

Vertical and horizontal links in constructional networks: Two sides of the same coin?

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Abstract:

Recent models of constructional networks combine vertical links between schemas and their subtypes with horizontal links between constructions at the same level of abstraction. It remains unclear, however, whether vertical and horizontal analyses express distinct information about the network, or whether one can be reformulated in terms of the other. In this paper, it is argued that vertical and horizontal links do not encode distinct cognitive mechanisms but that they are notational variants for representing a common notion of constructional similarity. The practical advantages of each notation are outlined, and some potential objections to the present account are addressed.

1 Introduction

Construction Grammarians, as well as proponents of other cognitive-linguistic frameworks, assume that speakers' grammatical knowledge consists of a mental network of constructions, or form-meaning pairings (Diessel 2019; Goldberg 2006; Langacker 1987). A primary concern for researchers who work in these paradigms is therefore to develop models of how the constructional network is organised and by what kinds of links its nodes (i.e., the constructions) are related. A distinction that has been prominently discussed in recent years is the one between 'vertical' and 'horizontal' links in the network. Vertical links (also called inheritance links) are assumed to capture taxonomic relations between schemas and their subtypes, i.e., between units at different levels of abstraction (Croft 2001; Goldberg 1995; Hudson 2007). Such vertical links may, for instance, relate speakers' abstract representation of the double-object construction, which encodes 'transfer of possession' events, with a number of more specific subconstructions that express variations of the schematic meaning, such as

‘actual transfer’, ‘intended transfer’ and ‘blocked transfer’ (Croft 2003; Zehentner 2019). Horizontal links, on the other hand, are thought to relate constructions at the same level of abstraction (Diessel 2015; Sommerer & Smirnova 2020; Van de Velde 2014). Horizontal links have been posited, for example, between the members of constructional ‘alternations’, such as the double-object and the *to*-dative construction, which together form the dative alternation (Zehentner & Traugott 2020), and between the members of constructional ‘paradigms’, such as verb-initial, verb-second and verb-final ordering in Dutch clauses (Van de Velde 2014).

While previous discussions of these linking types have yielded important insights about the degree of relatedness between specific constructions, the theoretical status of horizontal links and their distinction from the more traditional concept of vertical relations remain controversial. Smirnova and Sommerer (2020: 28), for example, comment that “scholars do not agree on the nature of horizontal links”. They continue to outline two central questions that underlie the current debate: first, what conceptual grounds horizontal relations rely on (as the less established linking type); and second, what the division of labour is between vertical and horizontal relations.

A closer look at the literature indeed reveals that the distinction between vertical and horizontal analyses is often less clear than assumed. For instance, in the case of constructional alternations, not all researchers have couched the relation between the two alternating variants in terms of a horizontal link (as mentioned above for the example of the dative constructions). While some scholars endorse horizontal analyses of alternations (Coleman 2020; Smirnova & Sommerer 2020), others posit instead a superordinate schema that is vertically related to the subconstructions and captures their similarities (Cappelle 2006; Lorenz 2020; Perek 2015), while yet others have combined both vertical and horizontal links in their models (Percillier 2020; Zehentner 2019). Some researchers have also noted that vertical and horizontal analyses can be difficult to distinguish: Zehentner and Traugott (2020: 194), for instance, comment that “visual representations of this kind quickly get quite complex, and the distinction between vertical and horizontal links is difficult to uphold”. Even more explicitly, Hoffmann (2020: 150) argues that “empirically, [...] it is impossible to distinguish between the two analyses”, which seems to raise the possibility that vertical and horizontal representations are in some way equivalent.

As these views from the literature illustrate, there is considerable disagreement about the role that vertical and horizontal links play in models of the constructional network. Given the difficulties that previous accounts have encountered when distinguishing between the two linking types, the present paper will put forward a new proposal about their mutual relationship.

The key suggestion of this account is that vertical and horizontal relations, rather than encoding *distinct* information about the constructional network, constitute alternative ways of representing the *same* information – namely, information about the shared features of similar constructions. In other words, vertical and horizontal links do not encode distinct cognitive mechanisms, but they are notational variants for representing a common notion of constructional similarity. It will also be shown, however, that vertical and horizontal models, while conceptually equivalent, differ in their practical usage: each notation comes with certain advantages and disadvantages that make it a more or less suitable tool for specific analyses.

The further structure of this paper is as follows: Section 2 discusses previous models of vertical and horizontal links and addresses some of their potential limitations. In particular, it is shown that the distinction between vertical and horizontal links is often blurred, and that vertical analyses can usually be recast in horizontal terms, and vice versa. Section 3 outlines the theoretical arguments for the present proposal. It is suggested that vertical and horizontal links form notational variants for expressing a common conceptual ground of similarity, but that each notation also has certain practical advantages over the other. Section 4 addresses four possible objections that could be raised against the present account. These include the status of ‘horizontal’ syntagmatic relations, the function of schemas, the difference between relations of similarity and relations of contrast, and the variable strength of vertical and horizontal links. Section 5 summarises the main points of the discussion and outlines some further implications.

2 A blurred distinction: previous accounts of vertical and horizontal links

While vertical links have been a feature of cognitive-linguistic network models since their conception, horizontal links form a relatively recent addition to the theoretical toolkit. The following sections will therefore provide only a brief summary of vertical relations before discussing in more detail two previously proposed models of horizontal links. For each model, it will be shown that the distinction between vertical and horizontal analyses is less clear than it may seem, and that one analysis can potentially be reformulated in terms of the other.

2.1 Vertical (inheritance) links

Goldberg (1995) was among the first to suggest that constructional networks are structured by vertical relations between constructional schemas and their subtypes. The abstract resultative construction, for example, can be vertically related to the more specific *drive-crazy* pattern illustrated in (1). Goldberg couched this relationship in terms of ‘inheritance’ (Hudson 1984; Lakoff 1987; Touretzky 1986), where the subtype is assumed to inherit, i.e.,

adopt, the features of the superordinate schema, including its constructional meaning (‘cause to become’) and the syntactic categories of its elements (subject – verb – object – oblique).

(1) *Chris drove Pat mad/bonkers/bananas/crazy/over the edge.* (Goldberg 1995: 79)

Since then, vertical inheritance relations have been used ubiquitously by cognitive linguists to model taxonomic relationships in a variety of grammatical domains. Croft (2001), for example, presents an extract from a hierarchy of English clause types, as depicted in Figure 1. The diagram illustrates that vertical links can relate categories at multiple taxonomic levels, ranging from the supercategory (‘clause’) to basic clause patterns (intransitive and transitive) to verb-specific subtypes of those clauses (e.g., ‘Subj *kick* Obj’) and to yet more specific idiomatic subpatterns (e.g., ‘Subj *kick the bucket*’).

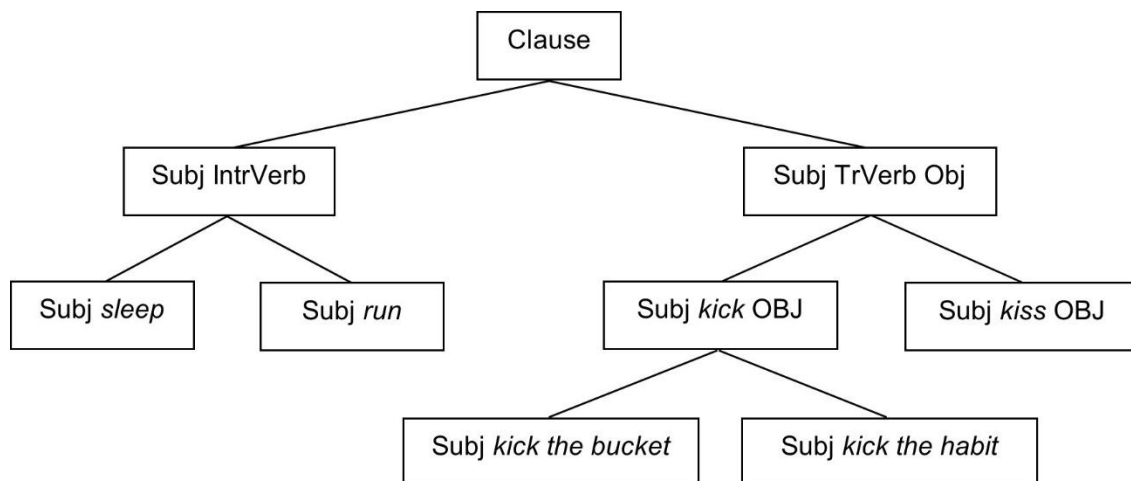


Figure 1. A vertical hierarchy of English clause types (from Croft 2001: 26); reproduced with permission of the Licensor through PLSclear

Alongside these vertical relations between units at different levels of abstraction, however, researchers have increasingly started to posit additional horizontal links between units at the same level of schematicity. Following Smirnova and Sommerer (2020), two main areas can be distinguished in which such horizontal relations have been discussed: the ‘allostructions’ model, which concerns the relationship between alternating constructions, and the ‘paradigmatic’ model, which captures links among the members of constructional paradigms. These two models will be examined in turn below, focusing on the role that vertical and horizontal relations play in each of them.

2.2 The allostructions model

Starting with the ‘allostructions’ model, Cappelle (2006) pointed out that early Construction Grammar work had not assigned any theoretical status to the relation between constructions that have been traditionally treated as members of an ‘alternation’ (Levin 1993; see Pijpops [2020] for varying definitions of the concept). Cappelle suggested that the semantic similarity between the alternating variants can be captured by regarding the constructions as ‘allostructions’ of a common schema, in analogy to allophones and allomorphs. Using the example of the verb-particle constructions in (2), Cappelle defined these allostructions as “variant structural realizations of a construction that is left partially underspecified” (2006: 18). His illustration of the verb-particle constructions is reproduced in Figure 2, which depicts the two allostructions as being subsumed under a common schema that leaves the position of the particle underspecified.

