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Advances in Morphological Theory: Construction Morphology and Relational Morphology

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Abstract

In recent years, construction-based approaches to morphology have gained ground in the research community. This framework is characterized by the assumption that the mental lexicon is extensive and richly structured, containing not only a large number of stored words but also a wide variety of generalizations in the form of schemas. This review explores two construction-based theories, Construction Morphology and Relational Morphology. After outlining the basic theoretical architecture, the article presents an array of recent applications of a construction-based approach to morphological phenomena in various languages. In addition, it offers reflections on challenges and opportunities for further research. The review highlights those aspects of the theory that have proved particularly helpful in accommodating both the regularities and the quirks that are typical of the grammar of words.

1. INTRODUCTION

Construction Grammar as a theory of syntax arose in the late 1980s (with classic papers such as Fillmore et al. 1988) and has since branched out into a family of theories (see Hoffmann & Trousdale 2013 for an overview). Morphology, however, was slow to develop a complementary theory. Booij's (2010) monograph on Construction Morphology (CxM) only saw the light of day a decade ago. Although earlier work exists (e.g., Jackendoff 1975; Rhodes 1992; Bochner 1993; Orgun 1996; Riehemann 1998, 2001; Gurevich 2006), this is a considerable time gap.

We can only speculate about the reasons for this delay. One argument might be that Construction Grammar was, in principle, meant to include morphology. As Goldberg (2003, p. 223) famously put it: "The network of constructions captures our knowledge of language in toto—in other words, it's constructions all the way down." The envisaged coverage of Construction Grammar therefore extended to the level of the word. In practice, however, morphology remained largely under the radar of construction grammatical work. For example, papers on morphology are scarce at the International Conference on Construction Grammar (ICCG), the main conference in the field.[1]

From another perspective, Construction Grammar constituted a theoretical revolution in syntax to a degree that might not have been the case in morphology. In syntax, the approach diverges radically from the dominant generative framework, with its principally rule-centered approach and its divide between competence and performance. In morphology, by contrast, there has always been a need to acknowledge and accommodate idiomaticity, semiproductivity, paradigmaticity, and a close relation between grammar and lexicon (see Rhodes 1992, p. 415, for similar arguments).

Yet, a construction-based view of morphology, as proposed by Booij (2010) in his seminal monograph, opened new avenues, and a decade later, the implications are still coming into clearer focus. Some of the implications have been worked out in another book (Jackendoff & Audring 2020) that develops a "sibling" theory, Relational Morphology (RM). Other consequences will surely emerge over the years.

This review provides a snapshot of the state of the field, as comprehensively as possible within the limitations of the format. I start with a brief sketch of the foundational principles of the framework (Section 2). Then I present a selection of construction-based analyses of morphological phenomena in a range of languages, highlighting those aspects of the theory that morphologists have found particularly helpful in their analysis (Section 3). I close the review with some reflections on open questions and desiderata for future research.

2. A CONSTRUCTION-BASED VIEW OF MORPHOLOGY

The two explicitly construction-based morphological theories discussed in this review are CxM, with Geert Booij as the figurehead, and RM, developed by Ray Jackendoff and myself. CxM and RM differ in nuances more than in substance; I highlight some of the differences in Section 2.4.

The two approaches have some degree of kinship with various other theories of morphology, the closest relatives being Bybee's Network Model (Bybee 2010, 2013), Word-based Morphology or Word and Paradigm Morphology (e.g., Blevins 2006, 2016; Blevins et al. 2019), and Word Grammar (Hudson 1984, Gisborne 2019). There are also ties to Cognitive Grammar (CG),

[1]The program for the tenth ICCG, held in 2018 in Paris, France, lists around 180 presentations, of which fewer than 10 deal primarily with a morphological topic.

Lexical-Functional Grammar (LFG), and Head-Driven Phrase Structure Grammar (HPSG) (see Langacker 2019 and Nordlinger & Sadler 2019 for a recent overview of morphology in CG and HPSG/LFG, respectively).

CxM and RM are based on a number of architectural principles that are briefly summarized below, drawing loosely on fuller discussions by Booij (2010) and Jackendoff & Audring (2020). Sample analyses from English illustrate the model and the formalism.

2.1. Lexical Items: Words

The central element within the framework is the lexical item, often called a construction: a bundle of associated structures containing semantic, pragmatic, morphosyntactic, and phonological information. In written languages, lexical items also include orthographic information, and in sign languages, the phonology specifies the relevant manual and nonmanual parameters. Within a construction, the various structures are associated (or linked) with one another, but—following the principles of the Parallel Architecture (Jackendoff 1997, 2002)—they are not derived from one another. In short, a lexical item is a multilayered piece of declarative knowledge, stored in the language user's memory. Such items can be word-sized or larger, as in the case of multiword units and phrasal constructions.

The literature offers two basic ways of notating lexical items. RM tends to use the form illustrated in example 1*a*, with the layers spelled out one by one. CxM often uses a shorthand notation, as in example 1*b*. (In these examples, pragmatics is omitted and the information on each layer is simplified in the interest of readability; example 1*b* gives the phonology in orthographic form.) Relations across levels are marked by coindices. For example, in the lexical entry for *reader*, index 1 links the semantics, morphosyntax, and phonology/orthography of the verbal stem *read*, while index 3 connects the phonology and the morphosyntax of the affix, and index 2 links the levels of the full word:[2]

(1a) Semantics: $[\text{PERSON WHO } [\text{READ}_1]]_2$
Morphosyntax: $[_N\ [V]_1\ \text{aff}_3]_2$
Phonology: /ri:d_1 $\underset{1}{\text{ɹ}}{}_3$/$_2$

(1b) Shorthand notation: $< [[\textit{read}]_{V1}\textit{er}]_{N2} \leftrightarrow [\text{PERSON WHO } [\text{READ}_1]]_2 >$

The smallest lexical item is the word. Contrary to other approaches, morphemes such as *-er* are not understood as individual constructions; instead, they are represented as parts of the internal structure of words, as demonstrated in example 1. There are various reasons for this. One is that morphemes often do not have a meaning in isolation. This statement holds not only for affixes but also for roots (consider, e.g., the words *hapless* and *listless*, where *hap-* and *list-* have no independent meaning). Even if words appear to be formed compositionally from morphemes, they often have noncompositional properties, such as an idiomatic meaning. In configurations such as those shown in example 1, both compositional and idiosyncratic properties can be encoded in the appropriate place. For example, *reader* occasionally appears with idiomatic meanings; think of the use of the term as an academic title in the United Kingdom and elsewhere. Such meanings can be stated on the semantic level, without compromising the transparent morphosyntax of the word. I return to this issue below after introducing schemas.

