to match them: the necessary links are present from the start, they are in fact inherent in the derivation. It is not immediately clear, however, that this is really a substantial difference; it may be merely cosmetic.

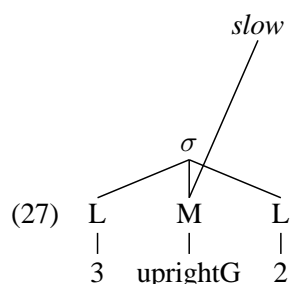
4.2 Autosegmental phonology

It is a standard assumption in phonological theory that phonological structure is best described as a collection of independent but interrelated (autosegmental) tiers. This idea, introduced by Goldsmith (1976) to describe tone phenomena, has been used very fruitfully by McCarthy & Prince (1990, 1996) to develop their theory of *prosodic morphology*. What I propose here is that autosegmental phonology is not only relevant for morphology, but also for syntax.

Prosodic morphology has not gone unnoticed among sign-language researchers. There are various suggestions that certain phenomena in sign language morphology should be treated along these lines (cf. especially Sandler 1989, 1990; see also the discussion and references in Sandler & Lillo-Martin 2006, 139–142). Consider the example in (7), repeated here:

- (7) **body:** exclusive
face: reluctant
hands: APPROACH-EACH-OTHER.Cl_{uprightG}.slow
 ‘two people approach each other slowly, reluctantly, and with hostility
 (Leuninger et al., 2005, 331)

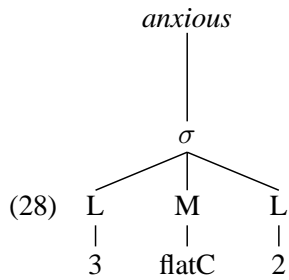
In this example, the adverbial *slowly* is expressed by realizing the path movement of the verb APPROACH more slowly than normal. On the assumption that *slowly* is morphological, these facts obviously suggest an analysis in terms of prosodic morphology, for example by treating the path movement as an autosegmental tier along the lines of (27):¹⁹



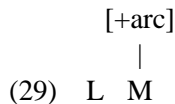
Here, I adopt a representation of the structure of the syllable in sign languages proposed by Sandler (1986, 1989): a sign consists of a movement (M) and two locations (L), the starting and end points of the movement.²⁰ In the sign in (27), the component *slow* is associated with the movement (M) part of the syllable. For adverbials realized on the face, we may assume that it is associated with the entire syllable (although nothing in the current proposal really hinges on this):

¹⁹Note that the phonological representations of sign language data here and below are simplified: although technically not really correct, the simplified representations are probably easier to understand than a system such as HamNoSys (basically an IPA for sign languages, cf. Hanke, 2004).

²⁰An earlier model of sign language syllables posits holds (H) instead of locations, cf. Liddell & Johnson (1989). See Sandler & Lillo-Martin (2006, 128–138) for a discussion of both models.



The analysis is in fact similar to the rule of *arc linking* proposed by Sandler (1990, 25):



The rule in (29) associates a feature [+arc] to the M part of the syllable, causing the sign to be realized with an arc movement. We may similarly assume that e.g., a duration feature [+dur] is associated with the M in (27). These features are comparable to distinctive features in spoken language phonology, in that they determine the phonological shape of the segment (sign). In the case of *anxious* in (28), it is not a phonological feature that is added. Rather, the sign is associated with an autosegmental element.

From a theoretical point of view, however, there is no fundamental difference between the two: both the [+arc] or the [+dur] feature on the one hand and the non-manual adverbial on the other are represented as autosegmental features. The difference is solely their realization: on the hand(s) in the one case and on the lower part of the face in the other. The analysis is the same in both cases: an autosegmental feature that is associated through standard phonological principles (e.g., Left-to-Right Association) to elements on the segmental tier.

4.3 Arabic verbal nouns

In order to see how the forms in (27) and (28) are created, it may be best to look at a more familiar form, prosodic morphology in Arabic. Consider the following Arabic verbal noun:

- (30) *'aqlaqa-nī* *-ntiqād-u* *-l-rajul-i* *-l-mašrū'-a*
 annoy.3sg.m-1sg.OBJ criticizing-NOM DEF-man-GEN DEF-project-ACC
 'The man's criticizing the project annoyed me.'

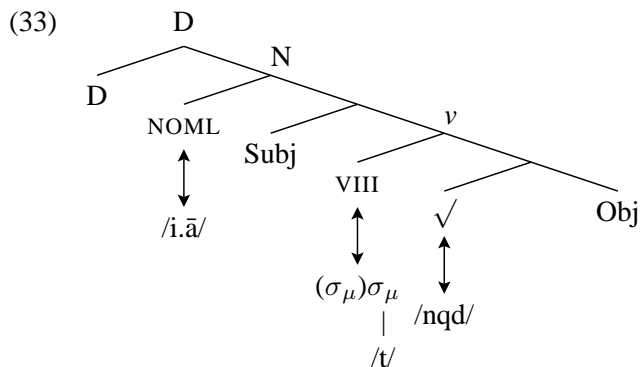
The relevant word form is *intiqād* 'criticizing', which is a verbal noun (*mašdar* in Arabic) derived from the verb *intaqada* 'to criticize'. The fact that this noun can assign accusative case suggests an analysis along the lines of Abney (1987), in which the verbal noun starts out as a verbal root and is converted to a noun by a nominalizing affix. McCarthy & Prince (1990) propose that verbal nouns in Arabic actually contain four different morphemes:

- (31) Root: «nqd» Nominalizer: «i.a»
 Stem VIII: (σ) σ_μ Non-finite: $-\sigma_{\mu\mu}$
 |
 t

