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Distributed Morphology

An oratio pro domo

Marijke De Belder
Carl Von Ossietzky Universität, Oldenburg
marijke.de.belder@uni-oldenburg.de

Jan Don
Universiteit van Amsterdam
j.don@uva.nl

Abstract

In this paper we aim to explain and illustrate the theory of Distributed Morphology for non-specialists. The goal is to take away any misunderstandings and to provide some illustrations of the workings of the theory, mainly on the basis of data from Dutch. Distributed Morphology is a theory of morphology that embraces the so-called Separation Hypothesis: derivation – the forming of a new word by some abstract operation – is separated from affixation – the realization or spell-out of the abstract operation by the addition of some phonologically specified element. The means used by DM to implement the Separation Hypothesis is by late (after syntax) insertion of affixes. Furthermore, Distributed Morphology claims that there is no separate component of the grammar where word-formation takes place. The operations that form new words are the same operations that may create syntactic phrases. Starting from these fundamental claims, we go into some detail of the way Distributed Morphology accounts for different morphological patterns. The paper also points at some cognate, but alternative, approaches to word-formation and inflection. In particular, we briefly address Borer's so-called exo-skeletal model, and the nanosyntactic approach.

Keywords: morphology, distributed morphology, roots, lexicon-syntax interface

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Guest (guest)
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1. Introduction

The aim of this paper is to describe and motivate the research program that has come to be known under the name Distributed Morphology (henceforth: DM). It was originally conceived by Halle and Marantz (1993,1994) as a reaction to lexicalist approaches to morphology (also see e.g. Marantz 1997). The reason for this *oratio pro domo* is that we have noted that there are many misunderstandings and misconceptions with respect to the aims and means of this research program. Furthermore, we believe that apart from explicit theoretical assumptions, the program, as any scientific undertaking, is also guided by some heuristics, and a certain feel for what counts as an interesting explanation. Since these ways of thinking and approaching the research subject remain mostly implicit, this may add to the misconceptions that we sometimes witness.

Such misunderstandings may unnecessarily deepen the perceived gap with other theoretical approaches. We hope to contribute to a better understanding of the program and some of its empirical results by making the theoretical assumptions and the more tacit guidelines more explicit (and hopefully they are recognized as such by other DM-proponents). In the end, we hope that this will add to a fruitful exchange of insights across theoretical boundaries. Finally, we add to this a quick glance at some other theoretical approaches that share most of the assumptions of DM but deviate from it in certain respects. This will serve to clarify the complex theoretical landscape that has quickly developed after the re-invention of morphology in the seventies.

2. What is DM?

2.1 Defining characteristics of Distributed Morphology

The seminal papers of Distributed Morphology appeared in the early nineties of the past century (Halle and Marantz 1993, 1994). The theory was preceded by earlier proposals. Robert Beard (1995) already pointed towards the need for separating morpho-syntactic content from morpho-phonological realization, and the same idea is proposed in the work of Stephen Anderson (1992).

Since the nineties, several features of the framework have been reinterpreted or adapted by individual authors or research groups.[1] Authors may have different interpretations or even opposing views on certain theoretical

1 A lucid introduction to the theory is Embick (2015).

Guest (guest)
IP: 147.96.141.129

assumptions. That being said, three theoretical assumptions already proposed by Halle and Marantz will be shared by anyone working in the framework. As such, they can be seen as defining features. These features are: the post-syntactic insertion of vocabulary items, a vocabulary insertion along the lines of an underspecification mechanism called the Subset Principle and the assumption that the structure of words and sentences are built in the same generative module, called syntax. This last characteristic is also known as 'syntax all the way down'. We will discuss these three features in turn below. We will also note that the framework is a morphemic, realizational approach to morphology. The morpheme is thus an abstract notion.

Late insertion involves the hypothesis that syntax operates with abstract features rather than lexical items. For example, rather than merging the Dutch nominal plural suffixes *-en* and *-s* directly in the syntactic structure, the feature [plural] will be merged on a terminal node in the tree. Only post-syntactically, an operation of lexical insertion will take place. This process involves the insertion of vocabulary items to realize the terminal nodes. So, only after syntax the feature-bundle [plural] will be realized, or spelled out, by inserting either the vocabulary item *-s*, or *-en*, depending on the context. Often, it is not a single feature, but a bundle of several features that merge on a single terminal node. For example, in the Dutch verbal paradigm, there are morphemes consisting of person, number and aspectual features. The vocabulary item *-t* (in e.g. *zij werk-t* 'she work-s') realizes a morpheme consisting of the features [3rd person, sing., pres. indicative]. Such a feature bundle, whether consisting of one or more features, is called a morpheme.

This organization of the grammar explains the exact synonymy of the nominal plural affixes, because semantic interpretation operates on the structure before spell-out (see Figure 1 below). Furthermore, it also makes clear why there cannot be syntactic rules that are sensitive to the phonological form of the items operated on; the phonology of these items only comes in after syntax.

The features that merge in the tree are assumed to come from UG: they are universal and innate. Their order in the syntactic hierarchy is commonly assumed to be universal as well. It is, however, often tacitly accepted that a specific language may only use a subset of these features (cf. Iatridou 1990).

Vocabulary items consist in a phonological form, and a set of features that specify the context for insertion. Interestingly, for functional items, the spell-out procedure is conceived of as a competition between vocabulary items. The vocabulary items of which the features are the closest match to the features of the syntactic node will realize the syntactic node. The closest match is determined via the Subset Principle (Halle 1997): the

Guest (guest)
IP: 147.96.141.129

features of the vocabulary item must be a subset of the features of the syntactic terminal node. In other words, the features of the lexical item can be an exact match for the features of the terminal node or it can be a proper subset thereof, in which case the vocabulary item is underspecified for the features of the syntactic node. In case several vocabulary items compete for insertion, the closest match will be inserted. The closest matching lexical item is the one which shares the most features with the syntactic node and which is still a subset thereof. A lexical item that is marked with a feature that is not part of the feature-bundle of the syntactic node will not be inserted.

For example, consider the following Dutch vocabulary items that are in competition to realize the fused Person and Number morphemes in subject/verb agreement. Dutch inflection does not show any form in which one sees an overt affix for person together with an overt affix for number. As such, it would be assumed that these person and number features either merge as a feature bundle on a single head, that they merge at the syntactic level via head incorporation or that they merge post-syntactically. (We will come back to fusion, and the repercussions for the set of Vocabulary Items in section 3.1):

(1) Person and Number Vocabulary items

-ø	↔	[1st person, singular]
-ən	↔	[plural]
-t	↔	[ ]

Suppose that the syntactic structure that needs to be spelled out contains the feature bundle [1st person, plural]. The vocabulary items in (1) are disjunctively ordered, meaning that the spell-out algorithm will first try to insert the most specific suffix -ø. Since the morpheme contains the feature [singular], the vocabulary item -ø cannot be inserted. Spell-out matches the vocabulary item *-en* with the morpheme, as its feature set is the closest match to the syntactic node, while still being a subset thereof. The insertion is successful, resulting in the addition of *-en*.