[2]Coindex 3 is not shown in the semantics, as affix semantics is a property of the construction as a whole. Therefore, index 2 takes care of the connection between the semantic tier and the formal tiers of the word (for discussion, see Booij 2010, p. 15, and Jackendoff & Audring 2020, p. 129).

2.2. Lexical Items: Schemas

Since an English language user's lexicon contains a multitude of nouns of the type *reader*, differing only in the verbal base, the mind is likely to recognize this structure and form a generalization or schema.[3] Example 2 illustrates the schema for person nouns ending in *-er*, again in both notations:

(2a) Semantics: $[\text{PERSON WHO } [X_x]]_y$
Morphosyntax: $[_N\ [V]_x\ \text{aff}_3]_y$
Phonology: $/\ldots_x\ \text{ɹ}_3/_y$

(2b) Shorthand notation: $< [[X]_{Vx}\ \textit{er}]_{Ny} \leftrightarrow [\text{PERSON WHO } [X_x]]_y >$

A comparison of examples 1 and 2 shows that words and schemas differ in only one aspect: Example 1 is fully specific, while example 2 contains a variable for the base. This variable is represented on every level of structure and is marked by the index x (letter indices indicate variables; numbers mark constants). Also, the schema in example 2 has an "outer" variable index (y). Otherwise, the schema in example 2 has exactly the same format as the word in example 1. Both are pieces of declarative knowledge stored in memory, and both are part of the same network of knowledge, the extended lexicon or constructicon.

Like full words, morphological schemas are word-sized (although syntactic schemas, which are larger, can also contain morphological information). Again, this has the advantage that we can accommodate holistic properties as well as properties of the parts. In the case of schemas, the parts are what procedural approaches call the input; thus, schemas can specify any preferences or restrictions with regard to, say, the syntactic category or phonology of the base. Example 3 shows the schema that generalizes over English verbs like *widen*, *darken*, and *blacken*. The two bottom rows stipulate that the base is a monosyllabic adjective ending in an obstruent (cf. Jackendoff & Audring 2020, p. 88):

(3) Semantics: $[\text{BECOME } (X, [<\text{MORE}> \text{PROPERTY}]_x)]_y$
Morphosyntax: $[_V\ [A]_x\ \text{aff}_4]_y$
Phonology: $//\sigma\ [+\text{obs}]/_x\ \text{ən}_4/_y$

At the same time, schemas specify properties of the output, that is, of the entire complex word. For example, Booij (1998) shows that the choice of plural allomorph in Dutch is determined by a preference for plurals ending in a trochee, resulting in forms like *katt-en* 'cats' but *kater-s* 'tomcats' (for arguments in favor of output-oriented schemas, see also Kapatsinski 2013).

Further abstraction allows us to add a more general schema for suffixation, which then consists entirely of variables: one for the base and one for the suffix (**Figure 1**). The semantics of such a schema is maximally vague, an issue to which I return in Section 2.4. First, however, there is an important if well-known point to make: Adding fully schematic entries to the lexicon in fact moves the grammar into the extended lexicon, thereby abandoning the traditional view that lexicon and grammar are discrete domains of linguistics knowledge. This unified architecture is a hallmark property of construction-based theories, both in syntax and in morphology.

Within the lexicon, schemas serve various purposes. First, they help organize the inventory of words by indicating which parts of their structure are not arbitrary or coincidental. Thus, the presence of a schema distinguishes systematic *-er* in nouns from unsystematic *-er* in adjectives like *bitter*, *slender*, *dapper*, *limber*, or *clever*. This function of schemas is called motivation, a notion

[3] This understanding of the origin of schemas situates CxM and RM among the so-called usage-based theories (e.g., Barlow & Kemmer 2000, Bybee 2010, Bybee & Beckner 2010).

going back to de Saussure [1959 (1915), p. 131] and fleshed out for CxM by Booij (2017) and for RM by Jackendoff & Audring (2020, chapter 3). Second, schemas can be expected to aid language processing, in particular morphological parsing, by lending support to analyses that match an existing derivational or inflectional pattern in the language. And third, some (but not all) schemas are productive. Those that are can serve as templates for new words, the way rules function in other models. Productive word formation is done by unifying (Shieber 1986) the variable of the schema with new lexical material, thereby creating a new instantiation of the pattern. I return to the issue of productivity in Section 4.

An important difference between generation and motivation is that motivation need not account for all properties of a complex word. That is, motivation can be partial (Booij & Audring 2018a). The word *reader* is a case in point. It is morphosyntactically motivated by the $[[X]_{Vx}er]_N$ schema (given in fuller form as example 2). In its academic title interpretation, the formal motivation remains, and the schema also helps us recognize the word as a person noun on the semantic side. However, the semantics of *read* does not contribute to the meaning of the complex word. In another interpretation of *reader*, 'book of selected writings', we do see a contribution of READ, but the verbal argument encoded by the noun is an object rather than a person and it has a patient rather than an agent role, in defiance of the schema. Partial motivation can also "see" a suffix in words like *plumber* or *carpenter*, which match the $[[X]_{Vx}er]_N$ schema in the phonology of the final syllable and in general semantics ('person', often 'profession') but contain no lexical base (**plumb*, **carpent*).[4] Again, we see that both predictable and idiosyncratic properties can be represented straightforwardly—predictable properties of a word are those that match the appropriate schema; idiosyncratic properties are those that do not. This is an important advantage over procedural word-formation rules, which address only predictable properties.