Note that in Arabic, roots are category-neutral; that is, the root «nqd» occurs in both nouns and verbs. The element that turns the root into a verb in this particular case is the stem VIII marker.²¹ The nominalizer is the morpheme that turns the verbal projection into a noun; it performs the function that the suffix *-ing* performs in Abney’s analysis of English gerunds. McCarthy & Prince also assume that vowel length acts as a non-finiteness marker, but in in Kremers (to appear a) I argue that this should not be analyzed as a separate morpheme (among other reasons, because it does not appear in participles, which are the only other category of non-finite verb forms in Arabic). Instead, the long vowel is part of the nominalizer:

- (32) $-\sigma_{\mu\mu}$
 |
 /i . a /

I assume the following syntactic structure for the example in (30):



The stem VIII marker verbalizes the root, which is why I assume it is a so-called little *v* head. The important point of this tree is that the three morphemes —the nominalizer, the verbalizer and the root— do not form a distinct subtree. In standard views, this would be problematic, because they form a distinct (prosodic) word. What I argue for in Kremers (to appear a) is that it is not actually necessary to combine the three morphemes in syntax. We only need to make sure their phonological forms can be combined successfully in phonology.

What is required for this is that the phonology ‘knows’ that the three morphemes are to be combined into a single word form. In order to achieve this, it is not necessary to establish a subtree that contains the three morphemes and nothing else. We can instead use Ackema & Neeleman’s (2004) principle of Input Correspondence.²²

²¹Each root in Arabic yields up to 15 different verb stems, which are numbered I–XV. Note, however, that no root exists for which all 15 stems are instantiated.

²²See also Sadock’s (1992) Constructional Integrity Constraint, which expresses the same idea.

- (34) *Input Correspondence*:
 If A selects (a projection of) B, $\Phi(A)$ selects $\Phi(B)$.²³

Input Correspondence crucially depends on Beard’s (1988; 1995) *Separation Hypothesis*. If the morphosyntactic structure does not contain phonological features, it is perfectly conceivable that in syntax, an affix attaches to a phrase rather than to a head. The requirement that an affix attach to a head should, Ackema & Neeleman claim, be construed as a *phonological* requirement: it is the phonological form of the affix that must attach to a prosodic word; more specifically, it must attach to the prosodic word that corresponds to the head of the projection it attaches to in syntax.

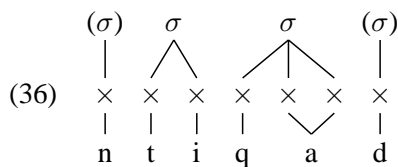
An example of a head attaching to a phrase is Abney’s (1987) analysis of the English gerund. According to Abney, the affix *-ing* may attach to V, creating a purely nominal construction in which the gerund’s subject is expressed as a possessor and the object with the preposition *of*. Alternatively, it may attach to VP, creating a structure in which the object is assigned accusative case. Finally, *-ing* may also attach to IP, in which the subject is assigned accusative:

- (35) a. John’s singing of the Marseillaise
 b. John’s singing the Marseillaise
 c. John singing the Marseillaise

The crucial insight that Input Correspondence expresses is the fact that even if an affix attaches to a phrase in syntax, its phonological form still attaches to the phonological form of the *head* of that projection. Occasionally, Ackema & Neeleman argue, the phonological requirement imposed by Input Correspondence cannot be met, so that the derivation crashes.

Applying Input Correspondence to the tree in (33), it is easy to see how we can derive the word form *intiḡād* without resorting to syntactic head movement. The nominalizer selects a verbal category (*v* in the tree here). Thus, according to Input Correspondence, $\Phi(\text{NOML})$ combines with $\Phi(v)$, which is the verbal stem marker VIII. Since the stem marker itself selects the root, all three morphemes combine into a single form. That is, Input Correspondence ensures that the three morphemes are combined in phonology. It is therefore not necessary to combine them in syntax.

In phonology, the three morphemes are combined through standard principles of autosegmental phonology: the root is realized on the segmental tier, the stem VIII and the nominalizer both combine elements realized on the segmental tier and elements realized on the syllabic tier. The two tiers are associated with each other through phonological principles, resulting in the following structure:



²³ $\Phi(X)$ here is to be read as “the phonological material onto which the syntactic element X is mapped”.

Note that the order of the stem marker and the nominalizer is determined by the fact that the latter is phonologically a suffix (which is indicated in (32) by the hyphen). Furthermore, all Arabic stems end in an extrametrical syllable, so one is added to the syllabic template in (36). Finally, the order in which the segments appear is determined in part by the order of the segments in the morphemes (the root is «nqd» and any stem derived from this root must have the consonants in that order; the same goes for the nominalizer). Additionally, basic phonological principles determine the order of the consonants and the vowels: Left-to-Right Association puts the «n» in the first consonantal position, the coda position of the first (extrametrical) syllable. In the second syllable, the onset is filled by the «t»; the nucleus position is not available for consonants. As a result, the second root consonant «q» appears in the onset of the third syllable. The third root consonant fills the onset position of the fourth, extrametrical, syllable.²⁴ The vowels of the nominalizer fill the nucleus positions from left to right.

4.4 Constructing a phonological form

The point of the Arabic example, complex as it may be phonologically, is to show how syntax and phonology cooperate to create the word form *intiqād*. Syntactic structures are built up out of syntactic heads, which are morphosyntactic feature bundles without phonological content. These structures are mapped onto (or rather linked with) phonological structures, which are then combined by the phonological component. As discussed in the previous section, the order and groupings within the phonological structure are determined partially by phonology-internal constraints and principles, and partially by lexical facts (e.g., whether an affix is a pre- or a suffix).²⁵

Additionally, principles governing the mapping from syntax to phonology influence the ordering of elements in phonology. One such principle, relevant for the present discussion, is Input Correspondence, as discussed above. It is this principle that brings the three morphemes together in the analysis of Arabic verbal nouns sketched here.