Usually, Vocabulary contains a highly underspecified vocabulary item which, as such, can function as a "passe-partout". This is the default or elsewhere vocabulary item. In the above example, we can see that the vocabulary item *-t* is such a default. It has no features, which yields it the typical 'elsewhere'-case: if no other vocabulary item can be inserted, then fall back on the insertion of *-t*. The Dutch definite article *de* is another such example: it appears in many different morpho-syntactic contexts,

Guest (guest)
IP: 147.96.141.129

including masculine and feminine noun phrases and singular and plural contexts.

The idea that morphology is syntax involves the hypothesis that there is only a single structure building module in the linguistic device, called syntax, which builds both words and sentences. Morphology and syntax are thus not assumed to be separate modules. Words are simply the lowest pieces of structures in the syntactic tree. We come back to this view in section 3.1.

In Distributed Morphology, exponents of both inflection and derivation are realizational: they realize the feature sets on the terminal nodes. This formulation also makes clear that these exponents do not *bear* the features: the exponents are simply marked with these features that define their context of insertion, as we have seen in the example above. Also, it follows from late insertion that they never *add* features to the structure; all features originate in syntax. The framework is simultaneously highly morphemic: separate terminal nodes will be realized by separate exponents.

If no overt exponent can be detected, a zero exponent will be assumed. For example, a form such as Dutch *zang* 'singing' will be decomposed into a root *zing* and a zero inflectional exponent.[2] As a result, zero affixes can easily be found in analyses within Distributed Morphology. This property has been criticized by several authors, most notably by Borer (2013). In section 5.1 we discuss her work, which offers a cognate approach, the Exo-Skeletal Model, which avoids this issue.

2.2 Root-based

As we have seen, given late insertion, at syntax, structures with identical syntactic properties will thus be represented by means of exactly the same syntactic tree (think back of the nominal plural in Dutch with either *-s* or *-en*). But late insertion also pertains to rich, open-class lexical items. Their 'lexical' content is assumed either to be absent or irrelevant. Therefore, there is no lexical node 'projecting' syntactic properties. A transitive verb will not project the properties 'transitivity' or 'verbhood' into the structure. It works the other way around: the structure will contain functional nodes that define the lexical node at the bottom in the tree as a transitive verb. Such frameworks, in which a lexical node will not project any syntactic features, not even categorial ones, will

2 At Vocabulary (see below), it will be specified which allomorph of *zing* will realize the root node in the given syntactic context.

Guest (guest)
IP: 147.96.141.129

refer to the lexical node as a 'root'. For example, a verb such as *schrijven* may occur in a wide range of syntactic contexts, as the sentences in (2) make clear:

(2)	a. zij schrijft graag	(intrans.)	'she likes to write'
	b. zij schrijft een brief	(trans.)	'she writes a letter'
	c. zij schrijft haar een brief	('ditrans.')	'she writes her a letter'
	d. zij schrijft het van zich af	(trans.-resultative construction)	'she writes it off'
	e. zij schrijft zich te pletter/een ongeluk/omhoog	('reflexive-resultative construction')	'she writes herself to death'
	f. deze pen schrijft heel lekker	('medial')	'this pen writes very nicely'
	g. dit artikel schrijft zichzelf	('medial 2')	'this article writes itself'

As such examples make clear, there is little reason to suppose that the syntactic context of a verb is somehow determined by, or coded on, the lexical item.[3] Rather, the item is inserted in a syntactic context of which the properties are constructed independently of the item.[4]

Regardless of the contents of the root node, all proposals share the view that, indeed, the root does not project functional superstructure. However, this does not mean that for some authors lexical properties will not kick in later, at Encyclopedia, and may license the interpretation of the structure or crash it on semantic grounds (Wood 2012).

2.3 The DM Y-model

The subsequent modules which are assumed in Distributed Morphology follow the basic format of generative linguistics in that it is, in essence, a Y-model. That means that structures are created at syntax and are then

3 The extensive work by Beth Levin and Malka Rappaport Hovav (e.g. Levin and Rappaport Hovav 1995) on semantic verb classes forms an important empirical challenge to Distributed Morphology. See, for example, Folli and Harley (2004) for a reaction.

4 There is no consensus as to what can be found at the root node at syntax. In the seminal papers, a 'root' feature occupied the node. In De Belder & Van Craenenbroeck (2011) the node is radically empty, i.e., completely featureless. In Harley (2014), following a proposal by Pfau (2009), the root node will contain an abstract index which refers to a node, others will assume a phonological index at the root node (as has been proposed by Borer 2013 for the Exo-Skeletal model, see section 5.1).

