Rui P. Chaves

Construction Grammar

Abstract: Broadly construed, Construction Grammar is a constraint-based, generative, non-derivational, mono-stratal grammatical approach to the modeling of linguistic knowledge that is committed to incorporating the cognitive and interactional aspects of language. The central tenet of Construction Grammar is the claim that language is a repertoire of more or less complex and conventionalized templatic patterns of phonologic, morphologic syntactic, semantics, and/or pragmatic information. Such conventionalized templates (constructions) form intricate networks of overlapping and complementary patterns that are used during comprehension and production to encode and decode linguistic expressions in context, while attending to extralinguistic information.

Keywords: Constructions, networks, unification, acquisition, idioms

1 Introduction

The study of constructions and their typology has played a crucial role in linguistics since Structuralism, and some of its ideas go as far back as to the time of Aristotle. The advent of Phrase-Structure Grammar (PSG) placed constructions in a more precise footing (Harris, 1951; Chomsky, 1957), but as PSGs struggled to cope with discontinuity phenomena (Chomsky, 1975, 190), and as movement became the key mechanism for arriving at cross-constructional generalizations (Chomsky, 1981), constructions came to be seen as epiphenomena rather than explicit part of grammatical knowledge (Chomsky, 1989, 43).[1]

The idea of viewing constructions as a fundamental component of natural language emerged in the mid-eighties, with the work of Charles Fillmore and colleagues. In such a Construction Grammar (CxG) framework, the linguistic knowledge that speakers acquire includes a large system of templates or schemata consisting of conventional associations of grammatical information (including morphosyntactic, semantic, pragmatic, and/or phonological information), assumed to range from the totally regular to the totally idiosyncratic, and

1 The motivation for movement remains controversial, however. See Borsley (2012) for empirical criticism.

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can be lexical, phrasal or in between. In CxG the term ‘construction’ is used to refer to the templates that comprise the grammar, and the term ‘construct’ refers to the utterances structures built from those templates. However, in the years that followed Fillmore’s work the term CxG came to mean slightly different things to different linguists. See for example Berkeley Construction Grammar (Fillmore et al., 1988; Fillmore and Kay, 1996; Kay and Fillmore, 1999), Cognitive Construction Grammar (Goldberg, 1995, 2006), Radical Construction Grammar (Croft, 2001), Embodied Construction Grammar (Bergen and Chang, 2005; Feldman et al., 2009), Fluid Construction Grammar (Steels, 2011), and Sign-Based Construction Grammar (Michaelis, 2012; Sag, 2012), among others. This paper provides an overview of the tenets and evidence for CxG grammar, as well as a formal and computational fragment to illustrate how a constructional account can be articulated.

2 Goals

Like many other approaches to language, the goal of CxG is to arrive at an explicit, contradiction-free, and generalization-prone model of natural language which has the widest possible empirical coverage, from the highly idiomatic and rigid to the fully productive and compositional. Hence, in a construction-based conception of language, it is to be expected that some regular clausal types have both regular and idiosyncratic uses. Mismatches between form and function such as (1), for example, are therefore not surprising from a constructivist perspective, and cannot be dismissed as mere marginalia. In fact, their hybrid status can shed light on phenomena that would otherwise remain undetected.

(1) a. What does she care? (*assertion*)
 b. Why don’t you just be quiet? (*command*)
 c. Don’t tell me you lost the keys again! (*interrogative*)
 d. I don’t suppose you’d like to buy this from me. (*interrogative*)

Consequently, there is no methodological separation between ‘core’ and ‘peripheral’ phenomena in CxG; a complete theory of any given natural language must account for all linguistic facts, including the interaction of highly idiosyncratic constructions with other, more regular ones, as the former and the latter are inextricably interdependent.

Second, CxG aims to be is maximally consistent with the available psycholinguistic and cognitive evidence about human language acquisition and processing. The constructivist null hypothesis is that grammars are composed of constructions, nothing else, and that they are acquired without a language-specific genetic endowment. More specifically, constructivist theories make the following claims.

I. Constructions are form-function templates that are stored in the mind of speakers as part of their grammar, acquired from the input via general cognitive mechanisms, and restricted by the stages of brain development. Such linguistic knowledge is to some extent processing-neutral, and deployed during both comprehension and production.
II. Constructions can introduce lexical, syntactic, semantic, pragmatic, prosodic constraints over and above those contributed by the expressions they combine, and induce varying degrees of regularity. For example, the same word is compatible with a wide range of different subcategorization patterns and novel interpretations.
III. The wellformedness of a complex linguistic expression is a matter of simultaneous constraint satisfaction, sensitive not only to various kinds of grammatical knowledge, but also knowledge of the discourse context, world knowledge, gestures and other kinds of visual information, social knowledge, and knowledge of style and genre.
IV. Constructions are clustered into networks, much like those assumed to represent non-linguistic knowledge in the mind, enabling generalizations that permit speakers to understand, acquire, and produce novel structures, sometimes through analogy.
V. Constructions exhibit degrees of language-internal irregularity, and vary across language families and genera. Typological patterns are likely due to historical, functional, and cognitive factors rather than language-specific genetic endowment.

The idea that grammars contain large inventories of constructions may appear to some researchers as a step backwards, away from deeper generalizations. There are several flaws with such a view. First, grammars that lack constructions come at the cost of increased complexity in other theoretical components and of limited empirical coverage (Johnson and Lappin, 1999; Culicover and Jackendoff, 2005). In other words, once a sufficiently large range of syntactic phenomena is taken into consideration – including the more idiosyncratic – the conclusion that constructions are a component oh human language is difficult to avoid. Second, a grammar consisting of a rich network of constructions is arguably a more cognitively plausible model of the linguistic knowledge that speakers *de facto* acquire and use during language processing. Embodied Construction Grammar (Bergen and Chang, 2005), for example, goes as far as focusing not just on what constructions are but on how they are used, as one of its primary goals to understand what cognitive and neural mechanisms do speakers engage while using human language. See for example Bryant (2008) for a psychologically-plausible best-fit probabilistic construction-based model of parsing and interpretation that aligns well with behavioral (human) sentence processing data.

Hence, CxG is in principle experimentally testable: if the linguistic knowledge in the brains of speakers does not include a large repertoire of constructions, then the constructionist view of grammar would be deemed incorrect. In this sense, CxG is closer to being an implementation-level theory of language, borrowing the terminology of Marr (1982, 25). See also Jackendoff (2002, ch.2) on the distinction between 'hard' and 'soft' idealizations.

To be sure, there is no conceptual, linguistic or psychologic obstacle with assuming that grammatical knowledge involves a large repertoire of constructions. The number of lemmas that the average adult native speaker of American English knows has been estimated to be around 40,000 (Brysbaert et al., 2016), for example, and therefore it is not unreasonable that they also learn hundreds of grammatical constructions. Even a small sample like (2) should suffice to illustrate the range of constructions that one and the same verb can appear in. As Goldberg (2006: 18) put it, 'it is constructions all the way down'.

(2)
a. Sam laughed. (*strict intransitive*)
b. Sam laughed his maniacal laugh. (*cognate object*)
c. Sam laughed the lyrics (rather than singing them). (*transitive*)
d. Sam laughed her his promise. (*ditransitive*)
e. Sam out-laughed Robin. (*comparative compound*)
f. Sam laughed the kids off the stage. (*caused motion*)
g. Sam laughed about the incident. (*cause*)
h. Sam laughed at me. (*directional*)
i. Sam laughed her way out of the room. (*way-manner*)
j. Sam laughed all the way to the bank. (*way-path*)
k. Sam laughed her throat hoarse. (*resultative*)
l. Sam laughed herself to tears. (*fake reflexive resultative*)
m. Sam laughed her head off. (*off-resultative*)
n. Sam laughed the idea off. (*phrasal verb idiom*)
o. Sam laughed it up. (*particle idiom*)
p. Sam laughed and laughed... (*X-and-X intensification*)
q. Sam laughs, and the world laughs with her. (*X and Y Xs with K*)
r. Sam laughed: *ho! ho! ho!* (*sound emission*)

Many of the above constructions involve idiosyncratic meaning and structure, both of which must be stipulated somewhere in the grammar, regardless of which theory one adopts. The advantage of CxG is that it allows the linguist to capture the regularities and irregularities more directly, at the level of the construction that captures the relevant patterns.[2] The phenomena in (2) underscore an important problem that CxG aims to tackle head-on: once a sufficiently broad range of linguistic phenomena are considered, simple overarching generalizations tend to vanish and a wide range of variation and idiosyncrasy often emerges, with different degrees of structural and semantic sub-regularity.

Crucially, constructions can interact with others in very complex ways. For example, in (3) we see various uses of *laugh* interacting with extraction, raising, control, and passivization. Thys, any account of (2) must also take into account the myriad of ways in which verbal arguments can be alternatively realized.

(3) a. It was the kids who Sam supposedly tried to laugh off the stage.
b. What Sam seemed to be laughing was his maniacal laugh.
c. Pictures were taken, laughs were laughed, and food was eaten.