And lastly, of course, the structure of the syntactic tree also has an influence on the phonological ordering of elements. The Exclusivity and Nontangling Conditions form the basis of the mapping from syntax to phonology, but they hold only to the extent that syntactic heads are mapped onto the same phonological tier.

In spoken languages, any structure above the syntactic head is usually mapped onto the segmental tier. Even heads themselves almost always are, with the exception of those cases traditionally captured by prosodic morphology. The result of this is that in spoken languages, there is little reason to assume that the Exclusivity and Nontangling Conditions are not absolute conditions. What facts there are that might be problematic can be dealt with morphologically (as in the case of prosodic morphology) or as non-syntactic, intonational effects (e.g., question intonation, so-called *hat patterns*, etc.)

²⁴Note that this is a language-specific association, not determined by Left-to-Right Association: the coda position of the third syllable would in principle allow a consonant. The need for an extrametrical syllable overrides Left-to-Right Association in this case. I suspect that this association would be better analyzed in terms of alignment, but that would go beyond the scope of this paper.

²⁵I assume that information about the status of an affix as a pre- or suffix is in fact stored as a strong alignment preference, cf. footnote 24.

In sign languages, things are different. Simultaneity is much more pervasive and there are cases of simultaneity that can hardly be claimed *not* to be syntactic. Negation and adverbs, especially sentential adverbs, are the best examples. Negation and sentential adverbs, apart from the fact that they have sentential scope, are realized simultaneously with not just a single manual sign, but with a sequence of manual signs. A morphological analysis (i.e., an analysis in terms of word formation) is therefore not feasible.

Given the necessity of a syntactic analysis, we are faced with the fact that even syntactic structures can map onto autosegmental tiers in phonology, resulting in configurations that do not conform to the Exclusivity and Nontangling Conditions. The most straightforward way to describe these facts appears to be to extend the ideas behind prosodic morphology to syntax.

To see how we may do this, consider again the example from Pfau (2008) given in (15), repeated here:

- (15) **head:** neg DGS
hands: IX:3 FLOWER BUY
 ‘She does not buy a flower’

Pfau uses this example to show that the spreading of the negative headshake in DGS is prosodic in nature: the headshake spreads over a prosodic domain. What this means is that the headshake, which is realized phonologically on a separate autosegmental tier, is associated with a phonological phrase. This can be expressed as follows:

- (37) NOT ↔ Neg^o ↔ *hs*
 |
 φ

The semantics in (37) is obviously oversimplified but is not at issue. On the phonological side, I have also made a simplification: I make no attempt to provide an accurate description of the actual phonological form, I just indicate the headshake with *hs*. What is important here, however, is the fact that the headshake is a prosodic morpheme associated with the phonological phrase (φ). It is this specification that causes the headshake to spread over (the phonological phrase corresponding to) the VP in DGS.

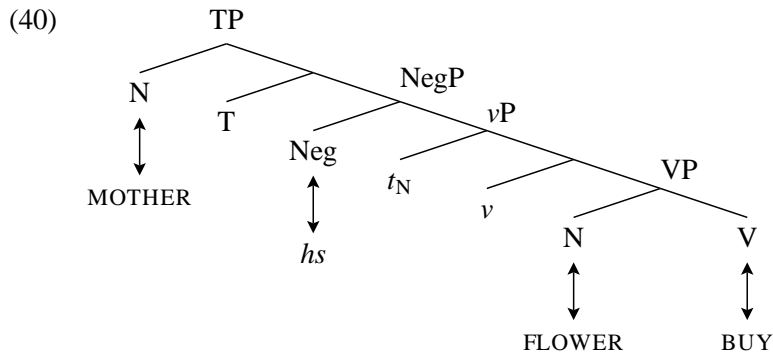
As discussed in section 2, the negative headshake in DGS can also be limited to just the verb, as in (38) (cf. (13)):

- (38) **head:** neg
hands: MOTHER FLOWER BUY

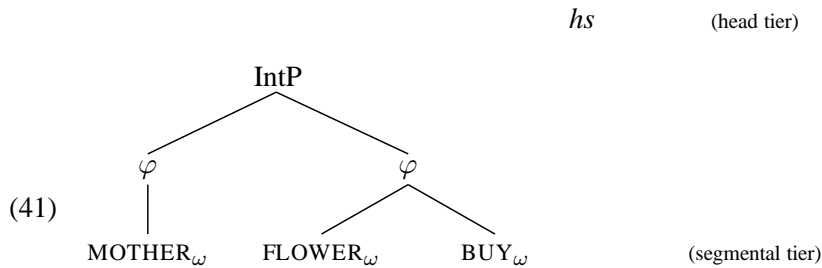
The phonological part of the negation’s lexical entry therefore must be assumed to be variable. Apart from the form in (37), there is a variant in which the headshake is associated with the prosodic word:

(39) NOT \leftrightarrow Neg^o \leftrightarrow *hs*
 ω

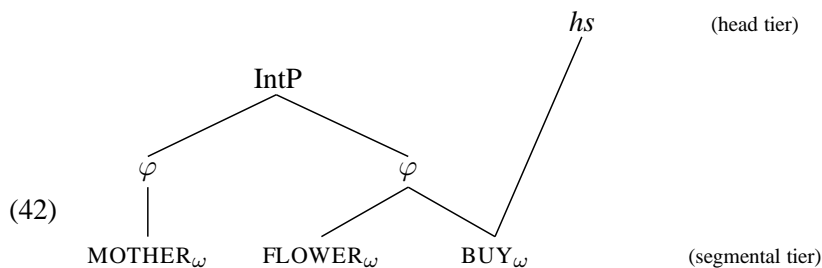
It is important to note that even though the object FLOWER is also a prosodic word, the negation is associated with the verb — or, more precisely, with $\Phi(V)$. It is the principle of Input Correspondence that guarantees this. The relevant tree structure for the sentence in (38) is (40):



This structure is mapped onto a phonological representation, which is partially displayed in (41):



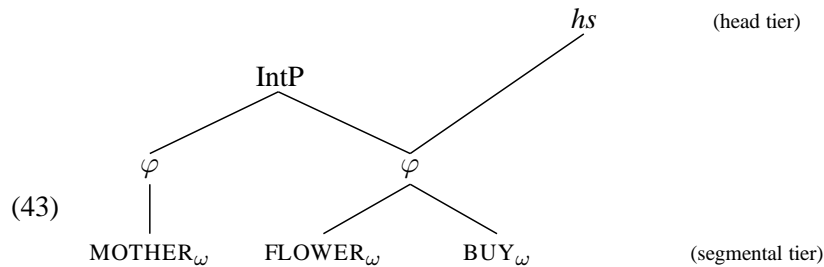
In principle, it seems that the headshake could be associated with any of the three prosodic words on the segmental tier. In actual fact, only an association with BUY is grammatical:



We need no additional assumptions, however, in order to account for this fact. The principle of Input Correspondence makes sure that the headshake can only be associated with the verb: Neg^o selects a verbal category (little *v* in my analysis), so that Input Correspondence requires

that $\Phi(\text{Neg})$ be associated with $\Phi(v)$, the head of the projection that Neg selects, which in turn selects V.

Note that this analysis will not be significantly different when instead of the phonological form in (39), the form in (37) is chosen. Input Correspondence still requires that the headshake be associated with the verb. What happens is that the headshake is associated with the phonological phrase containing the verb, rather than with the prosodic word:



The other simultaneity examples discussed in section 2 can be treated in much the same way. VP adverbials, for example, have a lexical entry of the following form:

(44) WITH EFFORT \leftrightarrow $\begin{bmatrix} \text{Adv} \\ uV \end{bmatrix}$ \leftrightarrow $w.e.$
 ω

Again, the phonological form here is a simplification: *w.e.* stands for the phonological features that make up the facial expression that conveys the meaning *with effort*. As with the negation in (39), these phonological features are associated with a prosodic word. Input Correspondence ensures that the adverb is associated with the prosodic word corresponding to the verb, rather than with any other prosodic verb in the c-command domain of the adverb. Note that I assume that the adverb actually selects an element of category V, as is often assumed in HPSG-style analyses.²⁶

One important aspect of this analysis is the assumption that adverbial facial expressions and negation are aligned with prosodic categories and not with (morpho)syntactic categories. It has been argued that non-manuals in sign language are aligned with syntactic categories (e.g., Neidle et al., 2000), but it is by now quite clear that certain types of non-manuals, especially interrogative and topic marking, are aligned with prosodic domains (see Sandler, 2011, who summarizes the relevant discussion).

For non-manual negation and adverbials, matters are not as clear. One datum suggesting that at least the non-manual negation in DGS aligns with prosodic categories and not with syntactic ones is the example in (15). For VP-adverbs, however, the data are compatible with both types of analyses. They align with the verb; whether they align with the syntactic head or with the prosodic word is not so easy to determine.

²⁶In (44), this selection has been formalized as an uninterpretable V-feature on the adverb, but obviously other methods are possible.

One fact that tentatively supports the assumption made here is that the current analysis makes one particular prediction. Because phonological structure is organized along the prosodic hierarchy, and because the prosodic hierarchy obeys the Strict Layer Hypothesis (Selkirk, 1984; Nespor & Vogel, 1986), we expect that two autosegmental morphemes are either coextensive or that one completely contains the other. That is, we do not expect to find structures of the following type:

(45) **tier 1:** \overline{x}
tier 2: \underline{y}
segm: pword pword pword pword

In this hypothetical example, an autosegmental marker on tier 1 overlaps with a marker on tier 2, but only partially. Given the assumption made in this paper that autosegmental markings coincide with prosodic constituents, the situation in (45) could only obtain if the relevant prosodic constituents violated the Strict Layer Hypothesis.

Presumably, the same prediction would hold if all autosegmental elements would align with syntactic categories. Crucially, the prediction would not hold if some autosegmental elements aligned with prosodic categories, while others aligned with syntactic categories. Because of the fact that syntactic and phonological constituents do not map onto each other one-to-one, cases such as in (45) might be possible.

In the simultaneity examples that I looked at, configurations of this type were conspicuously absent. Because at least some autosegmental elements are aligned with prosodic categories, it would seem that all must do so. More research is needed, however, to see if the prediction really holds.

Note, however, that under the assumptions made in this paper, alignment with a syntactic category is strictly speaking not even an option. A syntactic head does not carry phonological information, it consists of morphosyntactic features only. Therefore, it has no temporal extent, no left and right edges with which an autosegmental phonological element could be aligned.

The relevant question is therefore whether non-manuals align with a prosodic category that is lexically associated with a specific head or whether they can also spread over a prosodic domain that is not introduced by a lexical head. Take, for example, the VP adverb in (2), repeated here:

(46) **face:** $\overline{\text{with effort}}$ *DGS*
hands: STUDENT SIGN-LANGUAGE LEARN
 ‘The student learns sign language with difficulty.’