Guest (guest)
IP: 147.96.141.129

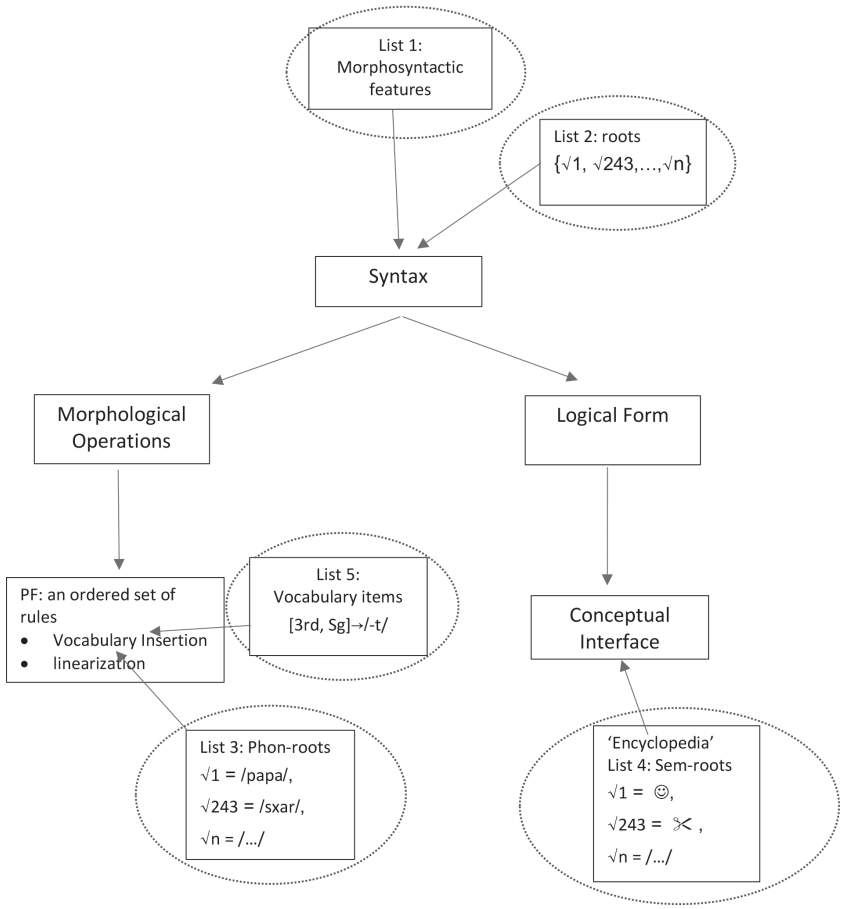


Figure 1 Cinque hierarchy (taken from Barbiers 2018: 61).

spelled out to a form-based module, called PF (phonological form), and a meaning-based module, called LF (logical form). Figure 1 is a somewhat extended copy of the picture in Harley and Noyer (1999: 4).

It is assumed that spell-out does not wait for an entire clause to be completed to occur. Smaller cycles are assumed to be units for spell-out, which are called phases. We discuss them in more detail in the next section.

In between syntax and PF there is a module called 'Morphology', which is responsible for some language-specific operations on the terminal node.[5]

5 As a reviewer correctly points out, there is a separate part of the grammar called 'morphology' after all. However, it should be clear from our presentation that the task of this module is much

Guest (guest)
IP: 147.96.141.129

It may fuse nodes (fusion), split nodes (fission) or impoverish nodes, in the sense that features may be deleted (impoverishment). Vocabulary insertion will work with these transformed nodes.

Above we already hinted at the possibility of fusion of the nodes Person and Number in Dutch. Let us also give a possible application of impoverishment in Dutch (see also Aalberse & Don 2009). First consider the following data from two nominal paradigms in Dutch. In (3) we see a paradigm of a noun of common gender; (4) contains a paradigm of a noun of neuter gender.

(3)	a. de jongen	'the boy'	(4) a. het beest	'the animal'
	b. de jongen-s	'the boys'	b. de beest-en	'the animals
	c. deze jongen	'this boy'	c. dit beest	'this animal'
	d. deze jongen-s	'these boys'	d. deze beest-en	'these animals'
	e. die jongen	'that boy'	e. dat beest	'that animal'
	f. die jongen-s	'these boys'	f. die beest-en	'those animals'
	g. een zwar-e jongen	'a heavy boy'	g. een zwaar-ø beest	'a heavy animal'
	h. zwar-e jongen-s	'heavy boys'	h. zwar-e beesten	'heavy animals'

The pattern to explain is that in the singular (4a, c, e and g) the neuter paradigm always has a different form than the common paradigm. However, in the plural (4 b, d, f and h) these patterns are always the same. In other words, gender is neutralized in the plural. To express this pattern, we may rely on an impoverishment rule, such as (5), which removes the feature [neuter] from the morphemic specification if it also contains plural:

(5) [neuter] → ø /[plural]

Since vocabulary insertion works after impoverishment has taken place, there is no way it can be sensitive to the gender distinction in the plural.

The morphological operations have been heavily criticized by the cognate framework Nanosyntax (see section 5.2) as being too permissive and unprincipled. We agree that one should not postulate *ad hoc* operations and we agree that one could certainly ask questions. For example, fusion creates exactly the same effects post-syntactically as head movement can derive at syntax. It is unclear, then, why such a post-syntactic operation should exist. As Caha (2016) correctly points out, in this way the morphology exactly prepares for the vocabulary of the language, rather than that the available vocabulary is used to realize the independently generated

smaller than what traditional views claim to be morphology.

Guest (guest)
IP: 147.96.141.129

structure. Although we fully agree with Caha's cogent criticism, two things should be noted at this point. Firstly, these morphological operations are sometimes informally seen as an anything-can-happen magical toolbox that is not based on any principles at all, but that is an undeserving caricature. Fission has been based on economy principles for the language acquiring child (Noyer 1997, Halle 1997) and the more general idea that, at the end of the day, the functional vocabulary of the language may cause surface variation is very much present in these proposals (ibidem, see Borer 1984 for this view on variation). Nevins (2011) links impoverishment in a principled way to markedness. Secondly, it is perfectly possible to write an article in Distributed Morphology or to build an entire career in Distributed Morphology without ever making use of one of these operations. In the massive literature on event structure in DM, for example, one does not easily find examples of morphological operations. Much of the work in the framework does not depend on whether one accepts these morphological operations or not.

After having passed these morphological operations, the structure is ready for spell-out and is transferred to PF. PF is an ordered set of operations, or perhaps even an ordered set of modules. It is responsible for linearization, vocabulary insertion and phonology. There is some debate on whether linearization precedes vocabulary insertion, or the other way around (Embick & Noyer 2001; Embick 2010; Arregi & Nevins 2012; Haugen & Siddiqi 2013), and there is no consensus on how phonology proceeds. For vocabulary insertion, PF will interface with 'Vocabulary', which is an acquired list of vocabulary items. Various approaches to phonology have been integrated in Distributed Morphology, even Optimality Theoretical approaches (e.g. Wolf 2008).

As can be seen in Figure 1, at the point where the structure leaves syntax, it is sent to PF and LF at the same time. Note that what is sent to LF is a structure that contains only syntactic features. As a result, LF computes the meaning compositionally on the basis of these features. LF will never compute a meaning such as 'the girl ate an apple'. It will restrict its computation to something like 'definite animate singular noun phrase is the subject of a transitive past action involving an indefinite singular noun phrase as the direct object'. This input will be sent to a module called 'conceptual interface' which is responsible for the final interpretation. To arrive at this goal, the conceptual interface will also interact with the syntactic structure that has been realized by means of vocabulary items and a module called 'Encyclopedia', in which the meaning of our vocabulary and world knowledge is stored (see section 2.5).

Guest (guest)
IP: 147.96.141.129

2.4 Phases

As mentioned above, linguists working in Distributed Morphology do not assume that a clause is spelled out in one single sweep through all of the steps specified in Figure 1. Spell-out is rather assumed to proceed cyclically: small units of structure are shipped off to PF and LF, and after having received an interpretation at these levels, these interpretations are no longer open to manipulation. Such units are called phases. The first spell-out is assumed to happen as soon as the first phase head has been merged.[6] Given that phases are units that are spelled out to PF and LF, they are the relevant domains for irregular form (e.g. allomorphy) and meaning (e.g. idiomaticity).