- (2) a. *She turned off the TV.*
 b. *She turned the TV off.*
 (both from Cappelle 2006: 4)

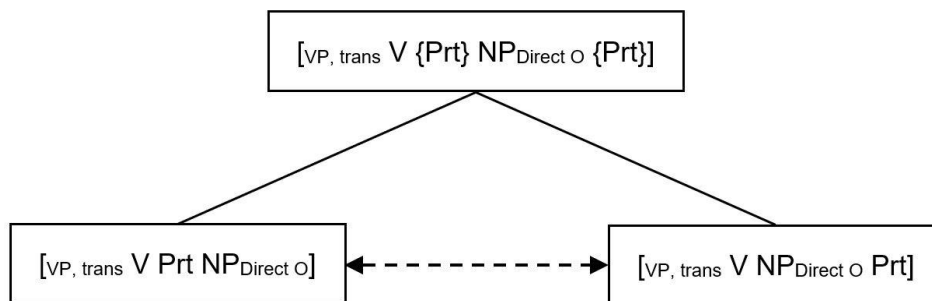


Figure 2. The English verb-particle constructions as allostructions (from Cappelle 2006: 18); reproduced with kind permission by the author

As illustrated by the solid lines in Figure 2, Cappelle’s analysis captures the relationship between the allostructions primarily via vertical links to the schema (which is sometimes called a ‘constructeme’). In addition to these vertical links, the diagram also contains a dashed horizontal arrow between the two lower-level allostructions. The theoretical status of this connection is, however, not further clarified. Cappelle (2006) himself does not use the term ‘horizontal link’, and his account foregrounds the role of the vertical connections.

Cappelle's model is adopted by Perek (2015) in his treatment of the dative alternation, illustrated by the examples in (3). In his network diagram (p. 156), Perek captures the relationship between the dative constructions in terms of vertical links to a superordinate constructeme, which encodes the common 'transfer of the possession' meaning of the two constructions but leaves the order and constituent type of the postverbal participants underspecified.

- (3) a. *Mary gave John a book.*
b. *Mary gave a book to John.*
(both from Perek 2015: 155)

Interestingly, however, Zehentner (2019) models the same relationship via a combination of vertical and horizontal links. According to her diagram (p. 324), the dative constructions are not only vertically connected to a common schema, but they are also related via a horizontal link at the same level of abstraction. In fact, Zehentner argues that this horizontal link precedes the vertical relations both conceptually and historically: i.e., it is only when horizontal links between allostructions are particularly strong (as emphasised by bold print in Zehentner's diagram) that speakers may form an abstract generalisation that is vertically connected to the subtypes (see Section 4.4 for further discussion).

The difference between Perek's vertical-only and Zehentner's vertical-plus-horizontal analysis of the dative constructions is mirrored by other authors' conflicting comments about the nature of allostructions (some of which were already mentioned in the introduction). On the one hand, some scholars have continued to defend Cappelle's (2006) original vertical analysis (Lorenz 2020), while others have interpreted the relationship between allostructions primarily in terms of a horizontal link (Coleman 2020; Smirnova & Sommerer 2020). Finally, some researchers have adopted Zehentner's (2019) 'middle way' and posited both types of links: Percillier (2020: 240), for instance, suggests that "[a]llostructions involve horizontal links between the specific realisations as well as vertical links between the specific allostructions and the more schematic constructeme" (see also Zehentner & Traugott [2020]).

Given this disagreement among previous accounts of allostructions, the distinction between vertical and horizontal analyses appears to be blurred. This is not too surprising if one considers that the function of the superordinate schema in vertical models has been described as "encod[ing] those elements that are shared by both variants", while the horizontal link has been characterised as expressing the "partial similarity" of the subconstructions (Smirnova &

Sommerer 2020: 25). According to these definitions, the content of the schema seems to overlap with the content of the horizontal link. This has been noted by Audring (2019: 281), who proposes that, in the case of the verb-particle constructions, “the generalization encoded in the mother [...] is already expressed in the sister links between the daughters”. While Audring still believes that vertical and horizontal models make distinct predictions for certain phenomena (see the discussion in Section 4.2), her remark raises the possibility that, at least in the case of allostructions, the two types of links may redundantly encode the same information. Hoffmann (2020: 150) makes this point even more explicit by commenting on Cappelle’s vertical analysis in Figure 2 above and suggesting that “this relationship is already adequately captured [...] by the dashed bidirectional arrow that horizontally connects the two ‘allostructions’”. Hoffmann goes on to say that “empirically, [...] it is impossible to distinguish between the two analyses” and that in his view, the existence of a superordinate schema instead of a lower-level horizontal link cannot be falsified (see Section 3.1 for further discussion of this question).¹

To sum up this first part of the discussion, previous accounts of allostructions have variably posited vertical links, horizontal links or a combination of both to capture the relationship between the alternating variants. The distinction between the two linking types is blurred: while the superordinate schema is assumed to store the shared features of the allostructions, those similarities can be simultaneously encoded by a horizontal relation between the subconstructions, suggesting that the two linking types may potentially represent the same information. Moving on to the other main model of horizontal links, it will be examined whether it yields a clearer distinction between vertical and horizontal relations.

2.3 The paradigmatic model

While Cappelle’s (2006) allostructions account only hints implicitly at a potential horizontal analysis, Van de Velde (2014) makes explicit use of the term ‘horizontal links’ in the context of his ‘paradigmatic’ model. In contrast to the allostructions model, Van de Velde’s model focuses not on semantically near-synonymous constructions that differ in their form, but on constructions that are partially different in both form and function and together form part of a constructional ‘paradigm’. Drawing the analogy with phonological and morphological

¹ Compare also a recent interview with Bert Cappelle (Cappelle et al. 2021), where he compares Audring’s (2019) account of sister links with his earlier vertical model (see Figure 2) and argues that “as far as I can see, Audring’s ‘flat’ representation and my ‘triangular’ one aren’t different in any cognitively crucial way” (p. 283). Cappelle goes on to support Hoffmann’s (2020) stance: “If that is correct, then I would agree that deciding which representation is the right one is beyond what can be determined scientifically by falsification.”

paradigms, Van de Velde examines ‘syntactic’ paradigms, i.e., closed sets of clause-level constructions that cover a particular functional domain (Diewald 2020). One of Van de Velde’s examples concerns the paradigm of Dutch clause types displayed in Figure 3, in which the three finite clause patterns of verb-initial, verb-second and verb-final ordering are represented as distinct but mutually related constructions.

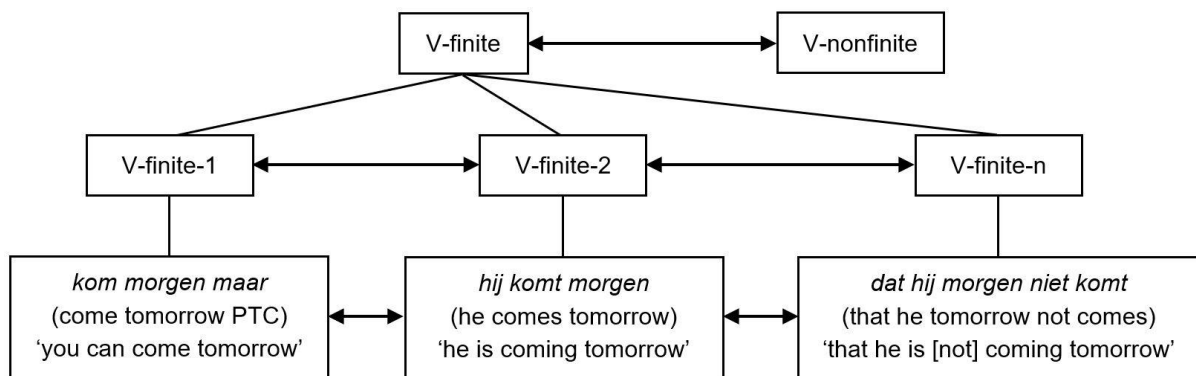


Figure 3. Paradigm of Dutch clause types (from F. Van de Velde, “Degeneracy: The maintenance of constructional networks”, in: R. Boogaart, T. Colleman, & G. Rutten (eds.), *Extending the scope of construction grammar*, Berlin & Boston: De Gruyter Mouton, 2014, p. 150, fig. 5)

In Van de Velde’s model, horizontal links can be posited between the members of this paradigm because they form “a network where the form-function relation of a particular construction may be partly motivated in relation to its neighbours” (2014: 147). As the author observes, the three Dutch clause types are not only formally distinct but also functionally differentiated: the sentence-initial position of the finite verb is reserved for ‘non-assertive’ meaning contexts such as polarity questions, conditionals and imperatives; the verb-final order occurs in ‘backgrounding’ contexts, mostly in subordinate clauses; while verb-second order is the default order in declarative main clauses. Van de Velde thus suggests that the three constructions ‘motivate’ each other via their partial similarities but also via their particular differences, and that these relationships of mutual motivation can be best captured by horizontal links.

It should be noted, however, that as with some of the allostruction accounts reviewed in Section 2.2, Van de Velde’s diagram of the constructional network in Figure 3 contains both vertical and horizontal links. The three finite clause constructions are horizontally related to each other, but they simultaneously share a vertical link to the ‘V-finite’ schema. One question

that arises in this context is why the ‘V-finite’ schema is, in turn, only horizontally related to its ‘V-nonfinite’ counterpart; if the two stand in a similar paradigmatic relationship, they could also be subsumed under a ‘verb-containing clause’ superschema. The more general concern, however, is that the simultaneous presence of vertically related schemas and horizontal links in Figure 3 (and in other of Van de Velde’s [2014] diagrams; compare pp. 148–149) blurs the distinction between the two linking types. This raises the question of whether the two types of relations can be used interchangeably to encode the partial similarities among the Dutch clause types (which necessarily also imply partial differences; see Section 4.3).

A similar impression arises in other recent analyses of paradigmatic links that have combined vertical and horizontal relations. Gyselinck (2020), for example, examines diachronic changes among subtypes of the Dutch intensifying fake reflexive resultative construction, illustrated in (4).