The lexical entry for the verb LEARN is (47):

(47) $\lambda e \lambda x \lambda y (\text{learn}(x, y, e)) \leftrightarrow [\text{V}, u\text{N}] \leftrightarrow \text{LEARN}$

The phonological component, which I have indicated simply as LEARN, is a prosodic word. The non-manual adverb *with effort* is aligned with this p-word by virtue of its lexical specification. The relevant question is now what happens with the adverb when the verb’s p-word is

modified in some way. The problem is that there are few modifications that one can think of that may provide a clue. In larger prosodic domains, e.g., IntPs or Utterances, it is not uncommon for additional boundaries to be introduced (e.g., when a parenthetical is added to the structure). At the level of the p-word, there is no equivalent process (at least, not that I am aware of). At best, one may glean something from processes that extend the p-word, for example, by incorporating a clitic. But in such cases, it would first need to be established on independent grounds that verb + clitic really do form a (single) p-word and not a larger prosodic category such as a clitic group or a recursive p-word.

Summarizing, the grammar architecture basically forces the conclusion upon us that non-manuals align with prosodic categories: the component of the non-manual that must be aligned is the phonological one, not the syntactic or semantic one, and the only type of element it can align with is also phonological. The question that needs to be answered in future research is whether non-manual adverbs align with the prosodic constituent that the verb introduces or whether they can also align with prosodic constituents that are not introduced lexically.

The lexical entries that I assume for the [+Q] C° head and the Top° head are the following:

- (48) a. $\text{INT} \leftrightarrow \begin{bmatrix} \text{C} \\ +\text{Q} \end{bmatrix} \leftrightarrow \begin{matrix} rb \\ | \\ \text{IntP} \end{matrix}$
- b. $\text{TOP} \leftrightarrow \begin{bmatrix} \text{Top} \\ u\text{N} \end{bmatrix} \leftrightarrow \begin{matrix} rb \\ | \\ \text{IntP} \end{matrix}$

Here, as before, I have simplified the representations. The *rb* in the interrogative and topic markers stands for *raised brows*.²⁷ Crucial for the current analysis is that these phonological forms are autosegmental: they are realized on an autosegmental tier and they are associated with a specific prosodic constituent. The autosegmental tier that is relevant for interrogative and topic marking may be called an upper face/head tier, as it involves the upper part of the face and the position of the head. It is different from the tier on which facial adverbials are realized, because, as Meir & Sandler (2008, 175) remark, these are usually associated with the mouth.²⁸

The lexical entries in (48) are built up in the by now familiar way: a piece of meaning is associated with a syntactic head, which is associated with a chunk of phonology. That is, there is no fundamental distinction between these entries and the entries for negation and adverbials above. They all follow the pattern that Jackendoff (2002) proposes for lexical entries in general. This analysis thus assigns syntactic status to intonational patterns, which is markedly different from the usual treatment of such phenomena.²⁹

²⁷A brow raise is an essential part of both the interrogative and the topic marker, but the representation in (48) is not intended to be exhaustive. Note, by the way, that in DGS, constituent questions are usually associated with furrowed brows. Brow raise as question marking occurs mainly with yes/no questions.

²⁸See also Wilbur (2000) for an overview of the different types of non-manuals found in ASL. Wilbur also discusses the different grammatical functions that different non-manual articulators have.

²⁹But see Neidle et al. (2000) and Cheng & Rooryck (2000) for similar proposals; cf. also footnote 10.

The fact that questions may have atypical non-manuals or intonation can simply be accounted for by assuming that there are in fact different $C_{[+wh]}$ heads in the lexicon, in the same way that there are different N heads in the lexicon. Syntactically, the nouns *dog* and *cat* are not differentiated, they both consist of a head N with features such as [+sg, +count, +animate]. The differences lie in the semantic and phonological features associated lexically with both heads. The same can be assumed for $C_{[+wh]}$: there are several such heads, which are not differentiated syntactically, just semantically and phonologically. That is, the existence of atypical interrogative non-manuals and intonation does not argue against a syntactic analysis.

Similarly, I do not regard the fact that interrogative and topic non-manuals in sign language are realized on the upper part of the face, contrary to other facial expressions, as an indication that these elements are fundamentally different. It is obviously an interesting question why it should be the case that interrogative and topic non-manuals are cross-linguistically realized in this manner, but claiming that they are non-syntactic does not provide an explanation of this fact. It would still need to be explained why the former follows from the latter.

As a last point, the lexical entry that I propose for sentential adverbs in DGS is the following:

$$(49) \text{ POSSIBLE} \leftrightarrow \begin{bmatrix} \text{Adv} \\ uC \end{bmatrix} \leftrightarrow \begin{array}{c} \text{possible} \\ | \\ U \end{array}$$

Here again the actual phonological form is not represented properly, instead I have just used the indication *possible*. It is associated with the phonological Utterance, although Happ & Vorköper's (2006) data is not really sufficient to determine whether sentential adverbials are associated with the Utterance or with the Intonational Phrase.

5 Input and Linear Correspondence interaction

Ackema & Neeleman (2004) propose not only Input Correspondence, discussed above in section 4.3, as a mapping principle. They also propose a second principle, called Linear Correspondence.³⁰ Because the analyses proposed here for the simultaneity data appear to violate Linear Correspondence, it is necessary to discuss this principle and how it interacts with Input Correspondence in some more detail. What I will argue is that Linear Correspondence is actually the primary principle of the two, but it may be violated under certain conditions. It is exactly in such cases that Input Correspondence plays a role: an element that violates Linear Correspondence must obey Input Correspondence.

