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SIGN LANGUAGE RESEARCH 1994

PROCEEDINGS OF THE 4TH EUROPEAN CONGRESS
ON SIGN LANGUAGE RESEARCH
MUNICH, SEPTEMBER 1-3, 1994

SIGNUM

Dependency Relations in the Phonological Representation of Signs

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Introduction

This article is concerned with the phonological representation of signs. Following recent developments in which nonlinear theories developed for spoken language phonology are applied to the phonology of signs, I will explore the usefulness of fundamental concepts of Dependency Phonology (cf. Anderson/Ewen 1987, van der Hulst 1989, 1994ab, 1995 c, forthc., Ewen 1995).

In section 1 I start with a general discussion of spoken and sign language units from both an articulatory and phonological point of view. Adopting a term from Uyechi (1995) I head this section 'the transfer problem' since the issue concerns whether and, if so, how we must use spoken language-based theoretical concepts in the domain of sign phonology.

Accepting the general insight that signs are composed of units like Place, Handshape and Orientation, section 2 will argue in favor of positing dependency relations between these 'packages of information'. This level of structure is referred to as the *macro-organization*. In part, this section will also be involved with the *micro-organization*, i.e. the featural organization within the units Handshape, Place etc. Section 2 slightly modifies the model I have proposed in van der Hulst (1993), previews van der Hulst (1995a) and aims at clarifying issues to researchers that are not specialized in phonology.

Section 3 briefly discusses the role that dependency relations play in two-handed signs, summarizing the main points of van der Hulst (1995b).

In the concluding section I suggest that significant correspondences between the phonology of spoken and sign language do not lie in the actual shape of the structure or in the number or labelling of the nodes, but

rather at a more abstract level where we formulate principles that govern recurrent structural patterns. Throughout this article I hope to show that phonological generalizations concerning the structure of signs and processes that affect this structure can be adequately formulated with reference to the kind of organization that principles of Dependency Phonology dictate. Asymmetries involving structural complexity of nodes or what kind of dynamic properties a monomorphemic sign may have, or what may spread in assimilatory processes can be systematically related to "appointing" certain units as heads and others as dependents. Since similar findings can be reported for the analysis of spoken language phonology (cf. Ewen 1995), it seems reasonable to expect that crossmodality universals can be formulated with reference to such abstract aspects of language structure.

1 The transfer problem

1.1 Building blocks

Studying the structure of sign languages, one could try to develop an entirely new terminology, but making analogies with spoken language phonology is difficult to avoid, and also undesirable. Although it is in principle entirely correct to state that the construction of a model for the phonology (and grammar) of sign language must be based on evidence from languages in the gestural-visual modality alone, we ultimately wish to develop a model of the language capacity that generalizes over language structure in *all* modalities. Developing a totally new terminology prevents one from setting up false analogies, but, at the same time, it may conceal crossmodality universals.

In order to be as explicit as possible with respect to how I see the analogies between spoken and signed phonological constructs, I start out with comparing both modalities at the articulatory level. I do this in order to show that the use of a common terminology is justified, but also to point out that the phonetic possibilities are significantly different. The differences lie not only in the obvious fact that the articulation of sounds takes place in the mouth and that of signs before and at the body, but also in the fact that the phonetic spaces that are available to sign language appear to be much richer, thus making available more phonological distinctions. I will argue that the availability of a richer inventory of phonological features and thus of a larger set of *segments* might ultimately lead us to an explanation for the fact that sign language makes no use of the possibility to group segments into a unit that is analogous to the syllable in spoken languages.

Let us start out, then, with making reference to the simple wisdom that speech sounds can be described in terms of four articulatory parameters:

(1) Articulatory parameters of speech sounds
   a. The active articulator : lower lip, tongue
   b. Place of articulation : upper lip, teeth, ...
   c. Manner of articulation : stop, fricative, lateral, nasal, ...
   d. States of the glottis : voice, aspiration, glottalization, ...

With respect to sign language, we may assume the following parameters to be relevant:

(2) Articulatory parameters of signs
   a. The active articulator : one or both hands
   b. Place of articulation : head, trunk, ...
   c. Manner of articulation : type of movement
   d. Non-manual aspects : facial aspect, body posture ...

It seems likely that (2d) involves more than one parameter. Let us concentrate on (1a-c) and (2a-c) and assume for the moment that these are in some sense analogous, simply because for both modalities we can say that:

(3) *manner* specifies how the *active articulator* acts with respect to the *place of articulation*

I will now show that an important and immediate difference exists between spoken and sign language in the phonetic richness of the active articulator.

Let us investigate the properties of the articulators in spoken language, i.e. the lower lip and the tongue. The choice between lower lip and tongue is potentially distinctive when the place is dental because this place can be reached by the lower lip (forming labiodentals) or the front of the tongue (forming interdentals). Thus one might argue that it is necessary to specify the choice of articulator if the place is dental. For all other places the choice of articulator is predictable (i.e. the tongue).

A second situation in which one might argue that the articulator must be mentioned is when its shape can be varied. This applies in two cases for the tongue. Firstly, when sounds are produced in the front of the mouth (ranging from teeth to palate) contact can be made with either the tip of the tongue (apical) or the blade (laminal). Secondly, it has been said that the tongue body can be shaped to produce different types of coronal

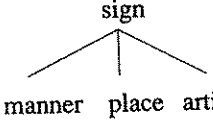
fricative sounds (called groove and slit fricatives). In all other cases the shape of the tongue is predictable on the basis of the choice of place.

For each of these cases, however, phonological feature systems have been proposed that make reference to the articulator entirely *un*necessary. Labiodentals can be distinguished from bilabials in terms of a manner feature like [strident]. The apical/laminal and groove/slit oppositions can also be seen as involving some kind of manner feature. Whatever the merit of these "place-only" theories, it is clear that, from a phonological point of view reference to the choice or shape of the articulator is minimal if at all necessary in spoken language phonology.