2.3. The Texture of the Lexicon

The extended lexicon is understood as a highly structured environment, usually envisaged as a network of connected entries. Entries can be related to one another in two ways: by what are called hierarchical, vertical, or mother–daughter links and by paradigmatic, horizontal, or sister links. Mother–daughter links are shown in **Figure 1**, again using English nominal *-er* as an example. The

$$< [[X]_a \text{aff}]_b \leftrightarrow [\text{REL } [X_a]]_b >$$
$$\vert$$
$$< [[X]_{Vx} er]_{Ny} \leftrightarrow [\text{PERSON WHO } [X_x]]_y >$$
$$\vert$$
$$< [[read]_{V1} er]_{N2} \leftrightarrow [\text{PERSON WHO } [\text{READ}_1]]_2 >$$

Figure 1

A partial hierarchy of English *-er* nouns. REL encodes an underspecified semantic relation.

[4]Sometimes there is evidence for such an analysis. Dutch has the noun *reiziger* 'traveler', which is a lot like English *plumber* in that it is not built around a transparent verbal base (**reizig*). However, the feminine form, *reizigster*, contains the suffix *-ster*, which routinely alternates with morphemic *-er* but not with phonological look-alikes. Therefore, speakers apparently assign suffix status to *-er* in *reiziger* (see Booij & Audring 2018a, p. 60, for a related case, and see De Smet 2016 for an innovative corpus study on the relatedness of root-based derivations like *ruthless*, *squeamish*, and *bashful* to their suffix family).

top tier is the general suffix schema. This schema is the mother of the $[[X]_{Vx}er]_N$ schema, which in turn is the mother of the word *reader*. More specific subschemas could be added in between, for example, for nouns denoting professions (*baker*, *builder*, *brewer*, and so on).

Networks of this type are usually understood as being inheritance-based, which means that daughter nodes inherit the properties of their mothers, unless a property of the daughter overrides a more general property (this is known as default inheritance). Inheritance is often invoked for the sake of storage efficiency, as more general information from the mother need not be repeated in the daughters. CxM and RM take a different approach: Lexical entries are assumed to be fully specified, even when parts of their form and/or meaning recur in other lexical items. This is known as the full entry conception of the lexicon (Jackendoff 1975, Booij 2017, Jackendoff & Audring 2020, p. 65; see Zeschel 2009 for discussion). Full entries have the advantage that they can be linked by the structure they share. Shared-structure links can then serve as pathways for the motivational function introduced in Section 2.2. This in turn has the advantage that motivation is no longer limited to mother schemas and their daughter words: Every two items linked by shared structure motivate each other. Therefore, the notion of motivation replaces the notion of inheritance and considerably enriches it (Jackendoff & Audring 2020, chapter 3, provides a fuller discussion).

A second type of link, called a sister link, connects daughters of the same mother as well as more generally related items on the same taxonomic level. In our example, *reader* would have sister links to words like *writer*, *designer*, *caller*, *explorer*, and *organizer*, which are members of its morphological family, but it would also be linked to *reading*, *readable*, and *unread*, with which it shares the verbal base.

Schemas can also be sisters. For example, we could expand the middle layer of the toy network in **Figure 1** with a schema for instrument nouns like *computer*, *printer*, *browser*, *blender*, *cutter*, or *knocker*. This schema would be a sister of the person schema. More interesting, however, are sister schemas of the kind shown in example 4, a configuration also known as a second-order schema (Booij & Masini 2015). In example 4, only the form side of the construction is given; the ≈ symbol expresses the sister link:

(4) $[[X]_N$ *ful*$]_A$ ≈ $[[X]_N$ *less*$]_A$

The two English suffixes in example 4 are related by the fact that they regularly take the same base; think of *careful/careless*, *helpful/helpless*, and *powerful/powerless* (there are around 38 such pairs in the CELEX database). The analysis as sisters is particularly useful when two morphological patterns are evidently related but neither can be identified as primary with respect to the other. This happens, among other cases, in affix replacement (see footnote 4 for an example) as well as when schemas contain nonlexical roots, as in example 5:

(5) $[[ø]$ *id*$]_A$ ≈ $[[ø]$ *or*$]_N$

This pair of sister schemas unites words such as *candid/candor*, *horrid/horror*, and *splendid/splendor*. These words can only be horizontally connected, as their base is not a lexical item (**cand*, **horr*, **splend*) that could serve as a common mother.

Sister schemas are a powerful modeling tool in construction-theoretic approaches. They are also particularly relevant for the modeling of inflectional paradigms, so I return to them in Section 3.5.

2.4. Construction Morphology and Relational Morphology

I conclude this brief outline of construction-based morphology with a few remarks on the differences between the two theories. Generally speaking, these reflect differences in focus rather than areas of actual disagreement.

The first is that CxM, like CG, basically assumes that constructions are Saussurean signs, that is, pairings of form and meaning (though this is not a strict requirement; see Booij 2010, chapter 10). However, RM countenances meaningless constructions as well, especially in the more abstract tiers of the extended lexicon. More generally, RM considers form–meaning links to be one type of link among many; of equal theoretical interest are form–form links, say, between morphology and phonology or between phonology and orthography. The possibility of meaningless constructions opens the door to including, for example, phonotactic patterns, which are not usually considered meaningful, unless "meaning" is stretched to include information such as what language the construction belongs to (Höder 2019).

Second, the name Relational Morphology was chosen to reflect a specific focus on the declarative nature of linguistic knowledge and the relations within and between lexical items. This choice implies a greater emphasis on the structure of the lexicon, as well as on the quirks of existing words, in contrast to approaches that consider possible or potential words to be the main responsibility of a morphological theory. CxM occupies a middle ground here: The model is fundamentally usage-based, but it also highlights the creation of new words or word forms, that is, the productive potential of derivational and inflectional constructions.

Third, RM offers a more detailed and explicit notation, as illustrated in examples 1*a*, 2*a*, and 3. Jackendoff & Audring (2020) present more extensive sections on psycholinguistic issues, with preliminary forays into lexical access, schema access, and acquisition, and discuss counterparts of the formal apparatus in other aspects of language and the mind. However, I emphasize again that there are close ties between the two theories, and they should be considered complementary rather than competing.

3. MORPHOLOGICAL PHENOMENA FROM A CONSTRUCTION-BASED PERSPECTIVE

Having outlined the main characteristics of the theory, I next review how it has been applied to morphological phenomena in various languages. I highlight selected issues, some of them classic problems in morphological analysis, where a construction-theoretic approach has turned out to be helpful. As most available work is on word formation, this area takes center stage (but I touch on paradigms in Section 3.5).