- (4) *Als cliënt van deze firma betaal ik me elke maand blauw.*
 as client of this firm pay I myself every month blue
 ‘As a client of this firm, I pay a lot of money every month.’
 (Gyselinck 2020: 108)

Gyselinck primarily uses vertical links to represent similarities among members of the constructional family. She posits, for example, an intermediate-level schema [SUBJ V REFL *suf*] to generalise over several more specific ‘micro-constructions’ that contain different verbs but the same intensifier *suf* ‘drowsy’. At the same time, however, the author notes that other micro-constructions share the same verb while differing in their intensifiers. Instead of positing additional verb-specific schemas, she proposes that these verb-based similarities could be encoded via horizontal links between the respective micro-constructions. Interestingly, Gyselinck does not suggest that the two linking types encode distinct claims about the organisation of the constructional family; rather, she argues that “these horizontal links are actually reinterpretations of the vertical links in another possible configuration of the network” (2020: 135). In an alternative network representation, the two network dimensions could be swapped around, by representing the verb-based similarities via vertical links and the intensifier-based similarities via horizontal links (see the diagrams in Gyselinck [2018: 234]). This suggests that vertical and horizontal models may be conceptually equivalent, and that the

two notations can be reformulated in terms of one another without changing the meaning of the representation.²

Similar questions about the role of vertical and horizontal links in the paradigmatic model are raised by Smirnova and Sommerer (2020: 27), who analyse the paradigm of the English demonstratives *this/that/these/those*, as well as Sommerer (2020a: 92), who examines Old English demonstrative–possessive constructions (see Section 3.2 for an example). In both cases, the authors posit horizontal links between the paradigmatic alternatives while simultaneously subsuming them vertically under a higher-level schema. Notably, Smirnova and Sommerer (2020: 27) explicitly address the potential limitations of their representation, commenting that “[t]he question is whether speakers really connect constructions in this way, or whether a more economic approach with only one (vertical? horizontal?) relation would suffice to capture the fact that these constructions are related to each other in a network”.

Finally, some additional proposals have been made about the role that vertical and horizontal relations play in constructional paradigms. Yet these models too do not distinguish convincingly between the two types of relations. Diewald (2020), for instance, argues that classic inflectional paradigms like the English case system can be modelled via a combination of vertical and horizontal links. On her account, vertical relations connect the zero-marked and the marked members of the paradigm: nominative case, for example, constitutes a superordinate category from which the subordinate category of accusative case inherits. Horizontal links, on the other hand, relate the marked members of the paradigm among each other, for example dative and accusative case. In addition, all these links together form a ‘hyper-construction’, an “aggregate of [...] indexical relations” (Diewald 2020: 278) that captures the paradigm as a whole. One problem of this analysis is that positing vertical links between the nominative and the other cases requires that the cases differ in their degree of abstraction (with the nominative forming an abstract schema that subsumes the other cases), which seems questionable. Moreover, if vertical and horizontal links are used to connect the members of the paradigm with each other, it is not clear by what mechanism these members are related to the overall hyper-construction, and therefore how the hyper-construction is represented within the network.

Similarly, Lorenz (2020) invokes another complex linking pattern, a ‘meta-construction’, to capture the analogical relationship between English modals and their

² Also note that the intensifier-based and the verb-based similarities in Gyselinck’s (2020) diagrams could alternatively be represented via vertical relations only, by making use of multiple inheritance (Sommerer 2020b).

contracted forms (e.g., *going to* – *gonna*; *want to* – *wanna*; *got to* – *gotta*). However, while Lorenz’ network diagram depicts a higher-level meta-construction that is vertically related to each of the modal constructions, the author argues that this relationship should be interpreted in horizontal terms: “In spite of the appearance in Figure 8, a metaconstruction is not a node on a higher taxonomic level but simply a formulation of analogy relations, that is, a paradigmatic association, or horizontal link” (p. 266). The discrepancy between the visual impression of the diagram and its interpretation hints further at the difficulty of distinguishing between vertical and horizontal analyses in this way.

In sum, previous applications of the paradigmatic model do not provide a clear distinction between vertical and horizontal links, similar to the allostructions accounts discussed above. Instead, they suggest that a constellation of vertical links between subtypes and a common schema can be reformulated as a ‘direct’ horizontal link between the subtypes, and vice versa. Moreover, researchers’ choices between the two linking types seem to be at least sometimes guided by practical considerations about the visual effectiveness of the diagrams, rather than by the desire to express distinct claims about speakers’ cognitive reality. Together, these observations hint at an alternative account of vertical and horizontal links, which will be outlined in the following section.

3 The proposal: vertical and horizontal links as notational variants

In this section, a new account of the relationship between vertical and horizontal links is proposed, which may help overcome some of the problems encountered by previous attempts to distinguish between the two linking types. In particular, the following discussions will outline four key claims: first, that vertical and horizontal links rely on a common conceptual ground; second, that they consequently form notational variants for representing constructional similarities, rather than encoding distinct cognitive mechanisms; third, that each notation comes with its specific practical advantages and disadvantages; and fourth, that the present account regards schemas as being ‘immanent’ in their instances, rather than being stored separately from them.

3.1 Similarity as a common conceptual ground

The central question in this article is whether vertical and horizontal links encode fundamentally distinct types of information about the constructional network, or whether they may encode the same information in different ways. Smirnova and Sommerer (2020: 25) summarise what is often assumed to be the key difference between the two linking types:

“[m]ost scholars differentiate between ‘taxonomic links’ (symbolizing relatedness through inheritance) and ‘horizontal links’ (symbolizing partial similarity but non-inheritance)”. On a closer look, however, the seemingly contrasting terms of ‘relatedness through inheritance’ and ‘partial similarity’ resolve into a common conceptual ground that underlies both vertical and horizontal links.

The key suggestion of the present account is that this common conceptual ground consists simply of similarity. As far as horizontal links are concerned, it is not only Smirnova and Sommerer’s comment above that identifies these links explicitly with relations of similarity. Other definitions of horizontal links, too, have described their function in terms of capturing the ‘similar’, ‘same’ or ‘shared’ features of constructions (Audring 2019: 293; Diessel 2015: 306–309; Fried 2021: 46; Perek 2015: 149). The role of similarity is made particularly clear in the context of the allostructions model discussed in Section 2.2, where a horizontal link is posited to capture the overlapping semantics of the alternating constructions.

As for vertical links, their relationship with the notion of similarity may, at first glance, not be equally apparent. The connection becomes clear, however, by considering that vertical, or inheritance, links are relations of categorisation. Categorisation, in turn, relies fundamentally on establishing similarities among the members of a category, as has been pointed out by cognitive linguists (Bybee 2013; Glynn 2022; Langacker 1987) and psychologists (Goldstone 1994; Nosofsky 1988; Rosch & Mervis 1975) alike. The concepts of categorisation, abstraction (or generalisation), taxonomy and similarity are thus inextricably linked, as is reflected by other comments in the literature: “Taxonomic relations are created by abstraction, which crucially relies on the recognition of similarity” (Diessel 2019: 16). Abstractions or schemas, as the outcomes of categorisation processes, contain the shared features of their subtypes. This is highlighted by Goldberg’s (2019: 7) most recent definition of ‘constructions’ as generalisations over more specific units: “constructions are understood to be emergent clusters of lossy memory traces that are aligned within our high- (hyper!) dimensional conceptual space on the basis of *shared form, function, and contextual dimensions*” (emphasis added). Again, the key word of ‘shared’ highlights the fact that speakers’ schematic representations arise from similarities among lower-level units.

It could be objected that things can be similar without being subsumed under a common category. For example, a reviewer suggests that both pencils and spaghetti are long and thin, but that they are not typically grouped in the same class. The response to this point, however, is that similarities vary in strength, and that weak similarities may be less relevant for speakers, thus not giving rise to an explicit category label, while stronger similarities may lead to explicit

category labelling (see Section 4.4 for further discussion). Also note that Japanese in fact uses a single numeral classifier *hon* (本) to count ‘long and stick-shaped objects’ like pencils and spaghetti, thus suggesting that they can be perceived as members of the same category. In the light of these observations, it is not clear in what ways the process of category formation should differ from the perception and subsequent storage of (salient) similarities.

The parallels between vertical and horizontal links are further illustrated by the fact that Goldberg (1995: 70), following Lakoff (1987), regards vertical inheritance links as a means of capturing the mutual motivation between constructions: “A given construction is motivated to the degree that its structure is inherited from other constructions in the language.” This is reminiscent of the way in which Van de Velde (2014: 147), in the context of his paradigmatic model (see Section 2.3), posits horizontal links between units that are “partly motivated in relation to [their] neighbours”. Both vertical and horizontal links can therefore be used to capture motivation in language, and Goldberg points out that the conceptual grounds for such motivation are “generalizations and similarities” (1995: 70).³

Finally, it is worth considering whether psycholinguistic experiments could distinguish between vertical and horizontal analyses, and thus provide evidence that the two linking types involve different psychological mechanisms. Priming, in particular, which is thought to “provide[s] perhaps the best evidence for constructional relations” (Diessel 2019: 204), may be a suitable candidate for this purpose. Intuitively, it would seem that priming between a schema and its instance, which should support the existence of a vertical link, can be contrasted with priming between similar instances, which would reflect a horizontal link. The problem with this approach is that schemas (at least on the phrase and clause level) can only be tested *via* their instances, i.e., when they are instantiated by specific sentences. As a result, it is not possible to distinguish between schema-to-instance priming and instance-to-instance priming. For example, Bock’s (1986) classic finding that double-object sentences prime each other could either indicate that speakers encode horizontal links between the instances, or that they represent a double-object construction that vertically subsumes the instances (see Ungerer [2023] for the interpretation of structural priming effects from a cognitive-linguistic network perspective). As long as the psychological correlates of vertical and horizontal links can thus not be differentiated, the present account sides with Hoffmann’s (2020: 150) view, cited above

³ A reviewer points out that there may be a difference between ‘motivation by similarity’ (addressed by Goldberg [1995]) and ‘motivation by contrast’ (in Van de Velde’s [2014] proposal). This question is taken up again in Section 4.3.

in the context of allostructions (see Section 2.2), that vertical and horizontal models are empirically indistinguishable.