Linear Correspondence is formulated as in (50):

(50) *Linear Correspondence:*

If a node A is structurally external to B, then $\Phi(A)$ is linearly external to $\Phi(B)$.

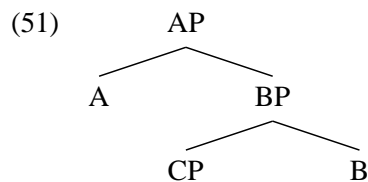
³⁰This principle also has a precursor in Sadock (1992). Note, by the way, that Ackema & Neeleman actually propose a third mapping principle, Quantity Correspondence. For the present discussion, this principle is not relevant.

Linear Correspondence states that if a node A is not contained in (dominated by) a node B, the phonological strings that A is mapped onto is outside the string onto which B is mapped. In essence, Linear Correspondence has the same effect as the Nontangling Condition: it establishes that association lines between non-terminals and terminals do not cross. The main difference is that Linear Correspondence presupposes the Separation Hypothesis, so that the association lines are in fact mapping links between morphosyntactic and phonological structure.

For Ackema & Neeleman, both Input and Linear Correspondence are principles governing the mapping of word-syntactic structures onto word-phonological structures. That is, they are *morphological* principles. Obviously, in the analysis proposed here, I assume that they also govern the mapping from syntax to phonology.³¹ There is no real reason to restrict these principles to morphology: like morphology, syntax generates tree structures that must be mapped onto linear phonological structures. Besides, as just stated, Linear Correspondence is closely related to the Nontangling Condition, which is obviously a condition on syntactic structures.

When we examine both mapping principles a bit closer, however, it becomes clear that they are not absolute. For instance, the example of the Arabic verbal noun violates Linear Correspondence: in the tree in (33) in section 4.3, the nominalizer is structurally higher than the subject, which should prevent it from combining with the verbalizer. The same is true of the sign language negation: if the negative headshake is realized on the verb alone, as in (38/40), it appears linearly inside the VP, although it is structurally external to it.

Ackema & Neeleman (2004) discuss such configurations and they claim that when Linear Correspondence cannot be met, an element that by Input Correspondence should combine with the head of its sister cannot do so. Consider the three in (51):



Suppose that A in (51) selects category B. Input Correspondence then requires $\Phi(A)$ to take $\Phi(B)$ as its host. If B's complement CP is linearized between A and B, because both A and CP precede or follow B, this is not possible: A is linearly separated from B by CP, so that A and B cannot combine into a single form. A possible solution to such a conflict is to linearize A and CP on opposite sides of B, if the language allows this. In this way, A and B end up linearly adjacent, which is a configuration that allows affixation of A to B.³² Another option is to realize A as a null affix, which according to Ackema & Neeleman is not subject to Linear Correspondence.

The tree given in (33) for the Arabic verbal noun displays the configuration in (51), since the nominalizer is structurally external to the projection of the verbalizer VIII (little *v*), so that

³¹In actual fact, I assume there is no distinction between phrasal syntax and “word syntax”, i.e., morphology, contrary to what Ackema & Neeleman (2004) assume. Arguing this point would go well beyond this paper, but see Kremers (in preparation) for discussion.

³²Ackema & Neeleman use this to account for the fact that in Quechua, both OV and VO main clause orders exist, while subclauses are strictly OV: the complementizer, which is suffixed on the verb, can only take the verb as its host in the OV order. (But see Myler 2009 for an analysis of Quechua subclauses, contradicting some of Ackema & Neeleman's claims.)

it should also appear linearly external to it. Since the subject is contained in the projection of VIII, Linear Correspondence requires that the nominalizer be linearized linearly external to the projection of the non-finiteness marker, which is not the case.

Note that the way out that Ackema & Neeleman offer does not really help us here. It would hardly be satisfying to assume that the nominalizer is a suffix, given that it is obviously a prosodic morpheme that cannot be classified as a pre- or suffix. Besides, it would require that the nominalizer be head-final, which is quite unlikely, given that Arabic is a head-initial language throughout.

However, there is another reason why such a proposal would be unsatisfactory, which has to do with the fact that the Arabic verbal noun is a head-initial structure (cf. the example in (30)). The proposed tree structure does not reflect this fact, however. In fact, it is not at all clear from this tree where the verbal noun should materialize. There are three heads involved in its formation, in three different structural positions. Which of those is the position in which the form is eventually realized? The example itself leaves no doubt as to which position it is: because the verbal noun is in initial position and because Arabic is generally head-initial, it must be the position of the nominalizing head. In other words, it is not so much the nominalizer that is violating Linear Correspondence, but rather the other two heads: the root and the verbalizer.

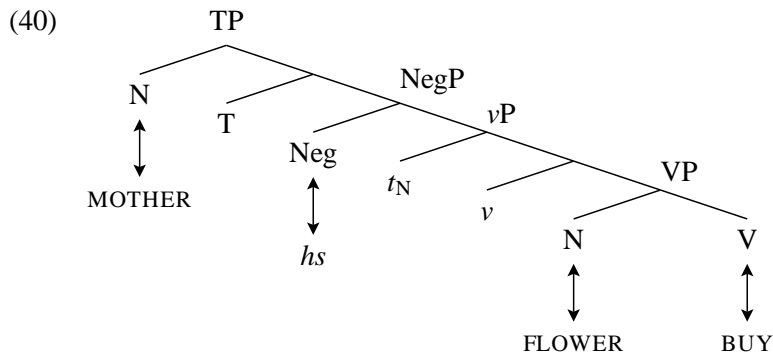
Note that all the heads involved have one property in common: they map onto phonological structures that are incomplete; i.e., forms that cannot be realized on their own. Without wishing to go into details,³³ I propose that a phonologically incomplete form cannot be realized until it is combined with sufficient phonological material to allow a licit phonological form to be realized. Specifically, there must be enough segmental material to produce a prosodic word,³⁴ and all prosodic requirements must be satisfied. An element for which these conditions are not met may violate Linear Correspondence in order to meet them.