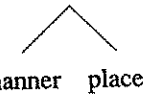
In the case of sign language we find an entirely different situtation. The point I wish to capitalize on is that the hand, as articulator, is a "world in itself". It can take a lot of different shapes, allows handshape changes, and it can point to or contact places in many different ways by chosing different orientations.

Thus, even though (1a-c) are analogous to (2a-c) from an articulatory phonetic point of view, it would seem that the phonological analysis of speech sounds can do without (1a), whereas the corresponding (2a) is in fact quite prominently present in the phonological analysis of signs:

(4) a.



b.



A consequence of the availability of one extra phonetic dimension that creates a sizeable number of phonological distinctions is that the set of possible monomorphemic signs, i.e. units built out of a combination of one value for place, articulator and manner, will most probably exceed that of the set of possible segments in spoken languages. Until we can base ourselves on completely worked out feature theories for both modalities, absolute numbers cannot be given, but it seems obvious to me that the number of possible simple (i.e. monomorphemic) signs exceeds the number of speech segments by far. (An explicit theory of the spoken language segment based on (4b) is offered in van der Hulst 1994ab, 1995c, forthc.)

1.2 Segments and syllables

The discussion in the preceding section and the graphs in (4) seem to suggest that a simple sign forms the analogue to what we refer to as a phonological segment in spoken language phonology. In order to further study the analogies between units and structures in spoken and sign pho-

nology in a meaningful way, it is necessary that I commit myself to rather specific views with respect to representations in both modalities.

1.2.1 In spoken language

We usually refer to a speech event [p] as a 'segment'. We mean by this that the sound [p] is the phonetic exponent of a unordered collection of phonological features that can occur in a single 'syllabic position'; we refer to this collection as /p/. If a language is said to have *branching onsets* it allows more complex feature collections that occur prevocalically and that are not broken up by a 'syllable boundary', e.g. the collection that underlies the phonetic event [pr]. In phonological terms such events are said to be 'bisegmental', /pr/, but it must be understood that bisegmental onsets are not simply random combinations of two segments that can also occur on their own. The set of combinations of two segments that can form a branching onset is extremely limited, especially if we bear in mind that not every cluster that may occur at the beginning of the word is necessary a possible onset; cf. Kaye, Lowenstamm and Vergnaud (1985, 1990).

It has been argued that branching onsets are *so* limited that one might entertain the hypothesis to represent their featural content as one *unordered* set, in which phonological primes occur at most only once distinctively. In this view, some sets of features can be realized cotemporally whereas others require some linearization. The difference has led to saying that onsets can be mono- or bisegmental (or branching), respectively.

The view just given finds an explicit defense in Hirst (1985). The essence of the proposal is to regard all true onsets, whether mono- or bipositional, as 'single segments' (from the view point of their featural content). An onset [pr] would then be a 'single segment' that, if permitted in the language inventory, calls for a certain amount of linearization to be realized:

(5) a. [Labial, Stop, Liquid]

b. Onset

Labial Liquid

Stop

The structure in (5a) is arguably all we need to represent [pr] from a phonological point of view, i.e. an unordered set. We can regard (5b) as a linearized intermediate step toward the phonetic surface.

We have so far considered 'onset material'. In spoken languages, we also find *rhymes* and these are said to form a unit *syllable* with onsets. Perhaps we can look upon rhymes in the same way as we have looked at

the onset, i.e. in terms of a single feature collection of which the members may be cotemperoral or sequential.

This hypothesis is more difficult to work out in view of the currently dominant view that vowels are specified in terms of the same features that also specify place in consonants. Accepting this view and assuming that a vowel – consonant sequence may form one rhyme (e.g. [ap], [ix] etc.) one cannot predict the correct linear order of their place specifications from an unordered set. A way out is to reject the hypothesis that vowel features and consonantal place features are the same and instead propose disjunct sets. In that case we can specify the rhymes [ap] and [ix] as follows:

(6) a. $\begin{bmatrix} \text{Low} \\ \text{Labial} \\ \text{Stop} \end{bmatrix}$ b. $\begin{bmatrix} \text{Front} \\ \text{Velar} \\ \text{Fric} \end{bmatrix}$

(For the purpose of this discussion I take Low and Front to be vowel place features.)

If this way out is considered to be unacceptable we must either claim that a vowel – consonant sequence cannot form a rhyme or we leave open the possibility that rhymes can consist of *two* unordered sets of features. In case we reckon with two 'rhymal' sets, the linearizations of these need not be seen as phonological information since the more sonorous set will always come first. (I assume here that relative sonority can be computed on the basis of the stricture features in the sets.). To chose between these two options we must know more about the composition of rhymes, but to address that issue here would take us far away from the subject matter of this article.

Be this as it may, we cannot maintain that all rhymes can be exhaustively specified in terms of feature sets alone (whether one or two). The reason for this is *length*. Rhymal sets that may characterize a short vowel, may (on a language-specific basis) also characterize long vowels. In that case the language is said to have a vowel length contrast. To allow a representation of length (without using a feature [long] or [tense]) we must hypothesize that rhymes contain a further layer of structure, a skeleton, the idea being that a rhyme containing a long vowel has two positions on the *skeleton*. A bipositional rhyme results automatically if the rhyme is characterized by two feature sets, as in (7a) (if this option is to be allowed; cf. supra), but the bipositionality may also be underlying, as in (7b):

(7) a. [═], [═] => [x x]$_R$
: :
[═] [═]

b. [x x]$_R$
\ /
[═]

It has been been claimed that *length* is a possible property of rhymes only, i.e. that onsets *never* consist of a 'long segment'. This would mean that long segments are found in two cases only. Either we find them as long vowels within the rhyme or as long consonants that belong to a rhyme and a following onset. To explain the absence of length *within* onsets, we might hypothesize that onsets for some reason do not contain skeletal positions, a view that is taken in 'moraic theory' (Hayes 1989). It may be, however, that we need skeletal positions for onsets too in order to distinguish between phonetic events like [pr] (bipositional), and complex segments like affricates like [pf]) (monopositional). It is therefore also possible that the impossibility of having onsets with long consonants is due to another reason.