Now, what counts as a phase head? Recall that the lowest node is nothing but a root, which does not project any syntactic features, not even categorial ones. To assign a category to the structure, the root will merge with a categorial head. These heads are referred to as 'little heads': little v, little n, little a, … Little heads can be overtly realized by means of a derivational affix or covertly by a zero affix. The Dutch words *kat* 'cat' and *moederschap* 'motherhood' thus have the same syntactic structure: they both consist of a root plus a little n. For *kat* 'cat' this little n is realized as a null morpheme, for *moederschap* 'motherhood' this little n is realized as the nominalizing affix *-schap*. The first categorial head is often assumed to be a phase head in Distributed Morphology (Marantz 2008). This has important consequences for capturing patterns of irregularities. The root always forms a unit together with this first categorial head and will be sent to PF and the conceptual interface as a unit. This means that they can be processed together and that phonological and semantic irregularities can be assigned to this domain. This option has been explored both to account for irregular phonological patterns, such as the selection of specific affixes or allomorphy and semantic patterns, such as idiomaticity. Indeed, the first categorial head that merges with the root defines the outer limit for idiomatic meaning (Marantz 2008, Arad 2003).

For example, consider the nominalizations in (6a) and (6b):

(6) a. zingen
(i) de zang 'the song/singing'
(ii) de melodieuze zang van de merel
'the melodious song of the blackbird'
(iii) *de zang van de pastoor gedurende twee uur
Lit. 'the song of the pastor for two hours'

6 This is a simplification of the exact mechanism (see e.g. Embick 2010 for a discussion), but it is a correct portrayal of the basic assumption.

Guest (guest)
IP: 147.96.141.129

b. zingen (i) het zingen 'the singing'
(ii) het melodieuze zingen van de merel
'the melodious singing of the blackbird'
(iii) het zingen van de pastoor gedurende twee uur
'the singing of the pastor for two hours'

The verb *zingen* (as many other verbs in Dutch) has two nominalizations. The noun *de zang* is formally irregular: it shows an ablaut, and there is no (or a zero-)affix. Following the DM-logic, this form has to be a nominalization of the root, or at least of that part of the structure in which the root is contained with the nominalizing morpheme. The ungrammaticality of (6a, iii) follows from this logic. Firstly, the noun *zang* has certain specific, listed meanings, including 'birdsong'. It does not, however, refer to a singing event. Secondly, *de pastoor* 'the pastor' is intended as the subject of the singing, but the structure does not contain a position that could host a subject of the event. Thirdly, the adverbial modification *for two hours* would modify an event, but the structure lacks verbal event structure. Example (6a, ii), in contrast is fine, as *de merel* 'the blackbird' is not interpreted as the subject of the singing, but as a classification of the song; the noun phrase is not about a specific singing event of a specific individual bird. In (6b), the nominalization follows verbal structure and thus takes place higher in the tree. The tree includes considerably more structure than in (6a). As a result, the root and the nominalizing morpheme are no longer in the same phase, and consequently, the root cannot have the idiosyncratic form triggered by the nominalization. What it does contain, however, is event structure and, as such, it has a position for the subject of the event and it allows for adverbial event modification (*gedurende twee uur* 'for two hours'). In (6b), we see that the regular form of a nominalization is compatible with a much larger structure, as predicted (for much more developed analyses, see Borer 2013 on nominalization structures).

There is much discussion on which heads count as phase heads, what their effects are and how the spell-out mechanism works precisely. However, there seems to be a consensus on the fact that structure is built cyclically, i.e., phases exist, that the word is probably a phase and that idiomaticity and irregularity are linked to phases.

2.5 The lexicon in DM

Above we explained why DM is a non-lexicalist theory of morphology. However, we also hope to have made clear that this does not imply that there

Guest (guest)
IP: 147.96.141.129

is no lexicon. In fact, DM proposes several lexica. The notion 'distributed' in the name of the theory refers to the concept that information about the morphological structure of a word is distributed over different grammatical components. Since some of these components are simply listing information, these can be considered different lexica. A schematic overview of the different grammatical components that DM proposes is given in Figure 1. This overview is a good starting point for a discussion of the different lists that DM proposes.

Above we already mentioned the list of features (Figure 1: List 1). DM proposes that features come in sets (often referred to as 'bundles'). These sets can be considered the morphemes of a language.[7] These feature-bundles are spelled out, or realized by so-called Vocabulary Items (Figure 1: List 5). Here we may think of rules that are in competition to spell-out the morpho-syntactic features (see (1)). The most specific rule wins the competition, and if no specific rule applies, the default spell out kicks in to realize the morpho-syntactic feature-bundle.

Next to this list of features, we also need a list of roots (Figure 1: List 2). There is an ongoing discussion in the literature about how we should represent roots in the theory. Here we follow a proposal by Pfau (2000, 2009) in which roots are inserted without any information about their syntax, phonology, or meaning. The only information they contain is their identity (i.e., not more information than needed to separate them from other roots). Here we use an integer to do the job. At Phonological Form this integer activates ('the root is spelled out as') a phonological representation (Figure 1: List 3), while at conceptual interface the same integer serves as an address through which we can activate the meaning pertaining to that particular root (Figure 1: List 4). This information is stored in the so-called Encyclopedia (Harley 2014) which contains a wide array of stored information, including information on idiomaticity and all kinds of semantic relations, such as polysemy. Most linguists in Distributed Morphology will finally assume that all kinds of non-linguistic information, such as world knowledge, will be involved in the interpretation of a sentence. It is unclear whether this kind of knowledge should also be listed in Encyclopedia or whether it should interface with the conceptual interface.

Let us now go somewhat deeper into some of the rationales that motivate the separation of information the way DM does. First, the reason not to

7 Nanosyntax criticizes this assumption, pointing at a redundancy in the theory: bundles of features form the input for syntax, but are exactly the same units that form the input for the Vocabulary Insertion rules at PF. In section 5.1, we will come back to this issue, and briefly sketch the nanosyntactic alternative.

Guest (guest)
IP: 147.96.141.129

include phonological and semantic information pertaining to the root in the root itself, is that so far no single syntactic rule in any language looks into the phonological or the semantic information of a root. For example, there is no language with a topicalization rule that only topicalizes NPs which heads start with [p]. Similarly, syntactic rules referring to the semantic content of the elements in focus are lacking. We only want to allow those features to the syntax that syntax actually operates on. If animate objects syntactically behave differently from non-animate objects then clearly [animate] is a feature that is syntactically active. However, if there is no single syntactic rule operating on this feature, there is no reason to assume that language users entertain this feature in their syntactic representations.