Importantly, such interactions sometimes reveal constraints and phenomena that would otherwise remain undetected. For instance, it is not obvious why the complement of (2r) can be clefted as in *It was* [*ho! ho! ho!*] *that Sam laughed* _ , but the complement of the *way*-Manner construction in (2i) cannot, viz. **It was* [*her way*] *that Sam laughed* _ *out of the room.* Similarly, the complement in (2n) can be extraposed *Sam laughed* _ *off* [*the idea*], but not that of (2m), viz. **Sam laughed* _ *off* [*her head*], and so on.

The key to a constructivist account of phenomena like (2) and (3) is the recognition that different kinds of construction impose constraints on different kinds of linguistic dimensions. Thus, some constructions govern how semantic arguments are linked to morphosyntactic categories (Linking Constructions), others govern the range of possible grammatical roles that such categories can have (Valence and Voice Constructions), and so on. For example, a standard assumption in CxG is that there is one lexical entry for verbs like *laugh*, neutral with regard to the possible realizations in (2); see for example Goldberg (1995, 50,99), Croft (2001, 54,168), Fillmore (2009, 120), and Sag (2012, 133–139) for different implementations of this insight, consistent with the fact that thematic roles and subcategorization frames associated with a verb are available shortly

2 Such grammars have a better chance of being acquired via statistical learning than those relying on highly abstract information for which the learners have no direct observable evidence (Fodor and Sakas, 2001; Newmeyer, 2004; Clark and Lappin, 2011).

after that verb is accessed, as experimentally shown by Boland (1993), Trueswell and Kim (1998) and others. Such an underspecified lexical entry is a construction in itself, but one that concerns a single lexeme. If combined with the intransitive construction we obtain uses like (2a), if combined with the ditransitive construction we obtain (2d) and so on, as informally depicted in Figure 1. As an analogy, suppose that each of the boxes below is a transparency that can be overlaid on top of another. As long as the result is legible, their combination is well-formed. Of course, each construction can impose particular morphosyntactic, semantic, pragmatic and/or phonological constraints on the word it combines with.

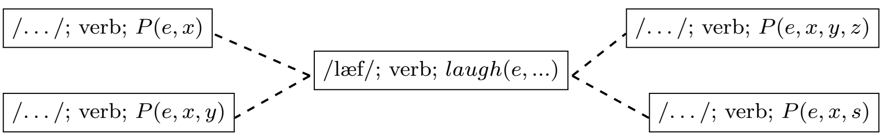

Fig. 1: An underspecified word and constructions it can combine with

Although the lexical entries of most words are underspecified as depicted above, and therefore can be used in a wide range of ways, the lexical entries of other words specifies additional constraints that restrict the range of constructions that they can combine with. Thus, the only lexical entry for the verb *rumor* is intrinsically passive (compare **We rumored Kim to be rich* with *Kim was rumored to be rich*). In other cases still, it is up to particular constructions to introduce idiosyncratic constraints. Thus, certain uses of *assure* require an argument to be *ex situ* (compare **I can assure you him to be the most competent* with *Who can you assure me _ to be the most competent?*), and obligatory transitive verbs like *devour* can drop their object only when used with constructions like the *way* construction (e.g. compare **He devoured* with *He devoured his way to victory by eating dozens of roaches*[3]).

For Kay (2002), Bergen and Chang (2005), Fillmore (2009), Steels (2011) and others, the operation responsible for combining constructions is unification (Shieber, 1986; Carpenter, 1992). Hagoort (2003, 2005) interprets various electrophysiological and neuroimaging findings in terms of a unification-based process that acts on syntactic, semantic, and phonological representations simultaneously. As in CxG, words are stored in the lexicon as part of a template, and that parsing involves a single combinatorial operation (unification) that joins

3 http://www.browardpalmbeach.com/news/edward-archbold-guy-who-dropped-dead-after-roach-eating-contest-died-of-asphyxia-6466687 such templates. Others like Goldberg (1995) and Croft (2001) are less committal about the nature of the operation that instantiates information across constructions.

Lexical entries such as the one at the center of Figure 1 are taken to be the result of grammatical generalizations made during acquisition. Learners eventually abstract the lexical entry of 'laugh' away from its multiple uses, and arrive at a number of templates that can be used for other verbs as well. In some cases, particular constructional realizations are so frequent that they become integral part of the grammar, rather than computed on-the-fly. In most versions of CxG, the constellation of constructions that can constrain a lexical construction forms a network, based on the information that such constructions have in common. For example, for Goldberg (1995, 135) and Goldberg (2006) such networks act as attractors and play an important role in giving rise to generalizations across verb classes during language acquisition, as well as in the coining of novel uses.

3 Data

Empirical adequacy, generality, simplicity, psychological reality and alignment with data about language acquisition, usage, historical change, and the evolution of language are all relevant sources of data to consider in rejecting or accepting a given constructivist account. In particular, CxG is in principle experimentally testable: psycholinguistic and neurolinguistic evidence should be brought to bear to determine if an analysis is consistent with the behavioral facts; for recent in-depth discussion see Goldberg (in press).

For example, there is much evidence that even compositional expressions can attain independent representation in the mental grammar, as a way of making their processing more efficient (Corrigan et al., 2009). For example, Alegre and Gordon (1999) and various others found wholeword frequency effects for regularly inflected words, suggesting that such wordforms can be memorized, and Bannard and Matthews (2008) showed that two and three-year-olds were faster and better at repeating higher frequency phrases compared to lower frequency ones, even though the two strings were equally plausible and matched on all other frequency measures. In addition, there is a growing body of historical evidence suggesting that complex forms can be memorized (Traugott and Trousdale, 2014; Bybee, 2006).[4] The process of storing the output of a com-

4 See Bybee (2013) and Diessel (2015) for more on the compatibility of usage-based approaches with CxG.

monly used function so that the solution can be simply looked up rather than computed from scratch is called *memoization* in computer science and *chunking* in psycholinguistics, and its redundancy provides a simple, robust, and efficient solution to a hard computational problem. This is one of the aspects of CxG which places it somewhere in-between a computational level theory of language (i.e. one that abstracts away from processing details) and an algorithmic level theory (which does not). The explicit goal of some CxG approaches, like that of Bergen and Chang (2005), for example, is precisely to bridge the gap between these levels. Indeed, construction-based frameworks have been informed by models of collocation analysis (Stefanowitsch and Gries, 2005), acquisition and syntactic processing (Abbot-Smith and Tomasello, 2006), computational modeling of concept learning (Steels and Beule, 2006), and models of activation of neural motor programs during perception (Feldman and Narayanan, 2004), among others.

If constructions are in fact part of the knowledge of language and in some cases can contribute with meaning over and above the meanings of the expressions they combine then there should be many linguistic examples of non-idiomatic structures in which the meaning of the whole is greater than that of its parts and most straightforwardly analyzable as the result of a constructional rule. I now turn to such evidence below.

3.1 Lexical constructions

Productive reduplication morphology is perhaps the strongest kind of evidence for constructional approaches, as it is cross-linguistically widespread and typically involves idiosyncratic meaning (Ghomeshi et al., 2004; Inkelas and Zoll, 2005; Masini and Thornton, 2008; Kay and Zimmer, 1990). For example, in Afrikaans complete reduplication is productive, as all lexical categories can be reduplicated to mean 'increase':

(4) Bakke-bakke veld-blomme versier die tafels
Bowls-bowls wild-flowers decorate the table
'The tables are decorated with wild flowers by the bowlful'
(Botha, 1988, 92)

The construction for reduplication of plural nouns can be assumed to be [N_{pl} N_{pl}] and to mean 'many Ns'. The alternative, of course, is to more indirectly stipulate the existence of a zero-affix that introduces the 'increase' denotation and selects two plural nouns. However, the very existence of reduplicative patterns such as these is predicted by the constructional approach to grammar. Similarly problematic for the zero-affix approach is the case of productive exocentric VN compounds in Romance languages, such as European Portuguese:

(5) a. lava-pratos
wash-dishes
'dish washer'

b. lava-carros
wash-cars
'car washer'

c. lava-janelas
wash-windows
'window washer'

d. lava-sanitas
wash-toilets
'toilet washer'

These compounds are nominals that denote an agent, not the action or the patient. As Booij (2010, 37) notes, there is no independent motivation for postulating a nominalizing zero-suffix, other than theory-internal assumptions.

Some productive compounding constructions similarly exhibit exotic structure as well as idiosyncratic meaning. This is the case of *Paired-Argument* compounds, illustrated by (6), from Jackendoff (2010). Such compounds involve two nominals that combine exocentrically to form a collective of sorts, which is then interpreted reciprocally by the following noun.

(6) a. a [love-hate] relationship

b. a [Port-cornstarch] mixture

The simplest account of such data is one where a dedicated construction imposes the appropriate form-meaning constraints, given that nothing else in the grammar derives these from independently motivated mechanisms.