We have just said, in accordance with common parlance, that sequences of an onset and a rhyme form a *syllable*, but the truth is that the need for a constituent syllable is far from obvious. At least one point strongly argues against such a unit. As is well-known, onsets play no role in the construction of prosodic structure, i.e. foot construction, whereas the internal structure of rhymes may be relevant in languages that have so called 'quantity-sensitive' stress.

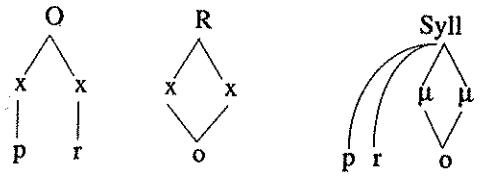
If a level of syllable structure is postulated one would expect foot construction to be sensitive to the complexity of the syllable node (i.e. to the presence or absence of onsets), rather than to the complexity of the rhyme node which is not locally accessible. It therefore seems reasonable to say that foot construction is directly based on rhymes cf. Kaye, Lowenstamm and Vergnaud (1985, 1990):

(7) F F
/\ /\
ORORORORO R

We can now define the notion rhyme as the constituent that forms the interface between featural material (i.e. content) and prosodic organization. The issue as to whether the syllable must be recognized deserves a

careful examination of arguments in favor of this node. Such a discussion, however, should perhaps be undertaken by those who wish to defend the syllable, rather than by those who claim it is unnecessary. The view that we have just presented can be quite easily translated into the so called 'moraic theory of the syllable'. The central claim of this theory is that the syllable contains featural material that is associated to subsyllabic positions called moras whereas it may also contain material that is directly linked to the syllable node. One can then say that when syllables are grouped into feet only the moraic daughers matter. It will not come as a surprise that mora positions correspond point-to-point with rhymal positions, whereas featural units that are associated directly to the syllable in the moraic view are those that form an onset in the onset – rhyme approach:

(8) a. onset – rhyme theory b. mora theory



The differences between the two theories, then, lie exclusively in how the prosodically *irrelevant* feature material is handled. In the OR theory, this material is considered to form a unit, labelled O; in (8a) I have chosen a variant of the OR theory that recognizes skeletal positions in the onset, but we have mentioned earlier that a variant in which featural units link directly to the node O can be defended too. In the moraic approach featural units that are not dominated by a mora are directly linked to the syllable node.

The two theories converge with respect to the representation of the feature material that is prosodically relevant, assuming that we do not confuse labeling choices (e.g. 'μ' instead of 'x') with theoretical claims. Both in the OR and the moraic tradition, we find explicit defenses of the hypothesis that the prosodically relevant unit has at most two positions.

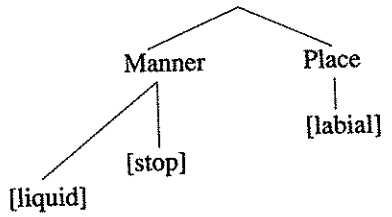
At this point we can make a choice with respect to defining the notion *segment*. Firstly, focussing on content, we can define a segment as a wellformed unordered collection of features, irrespective of whether this combination can be realized on one position or two. Secondly, we can take structure into account and decide to define a segment as a feature combination that can be realized on a single position. The second definition comes

closest to the traditional notion of segment. Thirdly, we can decide to use the term segment for units on *every tier*. In line with this practice we can talk about *skeletal segments* and *featural segments* and so on. This usage of segment is implied by the term *autosegmental* phonology: each feature or unit that is granted a separate tier acquires segmental status *on that tier*. I will henceforth use segment in the first sense. Cf. also Wilbur (1993) for a discussion of different usages of the term segment.

Before turning to sign structure, I will briefly discuss how featural material associates to skeletal positions. We assume here that the features (or tiers) group into classes much in accordance with the articulatory grouping given in section 1.1. In current models of phonology feature groupings have been justified *on phonological grounds*, although the details of available proposals differ greatly. For illustative purposes I use here a trimmed downversion of my own model (van der Hulst 1994ab, 1995c, forthc.) in which features are grouped into the classes Manner and Place. Within these major groups various subgroups are distinguished, but these finer details of the model will be suppressed here.

Thus, assuming the Hirst-hypothesis, a feature tree for [pr] could be something as in (9); to make it clear that there is no linear order I place every feature (i.e. tier) on a different line:

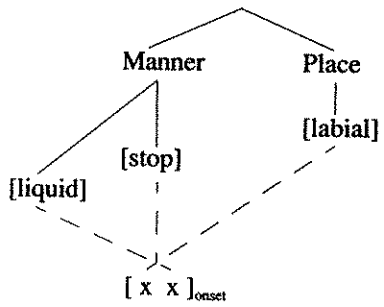
(9)



It is important to emphasize that neither the groups nor the features that they dominate are linearly ordered. It is only when featural content is associated to skeletal positions that linearization may result.

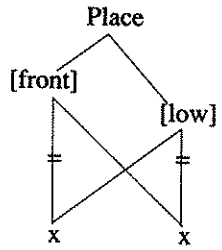
We can now imagine two modes of content – skeleton association. The first would be to associate the root node of the feature tree to the skeletal position(s). This is the standard view. The second possibility is to associate the terminal nodes of the feature trees, i.e. features themselves, to these positions. It would seem that the Hirst-model (translated to a non-linear model) requires the second option since we could otherwise not achieve the desired sequencing:

(10)



In approaches which do not incorporate the Hirst-hypothesis it has also been suggested, however, that the first option creates unsurmountable problems, for example if processes of diphthongization are considered. I present the argument here in a condensed form, referring to Hayes (1990) for a detailed discussion. Hayes (1990) shows that the dipthongization from [e:] to [ai] appears to call for delinking the relevant features from each of the two rhymal position independently:

(11)



Delinking features from only one of the positions that constitute a long vowel is impossible if features are associated to skeletal slots via the root node of the feature tree. Recently, Padgett (1995) also argues for the untenability of the traditional view, although he draws somewhat different conclusions.