The root of the verbal noun in Arabic cannot be realized, because it only contains three consonants. It selects the object, but since this complement is phonologically complete, the root cannot combine with it. The only way in which the root can be saved is to combine it with a higher head. The verb stem marker selects the root, but combining with it does not yield a licit structure either. Another selecting element is needed to rescue the combination of VIII and V. Only when the nominalizer becomes available can a licit form be produced. I assume that it is for this reason that the word form *intiḳād* appears in the position of the nominalizer: it is the nominalizer that introduces the material that allows the phonology to finally produce a licit form.

A slightly different situation exists in the case of DGS negation. To repeat the relevant tree:

³³See Kremers (to appear a) for discussion.

³⁴The requirement that a p-word can be produced is probably language-dependent. In languages such as Chinese a syllable may be sufficient.



Here, the verb BUY is a licit phonological form: it is a prosodic word with no additional prosodic requirements. Therefore it is realized phonologically in the position of $\Phi(V)$. Things are different for the negation, however. The negation is an autosegmental morpheme, which cannot form a prosodic word on its own and which additionally has a prosodic requirement, namely that it be associated with a prosodic word. Because of these requirements, $\Phi(\text{Neg}^o)$ can violate Linear Correspondence and be realized together with $\Phi(V)$.

What this means is that Linear Correspondence is a violable principle. The syntax-phonology mapping adheres to it only to the extent that the phonology allows it. If a phonological form would arise that violates basic phonological wellformedness principles, Linear Correspondence gives in order to allow the phonology to construct a licit form.

Still, when it does so, it adheres to the principle of Input Correspondence. In principle, the requirements of the DGS negation could also be met by associating it with the first prosodic word contained in the object, i.e., with FLOWER in our example. Because of Input Correspondence, this does not happen. This analysis suggests that Input and Linear Correspondence do not have the same status as mapping principles. Linear Correspondence is the primary principle, while Input Correspondence is secondary, only applying when the phonological form of the element(s) involved violates Linear Correspondence.

For Ackema & Neeleman (2004), Input Correspondence is relevant for quite a number of cases involving affixes. This does not contradict the conclusion reached here, however, because an affix is an element that carries a prosodic requirement: it has an alignment requirement with the left or right edge of a prosodic word (cf. McCarthy & Prince, 1993; Hayes & Lahiri, 1991). This requirement may result in a situation in which Linear Correspondence is violated, so that Input Correspondence applies.³⁵

Summarizing, Linear Correspondence is the primary principle: it applies to any two elements that are realized on the same autosegmental tier. When an element cannot obey Linear Correspondence, however, because it is phonologically not a licit form, it must still obey Input Correspondence.³⁶ The deeper reason for these two principles seems clear. Basically, both

³⁵Ackema & Neeleman do not discuss clitics, which take phrases as host, not words. We may tentatively assume that clitics are a lot like affixes, in that they are elements with a prosodic alignment requirement. Contrary to affixes, however, their alignment requirement is not with a prosodic word but with a phonological phrase. Because they are as small as or smaller than syllables, they will still incorporate into the adjacent prosodic word, but the alignment requirement is with the larger category.

³⁶As pointed out by a reviewer, there are a few cases in which Linear and Input Correspondence seem to interact in

principles state that elements that belong together syntactically must be realized together phonologically. This is obviously a necessary requirement for any mapping that must be reversible: the parser must be able to reconstruct the syntactic tree on the basis of the phonological form and it is aided in this task by the fact that it can assume that things that appear together in the phonological input belong together in the syntax as well.

6 Outlook

The main claim I have presented and tried to support in this paper is that simultaneity can be analyzed as a form of prosodic morphology at the syntax level. Specific syntactic heads map onto autosegmental phonological elements, which are integrated into the phonological structure by aligning with prosodic categories. However, I believe that the theoretical import of simultaneity does not end there. The phenomenon also raises important questions about linearization and the relation between syntax and phonology in general.

Often, the syntax/phonology relation is seen as in some sense temporally sequential: a syntactic (partial) structure is built, which is then linearized and subsequently interpreted by the phonological component in order to construct a phonological representation.³⁷

However, if the analysis presented here is on the right track and there are indeed syntactic heads that map onto autosegmental tiers in phonology, we may need to rethink our conception of the relation between syntax and phonology. First of all, there is little point in having linearization take place before all other phonological operations: linearization is *not* total, some heads are not linearized with respect to the rest of the clause. Only when the phonological form itself is taken into account, can it be determined which heads need to be linearized and which do not. It follows that linearization takes place in phonology, as part of a more general process that composes the entire phonological form, not just the linear order of the segmental elements.

As one reviewer points out, we may argue that syntax specifies a partial linear order. This raises the question how syntax determines which heads to linearize and which not to. That would seem to require a feature of some sort, but such a feature would obviously be redundant: it specifies information that is implicit in the phonological representation. Furthermore, it does not suffice to assume a feature [\pm linearize], because two autosegmental elements that are realized on the same tier do need to be linearized with respect to each other. The feature would need to be a multi-valued feature specifying the exact phonological tier on which an element is realized. Such a move, however, just makes the redundancy of the feature more obvious.