In the light of these comments, it seems no longer feasible to maintain the distinction between ‘inheritance’ and ‘(partial) similarity’ made by previous scholars. Instead, the preceding arguments suggest that horizontal links between constructions and their vertical relations to a common schema rely on a single conceptual ground of similarity. This allows for a new view of vertical and horizontal relations as alternative ways of encoding constructional similarities, as will be outlined in the following section.

3.2 Notational variants

If vertical links to a common schema and ‘direct’ horizontal links are equally used to encode similarities between constructions, there is no reason to assume that the two linking types encode distinct claims about the cognitive reality of speakers’ constructional networks. Instead, it seems more feasible to regard them as different ways of representing the same underlying reality. The present proposal is thus *that vertical and horizontal links do not encode distinct cognitive mechanisms, but that they constitute notational variants for representing constructional similarities*. On this account, schemas contain the shared features of the subtypes over which they generalise; these shared features can alternatively be represented by horizontal similarity links. Note that the claim is not that a single horizontal link is equivalent to a single vertical link – otherwise, relations at the same level of abstraction and between different levels of abstraction would be confounded. Rather, it is proposed that a horizontal link between two constructions is equivalent to a constellation of a schema node plus the two vertical links that relate the schema to its subtypes.

A simple schematic illustration of the theoretical equivalence between the two notational systems is provided in Figure 4. The two lower-level constructions in the example share one of their features (feature A) but differ in at least one other feature (B vs. C). As the diagram suggests, the overlap in feature A (which could, for instance, represent the shared constructional meaning of two allostructions) can either be captured by drawing a horizontal link between the two constructions (marked by a solid line) or by relating both constructions vertically to a common schema (marked by dashed lines). The line types are chosen merely to distinguish the two linking systems notationally; they do not express a difference in the psychological status (e.g., cognitive salience) of the links. Under this assumption, the diagram illustrates that the two linking types redundantly encode the same information: either one of them would be sufficient to capture the featural overlap among the two constructions.

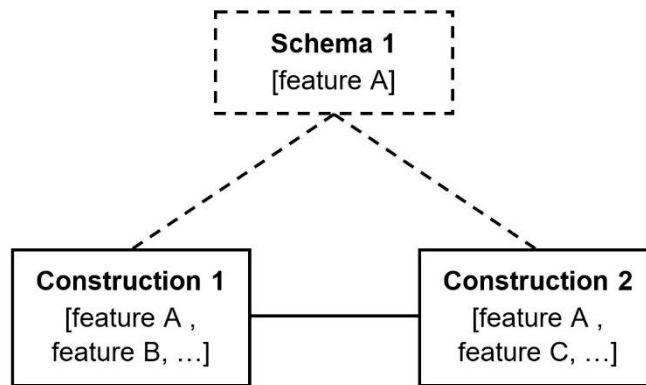


Figure 4. Vertical and horizontal analysis of a single similarity relation

While Figure 4 depicts a single similarity relation, more complex patterns of similarity can also be captured with either the horizontal or the vertical notation. This is illustrated in Figure 5, which provides a schematic model of the similarity relations between four constructions. The four patterns are assumed to be situated at the same level of abstraction, which is here represented as a three-dimensional plane to make the respective similarity relations more visible. Notably, the constructions form pairs of more strongly related members that overlap in two of their features (construction 1 and 2 share features A and B; constructions 3 and 4 share features A and C). Between the two pairs, similarities also exist but they are weaker since they only rely on one shared feature (feature A). As the diagram shows, these different degrees of similarity can be either encoded via horizontal links of varying strengths (marked by solid lines) or by a combination of vertical links and schema nodes at multiple taxonomic levels (marked by dashed lines). Crucially, the vertical hierarchical structure is implicit in the horizontal links (and vice versa), since the intermediate-level schemas capture the strong similarities between constructions that share two of their features, while the higher-level superschema encodes the weaker similarity shared by all four constructions.

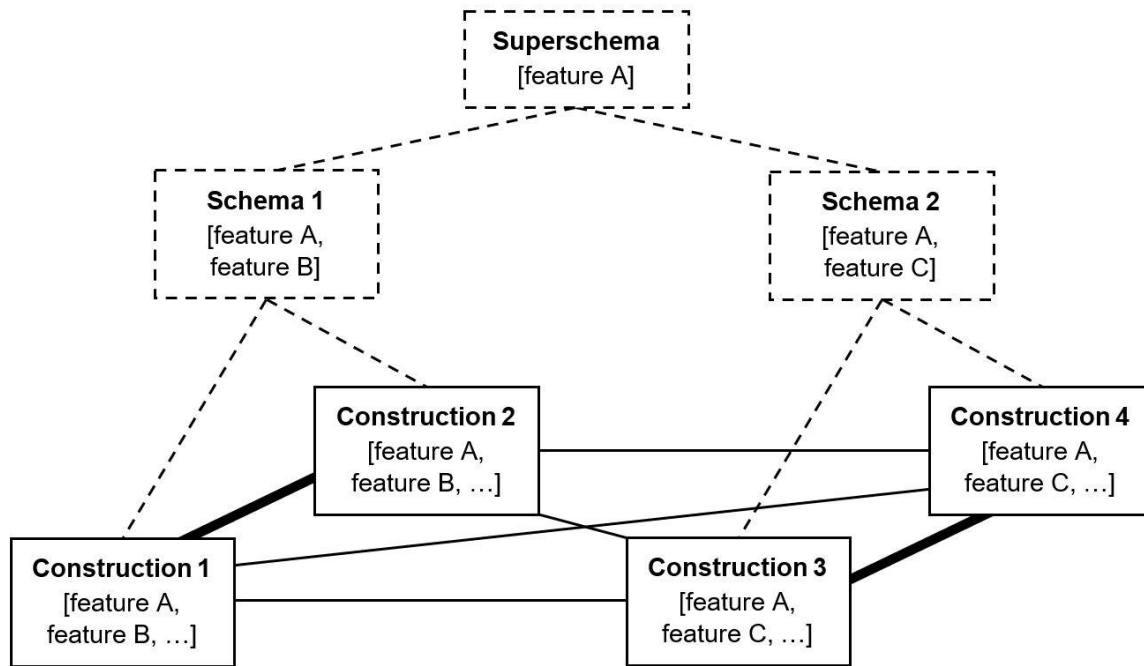


Figure 5. Vertical and horizontal analysis of varying degrees of similarity

This kind of model is comparable, for instance, to Sommerer’s (2020a) analysis of Old English DEM POSS/POSS DEM constructions, already mentioned in Section 2.3. These noun phrase constructions contained both a demonstrative and a possessive determiner, as illustrated in (5). Sommerer compares four members of this constructional family, represented schematically in (6). The four patterns can be divided into two pairs: while (6a) and (6b) have demonstrative-possessive order, (6c) and (6d) display possessive-demonstrative order (and are additionally restricted to the demonstrative *se*). Within each pair, the members only differ in the presence or absence of an additional adjective.

- (5) *Se heora cyning on gang þa singan & giddian*
 That their king began then to sing and to recite
 ‘then their king began to sing and to recite’
 (Sommerer 2020a: 71)

- (6) a. [[DEM_{infl}]+[POSS_{infl}]+[CN_{infl}]]NP_{def}
 b. [[DEM_{infl}]+[POSS_{infl}]+[ADJ_{infl}]+[CN_{infl}]]NP_{def}
 c. [[POSS_{infl}]+[DEM_{se,infl}]+[CN_{infl}]]NP_{def}
 d. [[POSS_{infl}]+[DEM_{se,infl}]+[ADJ_{infl}]+[CN_{infl}]]NP_{def}

(CN = common noun; all from Sommerer 2020a: 92)

As a result, the members of each pair are more similar to each other than the members of different pairs. This can be represented with either of the two notations provided in Figure 5: via horizontal links of varying strength or with vertical links at multiple taxonomic levels. While Sommerer (2020a: 92) combines both vertical and horizontal links in her own network diagram, the above account suggests that this may give rise to notational redundancy. This is also illustrated implicitly by Sommerer's discussion. At one point (pp. 92–93), the author wonders whether, given that the DEM POSS patterns are formally and potentially also functionally quite distinct from the POSS DEM patterns, the horizontal link between the two pairs of constructions should potentially be 'deleted'. At the same time, Sommerer also raises the question of whether past speakers really represented an abstract superschema that generalised across all four constructions, despite their considerable differences. While these two questions are posed separately, the present account suggests that they are, in fact, two versions of the same problem. If the similarities between the DEM POSS and the POSS DEM patterns are not strong enough, then speakers are unlikely to abstract to the level of a superschema that subsumes all four patterns. With respect to Figure 5, this could be either represented by the absence of the horizontal links between the two constructional pairs, or by the absence of the superschema node at the top of the diagram. This interdependence between the horizontal and the vertical elements of the network representation provides additional support that the two linking types are notational variants rather than distinct cognitive mechanisms.

3.3 Advantages of each notation

Even if vertical and horizontal analyses represent the same underlying reality, this does not mean that the two notations are identical in their practical usage. As with any other notational system, each linking type has its own practical advantages and disadvantages; as a result, one notation may be preferable to the other given the specific purposes of an analysis. In the following, three differences between vertical and horizontal representations will be outlined, which concern (i) their compactness; (ii) their explicitness; and (iii) their interpretability in terms of psychological mechanisms.

Regarding the first aspect, there are cases in which one of the linking types offers a more compact representation than the other. As illustrated by Figure 4 above, capturing a single similarity relation between two units with a horizontal link requires fewer links and fewer

nodes than if it is represented via an additional schema node and two vertical links. In Langacker's (1987: 75) terms, the horizontal notation can be regarded as a 'compacted' representation, while the vertical notation constitutes an 'exploded' representation.⁴ Given that researchers' network diagrams are limited by the constraints of physical space – especially when they are published in printed form – the spatial compactness of horizontal representations can be a significant practical advantage. This is particularly true when the same construction is shown to display similarities with several other network units. Using a vertical notation, each of these similarities needs to be stated via a separate schema that is vertically related to the construction via 'multiple inheritance' (Goldberg 1995; Sommerer 2020b). The more schemas the network contains, the more convoluted the representation becomes. Horizontal relations provide a simpler alternative in these cases because each similarity is represented as a single link without the need for additional schema nodes.