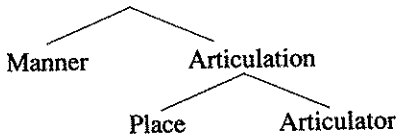
1.2.2 In sign language

In accordance with what one might expect on the basis of the articulatory aspects of signs that we mentioned in section 1.1, features of signs also group into classes. On the one hand one might think that this idea has been borrowed from models for spoken language (cf. supra), but in would seem more appropriate to say that the idea of grouping is directly rooted in the earliest work on sign phonology in Stokoe (1960), who argued that signs are composed of feaures that characterize three aspects of signs:

(12) *Articulatory parameters of signs*
a. Handshape (i.e. the active articulator)
b. Location (i.e. the place of articulation)
c. Movement (i.e. manner of articulation)

In Stokoe's view these three aspects are cotemporal. In this respect, Stokoe proposal is essentially (and formally) identical to that illustrated in (9). In (13), where we represent the groups in a tree format, the proposal is made that Handshape and Location form a structural unit which is the sister of Manner. I have labelled this unit *Articulation*. This grouping makes intuitive sense since Manner expresses the relation between the Place and the Articulator (a node label that I borrow from Brentari, forthc.), but I express it somewhat differently in section 2-4:

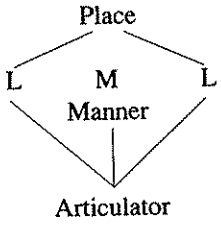
(13)



So far it would seem that the representation of a sign formally resembles that of a single segment in spoken language, according to the first definition (i.e. a permitted grouping of features).

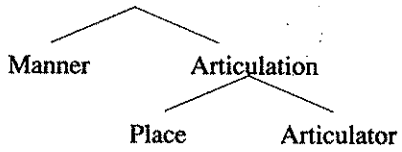
Subsequent developments have changed Stokoe's theory in two ways. Firstly, a further group, *orientation*, has been proposed (in Battison 1974), which Sandler (1989) argues to form part of the Articulator node (which she calls *Hand Configuration*). Secondly, something like a skeleton was introduced in Liddell and Johnson (1985) and subsequently adopted in Sandler (1989), Perlmutter (1992) and Brentari (forthc.).

Ignoring certain differences, we can say that in all (except the last) these proposals two types of units occur on the skeleton. One type represents the beginning and endpoint of movements (in 14 represented as L for location), while the other stands for the movement (M) itself. Sandler, for example, proposes a model that we can represent in a simplified way as in (14):



Place and Articulator features associate to the skeletal slots (partly directly and partly via their mother, a point I ignore here), and features of manner of movement are specified directly on the M skeletal unit.

Observe that the difference between (13) and (14) does not lie in the number of feature groups; each proposal has three groups. The key difference lies in the fact that in (13) the M has been "extracted" from the skeleton and integrated in the featural part of the sign. In addition, (13) incorporates higher-order grouping of the three feature groups. What is missing in (13) so far is a skeleton. If we accept the arguments in favor of formally recognizing the beginning and endpoint of signs, we end up with (15):



[x x]

The diagram in (15) represents, in a nutshell, the model proposed in van der Hulst (1993). In section 2 I will discuss this model in more detail, but before doing that, I would like to draw the consequences of our discussion for the use of terms like segment and syllable in sign phonology.

We have seen that we cannot make analogies without defining the terms in both modalities, thus committing ourselves to quite specific hypotheses (which may turn out to be untenable). In spoken language, the term segment has been defined (abstracting away from the notion position) as a set of features forming a single feature tree or as a skeletal position with all its associated features. In sign phonology, monomorphemic signs *typically* consist of *two skeletal positions* which largely associate to the same set of features. This reflects that signs typically have some form of movement. Thus we see that signs are typically *mono*segmental if we abstract away from the skeletal positions (definition 1) and bisegmental in much the same that long vowels (or diphthongs) are bisegmental: there are two positions, but they share most of their featural content (definition 2).

We now turn to the use of the term syllable. In view of the above claim that spoken languages actually do not have syllables, we should perhaps reformulate the question and ask whether the skeletal unit in (14) forms an interface between featural material and prosodic organization, much as the rhyme in spoken language does. If it does, as I would like to

suggest, we could conclude that the unit in question is analogous to the rhyme in spoken languages. A second conclusion we may draw is that sign languages do not seem to have a phonological analogue to onsets. I have suggested in van der Hulst (1993) that one might regard the phonetic non-distinctive transitions between different signs as analogous to onsets, which would still imply, however, that sign languages do not have *phonological onsets*. This has the further consequence that the differences between OR and moraic theories of the "syllable" are irrelevant to sign language phonology, because they essentially differ with respect to the representation of onsets. Cf. Sandler (1995) for this point.

As of this point, we might arbitrarily decide to label the skeletal bipositional unit 'syllable'. In that case we define this term as 'the unit that forms the interface between featural material and prosodic structure'. But if we do that we should actually replace the term rhyme for spoken language by the term syllable, bearing in mind that onset material falls outside this unit.

This is not a trivial point. Using the term 'syllable' in the traditional sense of an onset – rhyme package in sign phonology raises expectations with respect to the internal structure of sign 'syllables', viz. that there will be something like an onset – rhyme split. I have argued that there is no evidence for onsets in sign phonology. From this it follows that we either use the term rhyme in both modalities (avoiding the term syllable alltogether) or we redefine the term syllable and avoid the term rhyme.