But even more canonical compounding processes often exhibit peculiar structural and semantic constraints. For example in (7) the first noun is interpreted as a generic kind, and the second noun is interpreted as having been created with a benefactive goal. Hence, expressions like (7a) are interpreted as 'food created for generic dogs'.

(7) a. dog food

b. baby diapers

c. car seat

The compounds in (8), however, establish a meronymy relation between the first nominal and the head nominal, and existentially quantifies the former. Jackendoff (2010) argues that there are at least fourteen classes of semantic relationships in English compounds, and for evidence concerning adjective-noun combinations see Langacker (1987).

(8) a. cheese omelet
b. brick building
c. pebble beach

Interestingly, such compounds can interact with other compounds, such as the Numeral-N compounding construction illustrated in (9). Here we see a rather unusual combination of a plural numeral expression with a nominal root, which in turn combine with a nominal head.

(9) a. a [[two cheese] omelet]
b. this [[six valve] engine]
c. that [[ten story] building]
d. one [[five page] letter]

Nothing requires the numeral expression to be simple, as illustrated by *a* [[[*two-hundred thousand*] *mile*] *race*], or for it to be plural, e.g. *a* [[*one party*] *state*], *a* [[*one man*] *show*], *a* [[*no cholesterol*] *omelet*], or *a* [[*zero latency*] *engine*].

3.2 Phrasal constructions

Constructions in which the meaning of the whole is richer than that of its parts are in no way restricted to compounding as the sample in (10) illustrates. A straightforward account of such phenomena is one where each construction is brought about by a different grammatical template, with its own selectional constraints, semantic contribution, and/or prosodic phrasing. Either way, the grammar must be made more complex, as there is no way to derive the above patterns from more general rules. For construction-based accounts of (10a), for example, see Culicover and Jackendoff (1999), and Borsley (2004).

(10) a. The more you drink, the drunker you'll get.
(*Comparative correlative*)
(= 'If you drink more, you will get proportionally drunker')
b. It's a joke the way they run that place.
(*Extraposed exclamative*)
(= 'The way in which they run that place is a joke')

c. Miserable week after miserable week, we memorized the entire play, paragraph by paragraph, word for word.
(*N-P-N construction*)
(= 'During several weeks, we memorized every paragraph and word in the play')

d. They are planning to get engaged, war or no war.
(*X or no X*)
(= 'They are planning to get engaged, regardless of there being a war or not')

e. I like him, but I don't LIKE-HIM–like-him.
(*Focus reduplication*)
(= 'I like him to a moderate degree only')

Other phenomena that are consistent with a constructional account are illustrated in (11), which suggest a coertion-based approach via unary-branching rules like 'S $\rightarrow$ NP' that add the appropriate semantics and introduces the appropriate morphosyntactic information. Various other phenomena require such unary branching rules, such as bare NPs, grinding/packaging alternations, name-to-common-noun shifts, etc. See Fillmore and Kay (1996), Ginzburg and Sag (2000), Michaelis (2003), and Fillmore (2009) for specific proposals.

(11) a. A: Who owns a dog?
B: [Kim], and it's a dachshund. (= 'Kim owns a dog, and it's a dachshund')

b. A: Does Tom know ROBIN?
B: No, [Frank]. (= 'No, he knows Frank')

c. A: What do you think Robin wants?
B: Probably [Drugs]. (= 'Robin probably wants drugs')

One major advantage of construction-based approaches concerns the ability to model systematic constructional relations across constructions. Consider Subject-Auxiliary Inversion (SAI), for example, seen in (12).

(12) a. You have read the paper? (*non-inverted*)

b. Have you read the paper? (*inverted*)

Inverted and non-inverted uses of the verb can be modeled without any appeal to movement operations (Fillmore, 1999). For example, suppose that verbs come with an attribute that indicates whether they occur in inverted or non-inverted verbal structures. Thus, non-auxiliary verbs are lexically specified as INV-, and and (most) auxiliary verbs are underspecified. Hence, both kinds of verb can appear in the VP construction shown in (13), because no constraint is imposed on the value of INV. The PSG rule format adopted in (13) is highly simplified, but will do for the present purposes.[5]

(13) VP Construction
$\text{VP} \rightarrow \text{V}_{\text{INV-}}\ X_1 \ldots X_n$

Thus, (13) licenses both [*lifted* [*Kim*]] and [*will* [*lift* [*Kim*]]. The type of complement is restricted by the verb's semantics. In turn, the Subject construction in (14) combines such verb phrases with a specifier in order to saturate the semantic arguments and obtain a clause.

(14) Subject Construction
$\text{S} \rightarrow X\ \text{VP}$

Again, regardless of the verb being auxiliary or not, the construction in (14) derives both [[*We*][*lifted* [*Kim*]]] and [[*We*][*will* [*lift* [*Kim*]]]], by combining subjects and verb phrases. Finally, inverted structures are obtained via the construction in (15), which requires INV+ verbs. Hence, *Can we go* is licit because the verb is lexically underspecified for INV, but **Try we to go* is not licit because the verb is lexically specified as INV-.

(15) SAI Construction
$\text{S} \rightarrow \text{V}_{\text{INV+}}\ X_1\ \ldots\ X_m$

Most auxiliary verbs are therefore compatible with (13) and (15) because they are lexically underspecified for INV. Hence, the same verb is free to appear in inversion and non-inversion constructions, without necessitating any movement operation or anything equivalent to it. Moreover, such an account allows for a range of lexical exceptions. For example, *aren't* must be specified as INV+ so that it is only compatible with (15) (e.g. *Aren't I invited? / *I aren't invited?*), the auxiliary *better* is specified as INV- so it is only compatible with (13) (e.g. *You better not cry / *Better you not cry?*), and whereas future *shall* is INV- (e.g. *I shall go downtown* = 'I will go downtown'), deontic *shall* is INV+ (e.g. *Shall I go downtown?* = 'I should go downtown?). Clark and Eyraud (2007) and

5 The reader can assume that the semantics of the mother is the combination of the semantics of the daughters plus semantics contributed by the construction (if any). In CxG, constructions are nothing but static information about the internal structure of grammatical units, very much like phrase-structure grammar rules if viewed as declarative statements about mother-daughter configurations, rather than as string-rewriting functions (McCawley, 1968; Gazdar, 1982). Hence, constructions like (13) can be used by both the production and comprehension modules.

others show that SAI phenomena can be learned automatically using phrase structure grammar fragments of this kind, without explicit instruction, on the basis of a small set of positive data, and Bod (2009) obtains a similar result using child-directed data from CHILDES.

CxG takes the account just sketched above to the next level, by recognizing that there are in fact many SAI constructions, not just one like (15). As illustrated in (16) these have different distributions, function, and varying degrees of idiomaticity (Fillmore, 1999).

(16) a. [Shall we leave]?
(*canonical Y/N interrogative*)
b. Where [did they go]?
(*canonical wh-interrogative*)
c. What [does it matter if it's 2pm or 3pm]? We're late!
(*idiomatic wh-interrogative*)
d. [Wasn't that brave of him]?!
(*idiomatic exclamative*)
e. (Wow/Boy,) [can she sing]!
(*modal exclamative*)
f. [Don't you be late young man]!
(*negative imperative*)
g. (Oh) [don't I know it]...
(*expletive negation idiom*)
h. [May you have a fantastic birthday].
(*blessings/curses*)
i. The course was more confusing than [was the workshop].
(*comparative*)
j. [Had you warned me], we would be ready by now.
(*counterfactual conditional*)
k. [Should there be a storm], we will stay indoors.
(*concessive modifier*)
l. Rarely [had we seen them laugh so hard].
(*adverbial fronting*)
m. You're curious, and so [are we].
(*fronted so/as/neither conjuncts*)

A different SAI construction is responsible for each of the clause types in (16), all having in common the same SAI form seen in (15). These constructions thus form a form-resemblance family, and are typically depicted in CxG as a hierarchy with 'S $\rightarrow$ V_{INV+} X_1 ... X_m' at the top, or alternatively, at the center of the cluster. Although Fillmore (1999) argues that there is no general semantics shared by all aux-initial constructions, this is a controversial point, however. For Goldberg (2006, 179), for example, the construction in (15) is associated with certain functional properties; see also Goldberg (2009), Borsley and Newmeyer (2009), and the references cited there.

For Kay (2002) and others the constructional hierarchies that are common in CxG research are best seen as a (non-redundant) taxonomic characterization of the constructional knowledge shared by a cluster of constructions. In practice, it is the cluster of constructions that matters for speakers, not abstract taxonomies. The latter capture all the generalizations potentially available to the speaker of a language, though it is not assumed that the internal representation of the language in the mind of each speaker contains every generalization inherent in the data. Variability among speakers is an appropriate research question for psycholinguistics and variation studies. It is the grammarian's job to lay out the initial possibilities by identifying the full range of candidates. Thus CxG predicts that speakers of English have at least 13 constructions that share the general form in (15), subsets of which have semantic and pragmatic properties in common with each other and/or with non-SAI constructions in addition to their own morphosyntactic, semantic, pragmatic and/or prosodic idiosyncrasies (Langacker, 1987). Again, this is one of the aspects of CxG that places it somewhere in-between a theory of language that abstracts away from processing details and an algorithmic level theory, since it aims to be consistent with the knowledge that is *de facto* used by speakers during sentence processing.