Removing any phonological or semantic information from the root explains the lack of such rules: this information is simply not available at the point where syntax operates. Now the phenomenon known as 'heavy NP shift' in English, which refers to the tendency of having prosodically 'heavy' direct objects at the end of the sentence rather than directly right to the verb (which is the more canonical position), contradicts this claim to some extent. Such 'stubborn' facts that defy a general law, may spark further research, and may point us towards a type of rules (not depicted in Figure 1) that operate after Vocabulary Insertion. Again, an immediate further claim follows from the schema in Figure 1; such rules are predicted to have no semantic effect whatsoever since the structure has been 'shipped off' to LF in a much earlier stage.

Another rationale for the separation of information comes from the study of phrasal idioms. By definition, phrasal idioms are of course idiosyncratic with respect to their interpretation. However, the way they are syntactically constructed is fully in line with the general syntactic principles of the language (McGinnis 2002). According to the set-up in Figure 1, idiomatic expressions are built following the exact same principles that underlie any other expression in the language. The only difference is that such complex expressions are listed in the Encyclopedia. A language user familiar with the idiom will be able to retrieve any idiosyncrasies pertaining to the idiom upon recognizing it in the input. We will come back to the issue of idioms in section 4, where we will address some issues pertaining to the boundaries between syntax and morphology.

3. The program of DM

As we have seen in section 2, Distributed Morphology is a research program that starts out from a specific set of theoretical assumptions that logically hang together. This does not imply that the DM-approach is in some way less

Guest (guest)
IP: 147.96.141.129

empirical than other approaches to morphology. The theoretical framework serves to make predictions that need empirical testing. If the test fails, we need to revise some of our theoretical assumptions. Below, we will show that it is interesting and hopeful to see that more and more different types of empirical evidence are brought to the fore, which helps strengthening those elements of the theory that pass the empirical tests, and help us adapt those elements that are empirically contradicted. Before we get to this, let us first try to make explicit the way DM-proponents look at, and analyze morphological data. In doing so, we also reflect on the scientific practice, discerning several heuristics or guiding principles along the way. We try to make those principles explicit below.

3.1 Only one way to build words

As discussed in section 2, DM claims that morphology is syntax. Ever since Chomsky (1972), many linguists have argued for a separate component of the grammar in which word-formation takes place. And for, again, many linguists this component is the lexicon. Within generative grammar, this idea is presented by Aronoff (1976) with so-called word-formation rules in the lexicon, and is further advanced by e.g. Lieber (1980) and Di Sciullo and Williams (1987). However, in the beginning of the nineties, linguists working in the generative tradition started to realize that there is something fundamentally wrong with the idea of lexicalism. This is not the place to repeat the arguments against the lexicalist hypothesis in any detail, but it is important to note that those arguments came from quite different strands of research. First, the claims made by level-ordered morphology, strongly connected with a lexicalist standpoint, turned out to be both too strong, and too weak (see e.g. Fabb 1988). Second, there was no obvious explanation for an empirical generalization that was called the Mirror Principle (Baker 1985). The state of affairs described by the Mirror Principle presupposes a much narrower relation between morphology and syntax than could possibly be modelled within the lexicalist approach. Furthermore, complex inflectional systems (such as presented by the Georgian verbal paradigms) could not be handled insightfully in a lexicalist system (Anderson 1982, Jensen & Stong-Jensen 1984). And, last but not least, derived nominals were argued to also require a syntactic analysis rather than a lexical one (Marantz 1997).

As a result, the lexicalist viewpoint was abandoned by many, and the idea that words are built in syntax became one of the core hypotheses of DM. As we have seen, this does not imply that there is no lexicon in the grammar to begin with. Basic elements from which structures are built have no deeper explanation, or, to use a metaphor from physics, atomic

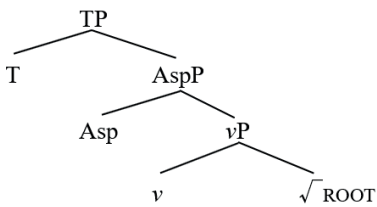
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building blocks with their inherent properties need to be stored. There is no other way than to simply list them. DM makes a distinction between different lists, rather than storing all the idiosyncratic information in the same 'lexicon'. But this is a minor issue at best. The important thing is that atomic elements are stored in a list, i.e., in a lexicon. However, there are no operations *in the lexicon* that construct or build more complex units. That is, the lexicon (or better: lexica) is only a list. Here, DM fundamentally differs from the lexicalist theory. Since the lexicon has no rules or other devices to construct more complex units, there is only one other possible component from which complex words may originate, i.e., syntax.

So, one of the spearheads of the research program of Distributed Morphology is to show that phrasal syntax also lies behind the organization of the internal structure of words. If successful, there is substantial theoretical gain: the set of operations responsible for the construction of linguistic form is reduced to one; both phrases and words are formed by the application of 'merge'.

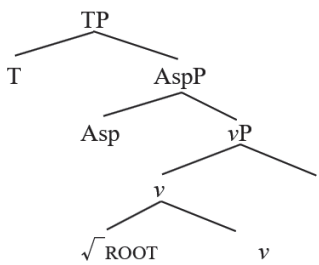
Let us illustrate this idea with a concrete analysis proposed by Embick (2000) of Latin complex verbs. The fundamental clause structure that underlies all verbal forms in Latin is given in (7) (slightly adapted from Embick 2000: 195)

(7)



Now, how can this be a word, since this clearly is a phrasal structure? The technical answer to this question is: head movement. This is (as a form of merge) an operation in which a head merges with a head higher in the structure. The lowest head in (7), i.e., the Root, moves to the neighboring functional 'little v'. The result of this application of head-movement on the structure in (7) is the structure in (8):

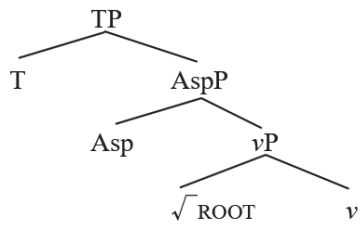
(8)



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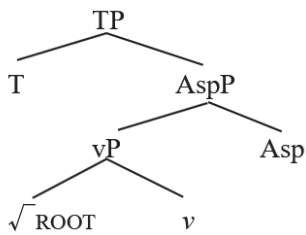
Since the right-hand branch of vP is now empty, we might as well write (8) as (9):

(9)



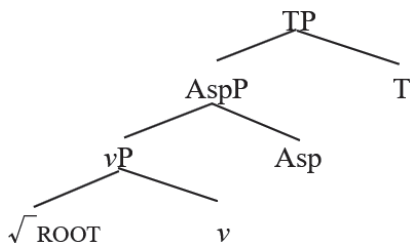
In a second application of head-movement, the complex *v*-head moves to the Asp-head, resulting in the structure in (10):

(10)



Finally, a third application of head-movement (Asp to T) completes the structure:

(11)



Technically then, the structure in (11) is a complex head. Complex heads are morphological words. So, head-movement is a central operation in creating words: it derives morphological words from phrasal structures.