3.1. Compounding, Affixoids, and Affixation

Compounding is probably the best-represented morphological pattern in the construction-theoretic literature. Many languages feature several compound types varying in lexical category, productivity, and semantic function, which can be insightfully modeled in a constructional network. The literature shows that, again, the advantage of the approach lies in the ability to state general properties where possible and specific properties where necessary.

For example, a partial network of English compounds could be represented in the simplified form shown in **Figure 2** (Audring 2019, p. 278; a similar schema appears in Langacker 2008, p. 239). The top level of this hierarchy says that English has compounds of some sort. The second level identifies the subclass of nominal compounds. This subclass can be further subdivided in noun–noun and verb–noun compounds. The words on the bottom level are instantiations of the various schemas and subschemas.

The ability to make local generalizations within a network such as **Figure 2** is relevant, for example, for the modeling of compound headedness. In the generative tradition, headedness is often regarded as a single parameter with a uniform setting per language. However, even within Indo-European, languages can show conflicting patterns with regard to headedness: Italian, for

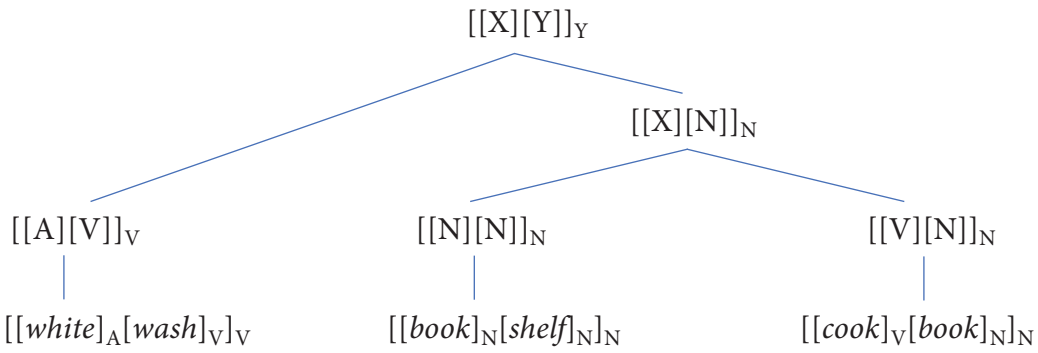

Figure 2

A partial hierarchy of English compounds. X and Y stand for unspecified syntactic categories.

example, has both right-headed and left-headed compounds (e.g., *soprabito* 'overcoat' versus *pesce spada* 'swordfish'; Arcodia 2012). In addition, various languages possess exocentric compounds that do not have a straightforward head, as in English *pickpocket*.

A construction-morphological treatment of headedness and exocentricity in compounds is offered by, among others, Arcodia (2012) for Italian and Vietnamese, Bagasheva (2015) for Bulgarian, Appah (2017) for the Niger-Congo language Akan, Arcodia (2011) and Arcodia & Basciano (2018) for Chinese, and Cetnarowska (2020) for Polish. These studies show that a construction-based perspective offers helpful solutions. As the network contains full entries (recall Section 2.3), headedness can be specified for each compound schema individually. Overall uniformity in headedness is not expected or required (although there can be functional advantages to having all heads in the same position). For exocentric compounds, both the category and the meaning can be represented as holistic properties of the compound schema, as illustrated in example 6 (from Masini & Audring 2019, p. 376, slightly simplified):

(6) $< [[V]_x\ [N]_y]_{Nz} \quad \leftrightarrow \quad [\{AGENT|INSTRUMENT\}\ \text{that PRED}_x\ [\text{SEM}_y]]_z >$

The schema in example 6 expresses the generalization that Italian has nominal compounds consisting of a verb and a noun and denoting a person or instrument doing something with respect to the item denoted by the noun. This motivates words like *tosta-pane* 'toaster, lit. toast-bread' and *acchiappa-fantasmi* 'ghostbuster, lit. catch-ghosts'. The exocentricity of these words follows from the fact that *tosta-pane* is not a type of bread and *acchiappa-fantasmi* is not a type of ghost (analogous to the way English *pickpockets* are not pockets and *scarecrows* are not crows). Instead, the compounds have an agent/instrument meaning that does not come from the parts. In addition, *fantasmi* is a plural noun, but *acchiappa-fantasmi* can be singular. Thus, the right-hand noun, although matching the compound in category, is not the head. The meaning and the word class of such compounds therefore need to be stated in the schema.

The option to specify properties holistically when necessary, rather than always trying to derive them compositionally from the parts, has additional advantages, as a derivational approach to exocentric compounds would necessitate empty or zero constituents to express meanings like 'agent' or 'instrument' in cases like example 6. Such empty morphemes can lead to difficulties in modeling, and many theories avoid them (e.g., Blevins et al. 2019, p. 271; but see Hoeksema 2012).

As with headedness, capturing the productivity and semantics of compounds may require lower-level specifications for certain subclasses. For example, within the partial network in **Figure 2**, only the $[[N][N]]_N$ schema is fully productive. In other cases, productivity can

depend on a particular left- or right-hand member or on a group of members. This observation has been made in numerous works and for a variety of languages. For example, Kapatsinski & Vakareliyska (2013) discuss an interesting case of $[[N][N]]_N$ compounds in Russian that consist of English loanwords like *-bar*, *-klub*, *-servis*, or *art-* plus another (mostly native) noun. The resulting loanblends, like *Nogti-Servis* 'Nail Service' (a manicure salon), often denote business establishments and typically carry connotations of Western coolness. The authors stress that this pattern has to be restricted carefully, first because it is tied to a particular group of loanwords with specific meanings, and second because speakers avoid overlap with a similar, older pattern with opposite pragmatic effects, evoking Soviet bureaucracy. Again, a network model proves useful, as the loanblend pattern can be linked "downward" to individual words and contrasted "sideways" with the competing (and here undesirable) sister pattern. Similar situations, in which a compound pattern develops local productivity for a certain group of left- or right-hand members and with a specific meaning, are discussed—among others—for Akan by Appah (2017), for Chinese by Arcodia & Basciano (2018), for French by Radimský (2020), and for German by Gaeta & Angster (2019).