4 Tools

CxG aims at a comprehensive description of the grammar of all languages, focusing both on regular and irregular constructions, and on their interaction. There is generally no limit to the size of local syntactic structures, as they can be unary branching, binary or longer. However, different constructional variants adopt different formalisms and different representational tools. As already mentioned, some assume the grammar is unification-based, others do not. Some adopt grammatical relations (such as subject and object), others do not.

For some constructivist researchers, CxG is 'generative' in the original sense of Chomsky (1965, 4), whereby a grammar is nothing but an explicit formal statement of the rules of the language, but for others the distinction between competence and performance is rejected. Like other monostratal frameworks (e.g. LFG, HPSG, CCG, etc; see present volume), all dimensions of linguistic information – phonology, morphosyntax, semantics and pragmatics – co-exist in lexical entries, grammar rules, and in the expressions licensed by the grammar. Moreover, all linguistic information, be it lexical or otherwise, is represented with the same basic format. Some constructivist approaches adopt featural representations, others reject them and remain non-committal about how best to represent linguistic information.

5 Evaluation

Although the idea that a same small set of mechanisms derive all constructions in all languages of the world is conceptually appealing, constructivist researchers find it difficult to justify, given the extremely wide range of typological variation across the languages of the world (Dryer, 1997; Croft, 2001; Hawkins, 2004; Haspelmath, 2007). Rather than assuming that all of this intra- and cross-linguistic diversity and idiosyncrasies should be the product of one and the same hyper-abstract language module that has somehow come to be part of the human genetic endowment, CxG is more conservative in that it assumes that human grammars differ to the extent that their respective languages differ.[6] And since CxG does not assume that all languages must be described in terms of the same core components, linguistic tests and even the repertoire of parts of speech can be language-specific (Croft, 2001). Recurrent cross-linguistic patterns are argued to be best described in terms the result of historical, functional, and cognitive pressures (Dryer 1997; Croft 2001; Hawkins 2004; Newmeyer 2005; Culicover and Jackendoff 2005; Goldberg 2006; Haspelmath 2007). Thus, the constructional grammarian usually first focuses on each language independently, in their own terms, and only later identifies any emergent cross-linguistic similarities.

6 It is now known that 98.8% of the human and chimp gene sequences are identical, not merely similar, and that the only human-specific genes that concern the brain simply govern the number of rounds of cell division during fetal brain development (Liu et al., 2012): Whereas cortical synaptogenesis in humans extends to five years it is only a few months in chimpanzees and macaques. Genes like FOX2P are in fact not specific to humans (Enard et al., 2002), and their mutation causes a diffuse range of effects, including problems with movement of the face and mouth unrelated to language, and significantly reduced IQ in the non-verbal domain (Vargha-Khadem et al., 1995). For more discussion see Elman (1999), Marcus (2001), and Marcus and Fisher (2003).

For construction-based crosslinguistic research on word order, for example, see Kathol (2000, Ch.7) and Wetta (2014).

6 A Grammar Fragment

It is impossible to do justice to all extant variants of CxG, as they differ in the formalism they adopt, their degree of explicitness, and in the analysis of certain phenomena (Hoffman and Trousdale, 2013). In what follows is a formally explicit grammar fragment that incorporates insights from a variety of sources, such as Fillmore and Kay (1996), Kay and Fillmore (1999), Goldberg (1995), Croft (2001), and Bergen and Chang (2005). Although the Sign Based Construction Grammar formalism (Sag, 2012) is adopted here in broad terms, various revisions are made in order to come closer to the spirit of the aforementioned strands of CxG, and to better highlight the key differences between CxG and other frameworks in this volume. To be clear, what follows is a grammar of English, rather than a grammar that is supposed to also model languages unrelated to English. Thus, the attributes and rules shown below should not be assumed to be necessarily appropriate for all other languages.[7]

Let us begin with a snapshot of the information that characterizes an English verb and how it is organized. The Attribute-Value Matrix (AVM) in Figure 2 states that signs of type *word* are composed of several major dimensions of linguistic information: FORM (phonology), SYN (morphosyntax), FRAMES (semantics), and ARG-ST (argument structure).[8]

The notation [PHON *list(phoneme)*] means that the value of PHON is required to be a list of phonemes. The value of PHON is oversimplified here since phonological representations have complex structure (syllables, feet, prosodic words, intonational phrases, etc.). The type *phr-phon* differs from *w-phon* in that it lacks *pref*, SUFF, and STEM attributes, and instead has phonological attributes that are appropriate for phrases. Analogously, the notation [ARG-ST *list(sign)*] requires that the value of ARG-ST must be a list of signs, which can be wither AVMs of type *word* or *phrase*. The value of any given attribute is typed (shown in italics) and some types introduce further attributes. Whenever an attribute has no additional information beyond that shown in Figure 2, it is referred to

7 A small computational grammar fragment created to illustrate the implementation of the present theory can be downloaded from `https://github.com/RuiPChaves/SBCG`.

8 Information structure is omitted due to space limitations; see Engdahl and Vallduví (1996) for example.

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \textit{list(phoneme)} \\ \text{PREFIX} & \textit{list(phoneme)} \\ \text{STEM} & \textit{list(phoneme)} \\ \text{SUFFIX} & \textit{list(phoneme)} \end{bmatrix} \\ \text{SYNTAX} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{vform} \\ \text{INV} & \textit{boolean} \end{bmatrix} \\ \text{VAL} & \textit{list(sign)} \\ \text{GAP} & \textit{list(sign)} \\ \text{REL} & \textit{list(index)} \end{bmatrix} \\ \text{FRAMES} & \textit{list(frame)} \\ \text{ARG-ST} & \textit{list(sign)} \\ \text{DTRS} & \textit{list(word)} \end{bmatrix}$$

Fig. 2: General attribute-value geometry of English verbs

as being ‘underspecified’ and the attribute is not made explicit in the AVM, for exposition purposes. Thus, applying this convention to the AVM in Figure 2 would result in an AVM that shows only the non-underspecified information, as depicted in Figure 3.

$$\begin{bmatrix} \textit{word} & \\ \text{SYNTAX} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Fig. 3: Attribute-value geometry of English verbs (underspecified attributes omitted)

The attribute D(AUGH)T(E)RS lists the sign’s daughters. For example, verbal compounds like *body-shame*, *slut-shame*, *dog-shame*, etc. are verbs that have two daughters: a root and a verb, as licensed by a binary branching verbal construction. Conversely, words like *dog* have no daughters, and therefore the value of their DTRS attribute is the empty list ⟨⟩. For exposition purposes, the DTRS attribute is depicted more conventionally from now on, as in Figure 4. The tree notation pertains to combinatorical signs licensed by the grammar (constructs) whereas the PSG notation pertains to the rules (constructions) that license them. Following Sag (2012), constructs are displayed inside a box.

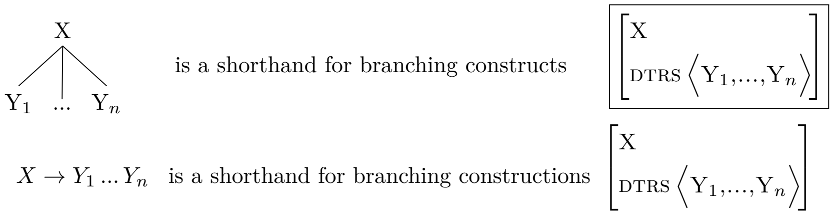

Fig. 4: The representation of immediate dominance information in AVM format

As a more concrete example, consider the verb *laugh* given in (17). This construction characterizes the idiosyncratic association of form, morphosyntax and meaning pertaining to a particular lexeme. This AVM states that there is a uninflected, uninvertable, verb stem /læf/ describing an action frame that involves a laughing state-of-affairs. This word is a verb because the value of CAT(EGORY) is of type *verb*, uninflected because no information about PREFIX and SUFFIX is given, and uninvertable because the value of INV is '–'. As stated above, underspecified information is not shown in the AVM, for perspicuity.[9]

(17) THE 'LAUGH' LEXICAL CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{STEM} & \langle \text{l,æ,f} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{INV} & - \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-pred-fr} & \\ \text{PRED} & \textit{laugh} \\ \text{INDEX} & e \end{bmatrix} \ldots \right\rangle \\ \text{DTRS} & \langle \rangle \end{bmatrix}$$

Semantic representations are cast in Frame Semantics (Fillmore, 1982, 1985; Fillmore and Baker, 2010; Fillmore et al., 2012), a framework which crucially assumes that meanings are relativized to rich representations that go beyond typical lexical semantics and include broader situational information. Thus, the *action-pred-fr* frame type has many sub-types, and a wide range of frame ele-