Horizontal analyses are, however, not always more compact than vertical analyses. In cases in which a single schema has many subtypes, all of which share the same similarity with each other, a vertical representation can be the more parsimonious option. While the vertical diagram contains a schema node and a vertical link from each subtype to the schema, the horizontal diagram would, at least if it provides a complete representation, have to depict a horizontal link between each possible pair of subtypes.⁵ As Audring (2019: 283) notes, this quickly leads to a "proliferation" of horizontal relations: for example, to represent six subtypes of a single schema, the vertical notation only requires six links while a horizontal analysis would encompass 15 links. In contrast to Audring, however, the present account regards this difference purely as a matter of notational parsimony, not as a difference in speakers' cognitive reality. While researchers may prefer a vertical analysis when describing a generalisation that holds across many subtypes, this does not mean that the schema 'exists' in this case and that the horizontal links among the subtypes 'do not exist'. Conversely, when researchers posit a horizontal relation between only two constructions, this does not mean that speakers have not formed a schema over those constructions. Rather, the two linking types are merely alternative notational devices for representing the similarities encoded within speakers' mental networks, which at the neurobiological level are presumably instantiated by myriads of synaptic

⁴ Note that Langacker (1987) makes this distinction in his discussion of syntagmatic hierarchies, but that the idea can be transferred to taxonomic hierarchies.

⁵ In practice, researchers often simplify the representation by placing the subtypes in a horizontal line and only adding horizontal links between the neighbouring units, not between each pair of units.

connections that do not directly map onto the structure of linguists' network diagrams (Lamb 1999).

With respect to the second difference between the vertical and the horizontal notation, a primary advantage of vertical representations is that by depicting schemas as separate nodes, they explicitly state the nature of the similarity between constructions (see Perek [2015: 153] for a similar argument). In some representations, the schema may express the similarity of its subtypes merely through its label (e.g., 'verb-finite' in Figure 3); but often, researchers provide a more detailed descriptions of the features that make up the schema (e.g., the syntactic components of the verb-particle schema in Figure 2). In contrast, horizontal representations often indicate merely that two constructions share some relevant similarity, without explicitly specifying what the similarity consists of. This may even be an advantage when researchers are not quite certain which features of the respective constructions speakers may perceive as similar. It would, of course, also be possible to annotate horizontal links with more detailed information about the type of similarities that they represent. In this case, the resulting diagram would be as explicit as the alternative vertical representation.

Apart from specifying the nature of the similarities, vertical links are better suited to make the hierarchical structure of the constructional network explicit. As illustrated by the earlier Figure 5, this hierarchical organisation arises from varying degrees of similarity among constructions. In a taxonomic hierarchy, closely related units are separated by few vertical links and subsumed under a relatively low-level schema, while weakly related units are separated by many vertical links and only subsumed under a higher-level schema. The path distance between two constructions in the taxonomic tree thus provides an explicit indication of their degree of similarity.⁶ In horizontal representations, on the other hand, the hierarchical structure is only implicit in the different weights of the relations, as indicated by the thickness of the links in Figure 5. This arguably makes for a visually less effective representation of hierarchical relationships; moreover, it would be difficult to capture subtle differences in similarity in this way. As a result, vertical representations may be preferable for analyses that focus on more complex hierarchical constellations within a constructional family.

Third and finally, another potential advantage of horizontal representations is that they are easier to interpret in terms of the underlying psychological mechanisms that shape speakers'

⁶ This logic has been implemented in computational models that determine semantic similarity by calculating the shortest taxonomic path distance between concepts in lexical databases such as WordNet (Fellbaum 1998). The path-distance measures have been found to correlate well with human similarity ratings (Ferlež & Gams 2004; Yang & Powers 2005).

mental networks. Horizontal links emphasise the fact that speakers' representations of abstract constructions arise from similarity relations among the specific instances that they have previously witnessed. This is in line with the 'emergent' view of language that has become widely accepted among cognitive-functional linguists (Bybee 1998; Goldberg 2006; Hopper 1987), and according to which higher-level abstractions emerge from speakers' experience in concrete usage events. Since horizontal links are, by definition, situated at the same level of abstraction, they illustrate particularly clearly that the generalisations that linguists usually focus on (and which are represented by the schema nodes of vertical analyses) are in reality only a shorthand description of complex linking patterns at much lower levels of granularity. In this sense, horizontal links arguably allow for a more straightforward interpretation of network diagrams at the psychological (or even neural) level, where, as some have argued, generalisations are not stored within discrete nodes but where "linguistic knowledge is available in one format only, namely, associations" (Schmid 2017: 25). This also aligns with the fact that horizontal links are often invoked in the discussion of psychological effects that arise from shifting activation patterns in speakers' constructional networks, for example priming (see, e.g., Diessel [2015], who uses priming as evidence for horizontal links; but see also Section 3.1, where it is argued that priming cannot distinguish between vertical and horizontal analyses).

It is important to note that vertical representations are, in principle, equally compatible with an emergentist perspective on language and a focus on the psychological processes within speakers' constructional networks. For this purpose, however, vertical links must be interpreted strictly in terms of a notational system: importantly, the schema nodes at different hierarchical levels must be understood as illustrative devices for capturing what are in reality complex patterns of similarity relations. A risk of vertical representations, however, is that they may tempt analysts into equating the network elements directly with a putative cognitive reality. That this danger is real will be illustrated in the next section, which addresses a prevalent view in the literature about the relationship between schemas and their instances, and contrasts it with an alternative account.

3.4 The nature of schemas

According to a commonly held view in the literature, schemas and their instances are regarded as discrete cognitive units that must be stored independently within speakers' mental networks. This view contrasts with the present account, which regards the schema nodes in vertically organised networks merely as notational devices that have no independent cognitive

reality from their instances. The following discussion will outline the limitations of the former perspective and illustrate the benefits of the latter, before relating them to the distinction between vertical and horizontal links.

The view that schemas are cognitively independent from their instances is most apparent in current models of inheritance. One central question for these models is where information is stored in the network: within the schema, within the instances or in both places. In one type of approach, so-called ‘complete inheritance’ or ‘impoverished-entry’ models (e.g., Boas & Sag 2012), information is assumed to be stored only within the highest-level schema, and then inherited by lower-level nodes in the network. Notably, the top-down mechanism of inheritance is thus opposed to the bottom-up direction of language acquisition, which involves the creation of increasingly higher generalisations over lower-level categories (Jackendoff & Audring 2020: 69). One problem of this view is that there is no discrete point at which acquisition ‘stops’, where schema nodes are ‘fully’ established and where the bottom-up process might consequently turn into a top-down process. Another problem of complete inheritance models is that the information at the lower levels would have to be deleted once it is stored within a higher-level node; however, no psychological correlate of such a deletion mechanism is known (Hudson 2007: 22). Finally, complete inheritance accounts try to minimise storage load while maximising computational load, but this conflicts with neuropsychological evidence that humans’ long-term storage capacity is vast while their working memory resources are very limited (Bresnan 1978; Goldberg 2019).

In response to the latter criticism, another type of inheritance approach, implemented in ‘normal inheritance’ or ‘full-entry’ models (e.g., Hilpert 2019), assumes that information is stored redundantly both within the higher-level and the lower-level nodes. In other words, schemas and their instances contain (partial) copies of the same information. One limitation of this account is that inheritance is no longer conceived of as an on-line process of information transfer from a schema to its instance (as in impoverished-entry models), but rather as a “static” (Goldberg 1995: 74) relationship between two fully specified units. When speakers, for instance, activate their concept for ‘cat’, they do not have to retrieve information from the superordinate node ‘animal’ because ‘cat’ already contains all the necessary information. This, however, raises the question of why part of the content of ‘cat’ should be stored *independently* at a higher level if it is not needed to process the lower-level unit.

Second, full-entry models seem to predict that every time speakers form a generalisation over previously unconnected units, they incur an increase in memory load because additional information is added to the network. This clashes, however, with the

intuition that establishing similarities between constructions should make it easier to store and retrieve them, rather than increasing memory cost (Jackendoff & Audring 2020: 81).⁷ A third problem is that in the full-entry model, the same piece of information would need to be stored an immense number of times. This is because *any* similarity that speakers encode between units could be represented as a separate schema; in other words, schemas might exist not just at a few levels of abstraction, but at myriads of intermediate levels of abstraction. All of these schemas would need to be stored independently from each other; that is, each feature that belongs to a highly schematic category would also need to be separately encoded at countless lower levels of abstraction.⁸

The above limitations of inheritance approaches all arise from a common source, namely the assumption that speakers represent schemas and their instances separately from each other. These problems can be overcome if schemas are assumed to be stored *via* their instances, i.e., as part of the overlapping representations of their instances. This view has been advocated for a long time by Langacker (1987: 92–93; *inter alia*), who has argued that schemas are ‘immanent’ in speakers’ representations of lower-level instances. In Langacker’s (2006: 141) words (original emphasis): “I have consistently maintained that a schema is not *distinct* from its instantiations but rather *immanent* in them, i.e., it ‘lies within’ them. The processing activity which constitutes a schema is inherent in the processing activity which constitutes an instantiation, so the former occurs whenever the latter does.” The question of whether similarities are encoded at the level of the instances or of the schema is thus, to Langacker (2009: 248), “a pseudo-question”, which “stems from taking the network metaphor too seriously, in particular by viewing the connected structures as separate and distinct”.

The idea that schemas are not stored separately from their instances also underlies connectionist approaches such as Elman’s (2004) model of the mental lexicon, in which types are assumed to be ‘implicit’ in their tokens rather than being represented separately. In the

⁷ Compare this view with Jackendoff’s (1975) concept of ‘redundancy rules’, also discussed below. In Jackendoff’s model, similarities among two network units are not stored separately within each unit, but they are stored only once as part of a redundancy rule that captures the overlapping content of the units. As a result, when speakers form a generalisation, their memory load actually *decreases* because the shared information can be stored once rather than as two distinct copies. This differs from full-entry models, in which schemas have to be stored independently alongside their instances, thus increasing memory cost.