If a local productivity boost involves a single compound member "going viral," new morphological constructions can emerge, often referred to as affixoids. Affixoids resemble free words in form but have a bound meaning within the particular (compound) construction. An example is the German adjective *fähig* 'able, competent', which appears in a large number of compounds such as *lernfähig* 'able to learn', *leistungsfähig* 'productive', and *anpassungsfähig* 'flexible'. In many such forms, the meaning of *fähig* is generalized and resembles the meaning of an affix—see the English translations of *leistungsfähig* and *anpassungsfähig*, which are affixed words rather than compounds. Ultimately, such forms may develop into affixes, the way *-ful* and *-less* are considered affixes in English, although the relation to their source lexemes is still evident.

Construction-based accounts of affixoids have appeared for, among other languages, German and Dutch (e.g., Michel 2013, Hüning & Booij 2014, Hartmann 2019), Italian (e.g., Masini & Micheli 2020), Hungarian (Kenesei 2007), Chinese (Arcodia 2011, Arcodia & Basciano 2018), and Aivaliot Greek (Ralli 2019). The particular challenge posed by such formations is their in-between status: They resemble compounds on the one hand and affixations on the other. From a construction-based perspective, the solution lies in partial motivation, introduced in Section 2.2, above. Affixoids can be represented as subschemas in a compound network, with lower-level overrides of certain properties for the affixoid member, specifically:

- the phonology, which is lexically fixed rather than variable;
- the semantics, which is often bleached in comparison to the lexical meaning, indicating grammaticalization; and
- (optionally) the category, when an affixoid begins to lose its original word class as it grammaticalizes.[5]

At the same time, the affixoid remains connected to its source lexeme via their shared phonology (the importance of shared structure for constructional linkage is discussed in Section 2.3, above), as well as via any metonymical or metaphorical relations that are still recoverable in the semantics. Therefore, the specific mix of grammatical and lexical properties of affixoids is reflected in their embedding in the constructional network.

As word-formation affixes are discussed in Section 2, I do not elaborate on affixation, but close this subsection with a brief look at combinations of word-formation patterns, for

[5]As part of speech membership can, strictly speaking, only be established distributionally, the category of bound items like affixoids is a matter of debate.

which the construction-based view has proved to be useful. Two relevant examples are as follows:

(7a)	*be-täub-en*	'to stun, to numb'	(German; discussed in Michel 2014)
(7b)	*an-nod-are*	'to knot'	(Italian; discussed in Masini & Iacobini 2018)

In example 7*a* from German, the adjective *taub* 'deaf, numb' appears as part of a prefixed verb. Since the prefix *be-* attaches only to verbs, the adjective needs to be verbalized first, but the relevant verb **täuben* does not exist. Similarly, the Italian case in example 7*b* shows a prefixed verb containing the noun *nodo* 'knot', but the intermediate forms **annodo* and **nodare* are not available. In these cases, we see the application of two word-formation patterns at the same time, here conversion and prefixation.

A derivational model that assumes the stepwise building of complex words from the root up has difficulties explaining the intermediate step involving nonexistent words. From a construction-based perspective, a different solution presents itself. As there are a sizeable number of words such as *betäuben* or *annodare*, German or Italian speakers can be assumed to develop a schema [aff [[A]]$_V$]$_V$ or [aff [[N]]$_V$]$_V$, respectively. This schema takes care of prefixation and conversion at the same time, while preserving the idea that the prefix can attach only to a verb: The conversion of A or N to V is internal to the affixation. From a usage-based perspective, this is a better analysis as the schema can be extracted from actually existing forms. Similar conclusions have been drawn for the so-called (para)synthetic compounds combining compounding and affixation (Gaeta & Zeldes 2017; Cetnarowska 2018, 2020; Masini & Iacobini 2018; Gaeta & Angster 2019).

3.2. Reduplication

A further morphological strategy used in both word formation and inflection is reduplication, that is, the repetition of a word or word part. As with compounding, various studies of reduplication have embraced a construction-based approach, especially for the way the effects of reduplication can be understood as a property of the construction as a whole (Inkelas & Zoll 2005, p. 15; Booij 2010, pp. 39, 241). For example, Japanese uses reduplication, among other things, to derive adjectival and adverbial expressions from nouns, as in *toki* 'time(s)' > *toki-doki* 'sometimes' (Petermann 2018, p. 112). This category change, and the semantics that goes with it, cannot be explained from the parts alone. This is analogous to the way exocentric compounds can diverge in word class and meaning from their parts. Holistic specification of the relevant properties are needed.[6]

Jackendoff & Audring (2020, p. 123) show how reduplication can be represented schematically in RM. Example 8 is for languages such as the Pama–Nyungan language Warlpiri, which uses reduplication of nouns to express plural. In the schema in example 8, the nominal stem (coindex x) is represented twice in the phonology. The meaning 'plural of X' and the morphosyntactic plurality are properties of the schema as a whole: PLUR and PL have no direct connection to the phonology, while the outer index y takes care of the connection between the levels of the schema:

(8)	Semantics:	[PLUR (X_x)]$_y$
	Morphosyntax:	[N_x, PL]$_y$
	Phonology:	/...$_x$ ...$_x$ /$_y$

While reduplication is vastly more common in languages outside Europe, van de Weijer et al. (2020) discuss an interesting case of apophonic reduplication in English. In pairs like *chitchat*,

[6]For a broader discussion of category change in constructions, see the volume edited by Van Goethem et al. (2018).

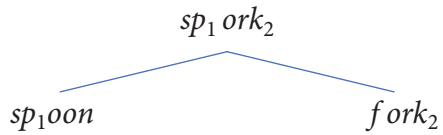

Figure 3

A representation of the blend *spork*.

zigzag, or *riffraff*, we see a systematic alternation of the stem vowels. Van de Weijer et al. (2020, p. 1702) point out that this pattern is worth capturing, "but not in a way that involves active deriva-tion." In other words, this type of reduplication in English is not a productive process, but neither is it unsystematic. A construction-based approach is an advantage here, as constructional schemas are first and foremost generalizations over stored instances—limited productivity is neither a sur-prise nor an embarrassment. I return to the issue of productivity in Section 4.

3.3. Nonconcatenative Morphology: Truncations, Blends, Splinters, and Conversion

The handling of nonconcatenative patterns, especially those that reduce the formal substance of a word, is often considered a challenge for theories of morphology. Among such patterns, truncation, blending, and splinters are traditionally regarded as noncore phenomena in morphological systems. From a usage-based perspective, however, there is no reason to marginalize them, as such patterns can be extracted from known words just like any other generalization.