9 The ellipses '...' in FRAMES indicate that the list may or not contain other frames. Departing from Sag (2012), the first frame in the FRAMES list corresponds to the semantics of the head, in order to simplify the syntax-semantics interface. See below for discussion.

ments as illustrated in Figure 5.[10] The type *monadic-pred-fr* allows no additional frame elements other than those introduced by *action-fr* and hence it corresponds to an intransitive use of the verb. The type *action-process-fr* introduces a theme participant and therefore licenses transitive uses. Similarly, the *action-result-fr* frame type corresponds to uses where the predicate causes the theme to undergo a change as in *Sam laughed the beer out of his nose.*

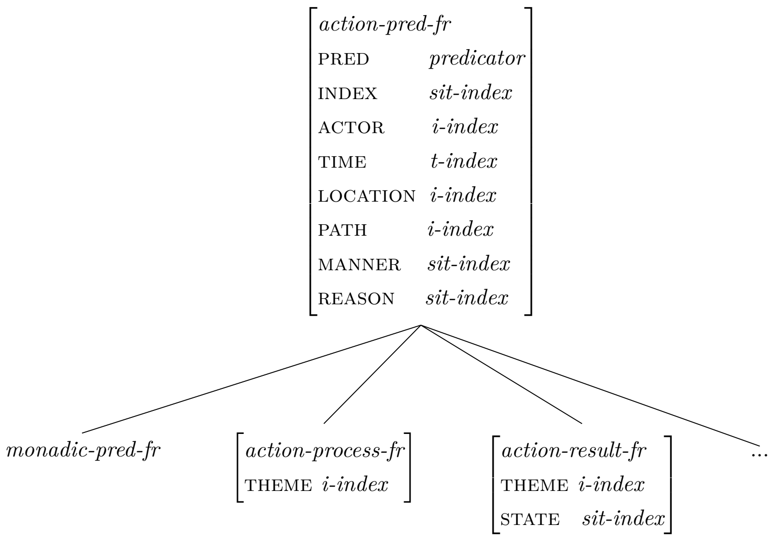

Fig. 5: Type hierarchy of action-predicate semantics (not shown in full)

Meaning postulates constrain how such arguments can be interpreted, given the semantics of the predicate. For example, as their name indicates, sound emission verbs like *laugh* involve the production of a sound signal, and as such the theme is required to describe a sound (e.g. *Sam laughed 'ha ha ha'*, *Sam laughed the lyrics*, *Sam laughed a nervous laugh*). Hence, *Sam laughed the shoe* is not felicitous because the theme is incompatible with the constraints imposed on the theme of a sound emission verb by predicate-specific meaning postulates. Thus, not all semantic frame elements are equally compatible with all predicators. For example, the sentence *Sam laughed my Nikes threadbare* is not felicitous because of world knowledge: sound emission actions such as laughing cannot ordinarily

10 The type *sit-index* is for events and states e and s, *i-index* is for individuals $x...y$, and *t-index* for temporal indices.

have the described effect on sneakers, except in contrived contexts where, for example, the soles of the sneakers in question happen to be molecularly so extremely unstable that human speech suffices to cause them to shed material.[11] In other words, the compatibility between the predicate and its frame is a matter of degree, constrained by meaning postulates, and contingent on contextual and extralinguistic information.

How semantic frame elements map into morphosyntactic categories is the purview of linking constructions such as the one in (18), which bind each variable in FRAMES to a an argument structure element, ordered in terms of obliqueness. Note that the morphosyntax of core frame elements like ‘actor’ and ‘theme’ is more specific than that of non-core frame elements like state, time, and location. This is because the latter can be realized by phrases of varying categories, whereas the former are required to be NPs by this kind of verb.

(18) The Caused-Motion Linking Construction

$$\begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{INV} & - \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-result-fr} & \\ \text{INDEX} & e \\ \text{ACTOR} & x \\ \text{THEME} & y \\ \text{STATE} & s \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix} \ldots \right\rangle \\ \text{ARG-ST} & \left\langle \text{NP}_x, \text{NP}_y, \text{XP}_s, \text{XP}_t, \text{XP}_k, ..., \text{XP}_z \right\rangle \end{bmatrix}$$

Any representation that is nominal and has an empty valence list is abbreviated as ‘NP’ as shown in Figure 6. In other words, noun phrases are signs of with ‘noun’ part of speech, no valents, and determiner frames (i.e. a semantics where the index is bound to a overt or covert determiner). See below for more discussion about nominal semantics. The abbreviation ‘XP’ is similar except that no constraints are imposed on the part-of-speech or on the index type of that linguistic entity. The symbols ‘PP’, ‘VP’, ‘S’, etc. are similarly nothing but abbreviations for AVMs with certain part-of-speech and VAL(ENCE) specifications.

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11 See Müller (2005) for a similar explanation for contrasts like *Robin ran her Nikes threadbare/*purple*, and other partial productivity phenomena.

$$\mathrm{NP}_x \quad \text{is shorthand for} \quad \begin{bmatrix} \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix}\textit{noun}\end{bmatrix} \\ \text{VAL} & \langle\,\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{determined-fr} & \\ \text{INDEX} & x \end{bmatrix} ... \right\rangle \end{bmatrix}$$

Fig. 6: The representation of phrasal categories

By unifying (17) with (18) we obtain the word in Figure 7. Such a combination is possible because there is no conflicting attribute-value information between the two constructions (i.e. the AVMs are *unifiable*).

Another linking construction analogous to (18) specifies instead that the frame is of sub-type *monadic-pred-fr* and that ARG-ST is $\langle \mathrm{NP}_x, \mathrm{XP}_t, \mathrm{XP}_k, ..., \mathrm{XP}_z \rangle$, giving us the canonical use of the verb, e.g. *Sam laughed*, and so on for many other argument structure constructions compatible with the constraints specified by (17). Some constructions will impose very specific constraints on some of their arguments, such as the 'way' constructions in (2i,j), or the 'off' constructions in (2m,n), for example. Other verbs are compatible with a different (though often overlapping) range of frames than that of sound emission verbs, and therefore will also partially overlap in the argument structure realizations they can have. Verbs with similar meaning will tend to be compatible with similar argument structure patterns, though there is always the possibility for particular verbs to lexically introduce additional constraints on argument structure so that only a more limited range of uses is possible.

Every sign (lexical or otherwise) is licensed if it satisfies all the constraints imposed by its constructional class, and if it satisfies all the constraints imposed by whatever combinatoric constructions it is a part of. In the former case we have several orthogonal dimensions that simultaneously constrain the sign and further instantiate it (constructional class constructions), in the latter case the sign functions as a daughter of a construction (combinatoric constructions). Both kinds of constraint are illustrated below.

6.1 Constructional Class Constructions

Constructional class constructions are organized into a network or cluster of constructions, each of which characterizes a different dimension of linguistic information. Such constructions can pertain to lexical signs or phrasal signs. Consider for example the cluster of verbal lexical constructions illustrated in Figure

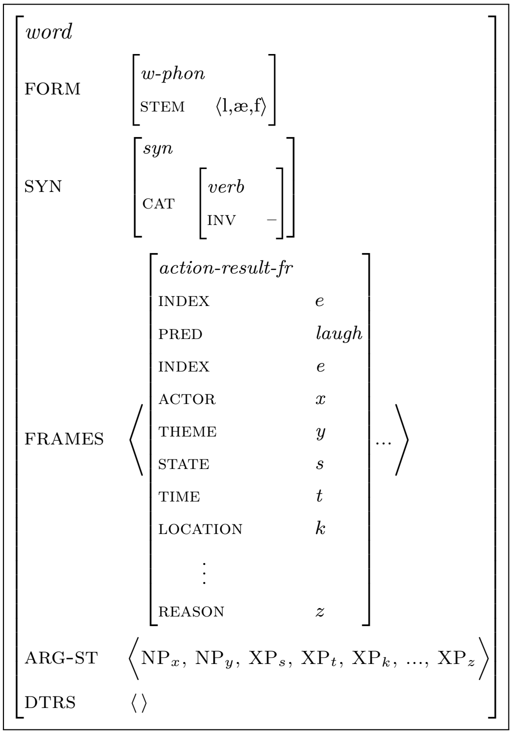

Fig. 7: Unification of the constructions in (17) and (18).

8. At the center we have a set of verb forms, i.e. a large number of constructions like (17), and connected to these verb forms we have verbal templates that instantiate different information in different ways, imposing constraints on voice, inflection, argument structure, and valence. Thus, in the linking construction cluster we have a large number of constructions like (18), and so on.[12]

As already discussed in §2, such clusters arise once learners realize that different uses of the verbal meaning are 'allolexemes', i.e. different combinations of the same core verbal form with various constructions that instantiate different di-

12 In HPSG and SBCG, the range of possible constructional combinations is encoded as multi-inheritance hierarchies, and as Koenig (1999) shows, such inheritance hierarchies can be computed on-the-fly rather than be listed explicitly. In the approach presented here, closer in spirit to CxG, cluster networks such as the one in Figure 8 are simply rules over word classes, where any given verb use is a conjunction of constructions from each of the verbal construction classes. In order to use a verb in a particular way, speakers must select one construction from each of these clusters and unify them into a single word.