2 The organization of one-handed signs

We now turn back to the model in (15). In this article I have very little to say about the internal structure of the node Manner. In section 1 I stated that the features dominated by this node specify how the hand relates to the place. I suspect that among the dimensions that might be relevant (i.e. phonologically distinctive) in this node, 'types of contact' is the most prominent one; cf. Friedman (1977) for a list of candidate features. I do not think that we must also reckon (all) features for shapes of movement to this dimension, since there are other possibilities, one being that certain so called distinctive properties of shape (such as arc) can be derived from other properties of the sign (cf. Uyechi 1995, van der Kooij 1994) or be represented in terms complex skeleta (cf. Greftegreff, forthc.). At the end of this section, it will be suggested that the specification of the joint that is involved in 'path' movement (shoulder, elbow etc.) must perhaps be specified under this node.

The focus of van der Hulst (1993) is on the nodes that are here

called Place and Articulator. With respect to the internal structure of these nodes I largely follow Sandler (1989, and subsequent work). I use here the term Articulator, suggested in Brentari (forthc.) rather than Hand Configuration (as I do in van der Hulst 1993) because, as we will see, the hand's orientation (which does not literally contribute to its configuration) (partly) falls under this node. In the next two sections I will discuss the internal organization of Place and Articulator. Before we get to that I will make a few general remarks about the notion *head* and *dependent* which play a rather crucial role in the subsequent discussion.

In most linguistic theories it is assumed that the compositional structure that underlies the morpho-syntactic and phonological organization of utterances can be properly represented in the form of *tree structures*. Many theories make the additional assumption that non-atomic (or non-terminal) constituent nodes are labelled in a way that is determined by one of their daughters. This daughter is called the *head*, while other daughters are called *dependents*. A further claim limits the number of dependents to *one* or, if more than one dependent is admitted, adjoins these at different levels so that the non-dependent daughter is the head of a number of inclusive constituents.

Head – dependent asymmetries play an important role in generative syntax. In generative phonology scattered references to the notions 'head' and 'dependent' have become more frequent over the years, but a unifying picture has not emerged, neither with respect to the use of these notions at various levels of phonological representation (i.e. segments, syllables, feet and so on), nor with respect to their use in both morpho-syntax and phonology. The only attempt to systematically investigate the role of head – dependency relations in phonology (and morpho-syntax) is found in the work of John Anderson and his collaborators (culminating in Anderson/ Ewen 1987). The phonological model that emerged from these works, known as Dependency Phonology, has inspired various more recent approaches such as Government-based Phonology (Kaye, Lowenstamm and Vergnaud 1985, 1990), Radical CV Phonology (van der Hulst 1994ab, 1995c, forthc.) and many other 'unlabelled' approaches (cf. Ewen 1995).

Dresher/van der Hulst (1995) capitalize on the role of head – dependent relations in phonology, arguing first of all that this notion does play a fundamental and rather similar role in both mainstream generative phonology and dependency-based approaches. They then propose a typology of such relations and investigate the recurrent properties that are associated with these.

A distinction they make is that between an 'α–α' and 'α-β' rela-

tion. The former involves a relation between two *isotypic* constituents, for example between two place features forming a complex articulation or two syllables forming a foot, whereas the latter relates two non-isotypic constituents, such as the manner and place gesture forming a segment, or a nucleus and coda forming a rhyme.

The asymmetries between heads and dependents that can be detected work out differently for both types of relations and Dresher/van der Hulst (1995) is no more than a first attempt to identify the relevant properties. An important asymmetry in case of α–α dependency involves *complexity*: the complexity of the dependent α can never exceed that of the head and is typically severely reduced. A clear example of this involves the fact that dependent syllables often must be less complex than head syllables with respect to the number of vowel constrasts that may occur in their nuclei. α-β asymmetries are less well understood. What appears to be important here is that the head itself is atomic and thus *not* complex in principle, whereas the dependents need not be atomic. α-β relations also typically allow adjunctions at different levels.

Within the analysis of spoken languages it is now accepted (especially in dependency quarters, but perhaps more generally as well) that the dependency relations and their associated properties cut through different modules of the grammar, even though many questions regarding the 'cross-module identity' of the relevant concepts remain unanswered to date. The central thesis of van der Hulst (1993, 1995ab) is that these concepts also cut through modalities and that sign language morpho-syntax and phonology reveals organizational properties that can be captured in terms of dependency relations.

2.1 Place and articulator

The search for phonological generalizations has produced two important and well-known results:

(16) a. *Place*
If the hand moves it moves *within* a subspace

b. *Articulator*
Dynamic aspects of the articulator do not involve changes in finger selection

Both claims were first thought to express structural properties of morphemes, but most researchers now claim that they are valid with respect to the phonological unit that (15) represents, and that morphemes

typically consist of one such unit. (This is much like the typical monosyllabicity of morphemes in Chinese; cf. Corina and Sandler 1993 for relevant discussion and further references.) We will see that these generalizations play an important role in my proposal for the internal organization of the nodes Place and Articulator, especially for the use of the notions *head* and *dependent*.

2.1.1 Place

Many signs involve a movement of the hand as part of their phonological structure. The claim in (16a) presupposes that the articulatory signing space can be divided in a fixed number of subspaces and states that movement of the hand must take place within a subspace. (16a) states, in other words, that the unit in (15) can be specified for only *one* subspace.

According to many researchers, movements can be specified in terms of three coordinates. I follow here the views of Greftegreff (1992, forthc.):

(17) *Movement coordinates*
a. high/low
b. ipsilateral/contralateral
c. proximate/distant

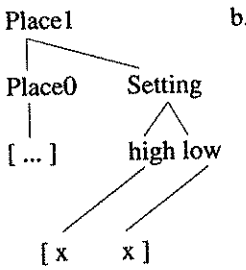
Within each subspace, (17) allows one to characterize a limited number of movements.

The problem with (16a) is its seeming unfalsifiability. What we need is an independent characterization of *subspace*. The central idea is that the set of distinctive subspaces consist of those spaces that are potentially contrastive between signs that are otherwise (manner- and articulator- and nonmanualwise) identical. Furthermore, as in spoken language, facts of physiology and perceptual or acquisitional studies may help to converge on the correct set of distinctive subspaces, as well as their relative markedness. The claim in (16a) rests on a perhaps preliminary consensus with respect to what the distinctive subspaces are and it is therefore not easy in practice in each specific case to decide whether a signs contradicts it. This, however, does not make (16a) unfalsifiable, in principle. (I abstract away here from the possible distinctiveness of settings, i.e. subdivisions of subspaces.)