⁸ Consider the following example: within the overall category of ‘cats’, speakers may store numerous increasingly more specific subschemas, such as ‘grey cats’, ‘grey Siamese cats’, ‘grey Siamese cats seen on TV’, ‘grey Siamese cats seen on TV in the evening’, ‘grey Siamese cats seen on TV in the evening while eating crisps’, etc. – the list is likely to continue much further. Crucially, the features that all cats have in common (e.g., ‘feline’, ‘four-legged’, ‘can purr’) would, by the logic of the full-entry model, need to be independently stored at each of these lower levels. The question is whether such an amount of redundancy is psychologically plausible, or whether it is merely an artefact of the model.

same vein, Goldberg (1995: 74) notes that “[a] connectionist system can capture the redundancy without inefficiency by allowing inherited information to be shared information; that is, instead of stating the specifications twice, aspects of the patterns that are inherited are shared by two overlapping patterns”. A similar idea was already expressed by Jackendoff (1975), who proposed that shared content can be efficiently encoded by so-called ‘redundancy rules’, without reduplicating information (see also footnote 7). Finally, this view aligns with Ambridge’s (2020: 641) exemplar-based account (in its revised version based on peer commentary), where the author proposes that abstractions do not exist independently but are “made of” exemplars, i.e., individual instances of use, and that “exemplars are re-represented in such a way as to constitute abstractions”.

All of these accounts assume that shared information is encoded only once as part of the overlapping representations of similar instances. The problems of the above inheritance approaches do not arise in this case: neither does information have to be exchanged between spatially distinct schema and instance nodes, nor does it have to be stored redundantly within indefinitely many units in the network. Inheritance, from this perspective, is regarded as a metaphor for the fact that the units in speakers’ constructional networks are related by a multitude of similarity relations, and that these similarities can be used to integrate newly witnessed instances into the already existing network structure.

The difference between the two perspectives discussed above is closely connected to the debate about the role of vertical and horizontal links. The motivation for regarding the two linking types as fundamentally distinct cognitive mechanisms seems to stem in large part from the assumption that schemas and their instances are stored separately in the network. Under this assumption, it is feasible to treat a horizontal link between constructions as distinct from a constellation in which they are vertically subsumed under a common schema, since the latter scenario involves positing an additional, cognitively independent unit. If, in contrast, schemas are considered to be immanent in their instances, there is no reason to assume that horizontal and vertical analyses encode distinct cognitive realities. The arguments provided above favour the latter position, thus supporting the interpretation of horizontal and vertical models as notational variants.

4 Some possible objections (and replies)

Having compared the present proposal with previous views of vertical and horizontal links, it has become clear that the new account scrutinises some widespread assumptions in recent cognitive-linguistic theorising. As such, it is likely to meet with a number of questions

and objections. The following sections anticipate four such potential concerns and suggest how they can be accounted for within the present framework.

4.1 What about horizontal syntagmatic relations?

One potential objection to the above account may be that it has only addressed vertical and horizontal links along the paradigmatic axis, i.e., relations of similarity between units that can fill the same position in a sentence. While these paradigmatic relations are also the focus of most previous accounts of vertical and horizontal links, some scholars have additionally discussed horizontal relations along the *syntagmatic* axis, which link up linearly co-occurring units in the same sentence. As Budts and Petré (2020) suggest, such links may relate collocating lexical elements, for instance the individual words that make up the phrase *a bunch of bananas*, but they may also connect more complex phrasal patterns with each other. For example, the authors argue that *be going to*, during the development from its lexical motion sense into a future marker, formed increasingly strong syntagmatic ties with co-occurring constructions in the sentence, such as topicalisation (which deprofiles the motion component) and passives (which deprofile the source of control). In a similar vein, Hilpert and Diessel (2017) interpret Goldberg's (1995) 'subpart' links in terms of horizontal links, suggesting for example that the double-object construction is horizontally connected to its subpart, the (mono)transitive construction.

While syntagmatic links can be analysed as 'horizontal' in a certain sense, they need to be strictly distinguished from horizontal paradigmatic relations. Eliminating the boundary between the two would be tantamount to giving up the distinction between the syntagmatic and the paradigmatic axis of analysis. The two types of relations rely on fundamentally different psychological mechanisms: while paradigmatic links encode relations of similarity, syntagmatic links arise from contextual association or 'contiguity' (Jakobson 1971) among units that are not necessarily similar. Moreover, the term 'horizontal' is potentially used in different senses when referring to the two linking types: while it is clearly a metaphor in the case of paradigmatic relations, based on the arbitrary convention of constructing taxonomies in an upward fashion, the reference to 'horizontal' syntagmatic relations seems to be, at least partially, guided by the physical arrangement of the elements in written sentences (in horizontal writing systems).

For these reasons, horizontal syntagmatic links cannot be compared with vertical paradigmatic links; the two linking types describe fundamentally distinct phenomena. Interestingly, however, an alternative vertical counterpart is available on the syntagmatic level.

Vertical syntagmatic relations, in this sense, correspond to Langacker's (1987) relations of 'composition': they describe the relationship between a whole and its parts. For example, while horizontal syntagmatic relations would connect the individual words *a*, *bunch*, *of* and *bananas* with each other in the above example, vertical syntagmatic links would relate each of the words (e.g., *bunch*) to the entire phrase (*a bunch of bananas*). Vertical syntagmatic links of this kind give rise to a type of hierarchy known as a 'meronymy', which is clearly distinct from a paradigmatic taxonomy (Barðdal & Gildea 2015).

Two further observations can be made: first, this account of vertical syntagmatic relations differs from Budts and Petré's (2020) perspective, who suggest that a vertical syntagmatic link connects the constructional template [*a bunch of X*] with the slot filler *bananas*. Under the present view, the latter example illustrates a vertical paradigmatic rather than a syntagmatic relation because *bananas* is related to an abstract constructional slot that generalises over its syntactic and semantic features. Second, while the present account assumes that syntagmatic and paradigmatic relations are fundamentally different, it regards the relationship between vertical and horizontal syntagmatic links as analogous to the relationship between vertical and horizontal paradigmatic links. On this view, horizontal and vertical syntagmatic relations are not assumed to encode distinct cognitive mechanisms. Rather, the horizontal links between the individual words in *a bunch of bananas* are regarded as a notational variant of the vertical relations between the individual words and the entire phrase.

4.2 Aren't some things only encoded at the level of the schema?

The present account assumes that *every* schema that is vertically related to two lower-level nodes can be recast in terms of a horizontal link between the subtypes, and vice versa. Given that schemas are not regarded as independently stored entities (see Section 3.4), this view does not leave room for any information to be stored *exclusively* at the level of the schema, separately from any lower-level linking patterns. At least intuitively, however, it seems appealing to ascribe to schemas some 'special', independent function that cannot be fulfilled by other units in the network. From the present perspective, however, the burden of proof lies with the proponents of the latter view: they need to show convincingly that vertically related schemas encode some independent content that cannot be alternatively expressed via horizontal links. Otherwise, the principle of Occam's razor, together with the argument that vertical and horizontal representations draw on a common conceptual ground (see Section 3.1), should prevent the two linking types from being regarded as ontologically distinct mechanisms.

The literature contains a few suggestions for information that may be uniquely encoded at the level of the schema. For example, Audring (2019: 284) argues that the similarities between the morphological bases of *boyish* and *childish* cannot be encoded by horizontal ('sister') links between the words, but that they have to be stored as part of a higher-level schema. According to the author, this is because *boy* and *child* are different nouns that only fulfil equivalent functions in the complex structure; but horizontal links can only encode relations of *sameness*, not of *equivalence*.

This view faces several problems. First, limiting horizontal links to relations of sameness would entail a much narrower understanding than the one assumed by previous definitions (see Section 2), which have interpreted horizontal links more generally as relations of similarity. As a result, some previous examples of horizontally linked constructions may be excluded under this narrow view. Instances of the double-object construction and the *to*-dative construction, for instance, are semantically similar but not fully lexically identical (see Section 2.2). Arguably, the presence of the preposition *to* in the *to*-dative would prevent the constructions from being structurally the same and thus from being analysed as horizontally related. Second, it is not clear which features of two constructions have to be the 'same': their syntactic, semantic and/or lexical properties? In the above example, *boy* and *child* differ lexically, but they are arguably the same in terms of their morphosyntactic category (noun) and their abstract functional role in the [N *-ish*]_A construction. On the other hand, the members of the English verb-particle alternation (see Section 2.2) are lexically the same and semantically near-equivalent, but they differ in terms of their syntactic structure. As long as functional similarity is not prioritised over formal similarity, it is not clear why the former example should be analysed as an instance of equivalence but the latter as an instance of sameness, as proposed by Audring (2019: 280–284). Finally, two constructions are in reality never fully the 'same'; instead, similarity forms a natural continuum, with complete identity as one extreme but unattainable end point. This is illustrated, for instance, by the fact that the verb-particle constructions, while semantically very similar, still differ in their information-structural properties (Cappelle 2006). Given that all units of linguistic analysis are partial abstractions that gloss over lower-level differences (even if only at the phonological or phonetic level), models of vertical and horizontal links can only ever capture varying degrees of similarity, but never complete sameness.

Another suggestion for what information may be uniquely encoded at the level of the schema concerns the productivity of constructions. Jackendoff and Audring (2020: 40–43) propose that the productivity of a pattern must be marked as a feature of the schema itself (or

technically, as a feature of the variables in the schema). Otherwise, speakers would not be able to distinguish between productive schemas (e.g., the plural noun schema) and non-productive schemas (e.g., the [_v ADJ-*en*] schema, as in *harden*, *widen*). Jackendoff and Audring’s account leaves open, however, how speakers would acquire this productivity feature, and in what cognitive format such a feature would be encoded. From an emergentist perspective, the assumption must be that speakers infer the productivity of a construction from the instances that they have previously witnessed. While the exact mechanisms by which such inferences are drawn may not be fully known, it seems feasible that they involve speakers’ ability to track the token frequency of the attested instances, determine their type frequency (by classifying similar instances together), and compare the latter to their expectations about what a fully productive or a non-productive pattern should look like (via mechanisms such as statistical preemption; see Goldberg [2019]). It is not clear why the outcomes of such an inference process should be represented as a single feature of a discrete schema node, rather than by a pattern of similarity relations among lower-level units that can be equally represented via horizontal links.