Jackendoff & Audring (2020) discuss blends such as *spork*, from *spoon* and *fork*, and truncations such as *Liz*, from *Elizabeth*. Again, shared-structure links are vital. Blends obviously rely for their semantic effectivity on their connection to the two (or more) blended items. Thus, *spork* must be linked to both *spoon* and *fork*. In formalizing this connection, coindexation can be used to specify which part of the blend comes from which part of a source word. A simplified representation for *spork* is given in **Figure 3** (see Jackendoff & Audring 2020, pp. 111–15, for a more detailed formalization).

Note that the relevant segments, namely *sp-* in *spoon* and *-ork* in *fork*, have no significance outside the blending relation, and they are not meaningful within the two words. Thus, the relation imposes structure on the participating words. This matches the general idea that the structure of a lexical item can only be recognized through similarities and differences with other lexical items, justifying the need for a relation-based theory of morphology like RM.

Shared-structure links are also important for truncations, since the truncation schema has to specify which parts of the source word are retained in shortening. For example, English nicknames like *Liz*, *Dave*, and *Tom* retain the stressed syllable of the original name, plus the following consonant (other languages make different choices here; for example, Italian shortens *Francesca* to *Fra*, not to *Fran*). Jackendoff & Audring (2020) argue that such relations can be captured in pairs of sister schemas (see Booij & Audring 2017, p. 291, for a similar analysis). Example 9 shows the phonological tier of the two schemas, again in a simplified representation. The schema on the left-hand side captures the phonology of the full name, in fact saying little else than that it contains a stressed syllable, optionally followed by a consonant. The English nickname schema on the right picks out this stressed syllable plus the consonant, as indicated by coindex x:

(9)

/(...)	/'σC/$_x$	(...)/	≈	/'σC/$_x$
E	*'liz*	*abeth*		*Liz*

A similar case is presented in example 14 in the next section.

Next, let us take a brief look at splinters, as these are discussed from a construction-theoretic perspective in various recent publications. Splinters are parts of words used productively as if they were affixes (Bauer et al. 2013, p. 19). A relevant case from Dutch is *-fie*, originally the final syllable of *selfie*, which was reanalyzed as a suffix meaning 'photo of oneself with/at X(ing)'. Example 10 shows two *-fie* nouns (Jackendoff & Audring 2020, p. 49):

(10)	*fietsfie*	'photo of oneself one a bike/biking'	[*fiets*(*en*) '(to ride a) bike']
	stemfie	'photo of oneself voting'	[*stemmen* 'to vote']

Norde & Sippach (2019) offer a CxM analysis of eight English splinters (which they call "libfixes"), *-cracy*, *-fection*, *-flation*, *-gasm*, *-licious*, *-*(*o*)*meter*, *-tainment*, and *-tastic*, arguing that such formations are organized in exemplar clouds connected by phonological similarity. Jurado (2019) discusses the splinter *-gasm* in more detail, showing that it splits into several semantic subschemas. Splinters are excellent evidence for a usage-based approach to morphology, since they are morpheme-like structures emerging solely from speakers recognizing similarities between words. While splinters differ in origin from bona fide affixes, their use is entirely analogous, so it is advantageous if a morphological model can handle both in a uniform way.

Another nonconcatenative strategy, conversion [as in (*to*) $cook_{V}$ > (*the*) $cook_{N}$], merits a brief mention, although it has not figured prominently in the construction-theoretic literature. Riehemann (1998, p. 71) points out that in a word-based approach, converted (i.e., zero-derived) forms are just like other derivations, except that the derivation is not reflected in the phonology. A constructionally interesting case is discussed by Booij & Audring (2018b). In Dutch, V > N conversions can occur embedded in the syntactic construction [*aan* [Det N]]$_{PP}$, literally 'at the N' but translated as '(having the habit of) Ving N' (where V is left implicit). An example is *aan de drugs* (*zijn*) '(be) addicted to drugs'. While the variable N is a nominal slot, the construction is often used with verbal stems, as in *aan de zwem gaan* 'to go swimming'. The interesting observation is that most of these nominalized verb stems like *zwem* do not occur outside this construction. Thus, we are seeing a case of embedded productivity: V > N conversion is more productive within a particular construction than elsewhere. This phenomenon has been discussed as a case of coercion (Audring & Booij 2016, Booij & Audring 2018b), but the construction-theoretic perspective allows us to make the link to productivity, which seems relevant.

3.4. Templatic Morphology

To conclude this overview of construction-based analyses of morphological phenomena, I briefly review some work on two larger configurations in morphological knowledge: templatic morphology and paradigms (Section 3.5).

The term "templatic" subsumes quite heterogeneous phenomena. One the one hand, it is used for the CV templates of root-and-pattern morphology and for morphophonological templates in general. On the other hand, it refers to the slot structure of morphological templates, in which morphemes are arranged in position classes. I take these up in turn.

Semitic languages are known for their root-and-pattern morphophonology. Words can be separated into a consonantal root and a vocalic melody. Inflection and word formation are typically realized by unique CV patterns, in which the vowels vary but the consonants remain fixed, though there can be adjustments like gemination or inversions in order. Davis & Tsujimura (2018) develop a construction-based analysis for such patterns in Arabic. For example, hypocoristics in the Ammani-Jordanian dialect are characterized by a C*a*CC*uu*C pattern, as shown in example 11 (Davis & Tsujimura 2018, p. 323). The consonants of the derived form are identical to those of the base, with gemination of the second consonant:

(11)

Name		Nickname
hind	≈	*hannuud*
saliim	≈	*salluum*

Such patterns are especially well suited for an analysis in terms of sister schemas, where one sister generalizes over the name and the other over the nickname, with coindexation marking the identity relation between the consonants (recall example 9 on English nicknames). Example 12 presents a simplified sketch, showing only the phonological tier of the schema. The left-hand schema generalizes over the full name; the right-hand schema encodes the nickname pattern. Coindexation shows that the consonants are identical in both schemas:

(12) /C_xVC_y(V)C_z/ ≈ /C_x*a*$C_y$$C_y$*uu*$C_z$/

Davis & Tsujimura (2018) opt for a different schematic representation, but their solution is similar in spirit. The analysis shows that root-and-pattern morphology can be represented as constructional schemas (see also Good 2018). The meanings of the schemas have to be specified holistically, just as is argued for exocentric compounding in Section 3.1 and for reduplication in Section 3.2.