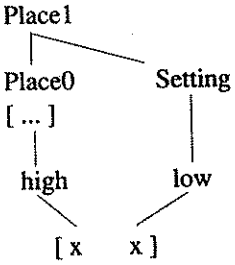
Van der Hulst (1993) proposes to represent movement (within a subspace) in terms of *split coordinates values* (following a line of work that Sandler (1995) has termed no-movement theories; cf. Stack 1988, Wilbur 1993, Hayes 1993, Uyechi, forthc. to mention just a few). Here I

represent this as in (18a) in terms of a branching *setting* node (rather than as in (18b), which I did in the 1993 article), following a suggestion by Corine Ballering (p.c.) and in van der Kooij (1994), since I did not give any specific reason for placing the first setting under the subspace node:

(18) a.



b.



The diagrams in (18) makes a distinction between vertical and slant lines. The vertical line above 'subspace' (formally labelled place0) is meant to express that the subspace is seen as the *head* of the Place unit and Setting as the dependent. This allows us to identify 'invariance' (i.e. the impossibility to branch) as a property of the head. At this point this seems ad hoc, but I will show below that we can identify invariance as a recurrent property of heads.

In (18) setting values are associated to skeletal positions. The linear order of association is distinctive, since the hand can move in both directions for all three coordinates. (This kind of distinctive association does not occur in spoken language.) This can be represented in two ways. Firstly, we can say that association itself is underlyingly present. The second option is to represent one of the coordinate values as the head and then say that association is 'head directed' (i.e. head-first or head-last). At present I see no principled reason for choosing between these two options.

Van der Hulst (1993) proposes a node Hand Position as a dependent of Place2. This node was meant to specify the position of the hand vis-a-vis the target of movement. I discuss this node in section 2.2 in conjunction with the better-known node Hand Orientation which is usually grouped together with Hand Shape (following the model in Sandler 1989).

There is a further aspect of movement that deserves our attention, although I have no definite proposal to contribute at this point. When the hand moves in a subspace this may be the result of joint flexion at the shoulder, the elbow or the wrist. If we focus on the finger-part of the hand, we might even say that at least certain kinds of 'path' movement can be articulated with the joints that connect the finger to the palm part of the hand. This point, which I believe to be correct, makes the term *path move-*

ment less appropriate. Below, I suggest the term *articulator movement.*

Thus, considering a movement in neutral space from distal to proximal with a body orientated palm, we can imagine four possible gestures that are compatible with this description, i.e. the movement can be executed by flexion at four points:

(19) a. *Shoulder* b. *Elbow* c. *Wrist* d. *Base (finger) joints*

Naturally, actual movements may very well activate more than one of these flexion points at the same time. With respect to the lower joints, we might even consider to reckon with flexion at the non-base finger joints.

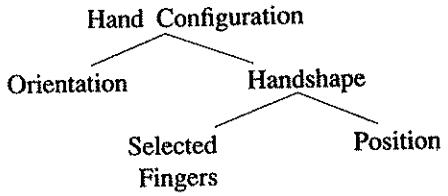
A movement with the ulnar or radial lateral side of the hand facing the direction or target of movement allows the same options, although a sideway movement of the fingers at the base (i.e. metacarpophalangeal) joints is articulatorily somewhat limited. Even a front/back movement can be articulated at the finger level. We do this when we make a pointing gesture by stretching the finger from curved position.

The question arises whether these articulatory choices are potentially distinctive or merely function to vary from normal sign to "whispering" and "shouting". The shoulder joint seems exclusively functional in this dimension and otherwise merely relevant as "supporting" a flexion of the lower joints.At present, it is not clear to me whether this kind of information must be phonologically specified, and if so, where. To establish phonological relevance we need minimal pairs or at least signs that are only wellformed if the flexion occurs at a specific joint. E.g. in SLN SET-THE-TABLE a dorsal flexion at the wrist is necessary. If we take this to be a sufficient criterion for phonological relevance, we have to decide where it must be specified. Intuitively it seems to fall under the heading "how the hand moves with respect to place", i.e. under Manner. I leave this question for further research, having raised it hoping to initiate relevant discussion.

2.1.2 Articulator

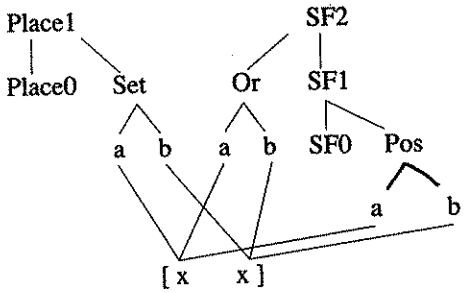
Sandler (1989) proposes a node Hand Configuration which subsumes the shape of the hand and its orientation. Handshape is further subdivided in a node Selected Fingers and a node (Finger) Position. The latter specifies whether the fingers are bent, curved and whether they make contact with the thumb:

(20)



In van der Hulst (1993) I follow this proposal and focus on the issue of headedness, taking (16b) as my starting point. If, as in the case of Place, invariance is a trait of headedness, Selected Fingers must be the head node of Hand Configuration. The dependent nodes Orientation and Position allow branching to represent hand-internal movement or orientation change. Beginning and end point of these branching nodes associate to the skeletal points:

(21)



A difference with van der Hulst (1993) is that I no longer wish to assume that a bipositional skeleton only occurs in case of a branching Setting node. Without discussing the issue here, I follow van der Kooij (1994) in assuming that the skeleton of signs is universally minimally bipositional.