To avoid such redundancy, we need to assume that linearization takes place in phonology. More precisely, linear order emerges when the phonology tries to combine various chunks of phonological structure into a larger structure. In a way, linear order is not even the goal that the phonological system is striving for. Rather, it is an emergent property, the inevitable outcome of

a more complex way: although **pass by-er* is ungrammatical, *come-outer* is not. Sometimes the suffix *-er* even appears twice: *fixer-upper*. I assume these are lexically stored violations of the mapping principles, which do not undermine the general argument. See also the discussion in Ackema & Neeleman (2004, 160–161).

³⁷ Depending on the framework, linearization is trivial (Kayne, 1994) or it is a distinct process involving linearization parameters, as in HPSG but also in some theories within G&B and minimalism, (e.g., Neeleman & Weerman, 1999; Abels & Neeleman, 2009; Kremers, 2009).

a phonological system trying to combine the phonological parts of the elements in the structure (see also Kremers to appear b for some discussion).

If linearization is indeed a phonological process, we need new ways to deal with such basic things as the head parameter, basic clause ordering, etc. There appears to be a correlation between the head parameter and the alignment of stress within the phonological phrase (Truckenbrodt, 1995; Nespor et al., 2008), and there are indications that children acquire the setting of the head parameter through stress patterns, a process known as *prosodic bootstrapping* (Christophe et al., 2008). It may therefore be possible to reduce the head parameter to an alignment requirement of p-phrase stress. Obviously, though, much research will be needed in order to determine to what extent this assumption holds and how it can be implemented theoretically.

All in all, simultaneity suggests that there is a more direct relation between syntax and phonology than usually assumed in generative approaches. One cannot consider the syntactic structure of an utterance without taking its phonology into account. In the analysis developed here, such syntax-phonology interaction is accounted for by assuming a parallel grammar architecture: the introduction of a syntactic head into the derivation also makes its phonological features available, so that syntax-phonology interaction can be modeled.

This conclusion actually finds corroboration in data that suggests an even stronger link between syntax and phonology: there are syntactic structures that are influenced by the phonological structure of the elements involved. A well-known example is Heavy-NP Shift, which, according to Zec & Inkelas (1990) requires that the shifted NP consists of at least two phonological phrases. More recently, Erteschik-Shir & Rochman (2010) collect a number of papers that argue for such a phonology-to-syntax connection.

Furthermore, Richards (2010) argues extensively that certain syntactic phenomena are triggered by phonological requirements of the elements involved. One of the phenomena that Richards discusses in some detail is what appears to be a cross-linguistic requirement for *wh*-words to appear in a single prosodic domain with a (possibly covert) interrogative complementizer. If the prosodic structure of the language allows this domain to be created with the *wh*-word in situ, no *wh*-movement takes place. If the prosodic structure does not allow creation of this domain, syntactic operations can be triggered that improve the situation.³⁸

Phonology-syntax interactions of this kind make a parallel architecture virtually unavoidable. It is not clear how else we could describe the fact that syntax and phonology influence each other: because the interactions between the two modules are bidirectional, it cannot be the case that the two modules operate sequentially.

In a grammar architecture of this type, it is especially important to specify the principles that underlie the syntax-phonology interface, whereby we must distinguish the principles that govern the mapping from syntax to phonology from the principles that govern the feedback from phonology to syntax. For the moment, there seems relatively little that we can say about the latter; the relevant phenomena need further study in order for us to come to meaningful generalizations about them. We can say more about the former. The principles of Linear and Input Correspondence are two fundamental principles governing the mapping from syntax to

³⁸See also Cecchetto et al. (2009), who show that the analysis proposed by Richards can also be used to account for *wh*-word placement in Italian Sign Language (LIS).

phonology. We also know quite a bit about the relation between syntactic and prosodic categories (cf. Selkirk, 1984; Nespor & Vogel, 1986; Truckenbrodt, 1995 and much related work).

Note, by the way, that the bidirectional interactions are not entirely equivalent. This is evident in the formulations that I use: I speak of *mapping* from syntax to phonology, but of *feedback* from phonology to syntax. We expect all parts of syntactic structure to be mapped onto phonology, at least in principle, otherwise the parser could not reconstruct them. This expectation does not hold in the other direction: we do not expect all parts of phonological structure to have some effect on syntax. It generally does not matter for syntax whether a head N is realized phonologically as /kæt/ or /dɔg/. Only in some cases does phonology have an effect on syntax, namely when an initial syntax-phonology mapping fails due to some phonological constraint being violated.³⁹

7 Summary and Conclusions

Sign languages have the ability to express two or even more meaningful units simultaneously. These units are part of the syntactic structure and are realized phonologically on different tiers. Analyzing such phenomena requires that we extend the principles behind prosodic morphology to syntax. Syntactic heads may be associated with an autosegmental phonological form. This form is not restricted to prosodic words or syllables: it may also be associated with higher levels in the prosodic hierarchy, such as the phonological or the intonational phrase.

The mapping from syntax to phonology is governed by two important principles: Input Correspondence and Linear Correspondence. Crucially, however, Linear Correspondence only holds for elements that are phonologically “complete”. Forms that are not complete, i.e., that do not constitute a licit phonological form on their own, are subject to Input Correspondence.

The implications of the simultaneity data (and of Richards’s *wh*-data) for theories of the syntax-phonology interface are possibly far-reaching. Unlike common assumptions, the relation between syntax and phonology is not unidirectional. Rather, it is a bidirectional relation, with syntactic structure influencing, but also being influenced by, phonological structure. Future research will need to shed more light on this topic.

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³⁹It is perhaps for this reason that the feedback from phonology to syntax is not understood as well: it is more arbitrary and probably more idiosyncratic than the mapping from syntax to phonology.

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