4.3 Do (some) horizontal links express contrast rather than similarity?

A third potential objection is that horizontal links may not only encode relations of similarity, which were the focus of the present account, but that they may also represent relations of contrast (or opposition) between constructions. Diessel (2019: 200), for example, defines horizontal links as relations “between similar or contrastive constructions”. Especially in the context of the paradigmatic model (see Section 2.3), it has been highlighted that the members of a paradigm, such as the different clause types in Dutch, motivate each other not only in virtue of their similarities, but also via their differences (Smirnova & Sommerer 2020: 27).

A first response to this argument is that if vertical models are assumed to encode only relations of similarity, while horizontal links can encode both similarities and contrasts, this would mean that the two linking types are not fully identical, but that they still *partially* overlap with each other. Especially in the context of the allostructions model, where the horizontal link has been interpreted as encoding the shared semantics of the alternating constructions (see Section 2.2), the problem would remain that vertical and horizontal analyses capture the same constructional relation. Moreover, this view would entail that horizontal relations can be divided into two distinct types – relations of similarity and relations of contrast – which constitute distinct mechanisms in the constructional network and should therefore not be subsumed under the same phenomenon (see Smirnova [2021] for this position).

Second, since contrast is the natural complement of similarity, the two concepts are crucially dependent on each other. For example, the relationship between verb-initial, verb-second and verb-final Dutch clauses (see Section 2.3) can be described in terms of their similarities (the fact that both constructions contain the same elements and express whole propositions), but these partial similarities simultaneously imply partial differences (the different positions of the verb). Focusing on one dimension of this two-sided coin over the other is an analytical decision, but it is unlikely to correspond to a neuropsychological difference between separately encoded relations of similarity and relations of contrast within speakers' mental networks.⁹

Third, in diagrammatic terms, it seems somewhat counterintuitive to use the network links between units to capture their *differences*, since it is commonly emphasised that whatever content is unique to a construction, i.e., not shared with other units, should be represented as part of its node rather than via the links. Also note that if relations of contrast are allowed in the network model, they could potentially be drawn between *any* pair of distinct constructions, with the strongest links of contrast existing between those constructions that share none of their features and thus stand in no theoretically interesting relationship with each other. The most relevant relations of contrast, however, are the ones between units that share many of their features and only contrast in one or a few salient properties; in other words, between units that are strongly similar and weakly contrastive. This suggests again that a network that models different degrees of similarity between constructions – via either the vertical or the horizontal notation – can implicitly capture relations of contrast, without the need to encode the latter via a distinct linking mechanism.

4.4 Is it only strong horizontal links that can give rise to a schema?

A final objection to the above account is presented by Zehentner (2019), who argues that the crucial difference between horizontal and vertical links concerns the strength of the relations (see also Zehentner & Traugott [2020]). Specifically, she suggests that “horizontal connections may hold between many constructions, but only very strong, systematic and pervasive links will lead to abstractions forming in the minds of at least large parts of the speaker population” (Zehentner 2019: 324). In other words, while horizontal links may exist at

⁹ In this sense, the fact that units in the constructional network ‘motivate’ each other via their similarities as well as via their differences is a feature of both horizontal and vertical models. Members of the same taxonomic category are not only similar to each other, but they necessarily also contrast in certain features; this parallels the way in which horizontally related units are both partially similar and partially different.

varying degrees of strength between constructions, vertical links can only be posited when the relatedness of the patterns is particularly strong.

While it is possible to stipulate such a theoretical distinction between horizontal and vertical models, it is not clear whether it is conceptually justified. In particular, Zehentner's view seems to conflict with the many accounts in the literature which assume that *both* horizontal links and vertical schemas vary in strength. For horizontal relations, this is usually couched in terms of the variable degrees of similarity encoded by the links (Audring 2019; Lorenz 2020). But for vertical models too, many researchers have posited that schemas vary in their degree of entrenchment – which, in turn, is also determined by the degree of similarity among the instances of the schema, plus other potential factors such as the number of the instances (Hilpert 2015; Langacker 1987; Schmid 2020). As a result, Schmid (2020: 234) regards schemas not in categorical terms, focusing on the question of which schemas exist and which ones do not, but in gradient terms, discussing the factors which increase the *likelihood* that speakers form schematic representations.

This gradient view of horizontal links and vertically related schemas aligns with the present account. Regarding both concepts as gradient is, in fact, unavoidable under the view espoused in Section 3 that vertical and horizontal models are notational variants for representing a common conceptual ground of constructional similarity. On this account, weak horizontal links express the same information as weakly entrenched schemas, while strong horizontal links correspond to strongly entrenched schemas (compare the earlier Figure 5). Note how this perspective avoids the challenges faced by Zehentner's (2019) model, which combines a gradient view of horizontal links with a categorical view of vertical relations (framed in terms of whether speakers form a schema or not). The latter categorical view requires the existence of a threshold value for the degree of similarity above which schemas are posited. First, however, it remains unclear by what strategy this threshold should be determined. Second, even if an approximate threshold was chosen for a specific analysis, the threshold could be equally applied to vertical and horizontal links: horizontal links and vertically related schemas below the threshold would be omitted from the analysis; while relations above the threshold would be included. Finally, once the network units are posited in this way, the question would remain of whether the schemas and the horizontal links in Zehentner's model differ in their roles, or whether they redundantly encode the same information.

5 Conclusion

This paper has put forward a new proposal about the relationship between vertical and horizontal links, two types of relations that have been prominently discussed in cognitive-linguistic network models of grammar. It was argued that previous analyses have not clearly distinguished between the roles of the two linking types, and that combinations of vertical and horizontal relations in the same diagram seem to give rise to notational redundancy. As an alternative view, it was suggested that vertical and horizontal links, rather than encoding distinct cognitive mechanisms, constitute notational variants for representing a common notion of constructional similarity. On this account, a horizontal link between two constructions is assumed to encode the same information as a superordinate schema that is vertically related to its two subtypes. Some potential objections to this account were addressed, but they were shown to be either reconcilable with the present stance or subject to theoretical limitations of their own.

It should be noted that the goal of this article is not to argue against the existence of abstractions; rather, it is concerned with the ‘format’ in which such abstractions are represented in network models, and the possibility that abstractions can be captured via both vertical and horizontal links.¹⁰ Nor is the aim of the present account to deter researchers from using both vertical and horizontal relations in their daily practice: as outlined in Section 3.3, the two notations differ (somewhat) in their practical use, for example by emphasising different aspects of the underlying psychological reality. Crucially, however, the present discussion has highlighted that a distinction needs to be drawn between the role of vertical and horizontal links as notational devices, on the one hand, and their connections to a putative psychological reality, on the other. While previous models have assumed a straightforward mapping between the notational and the psychological level, the arguments presented here suggest that vertical and horizontal analyses are notationally distinct but conceptually equivalent.

In this way, the present proposal highlights two possible avenues for further research. First, for researchers who remain unconvinced by the treatment of vertical and horizontal models as notational variants, the discussion constitutes an invitation to spell out the conceptual differences between the two linking types more clearly. In particular, scholars would need to specify the psychological mechanisms that underlie vertical and horizontal relations, and show

¹⁰ As a result, the discussion does not bear on the question of how plausible highly abstract schemas are, or whether speakers may primarily encode lower-level generalisations (Dąbrowska 2008; Langacker 2000; Schmid 2020). The present proposal is merely concerned with how these generalisations, whatever their status is, can be notationally represented.

that the two types of analyses capture distinct linking patterns which cannot be reformulated in terms of one another. Second, for scholars who agree that vertical and horizontal models can be regarded as alternative notational devices, Section 3.3 provided some starting points for a discussion of which practical advantages each notation has, and in which cases one type of model might therefore be preferable over the other. This discussion could be extended and applied to more concrete examples, thus illustrating the potentially conflicting factors that determine researchers' choices of a given network diagram (e.g., the tension between notational economy and expressiveness). Both of these research directions will hopefully contribute to the ongoing critical reassessment of cognitive-linguistic network models and of the cognitive realities they represent.

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References

- Ambridge, B. (2020). Abstractions made of exemplars or ‘You’re all right, and I’ve changed my mind’: Response to commentators. *First Language*, 40(5–6), 640–659.
- Audring, J. (2019). Mothers or sisters? The encoding of morphological knowledge. *Word Structure*, 12(3), 274–296.
- Barðdal, J., & Gildea, S. (2015). Diachronic Construction Grammar: Epistemological context, basic assumptions and historical implications. In J. Barðdal, E. Smirnova, L. Sommerer, & S. Gildea (Eds.), *Diachronic Construction Grammar* (pp. 1–50). Amsterdam & Philadelphia: John Benjamins.
- Boas, H. C., & Sag, I. A. (Eds.). (2012). *Sign-Based Construction Grammar*. Stanford: CSLI Publications.
- Bock, K. (1986). Syntactic persistence in language production. *Cognitive Psychology*, 18(3), 355–387.
- Bresnan, J. (1978). A realistic transformational grammar. In M. Halle, J. Bresnan, & G. A. Miller (Eds.), *Linguistic theory and psychological reality* (pp. 1–59). Cambridge, MA: MIT Press.
- Budts, S., & Petré, P. (2020). Putting connections centre stage in diachronic Construction Grammar. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 317–351). Amsterdam & Philadelphia: John Benjamins.
- Bybee, J. (1998). The emergent lexicon. *Chicago Linguistics Society*, 34, 421–435.
- Bybee, J. (2013). Usage-based theory and exemplar representations of constructions. In T. Hoffmann & G. Trousdale (Eds.), *The Oxford handbook of Construction Grammar* (pp. 49–69). Oxford: Oxford University Press.
- Cappelle, B. (2006). Particle placement and the case for “allostructions.” *Constructions, Special Volume 1*, 1–28.