Templatic morphology can appear in another guise, namely as position classes of morphemes: formal structures that specify the linear arrangement of morphemes or morpheme types. Relevant work within CxM includes that by Gurevich (2006, pp. 54–57), Good (2018), and Baker (2018); Good (2016) provides a book-length typology. The following representation gives the maximal morphological template for nominals in Ngalakgan (Gunwinyguan), with an example word (Baker 2018, p. 274):

(13) [(Noun class-)(Bound stem-)N(-Dative pronoun)(-Number)(-Case)]$_N$
cu-jappa-ŋki-ppulu-kka?
FEM-sister-2MDAT-PL-LOC
'at your (sg.) sisters'

In principle it seems unproblematic to represent such templates as constructions—constructions are, after all, themselves templatic in nature (but see Baker 2018 for various complexities). However, Good (2018, p. 41) points out that a morphological template "is not a signifier in its own right, but, rather, represents a kind of constraint on possible signifier shapes in specific constructional contexts." In other words, templates are not signs. This relates to the question of whether all constructions are meaningful. If morphological templates are accepted as constructions, then they are underspecified both on the semantic and on the phonological layer. RM countenances this type of construction, but other variants of construction-based theories might not (see Jackendoff 2013 for discussion). These issues await further theoretical work.

3.5. Paradigms

I close with the challenging topic of (inflectional) paradigms, which is relatively underresearched from a construction-based perspective. Paradigms are configurations of inflected (and perhaps also derived) forms. A small section of the paradigm for the German verb *lieben* 'to love' is shown in example 14, in a simplified representation:

(14)

< [*lieb*$_V$-*e* $_{PRS, 1SG}$]	↔	[(I) love] >
< [*lieb*$_V$-*st* $_{PRS, 2SG}$]	↔	[(you) love] >
< [*lieb*$_V$-*t* $_{PRS, 3SG}$]	↔	[(he/she/it) loves] >

Paradigms are similar to morphological templates in that they are larger configurations (Diewald 2020 uses the term "hyperconstruction") that may or may not themselves be meaningful. In construction-based theories, there is comparatively little work on inflection (but see, e.g., van der Spuy 2017a,b, 2020; Jackendoff & Audring 2020, chapter 5; and Beuls 2012 for a computational model, and Masini & Audring 2019, p. 384, for an overview) and even less on paradigms. Recent initiatives to address this lacuna include those by Politt (2019) and Diewald (2020).

Paradigms are important for all theories of morphology, due to the "Paradigm Cell Filling Problem" (Ackerman et al. 2009): How does a language user reconstruct the full paradigm of inflected forms for every lexeme? Solutions can be situated on a scale between two extremes: (*a*) listing of inflected word forms and (*b*) utilizing an abstract system of rules or schemas. As inflectional systems can be very complex indeed, option *a* presents the problem of massive storage. It also raises the question of how to deal with novel forms. Inflection is generally considered productive, so speakers have to be able to generate inflected forms they have not encountered. For option *b*, an issue arises as to how to link individual lexemes to a particular paradigm when there is a choice, that is, when a language has inflectional classes. As Blevins (2006) demonstrates, inflectional behavior cannot always be predicted from properties of the stem. Word-based theories of morphology often invoke a compromise: Paradigms are constructed as generalizations over stored forms, whereby a limited number of stored forms for every lexeme ensures the connection of the right lexeme to the right paradigm (sometimes a privileged group of forms called principal parts is assumed for this purpose). CxM and RM follow this general approach, although Jackendoff & Audring (2020, p. 158) argue for opportunistic storage of forms—after all, language users cannot know in advance how informative a particular form will be with regard to the paradigm.

For the modeling of paradigms, and of paradigmatic relations in general, the concept of sister schemas seems particularly promising (Audring 2019, Masini & Audring 2019). Each paradigm cell can be captured in a schema, and all the schemas form a network of sister schemas, characterized by a shared base. However, paradigms are closed sets, and not every item with a shared base is a legitimate member of the paradigm. For example, the derived nominal *Lieb-e* 'love' is not a member of the paradigm in example 14. Therefore, paradigms needs to be systematically restricted by specifying the category of the participating word forms as well as the relevant array of morphosyntactic features, such as person, number, or tense. Construction-theoretic work has not yet agreed on a uniform way to capture such configurations. A further challenge is presented by gaps, that is, missing forms within a paradigm (see Sims 2015 on defectivity in paradigms). In a model where linguistic knowledge is assumed to be based on stored forms, it is not easy to encode what cannot be said (see Goldberg 2019 for a book-length discussion of this general problem). Last but not least, more specific paradigmatic configurations such as inflectional classes and morphomes have yet to be worked out in a construction-theoretic model.

4. REFLECTIONS AND DESIDERATA

This review concludes with some reflections on where we are and what open questions await us. I concentrate on two issues: productivity and types of relation in the extended lexicon.

4.1. Productivity

Linguistic theory has long been dominated by the generative ideal that grammatical patterns are productive and can be used to create novel words and sentences. This has left traces in the theoretical landscape: less attention for unproductive phenomena and a certain disregard for the lexicon. Even within morphology, where such a position is harder to maintain than in syntax, we are still seeing a fundamental divide: Should productivity be considered the norm, and is it the task of a

theory to explain the restrictions we find? Or is productivity itself the phenomenon that needs explaining?