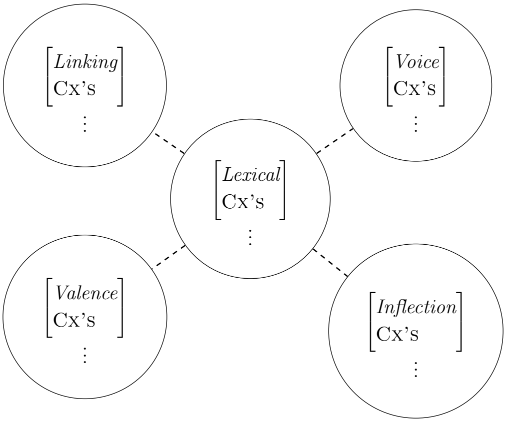

Fig. 8: Constructional verb clusters

mensions of linguistic information. Learners begin by memorizing particular uses of the same verb, but given enough experience, arrive at underspecified versions of such verbs by factoring out regular patterns concerning linking, voice, valence, and inflection information. The end result are clusters of different verbs that behave similarly, connected to constructions that constraint their use in various ways. In production, enough constructions must be factored in so that the constraints on the form of the sign is sufficiently instantiated given the constraints on the meaning and function, and in comprehension, enough constructions must be factored in so that semantic information is sufficiently instantiated given the form information. In some cases, the unification of some of these constructions is so frequent that the fully resolved form becomes part of the grammar as well, and can be accessed directly. Through analogy, constructional clusters and networks are expanded, and in the absence of certain uses, speakers counterfactually assume that certain verbs are incompatible with certain constructions.

An alternative way to conceptualize the cluster network in Figure 8 is as a rule that defines any given verb use as the unification of a core (underspecified) verbal lexical entry with one linking construction, one valence construction, one inflection construction, and so on, for all of the different kinds of construction that restrict the space of possible verb uses. Beyond this, the grammar has nothing to say about how speakers effectively choose to combine two given constructions. It is up to the production module to select the appropriate constructions based on the semantic frame F that the speaker wishes to covey, also taking into consideration contextual, visual and gestural information, as well as social knowledge, style, and genre. In other words, the particular linking, valence, voice, and inflection constructions that the verb combines with at any point are selected given their compatibility with the frame F in question, and their likelihood given the utterance context. Similarly, the comprehension module selects the constructions that are most likely and consistent with the input.

Let us take a closer look at the construction classes in Figure 8. Following Koenig (1999, Ch.3), Goldberg (2006, 5), Jackendoff and Audring (2014), and others, inflectional phenomena are modeled by constructions such as (19), which instantiate the affixal phonology, set the value of VFORM accordingly, and add the necessary tense information to FRAMES. Of course, further constraints should be added to (19) so that only certain kinds of stem are appropriate for this construction. Irregular inflection is handled by other constructions which in turn select different kinds of stem.

(19) THE REGULAR PAST TENSE INFLECTION CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PREFIX} & \langle\,\rangle \\ \text{SUFFIX} & \langle \text{d} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{finite} \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-pred-fr} & \\ \text{ARG} & e \end{bmatrix}, \begin{bmatrix} \textit{tense-fr} & \\ \text{PRED} & \textit{past} \\ \text{ARG} & e \end{bmatrix} \right\rangle \end{bmatrix}$$

Thus, some constructions introduce information about the stem, others about the affixes. It is up to the construction in (20) to determine how the PHON value of words in general is computed. Capitalized letters in italics are variables over attribute values. Thus, the prefix phonological information in P_1 is concatenated (via the list append relation '$\oplus$') with that in STEM, P_2 and the result is concatenated with that of SUFFIX P_3.

(20) THE LEXICAL PHONOLOGY CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \text{PHON} & P_1 \oplus P_2 \oplus P_3 \\ \text{PREFIX} & P_1 \\ \text{STEM} & P_2 \\ \text{SUFFIX} & P_3 \end{bmatrix} \end{bmatrix}$$

Unifying the AVM in Figure 7 with (19) and (20) results in the past tense verb in Figure 9. As in Sag (2012), the VFORM attribute has as its value the type *vform* which has two sub-types: *finite*, *infinitive*, *base*, *present-participle*, *past-participle*, and *pass-participle*.

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{l,æ,f,d} \rangle \\ \text{PREF} & \langle\,\rangle \\ \text{STEM} & \langle \text{l,æ,f} \rangle \\ \text{SUFFIX} & \langle \text{d} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{FORM} & \textit{finite} \\ \text{INV} & - \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-result-fr} & \\ \text{INDEX} & e \\ \text{PRED} & \textit{laugh} \\ \text{ACTOR} & x \\ \text{THEME} & y \\ \text{STATE} & s \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix}, \begin{bmatrix} \textit{tense-fr} & \\ \text{PRED} & \textit{past} \\ \text{ARG} & e \end{bmatrix} \right\rangle \\ \text{ARG-ST} & \left\langle \text{NP}_x, \text{NP}_y, \text{XP}_s, \text{XP}_t, \text{XP}_k, ..., \text{XP}_z \right\rangle \end{bmatrix}$$

Fig. 9: Past-tense inflected verb *laughed* with resultative use.

The word in Figure 9 is not quite sufficiently instantiated, however. For example, there is no information about the grammatical function of the arguments, or whether they are locally realized or not. Two kinds of construction from the network in Figure 8 are responsible for constraining valent realization, namely, valence constructions and voice constructions. For example, the valence construction in (21) requires that the list of arguments of a word be (non-deterministically) mapped into three (potentially empty) sub-lists: a sublist X corresponds to locally realized valents, a sublist Y corresponds to non-locally realized valents (e.g. clefted, topicalized, extraposed, etc.) and a third list corresponds to unrealized valents (e.g. null complements, passive subjects, etc.).[13]

(21) THE VALENCE CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{VAL} & X_{list(local)} \\ \text{GAP} & Y_{list(non-local)} \end{bmatrix} \\ \text{ARG-ST} & X \bigcirc Y \bigcirc Z_{list(pro)} \end{bmatrix}$$

Based on Sag (2012, 98), the type *syn* is assumed to have three sub-types: *local* (which indicates that the sign is locally realized), *non-local* (which indicates that it is non-locally realized), and *pro* (which indicates that the sign is not realized). The type hierarchy of *syn* types is given in Figure 10. The construction in (21) requires the members of the VAL list to be typed as *local*, GAP members are *non-local*, and the members of Z must be typed *pro*.

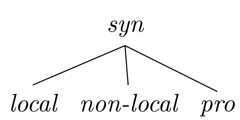

Fig. 10: Type hierarchy of *syn* types

Depending on how the '◯' constraints in (21) are resolved, a wide range of lexemes will be licensed, each with a different constellation of local, non-local, and unrealized valents. Semantic and pragmatic constraints should be added to (21) so that the realization of dependents is constrained, like those in Fillmore and Kay (1996), Goldberg (1995), Goldberg (2006, Ch. 9), Lee-Goldman (2011) and Ruppenhofer and Michaelis (2014). For example, suppose that the verb

13 The 'shuffle' relation '◯' (Reape, 1994) is a non-deterministic version of list concatenation, defined in terms of '⊕'. For example, the unification $\langle \text{NP, PP} \rangle = A \bigcirc B$ has a total of four possible solutions: $A = \langle \text{NP,PP} \rangle$ & $B = \langle\rangle$, $A = \langle \text{NP} \rangle$ & $B = \langle \text{PP} \rangle$, $A = \langle \text{PP} \rangle$ & $B = \langle \text{NP} \rangle$, and $A = \langle\ \rangle$ & $B = \langle \text{NP, PP} \rangle$.

laughed in Figure 9 is unified with (21) so that: (i) X is resolved as a sublist containing NP_x and PP_s, (ii) Y is resolved as a singleton list containing NP_y, and (iii) Z is resolved as containing the remainder. The result is in Figure 11.

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{l,æ,f,d} \rangle \\ \text{STEM} & \langle \text{l,æ,f} \rangle \\ \text{SUFFIX} & \langle \text{d} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{finite} \\ \text{INV} & - \end{bmatrix} \\ \text{VAL} & \left\langle \text{NP}_x,\ \text{PP}_s \right\rangle \\ \text{GAP} & \left\langle \text{NP}_y \right\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-result-fr} & \\ \text{INDEX} & e \\ \text{PRED} & \textit{laugh} \\ \text{ACTOR} & x \\ \text{THEME} & y \\ \text{STATE} & s \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix}, \begin{bmatrix} \textit{tense-fr} & \\ \text{PRED} & \textit{past} \\ \text{ARG} & e \end{bmatrix} \right\rangle \\ \text{ARG-ST} & \left\langle \text{NP}_x,\ \text{NP}_y,\ \text{XP}_s,\ \text{XP}_t,\ \text{XP}_k,\ \ldots,\ \text{XP}_z \right\rangle \\ \text{DTRS} & \langle\, \rangle \end{bmatrix}$$

Fig. 11: A possible unification between (21) and the AVM in Figure 9.