- Cappelle, B., Travassos, P. F., Mota, N. A., Costa, M. G. da, Nunes, L. F., Martins, G. L., & Vieira, M. dos S. M. (2021). Constructional variation - unveiling aspects of linguistic knowledge: Interview with Bert Cappelle. *Revista Da Anpoll*, 52, 258–306.
- Colleman, T. (2020). The emergence of the dative alternation in Dutch: Towards the establishment of a horizontal link. In C. Fedriani & M. Napoli (Eds.), *The diachrony of ditransitives* (pp. 137–168). Berlin & Boston: De Gruyter Mouton.
- Croft, W. (2001). *Radical Construction Grammar: Syntactic theory in typological perspective*. Oxford: Oxford University Press.
- Croft, W. (2003). Lexical rules vs. constructions: A false dichotomy. In H. Cuyckens, T. Berg, R. Dirven, & K.-U. Panther (Eds.), *Motivation in language: Studies in honor of Günter Radden* (pp. 49–68). Amsterdam & Philadelphia: John Benjamins.
- Dąbrowska, E. (2008). The effects of frequency and neighbourhood density on adult speakers' productivity with Polish case inflections: An empirical test of usage-based approaches to morphology. *Journal of Memory and Language*, 58(4), 931–951.
- Diessel, H. (2015). Usage-based construction grammar. In E. Dąbrowska & D. Divjak (Eds.), *Handbook of Cognitive Linguistics* (pp. 296–322). Berlin & Boston: De Gruyter Mouton.
- Diessel, H. (2019). *The grammar network: How linguistic structure is shaped by language use*. Cambridge: Cambridge University Press.
- Diewald, G. (2020). Paradigms lost – paradigms regained: Paradigms as hyper-constructions. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 278–315). Amsterdam & Philadelphia: John Benjamins.
- Elman, J. L. (2004). An alternative view of the mental lexicon. *Trends in Cognitive Sciences*, 8(7), 301–306.

- Fellbaum, C. (Ed.). (1998). *WordNet: An electronic lexical database*. Cambridge, MA: MIT Press.
- Ferlež, J., & Gams, M. (2004). Shortest-path semantic distance measure in WordNet v2.0. *Informatica*, 28(4), 385–390.
- Fried, M. (2021). Discourse-referential patterns as a network of grammatical constructions. *Constructions and Frames*, 13(1), 21–54.
- Glynn, D. (2022). Emergent categories: Quantifying analogically derived similarity in usage. In K. Krawczak, B. Lewandowska-Tomaszczyk, & M. Grygiel (Eds.), *Analogy and contrast in language: Perspectives from Cognitive Linguistics* (pp. 245–282). Amsterdam & Philadelphia: John Benjamins.
- Goldberg, A. E. (1995). *Constructions: A Construction Grammar approach to argument structure*. Chicago: University of Chicago Press.
- Goldberg, A. E. (2006). *Constructions at work: The nature of generalization in language*. Oxford: Oxford University Press.
- Goldberg, A. E. (2019). *Explain me this: Creativity, competition, and the partial productivity of constructions*. Princeton: Princeton University Press.
- Goldstone, R. L. (1994). The role of similarity in categorization: Providing a groundwork. *Cognition*, 52(2), 125–157.
- Gyselinck, E. (2018). *The role of expressivity and productivity in (re)shaping the constructional network: A corpus-based study into synchronic and diachronic variation in the intensifying fake reflexive resultative construction in 19th to 21st Century Dutch* [Doctoral dissertation]. Ghent: Ghent University.
- Gyselinck, E. (2020). (Re)shaping the constructional network: Modeling shifts and reorganizations in the network hierarchy. In L. Sommerer & E. Smirnova (Eds.), *Nodes*

- and networks in Diachronic Construction Grammar* (pp. 107–140). Amsterdam & Philadelphia: John Benjamins.
- Hilpert, M. (2015). From *hand-carved* to *computer-based*: Noun-participle compounding and the upward strengthening hypothesis. *Cognitive Linguistics*, 26(1), 113–147.
- Hilpert, M. (2019). *Construction Grammar and its application to English* (2nd ed.). Edinburgh: Edinburgh University Press.
- Hilpert, M., & Diessel, H. (2017). Entrenchment in construction grammar. In H.-J. Schmid (Ed.), *Entrenchment and the psychology of language learning: How we reorganize and adapt linguistic knowledge* (pp. 57–74). Boston & Berlin: APA & De Gruyter.
- Hoffmann, T. (2020). What would it take for us to abandon Construction Grammar? Falsifiability, confirmation bias and the future of the constructionist enterprise. *Belgian Journal of Linguistics*, 34, 148–160.
- Hopper, P. J. (1987). Emergent grammar. *Berkeley Linguistics Society*, 10, 139–157.
- Hudson, R. (1984). *Word Grammar*. Oxford: Blackwell.
- Hudson, R. (2007). *Language networks: The new Word Grammar*. Oxford: Oxford University Press.
- Jackendoff, R. (1975). Morphological and semantic regularities in the lexicon. *Language*, 51(3), 639–671.
- Jackendoff, R., & Audring, J. (2020). *The texture of the lexicon: Relational Morphology and the Parallel Architecture*. Oxford: Oxford University Press.
- Jakobson, R. (1971). The metaphoric and metonymic poles. In R. Jakobson & M. Halle (Eds.), *Fundamentals of language* (2nd ed., pp. 90–96). Berlin & New York: De Gruyter Mouton.
- Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago: The University of Chicago Press.

- Lamb, S. M. (1999). *Pathways of the brain: The neurocognitive basis of language*. Amsterdam & Philadelphia: John Benjamins.
- Langacker, R. W. (1987). *Foundations of Cognitive Grammar. Vol. 1: Theoretical prerequisites*. Stanford: Stanford University Press.
- Langacker, R. W. (2000). A dynamic usage-based model. In M. Barlow & S. Kemmer (Eds.), *Usage-based models of language* (pp. 1–63). Stanford: CSLI Publications.
- Langacker, R. W. (2006). On the continuous debate about discreteness. *Cognitive Linguistics*, 17(1), 107–151.
- Langacker, R. W. (2009). Constructions and constructional meaning. In V. Evans & S. Pourcel (Eds.), *New directions in cognitive linguistics* (pp. 225–267). Amsterdam & Philadelphia: John Benjamins.
- Levin, B. (1993). *English verb classes and alternations: A preliminary investigation*. Chicago: University of Chicago Press.
- Lorenz, D. (2020). Converging variations and the emergence of horizontal links: *To*-contraction in American English. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 243–274). Amsterdam & Philadelphia: John Benjamins.
- Nosofsky, R. M. (1988). Similarity, frequency, and category representations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 14(1), 54–65.
- Percillier, M. (2020). Allostructions, homostructions or a constructional family? Changes in the network of secondary predicate constructions in Middle English. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 213–242). Amsterdam & Philadelphia: John Benjamins.
- Perek, F. (2015). *Argument structure in usage-based construction grammar*. Amsterdam & Philadelphia: John Benjamins.

- Pijpops, D. (2020). What is an alternation? Six answers. *Belgian Journal of Linguistics*, 34, 283–294.
- Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology*, 7(4), 573–605.
- Schmid, H.-J. (2017). A framework for understanding linguistic entrenchment and its psychological foundations. In H.-J. Schmid (Ed.), *Entrenchment and the psychology of language learning: How we reorganize and adapt linguistic knowledge* (pp. 9–36). Boston & Berlin: APA & De Gruyter.
- Schmid, H.-J. (2020). *The dynamics of the linguistic system: Usage, conventionalization, and entrenchment*. Oxford: Oxford University Press.
- Smirnova, E. (2021). Horizontal links within and between paradigms: The constructional network of reported directives in German. In M. Hilpert, B. Cappelle, & I. Depraetere (Eds.), *Modality and Diachronic Construction Grammar* (pp. 185–218). Amsterdam & Philadelphia: John Benjamins.
- Smirnova, E., & Sommerer, L. (2020). Introduction: The nature of the node and the network – Open questions in Diachronic Construction Grammar. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 1–42). Amsterdam & Philadelphia: John Benjamins.
- Sommerer, L. (2020a). Constructionalization, constructional competition and constructional death: Investigating the demise of Old English POSS DEM constructions. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 69–103). Amsterdam & Philadelphia: John Benjamins.
- Sommerer, L. (2020b). Why we avoid the ‘multiple inheritance’ issue in Usage-based cognitive Construction Grammar. *Belgian Journal of Linguistics*, 34, 320–331.

- Sommerer, L., & Smirnova, E. (Eds.). (2020). *Nodes and networks in Diachronic Construction Grammar*. Amsterdam & Philadelphia: John Benjamins.
- Touretzky, D. S. (1986). *The mathematics of inheritance systems*. London: Pitman.
- Ungerer, T. (2023). *Structural priming in the grammatical network*. Amsterdam & Philadelphia: John Benjamins.
- Van de Velde, F. (2014). Degeneracy: The maintenance of constructional networks. In R. Boogaart, T. Coleman, & G. Rutten (Eds.), *Extending the scope of construction grammar* (pp. 141–179). Berlin & Boston: De Gruyter Mouton.
- Yang, D., & Powers, D. M. W. (2005). Measuring semantic similarity in the taxonomy of WordNet. In V. Estivill-Castro (Ed.), *Proceedings of the Twenty-eighth Australasian Computer Science Conference - Volume 38* (pp. 315–322). Darlinghurst: Australian Computer Society.
- Zehentner, E. (2019). *Competition in language change: The rise of the English dative alternation*. Berlin & Boston: De Gruyter Mouton.
- Zehentner, E., & Traugott, E. C. (2020). Constructional networks and the development of benefactive ditransitives in English. In L. Sommerer & E. Smirnova (Eds.), *Nodes and networks in Diachronic Construction Grammar* (pp. 167–212). Amsterdam & Philadelphia: John Benjamins.