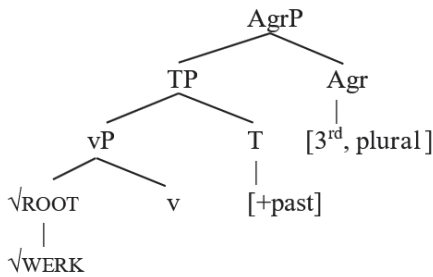
During a second step in the derivation, after these syntactic operations, the different end-nodes of the structure in (11) are subject to a process of Vocabulary Insertion, i.e., each node is subject to a set of rules that compete for the spell-out of that particular node, working from bottom to top. To make it somewhat more concrete, the structure in (11) is assumed to underlie a Latin verb form, such as *am-a-v-er-am* 'I had loved'. We recognize the root √*am* 'to love'. Next to the root, the (long) [a] is the realization of the 'little

Guest (guest)
IP: 147.96.141.129

v',[8] the [v] realizes the Aspectual node (indicating perfective), whereas the Tense-node (containing the feature [future] in the case at hand) is realized by *-er*. We have left the Agreement-node (realized by *-am*) out of the structure in (7)-(11).

Similarly, in Dutch we may assume that after head-movement the following structure results for an inflected verb, such as e.g. *werkten*:

(12)



We take the structure in (12) as the direct input for spell-out. There are separate sets of Vocabulary Items for the T-node and the Agr-node. To guarantee that the word will be spelled out as a single phonological word, the root will merge into little v (i.e., head movement or incorporation), which then subsequently moves into T and Agr.

(13) Tense:[9]
-/də/ ↔ [past]

Agreement:
-ø ↔ [1st person, singular]
-ən ↔ [plural]
-t ↔ [ ]

The effects of head movement are most notable in contexts where affixations alternate with periphrastic forms. For example, a comparative form formed with the affix *-er* will be subject to head movement to guarantee word-hood, a comparative form with *more* will not be subject to head movement (Bobaljik 2012). Root suppletion also depends on head movement: a morpheme will

8 More precisely, the long vowel [a] is the so-called theme vowel. Apparently, depending on the conjugation class to which a verb belongs, this element is realized differently. There are different ways of technically executing this dependency, which is immaterial to the issues at stake.

9 Note that /də/ may either surface as [də] or [tə] depending upon the underlying voicing of the final consonant of the stem.

Guest (guest)
IP: 147.96.141.129

only be able to trigger a suppletive form for the root if that morpheme and the root form a complex head (Bobaljik 2012: 68; De Belder 2018).

3.2 Universal Grammar

We can now appreciate how head-movement plays an explanatory role in deriving the Mirror-Principle. The hierarchical order of syntactic projections in (7) is translated by Head-Movement into a 'mirror-image' linear order of affixes in (11). Applied to the Latin verb: if under specific circumstances, a passive is expressed analytically, the attested hierarchical order of the syntactic elements will be as in (1). Synthetically, this corresponds to the linear order of affixes as in (4).

Stepping back somewhat further, we can say a few words about the role of UG in the theory, and related theoretical claims. At the core of UG is the operation Merge. Theoretical sparsity forces one to make as few assumptions as possible, and therefore, we may consider it a theoretical success if we can show that phrases and words are built by the same device. Not only can we do without special word-formation rules (in whatever form), it also deepens our insight in the most fundamental properties of language: there is nothing special about the generation of morphologically complex words vis-à-vis phrases. So far, there have been no proposals that reduce Merge to an even more fundamental principle. In the absence of such proposals, there is no other way than to assume that this is part of UG. The same applies to the set of features, such as [future], [plural], [perfective], etc., that languages make use of to generate expressions and that are the atoms from which expressions are built. They cannot be reduced to smaller elements, nor are there any proposals from which such a set of features may be derived. Again, as long as there are no proposals in this direction, we have to assume that they are part of UG. Individual languages make particular choices for subsets of these features that are 'active' in the language, which explains the quite substantial differences found between languages. Part of the research program, often referred to as 'cartography', aims to uncover a fixed hierarchical order (the 'universal spine') in which these features are organized.

Given the above brief exposition of one of the theoretical spearheads of DM, it should not come as a surprise that DM-theoreticians are always on the lookout for structure. So, as one of the heuristic principles that we discern in our analytic practice, we can formulate the following imperative:

(14) 'Look for structure.'

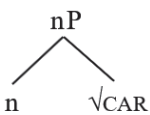
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IP: 147.96.141.129

It is important to realize that in DM, syntax puts together morphemes (a notion that will become clearer in due course) rather than putting together words. This idea of word-formation as a part of syntax is of course fully in line with a more general methodology, hinted at above, of deriving properties of complex units from the composing elements.

Another heuristic that guides morphological research in the DM-framework directly derives from embracing the idea of Universal Grammar. We have given it the formulation in (15):

(15) 'What we see in language x, should be true for language y.'

A typical example of this adage is the assumption that in English an adjective such as *red*, a verb such as *drive*, and a noun such as *car* are in fact complex. The assumption is that these words break down into a root that has no category, and a functional head (the 'little n' in 16) that determines the category of the root. So, the noun *car* has a structure as in (16):

(16)


This idea is, among other things, motivated by the observation that in for instance Spanish, adjectives and nouns necessarily should have an inflectional suffix before they can be inserted in syntax. So, for example, the root √ALT never occurs as such in a syntactic environment but should always go with a gender-marking suffix: *alt-o* "high-masc.", *alt-a* "high-fem."

A second example is the famous root-and-pattern morphology that we find in Semitic languages, such as Arabic. A word such as *kitaab* "book" consists of a root √KTB that, just as the element *alt* in Spanish, cannot appear without further morphology in a syntactic environment. It should always go with another morpheme that may turn it into a particular verb-form, a noun, a participle, etc.

So, what we see in Spanish and Arabic is also good for English, although on the face of it, there is little reason to assume the same kind of morphological complexity in English. As we noted above, Borer (2013) argued against the assumption of such productive zero-elements. We will come back to this critique, and the interesting alternative in section 5.1.