From a usage-based perspective, the latter approach makes better sense. If grammatical schemas are first and foremost generalizations over words stored in memory, then the productive use of such schemas to form new words is, in fact, an upgrade. What causes this upgrade in the mind of a language user is not as well understood as we would like. A consensus in the literature is that type frequency is an important factor. However, morphological patterns with a high type frequency can nevertheless be unproductive. A case in point is the Dutch adjectival suffix *-(e)lijk* (cognate with English *-ly*, as shown by some of the translations in example 15). It represents a native, formally transparent, and semantically regular schema with several hundred types. Example 15 shows the schema and a small selection of daughter words:

(15) [[V/N/A] *(e)lijk*]$_A$
gruwelijk 'gruesome', *sterfelijk* 'mortal', *lichamelijk* 'bodily', *mannelijk* 'male', *ziekelijk* 'sickly', *lief(e)lijk* 'lovely'

Despite its high frequency and transparency, the suffix *-(e)lijk* is not synchronically productive, and doubtlessly the same holds for other, equally well-entrenched derivational patterns. What stops speakers from extending such a pattern to new instances is a puzzle that belongs on the agenda of construction-based theories, or in fact any morphological theory.

A related conundrum is presented by Lamberty & Schmid (2013), who discuss English NV compounds such as *vacuum-clean*, *babysit*, and *cherry-pick*. Such compounds mostly arise via backformation from derivations: *vacuum cleaner*, *babysitter*, *cherry-picking*. However, given that NV compounds form a sizeable class, how come speakers do not regard this type of compounding as productive? A nonce word test by Lamberty & Schmid (2013) reveals that speakers prefer novel compounds when these correspond to an existing derived word. For example, the verb **lion-tame* is considered better than the verb *crutch-walk* due to the existence of *lion tamer*. From a construction-theoretic perspective, this observation suggests that language users form generalizations in the form of sister schemas, with the derivation on one side and the compound on the other. Thus, the NV compound schema is tied to another schema, which may influence its perceived (un)availability for productive use. In addition, Lamberty & Schmid (2013) found that novel compounds were rated higher when they shared a constituent with a group of existing NV forms (*to *househop* < *to jobhop/tablehop/barhop*), which suggests low-level subschemas of the type discussed in Section 3.1. These findings open new avenues in research on productivity, and on the conditions under which speakers upgrade a generalization to a productive schema.

Another issue of interest is the observation that productivity can arise in semantic niches. That is, a not particularly productive mother schema can contain a productive daughter. A potential case from Russian is presented above in Section 3.1 (Kapatsinski & Vakareliyska 2013); others are described contrastively for German, Dutch, and English by Hüning (2009). One of the patterns mentioned is N > V conversion in Dutch. This pattern cannot be applied to just any noun. However, it is automatically available for nouns denoting sports (*tennis* > *tennissen*, *judo* > *judoën*, *ski* > *skiën*, and so on; players of the racquet sport *padel*, recently introduced in the Netherlands, speak of *padellen*). A question to ask here is to what extent a productive subpattern contributes to the productivity of the more general schema (in this case, N > V conversion in Dutch). A construction-based approach suggests two opposing views. On the one hand, the ability to specify properties and behavior locally rather than globally is considered an important advantage. Thus, productivity of a daughter schema need not mean productivity of a mother schema, and vice versa. On the other hand, any new instantiation of the daughter schema is also, in a sense, an instantiation of the mother. If new instantiations boost the schema, then some measure of this effect might

also reach the higher-order schemas in the relevant part of the network. Empirical ways to probe such questions might be found in the experimental realm, as these issues are closely tied to the psycholinguistic understanding of the mental lexicon, the nature of representations of words and schemas, and the way they are activated in language production and perception. Bigger issues are at stake here, requiring close collaboration between different linguistic subfields.

4.2. Types of Relation in the Extended Lexicon

Another issue that awaits further work concerns the types of relation found in the extended lexicon. The most widely cited classification of links between constructions is that by Goldberg (1995, pp. 75–81), who proposes four types: instance links, subpart links, polysemy links, and metaphorical extension links. Instance links are roughly equivalent to the mother–daughter links presented in **Figure 1** (Section 2.3) and **Figure 2** (Section 3.1). Subpart links connect constructions of which one is a proper subpart of another. The last two types are semantic links, connecting various senses of a construction and metaphorical mappings between constructions, respectively. Diessel (2019) develops a different classification involving six types of relation, only one of which (taxonomic links) matches Goldberg's. A simpler classification is proposed by Jackendoff & Audring (2020), who distinguish only two basic types: interface links within a construction and relational links between constructions. Interface links take care of the mapping among semantics, morphosyntax, phonology, and orthography within a lexical item; relational links connect shared structure across items. Some of these subsume Diessel's link types, but both types are broader and more inclusive.

This brief comparison shows that there is little agreement on the nature of connections within and between lexical items. More work is needed here, especially if the links are expected to have some degree of psycholinguistic reality. Even more consequential is the question of what information is encoded in the lexical items themselves and in the links between them. For example, as pointed out by Audring (2019), some morphological patterns can be expressed by means of sister links between constructions, without an additional mother schema. Examples are presented in Section 2.3: the sister patterns $[[X]_N$ *ful*$]_A \approx [[X]_N$ *less*$]_A$ and $[[\emptyset]$ *id*$]_A \approx [[\emptyset]$ *or*$]_N$. These are simply oppositional pairs, and sister links can say everything that needs to be said about their relation. The conditions under which sister links suffice, or a mother schema is needed, are of great interest for the theory. A special issue of *Word Structure* (Hilpert 2019) and a volume edited by Sommerer & Smirnova (2020) mark the start of the exploration.

5. CONCLUSIONS

Construction-based thinking in morphology has attracted a thriving research community and has sparked a great variety of theoretical and empirical work. I have outlined two versions of the theory based on two publications: Booij (2010) on CxM and Jackendoff & Audring (2020) on RM. After sketching the foundations of the approach, I have presented an overview of work on various morphological phenomena, from compounding to templatic morphology. In summary, some of the most attractive aspects of the theory are the following:

- Linguistic patterns can be more or less general. The model does not privilege general over local patterns.
- The network architecture allows general and specific information to be interwoven with each other yet kept distinct.
- Some properties of constructions are holistic and cannot be derived from the parts. This does not mean that there are no parts. Both holistic and compositional properties can be accommodated, each in their own place.

- Hierarchical mother–daughter links are not the only type of link in the network. Sister links are a powerful modeling device, both for individual words and for more abstract schemas.
- The model is data-driven and usage-based. It can be applied to all kinds of morphological patterns, productive or unproductive, common or marginal.

There are many issues I have not been able to cover. I warmly invite the reader to consult the varied and interesting literature for broader and deeper discussions of morphological constructions.

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CELEX database. **http://celex.mpi.nl/**