I will specify the relation between Place2 and SF2 in section 2.3, involving the Manner node in that issue. First I would now like to briefly discuss the internal structure of the Position node. I draw here on van der Hulst (1995a) where the node is referred to as *Finger Configuration* (following Ann 1992).

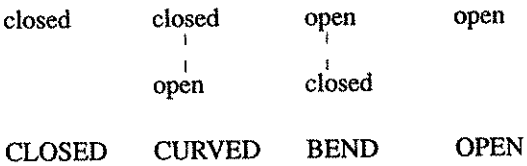
In many traditional feature systems we find features specifying bending and curving of the fingers as well as a feature such as [±open] to specify the relation between fingers and thumb. More recent feature systems conflate these two dimensions. Corina (1990), for example, proposes the following system:

(22)

	+bend	-bend
+curved	CLOSED	CURVED
-curved	BEND	OPEN

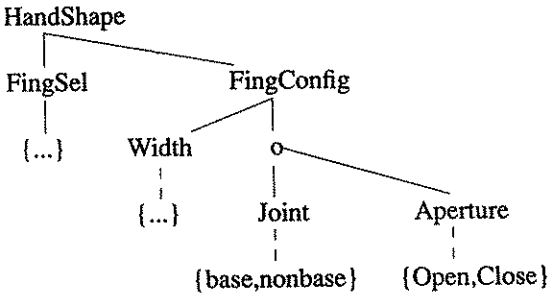
Sandler (1995, in press) proposes a dependency-based system with two unary features, *open* and *closed* (cf. also Blees 1994):

(23)



The proposal in van der Hulst (1995a) is to return to separating bending/curving from closure. The difference with traditional systems is that I add the concept of feature grouping:

(24)



I suggest that hand-internal movement can only involve a branching aperture node, which is therefore represented as the dependent node. I thus explain that such movements cannot go from bend to flat, a fact that must be stipulated in other approaches. This, then, is the third time we encounter invariance as a property of the head.

Making the assumption that the absence of a specification for Joint gives *fist* (if the aperture is *close*) and *flat hand* (if aperture is *open*) this approach allows six possible hand-internal changes, all of which occur with the FingSel node specified as 'broad' (i.e. all fingers selected):

(25)

Aperture	closed		open
Joint			
–	fist	<-->	flat hand
base	closed beak	<-->	open beak
nonbase	O	<-->	C

The examples in (25) involve all fingers selected, but the idea is that the same aperture relations apply to other values for the selected finger node.

A problem for this approach are so called *partial hand-internal movements*, like clawing (where we go from 'unspecified joint' to nonbase joint) and winging (where we go from 'unspecified joint' to base joint); in (26) and (27) 'o' represents the body of the hand and the dashes the finger parts:

(26) a. Clawing b. Winging

For discussion of these cases I must refer to van der Hulst (1995a). Under FingConfig I specify a further node which contains features like [adduct] (i.e. non-spread) and perhaps [crossed]. Again I refer to van der Hulst (1995a) for further discussion of this node.

2.2 Hand Position and Hand Orientation

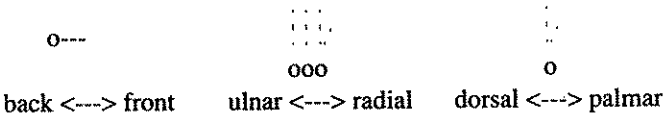
We now turn to a question raised earlier, viz. how and where we specify the orientation of the hand. One understanding of orientation reckons both with orientation of the palm and orientation of the fingers. In the KOMVA (1988) and Hamburg notation systems (Prillwitz et al. 1989), both parameters get values that are relative to the body of the signer. In the work of Sandler (1989) we only find the parameter of palm orientation with a limited number of values.

The proposal in van der Hulst (1993) adopts Sandler's Hand Orientation node as a sister of Handshape, but I do not discuss the relevant features. The Place node in that model dominates a further node called Hand Position, defined as specifying the part of the hand that faces the direction or target of movement. This nodes has three values (frontal, lateral and indexical), the idea being that the choice between dorsal or palmar side for frontal, and ulnar of radial side for lateral is made in term of the node Hand Orientation.

For the present discussion I will slightly adjust the original pro-

posal for Hand Position (following ideas in Uyechi, forthc.) and say that it specifies *exactly* which part of the hand faces the direction or target of movement:

(27) a. indexical b. lateral c. frontal

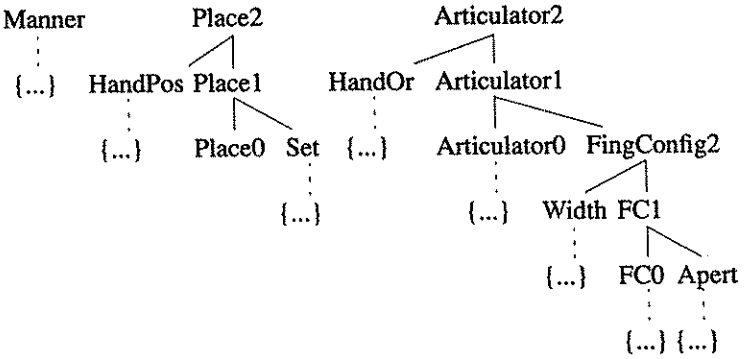


This extension of the Hand Position node does not of course make the Hand Orientation node superfluous. If, for example, the front of the hand faces movement from proximate to distal, we do not know whether the palm of the hand is down (as in SLN DRIVE A CAR) or up (as in SLN GIVE). Likewise, if the palm faces the trunk, we do not know whether the fingers point sideays, up or down. We therefore maintain this node which, as Sandler (1989) argues forms a unit with Handshape, although I do not fully understand how its featural content interact with that of the Hand Position node.