3.3 Empirical focus

Above we already stressed the fact that the strong theoretical framework does not imply less attention for empirical research. We would hasten to

Guest (guest)
IP: 147.96.141.129

say: "On the contrary!" As in any natural science, it is only through the study of empirical data that we can reformulate our hypotheses and theories. There have been studies in Distributed Morphology on a wide variety of languages. Here we mention just a few to give the reader an impression of this variety. Analyses making use of Distributed Morphology have been given of morphological phenomena in many different languages, such as English (e.g. Embick 2015, Lowenstamm 2015, Borer 2014, Adamson 2018), Amharic (Kramer 2016), Catalan (Oltra-Massuet 2013), Dutch (De Belder 2011, Creemers et al. 2018), French (Don et al. 2015), Greek (Alexiadou 2009, Anagnostopoulou 2003, Panagiotidis 2014), Hebrew (Arad 2003 among others), Hiaki (Harley 2014), Italian (Calabrese 2013), Japanese (Volpe 2005), Korean (Choi & Harley 2019), Mandarin Chinese (Zhang 2013), Kuikuro (Franchetto 2006), Latin (Embick 2000), Persian (Anoushe 2015), and many, many more.

Apart from the explicit goal to confront the theory with as many different languages as possible, including those languages for which data have been gathered in fieldwork (see e.g. Harley, Tubino & Haugen 2017 on Hiaki), there is also growing attention to experimental data. Important labs for experimental work in Distributed Morphology can be found in the United States. Liina Pylkkänen is the lab director of the NYU Neurolinguistics Lab, where advanced experimental research finds neurological support for the theoretical assumptions in Distributed Morphology. Another example of such work is the Embick Lab lead by David Embick at the University of Pennsylvania, where MEG studies are carried out. Many other examples can be found (and we apologize to those we have not mentioned).

However, experimental research is not limited to such neurological studies. During the latest decade more and more methods from psycholinguistics and language acquisition studies have been coupled to studies within the DM framework. This can be seen, for example, in the program of the 2020 EESLIG workshop,[10] in which theoretical work and experimental work co-exist and complement one another. Furthermore, data from well-known languages are now often checked or gathered in corpora or tested in judgment tasks that meet the requirements of responsible experimental work. In sum, the growing attention to experimental methods and field work can be seen as part of a larger trend within generative grammar to employ more structured methodological means than was done previously. The 'armchair linguistics method' is starting to belong to the past, as it is no longer adopted by the younger generations.

10 https://sites.google.com/view/eeslig/programme

Guest (guest)
IP: 147.96.141.129

4. Morphology versus syntax

Above we explained that one of the programmatic starting points of DM is the idea that there are no separate places in the grammar where words and phrases are constructed; everything is built 'in the syntax'. However, this does not necessarily imply that there cannot be a difference between words and phrases. Ackema & Neeleman (2007) observe that stranding is not possible for words in languages such as English. They use this as an argument against the idea that words are built in the syntax. If x is possible in phrases why is it not possible in words? We will go somewhat deeper into this argument since it allows us to explain how DM in general deals with the observed differences between words and phrases. Let us first give an example of their central observation (Ackema & Neeleman 2007: 332):

(17) a. the centre of a prosperous medieval city in Northern Italy
b. *the $city_i$ centre of a prosperous medieval t_i in Northern Italy

The argument is straightforward: if word-formation involves head movement, why is head-movement excluded in the above example? Does DM not predict (17b) to be a grammatical structure of English? It is clear that nothing is wrong with the compound *city centre*. The culprit are the left-over adjectival and prepositional modifiers that now suddenly lack a head. Clearly, English does not allow a head to be moved out of a full DP, 'stranding' any modifying material.

Before answering this empirical challenge, let us first make matters worse and look at a second empirical problem that Ackema & Neeleman (2007) raise for the word-formation-as-syntax theory.

(18) a. *driver truck
b. he drives a truck
c. truckdriver

What this and similar examples show according to Ackema & Neeleman is that complex nouns built from a verb cannot license the internal argument in the same way as the verb can. This is, however, according to Ackema & Neeleman what would be expected on the assumption that words are built in the syntax. Their reasoning is based on the structure in (19) that should underlie (18c) in a DM-type theory:

(19) *[NP [N [V drive] er] [VP tV [NP a truck]]]

Guest (guest)
IP: 147.96.141.129

Crucial is the idea that the structure would start out with a VP. However, we may assume alternatively (following Harley 2009) that (18c) has a different underlying structure:

(20) [n -er [√P √DRIVE [nP truck]]]

In (20) the complement *truck* is a complement of the category-neutral root DRIVE, rather than a complement of the noun. That is, before the root DRIVE is nominalized, it is merged with its complement. Next, the root + complement are merged with the nominal head *-er*. This way of analyzing (18c) does not immediately imply that (18a) would be grammatical. What prevents (18a) under this analysis is the claim that internal arguments are internal arguments of the root, rather than internal arguments of the verb (or the noun).

Let us now go back to the example in (17). Again, we would argue that a compound arises from a structure in which the root of the head of the nominal compound (here *centre*) merges with the root of the left-hand member (here *city*). Now, does DM predict that the structure in (17b) is derivable? Well, certainly not. The hypothetical derivation presents several hurdles that cannot be taken. The obvious first problem is the head movement constraint (Travis 1984:131), which states that no governing head position can be skipped. Long head movement is thus successive-cyclic head movement. The noun *city* would thus pass the DP-layers, the preposition and perhaps the adjectives. Within DM, the head incorporation would create word-hood: the entire sentence would roll up into one large head incorporation resulting in one big head. It would no longer be a sentence.

On its way, the head would encounter a D-head, adding referential semantics to 'city'. This would result in a semantic contradiction: the non-head of the compound would be both referential (due to the D-layer) and non-referential. It is commonly assumed in Distributed Morphology that D-layers are illicit for non-heads, for semantic reasons. Non-heads should be non-referring. Deleting the semantics of the D-layer is not an option. Meaning is assumed to be built in a compositional and monotone fashion. Even if one would not adopt the successive-cyclic head movement, the problem would remain that 'city' would be both referential and non-referential simultaneously.

Furthermore, there is the more general hypothesis that a single head cannot host two words (Roberts 1997). 'City' would be a word in its base position: the root has its nominal functional structure and thus acts as a noun in the DP. In its landing position it would function as a part of a word.

Guest (guest)
IP: 147.96.141.129

This is illicit due to Roberts' more general constraint that words cannot incorporate into words to become a part of a word.