This use of *laugh* corresponds to one where the object is not *in situ*, as in *It was Sam* [*who*]$_i$ *the crowd laughed* _$_i$ *out of the room* or [*Who*]$_i$ *Kim laughed* _$_i$ *off the stage were the kids.*[14] As detailed in Ginzburg and Sag (2000), Sag (2010), and Sag (2012), any elements in GAP are constructionally shared across

14 If instead the subject phrase is in GAP and complements in VAL then one obtains subject extraction patterns like [*Who*]$_i$ *I think* _$_i$ *laughed the kids off the stage was Kim*, and similarly, if both the object and the subject are in GAP then we license extraction

mother-daughter configurations, so that they 'percolate' in syntactic structure until they can be unified with a fronted element as illustrated in Figure 12. As we shall see below, phrasal constructions require the GAP values of the mother and daughters to combine via unification, which in effect allows the information about a missing argument to be propagated on the tree, much the same way that information about the phonology, semantics, valence, or part of speech of a phrase propagates in the tree via unification.

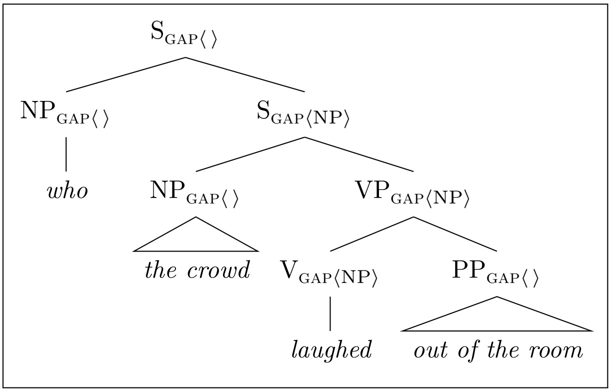

Fig. 12: Propagation of GAP information (AVMs abbreviated)

For most words, the type of the ARG-ST members is underspecified as *syn*, so that they can be locally realized, *ex situ* or elided. For other words, however, certain arguments in ARG-ST are more restrictively typed, by stipulation of the lexical entry itself, or by stipulation of some of the constructions that they can be unified with. For example, the lexical entry for the verb *rumor* is necessary passive, whereas only certain uses of *assure* require a dependent to be *ex situ*.

The valence construction in (21) also entails that only arguments can be extracted, not modifiers. And since we have taken a broad view of what counts as a valent, following Fillmore (1982) and Croft (2001), we account for extractions like those in (22) and the impossibility of extracting modifiers like (23).[15]

patterns like [*A comedian* THAT *experienced*]$_i$, *I doubt* [*even the worst hecklers*]$_j$ *would easily* _$_j$ *laugh* _$_i$ *off the stage*, and so on. See below for more details.

15 Just like some nominal, verbal, adjectival and prepositional phrases lead a double life as modifiers and as arguments, it is however possible that some temporal, locative, path, manner, and reason phrases also lead a double life, functioning either as modifiers or as arguments. There is a construction that allows sequences of adverbials to characterize the

(22) a. It was [yesterday/mistakenly] that I think Sam skipped school _ .
b. [How often] did you say that Robin was late this week _ ?
c. Was it [by accident] that the driver didn't run over the squirrel _ ?
d. [For what reason] do you believe that Sam resigned _ ?

(23) a. *It was [definitely/never] that I think Sam _ skipped school.
b. *[How happy] did you say that Robin has a _ dog?
c. *It was [by them] that Sam was rumored to be rich _ .
d. *Was it [this] that the driver almost ran over _ squirrel?

Let us now consider voice constructions. Drawing from Fillmore and Kay (1996), Koenig (1999, Ch.3), Goldberg (1995, 57), Croft (2001, 216), and Davis (2001, Ch.6) among others, constructions like the passive in (24) state that the verb must be inflected appropriately and that the type of *syn* of the first element in ARG-ST must be resolved as *pro*. The latter effectively prevents the argument from being realized, since (21) does not allow *pro*'s to reside in VAL or GAP.[16]

(24) THE PASSIVE VOICE CONSTRUCTION (regular case)

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix}\text{SUFFIX} & \langle d \rangle\end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{pass-participle} \end{bmatrix} \end{bmatrix} \\ \text{ARG-ST} & \left\langle \begin{bmatrix}\text{SYN} & \begin{bmatrix}\textit{pro}\end{bmatrix}\end{bmatrix} \ldots \right\rangle \end{bmatrix}$$

Following Koenig and Davis (2003), the passive by-PP phrase is a VP modifier that binds its index to the actor role of the verb heading the modified VP. The

trajectory along a path, or to narrow down a spatial or temporal location, shown in (i) and (ii). Such complex adverbial sequences form a complex constituent, as seen below.
i. Was it [in 1945, on the 16th of July, at 5:39 a.m.] that the first nuclear bomb was detonated _ ?
ii. Q: When was the first nuclear bomb detonated _ ? A: [In 1945, on the 16th of July, in the morning].

16 As in the case of other inflectional constructions, this passive construction is simplified here given that constraints on the stem must be added, so that the -*d* suffix is added to only with certain stems. Other passive rules impose different constraints on the stem, and introduce a different suffix, e.g. -*en* as in *He was seen yesterday.*

passive by-PP phrase can access the correct role by inspecting the first frame listed in the VP's FRAMES. The fact that the passive by-PP phrase is a VP modifier predicts that it can in principle be coordinated with other kinds of modifiers, as shown in (25).

(25) Every chapter of his book was written (both) [[by students] and [for students]].

In contrast, the active construction in (26) remains neutral about inflection, requires that the first element in ARG-ST of the verb is not *pro*, and that its index is the same as the highest ranking thematic role in the verb's semantic frame, as depicted in (26). Additional constraints can be imposed on the verbal frame, and more specifically on the value of PRED, so that the range of passivizable verbs can be semantically restricted as appropriate.

(26) The Active Voice Construction

$$\begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-pred-fr} & \\ \text{ACTOR} & x \end{bmatrix} \ldots \right\rangle \\ \text{ARG-ST} & \left\langle \begin{bmatrix} \text{SYN} & \begin{bmatrix} \neg \textit{pro} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \textit{sem} & \\ \text{INDEX} & x \end{bmatrix} \end{bmatrix} \ldots \right\rangle \end{bmatrix}$$

Another type of lexical construction that further restricts morphosyntax concerns case assignment. Such a construction requires that the first non-*pro* NP in the ARG-ST of a finite verb must have its value of CASE resolved as *nom*, and that CASE value of any other NP must be instantiated as *acc*. For heads that are not finite verbs, case can be assigned lexically. For example, prepositions require accusative objects, and gerunds non-nominative subjects.

All of the constructional class constructions discussed above are lexical in nature, but constructional class constructions can also be phrasal in the sense that they further constrain signs that have daughters. For example, such constructions may specify how phonological phrases combine to form intonational phrases, or how phrasal semantic composition is to proceed. In what follows I focus on constructions (lexical or otherwise) that have daughters.

6.2 Combinatoric Constructions

Whereas class constructions serve to make underspecified signs more instantiated, combinatoric constructions take one of more instantiated signs and license a different sign (though when there is only one daughter, the name ‘combinatoric’ is somewhat of a misnomer). For example, compounding constructions are binary combinatoric constructions, as discussed in §3.1, but derivational morphology constructions are combinatorical unary constructions, following Koenig (1999), Booij (2010), and Sag (2012). The latter is illustrated by the *-er* construction in (27), which is essentially a PSG rule of the form ‘N → V’. The notation $Y{:}\alpha$ means that the value of the variable Y has at least the information in the AVM α. Thus the *action-pred-fr* semantics Y of the verbal daughter is also part of the nominal mother.

(27) The ‘-er’ Nominalization Construction

$$
\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix}\textit{w-phon} & \\ \text{STEM} & X\end{bmatrix} \\ \text{SYN} & \begin{bmatrix}\textit{syn} & \\ \text{CAT} & \begin{bmatrix}\textit{noun}\end{bmatrix}\end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix}\textit{common-n-fr} \\ \text{INDEX}\ x\end{bmatrix}, Y \ldots \right\rangle \end{bmatrix} \rightarrow \begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix}\textit{w-phon} & \\ \text{PHON} & X \\ \text{PREFIX} & \langle\,\rangle \\ \text{SUFF} & \langle \text{ɹ} \rangle\end{bmatrix} \\ \text{SYN} & \begin{bmatrix}\textit{syn} & \\ \text{CAT} & \begin{bmatrix}\textit{verb} & \\ \text{VFORM} & \textit{base} \\ \text{INV} & - \end{bmatrix}\end{bmatrix} \\ \text{FRAMES} & \left\langle Y{:}\begin{bmatrix}\textit{action-pred-fr} \\ \text{ACTOR}\ \ x\end{bmatrix} \right\rangle \end{bmatrix}
$$

Note that the VFORM value of the verbal daughter is *base* (preventing it from having been inflected), and the mother node is required to be a case-underspecified common noun co-indexed with the actor of the verb’s frame Y. Other examples of unary-branching constructions include those of the form ‘NP → N’, which license determinerless NPs by directly adding the correct determiner to the top of the frames list of the nominal.[17] See Fillmore (2009) for more detailed account of a broad range of such bare NP constructions. According to Chaves (2014), another kind of unary branching construction is the one responsible for so-called Right Node Raising (RNR) structures. As illustrated below, RNR can apply to a wide range of constructions other than coordination.