2.3 Secondary movements

So far we have argued for the following overall structure:

(28)



I have proposed to represent invariant aspects of simple signs as heads of feature groups. Thus, choice of subspace, finger selection and joint selection are taken to be heads of the groups Place, Articulator and Finger Configuration, respectively. Dependent nodes are those that potentially specify movement:

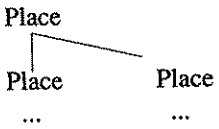
(30) a. Setting : articulator movement
b. i Orientation : orientation change
ii Width : spreading, rubbing
iii Aperture : opening, closing

The movements in (30b) can be combined with articulator movement in (30a), both repeated and unrepeated. This approach leaves certain types of repeated secondary movements unaccounted for:

(31) a. i Circling, arcing
ii Nodding (on a lateral or indexical path)
iii Pivoting (on a frontal or indexical path)
b. Wiggling

Here I do not defend a specific proposal for Wiggling and focus on the movements in (31a). Stack (1988) proposes that movements as in (31a) are repeated articulator ('path') movements which can be combined, as secondary movements, with a (primary) articulator movement. Without going in details, I would like to put forward a proposal here that differs somewhat from that in van der Hulst (1993), and in fact follows more closely the original insight of Stack. The idea is that the Place node can be complex:

(32)



This proposal does not necessarily entail that the set of secondary path movements is as rich as that of primary path movements. A fundamental and recurrent pattern of linguistic structure is that if two nodes of the same type are combined, the dependent typically allows only a subset of all the possible expansions (Dresher and van der Hulst 1995, forthc). In the case at hand this means that the dependent Place node only allows fairly simple straight and circular movement.

2.4 Dependency relations between Manner, Place and Articulator

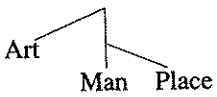
We now must determine dependency relation at the macro level, i.e. between the units Manner, Place and Articulator. In van der Hulst (1993) I only considered the relation between Place and Articulator, arguing that the former is the head. The main reason for this choice was a spreading asymmetry between Articulator and Place. Sandler (1989) discusses cases in which the Articulator node is involved in spreading processes in com-

pounds. Place spreading is not reported and does perhaps not occur. I took this as evidence for the Headhood of Place arguing that spreading behaviour is a recurrent property of dependents.

Since the manner node did not receive much attention (and, in fact, was added to the core of the proposal as an 'afterthought'), the relation between that node and the two others was not discussed.

If the analogies between Manner in spoken and sign phonology that we saw in section 1 are taken seriously, we may look at spoken language models and see how the Manner node is treated there. Van der Hulst (1994abc, forthc.) proposes to regard Manner as the head of segmental structure. The principal reason for this is that Manner (which comprises Stricture distinctions such as vowel vs. consonant, sonorant vs. obstruent consonant, nasal vs. liquid consonant and so on) determines the syllabic organization of segments, i.e. the position a segment occupies in the Onset – Rhyme organization is determined by its manner properties and not by its place properties. Let us consider, then, the possibility of treating Manner in sign phonology as the head too. This gives us a way of bringing home the recurrent claim that 'movement' is perceptually central to the sign, at least to the extent that our Manner node expresses properties of movement:

(33)



(33) still offers a basis for the spreading assymetry, if we maintain that higher dependents spread more easily than lower dependents. We find support for this in the internal organization of the Articulator in that evidence has been supplied for spreading of Hand Orientation, but not for Finger Configuration (Sandler 1989). Van der Hulst (1994a) argues that eagerness to spread in spoken language phonology decreases in proportion with closeness to the head, the head itself being the champion of immobility.

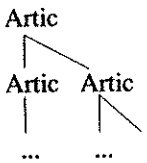
3 Two-handed signs

As a final demonstration of the use of dependency relations, I will briefly discuss a proposal made in van der Hulst (1995b) for the representation of two-handed signs. The central (and simple) idea in that article is that the weak hand is represented as a dependent of the strong hand. A further point that is proposed is that the weak hand is so represented in *all* two-handed signs, i.e. those in which the weak hand is a copy of the strong

hand and those in which the weak hand functions as the place of articulation.

This proposal creates a structural possibility that we have also proposed for Place, i.e. a complex unit formed by two nodes of the same type:

(34)



I argue that the dependent status of the weak hand explains the limited possibilities of Handshape choices and thus the emergence of unmarked shapes in two-handed signs in which the weak hand is the place. Secondly, the representation of two-handed signs as a complex Articulator node explains why the two hands cannot both have their own Place and Manner properties. Thirdly, the weak hand may be involved in assimilation processes (as demonstrated in Sandler (1989, 1993), which strenghtens the idea to represent it as a dependent.

For the specifics of this treatment of two-handed signs I refer to van der Hulst (1995b) and to van der Hulst and Sandler (1994) where the proposal is compared to that of Sandler (1993), and to Brentari (1990, forthc.), Brentari/Goldsmith (1993) who defend a rather similar position.

4 Summary and conclusion

The goal of this article has been to outline a model of the phonological structure of signs that is based on the idea of feature grouping and dependency. (I also assume that features are unary, but this aspect has not been focused on here.)

We have identified *invariance* and *immobility* as a recurrent property of heads and their opposites as properties of dependents. Where dependency relations hold between units of the same type, we see that the complexity of the dependent is lower than that of the head, which shows the full array of possbilities. For a discussion of head – dependent asymmetries in a broader context I refer to Dresher and van der Hulst (1995).

With respect to correspondences between phonological structure for spoken and sign languages, I have attempted to reveal the 'true' analogies and proposed a meaningful crossmodality use of terms like syllable (or rhyme) and segment. The use for these terms that I have suggested respects striking crossmodality differences such as the phonological absence of onsets in sign phonology and of an Articulator node in spoken

phonology. Such differences do not undermine the idea that structure in both modalities is the product of a single language capacity. This capacity ('UG') therefore cannot be taken to predetermine specific lists of features organized in specific structures. Rather, it makes available a 'method' for parsing phonetic scales into monovalent features (which form binary groups) and the structural principle of the head-dependency relation including the typical properties associated with this relation.

Notes

I would like to thank Els van der Kooij and Wendy Sandler for helpful comments and their insistence on clarification. According to them the article contains far too few examples and illustrations.

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