More generally, the idea that morphology is syntax does not do away with the idea that a word is a reality that obeys to principles. There certainly remain pieces in the structure which the linguist can point at and call a word. Words cannot integrate all kinds of projections from the functional superstructure, they cannot be split up and have parts of them moved around, they cannot integrate into other words if they already projected functional superstructure, they cannot move around if the move is not motivated, etc. In short, they are built in syntax according to principles. The essence of what we hypothesize is that these are nothing but bona fide syntactic principles (see Borer 1998).

5. Cognate approaches

5.1 The Exo-Skeletal Model

The Exo-Skeletal Model (henceforth XSM, Borer 2013) is a cognate approach. It is similar to Distributed Morphology in the sense that it is also a root-based work. In fact, the XSM is a more consistent anti-lexicalist, root-based approach than Distributed Morphology. Linguists working in DM have sometimes formulated proposals with lexicalist properties (e.g. Wood 2012). This is not an option for linguists working in the XSM. The anti-lexicalism is even more emphasized than in DM. Another characteristic shared by the two approaches is the cartographic nature of the work. Structures are carefully decomposed into functional sequences of which the features and the order are given by Universal Grammar. Because of these two similarities, it is easy for scholars in DM to borrow insights and analyses from Borer, which is indeed often done.

However, the two models also differ in crucial respects (see De Belder 2014 for a full discussion, from which we borrow here). Borer holds, amongst other things, different views on the nature of inflection, categorization, and the domain of content assignment.

Borer's proposal is an early insertion proposal. Yet, she shares the assumption with DM that inflection is realizational (see Halle & Marantz 1993, 1994). Contra DM, however, she submits that it is amorphemic (see Anderson 1982, 1992). The root will move to the relevant inflectional heads, the inflectional heads are not realized by a separate affix. She argues that inflected forms such as *wandelde* 'walked' and *zong* 'sang' are non-complex and that their form results from a spell-out rule. She assumes that a spell-out rule at phonology will

Guest (guest)
IP: 147.96.141.129

stipulate that the forms will simply be realized as such in the relevant context (here: 'past'). Amorphous approaches to inflection are counter-intuitive for *wandelde* 'walked', but they avoid the stipulation of a zero morpheme for *zong* 'sang'. This contrasts with her approach to derivation which is strictly morphemic (*pace* Beard 1981, 1995): derivational affixes merge and project in syntax. In short, Borer distinguishes theoretically between inflection and derivation. Inflection is amorphous, while derivation is morphemic.

Categories are distributionally defined in the Exo-Skeletal Model. For example, those roots which occur below nominal projections, such as D°, become nominal in that specific structure through distribution. Similarly, derivational affixes may define their complements as equivalent to a specific category. For example, *read* becomes equivalent to a verb when it merges with *-able*, which is an adjectival suffix. Interestingly, this mechanism allows Borer to do without productive zero categorial affixes to categorize a root. As such, she succeeds in uniting the observation that the root that has merged with *-able*, for example, has a verbal distribution with the fact that there is no direct proof of a zero morpheme, and with the claim that the root itself is categoriless.

Borer's approach is a phasal approach, just like DM. In her proposal every instance of 'merge' creates a phase (Borer 2013: chapter 10). However, idiomatic content assignment is not linked to the first phase. Content assignment is applied iteratively: each additional cycle may go through content assignment together with previous cycles as long as derivational heads are merged. This iterative mechanism will stop as soon as inflectional or other functional material is added to the structure. As a result, idiomatic meaning can stretch beyond the first derivational affix in the XSM. For example, a word such as *naturalize* is predicted to be impossible by DM as the affix *-ize* adds meaning to the word *natural* in a non-compositional fashion beyond the first derivational head *-al* (Borer 2013: 445). Whether the approach in DM or the XSM is the more adequate one is an empirical question, given that the approaches make clear-cut different empirical predictions. A systematic, cross-linguistic study to settle this issue has, to the best of our knowledge, not been carried out.

5.2 Nanosyntax

Nanosyntax is a theoretical framework that adopted many elements from Distributed Morphology, but also differs considerably from it. Caha (2016) presents a state-of-the-art comparison between the two approaches on which we briefly report here. He notes that Nanosyntax and Distributed Morphology fully agree on the late insertion approach and the assumption known as

Guest (guest)
IP: 147.96.141.129

'syntax all the way down', which assume that words and sentences are both constituents of the same tree, generated in a single module. However, Nanosyntax differs in two important ways from Distributed Morphology. Firstly, it strongly rejects the proposal that morphological operations take place between syntax and PF. We have commented on morphological operations in section 3. Secondly, the theory rejects the bundling of features on a single node in the tree. Rather, the syntactic tree is constructed by merging each feature in a separate step. Consequently, each terminal node can only host a single feature. Furthermore, these features are universal and universally ordered. If there is evidence for a single feature in a certain language, its presence will be assumed in the syntax of every language. In other words, they subscribe to a strict, universal cartographic approach. Similar cartographic tendencies are inherent to Distributed Morphology, but many proponents of Distributed Morphology may tacitly assume that a language builds syntactic structure with only a subset of the universal feature set and it is certainly assumed that features are bundled on a single terminal node, building a single morpheme. For example, someone working in Distributed Morphology would group the features [definite] and [determiner] on a single node if they are realized by means of a single morpheme in a given language: {[definite], [determiner]}. Indeed, feature bundling is possibly language-specific and reflects the lexicon. In Nanosyntax, they would always merge on separate nodes, regardless of their realization. The consequence is that a single morpheme, such as a pronoun, or an article, would necessarily realize a constituent in Nanosyntax, whereas they can realize a single terminal node in DM. From the 'no bundling' hypothesis in Nanosyntax, it follows that Nanosyntax assumes a very different vocabulary insertion mechanism than DM. It is at this point that the frameworks start to differ fundamentally. We refer the reader to Starke (2009, 2014) and Caha (2020) for detailed discussion. However, it is important to note that the difference between the two frameworks cannot be reduced to some differences in the algorithms in vocabulary insertion. We believe the differences are more fundamental. They touch on the nature of the syntactic tree, the universality of syntax, the source of language variation and the interface between the lexicon and syntax.

6. Concluding remarks

Above, we hope to have shown that Distributed Morphology is by no means a finished project. It is a lively framework attracting researchers interested in explaining all kinds of generalizations related to linguistic

Guest (guest)
IP: 147.96.141.129

morphology. There are many open issues, involving both fundamental questions pertaining to the structure of language itself, and to the way it is processed by our brain. In line with the above, despite, or more probably, thanks to several shared fundamentals, there is also a lively debate with respect to different aspects of the theory (the proper definition of locality, the definition of root, the role of post-syntactic operations, etc.). In some cases, this discussion has led to new theories such as Nanosyntax, which have grown out to become full-fledged different approaches, still sharing some of the fundamentals of DM.

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