17 English bare NP uses are not restricted to plurals and mass nominals, see for example *Mother told me to go home* and *This can help baby sit up independently.*

(28) a. Explain how signals move from a PRE- to a POST-[synaptic neuron].
b. Are you talking about A NEW or about AN EX-[boyfriend]?
c. Robin does NOT PLAY – or PRETENDS not to play – [with a full deck].
d. This is the difference between AN INTERESTING and A BORING [book].
e. I said that John – and you said that Mary – [were wonderful students].

In order to illustrate how branching phrases are obtained, we turn to the example sentence in (29) and show how it is decomposed, piecemeal.

(29) After Mary introduced herself to the audience, she turned to a man that she had met before.

I will start by focusing on the sentence *Mary introduced herself to the audience*, and in particular, on its sub-constituents. I assume that pronouns and most English proper names already have a determiner frame in their semantics, which in effect means that such expressions are ready to function as NPs. For illustration, consider the determiner *the* in (30). From now on I omit the affixal and stem attributes, for convenience. The type *the-fr* (specific to the word 'the') is a subtype of *definite-fr* (the type for all definite nominals), which in turn is a sub-type of *determined-fr* (the type for all nominal phrases).

(30) a. THE 'THE' LEXICAL CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{ð,ʌ} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \textit{det} \\ \text{VAL} & \langle\rangle \\ \text{GAP} & \langle\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{definite-fr} & \\ \text{INDEX} & x \end{bmatrix} \right\rangle \end{bmatrix}$$

b. The 'audience' Lexical Construction

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{ɔ,d,i,j,ə,n,t,s} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{noun} \end{bmatrix} \\ \text{VAL} & \langle\rangle \\ \text{GAP} & \langle\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{person-fr} & \\ \text{INDEX} & x \begin{bmatrix} \textit{agr} & \\ \text{NUM} & \textit{plur} \\ \text{PER} & \textit{3rd} \end{bmatrix} \\ \text{PRED} & \textit{audience} \end{bmatrix} \right\rangle \end{bmatrix}$$

The 'NP → DP N' construction in (31) allows determiners to combine with common noun nominal heads, based on Fillmore and Kay (1996) and Bergen and Chang (2005). Either daughter can be of type *word* or *phrase*, and therefore can be lexical or phrasal. The x indices of the two daughters are unified, thus binding the quantified variable to the variable introduced by the nominal. Since agreement information is recorded at the index level, the unification of the two indices causes them to agree in number, gender and person. The index of the determiner in (30a) is underspecified for agreement and therefore it can combine with any nominal.

(31) The Determination Construction

$$\begin{bmatrix} \textit{phrase} & \\ \text{FORM} & \begin{bmatrix} \textit{phr-phon} & \\ \text{PHON} & P_1 \oplus P_2 \end{bmatrix} \\ \text{SYN} & X \\ \text{FRAMES} & \left\langle Y{:}\begin{bmatrix} \text{INDEX} & x \\ \text{ARG} & Z \end{bmatrix} \right\rangle \end{bmatrix} \rightarrow \begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON} \; P_1 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} \\ \text{CAT} \; \textit{det} \end{bmatrix} \\ \text{FRAMES} & \langle Y \rangle \end{bmatrix} \begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON} \; P_2 \end{bmatrix} \\ \text{SYN} & X{:}\begin{bmatrix} \textit{syn} & \\ \text{CAT} & \textit{noun} \\ \text{VAL} & \langle\,\rangle \end{bmatrix} \\ \text{FRAMES} & Z{:}\left\langle \begin{bmatrix} \textit{common-n-fr} & \\ \text{INDEX} & x \end{bmatrix}, \ldots \right\rangle \end{bmatrix}$$

Note also that (31) requires all SYN information of the nominal daughter to be unified via the SYN information of the mother node, via the variable X.[18] The result of combining (30a) with (30b) via (31) is seen in Figure 13.

---

18 Thus if the noun is specified as [GAP ⟨PP⟩], for example, then so is the NP mother node, and vice-versa, which is necessary to license extraction patterns like *It was* [*from Sue*] *that I got* [*a letter* _].

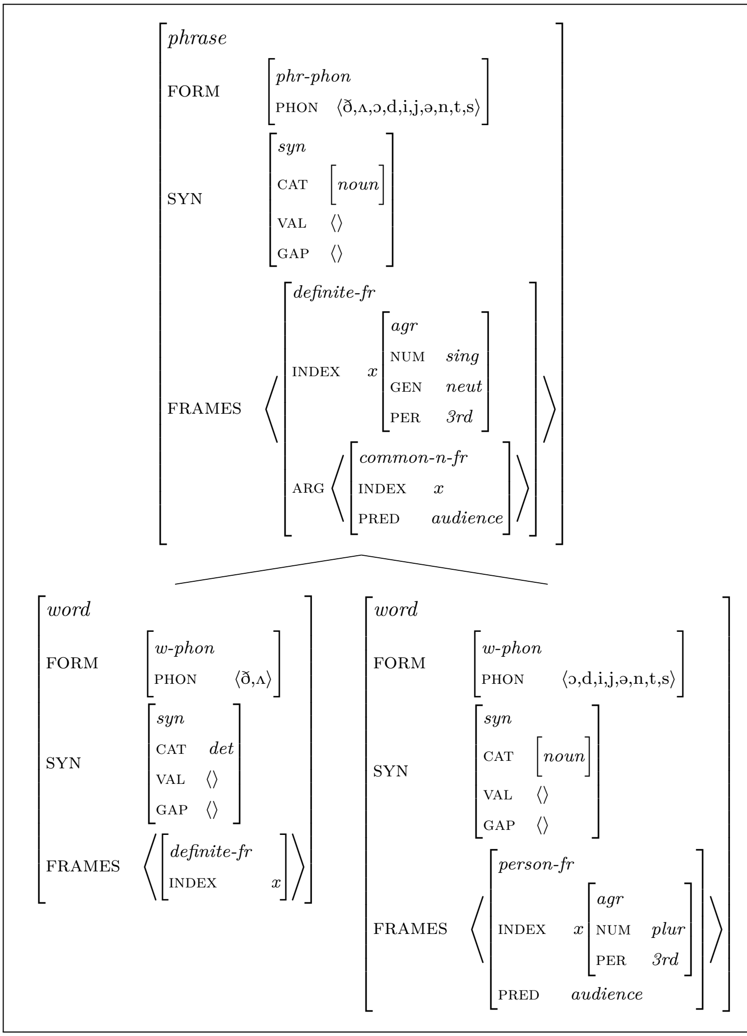

Fig. 13: The representation of *the audience*

The obtained semantic representation is interpreted as $\iota_x\, audience(x)$. Because the case is underspecified, this NP can function as a subject or as a complement. Determiners cannot combine with NPs because the latter have *determiner-fr* at the top of their FRAMES list. Conversely, pre-determiner expressions are only allowed to combine with expressions with a *determiner-fr* already at the top of FRAMES.

Some words can combine with NPs without adding much meaning to them at all. This is the case of argument-marking prepositions like (32), which merely impose a thematic role on their complements (Wechsler, 1995; Davis, 2001), and have a singleton ARG-ST list $\langle \mathrm{NP}_z \rangle$. The use of *to* shown in (32) arises when the valence construction in (21) determines that the NP must reside in VAL, rather than resolving it as a null (*pro*) complement (a null complement use), or as a member of GAP (a preposition stranding use).

(32)
$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{t,u} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \textit{prep} \\ \text{VAL} & \left\langle X{:}\mathrm{NP}_z \begin{bmatrix} \text{CASE} & \textit{acc} \end{bmatrix} \right\rangle \\ \text{GAP} & \langle\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{recipient-fr} & \\ \text{INDEX} & z \end{bmatrix} \right\rangle \\ \text{ARG-ST} & \left\langle X \right\rangle \end{bmatrix}$$

In general, prepositions combine with their complements via the 'PP → P XP' construction seen in (33).

(33) THE PREPOSITIONAL-COMPLEMENT CONSTRUCTION
$$\begin{bmatrix} \textit{phrase} & \\ \text{FORM} & \begin{bmatrix} \textit{phr-phon} & \\ \text{PHON} & P_1 \oplus P_2 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{prep} \\ \text{VAL} & \langle\, \rangle \\ \text{GAP} & G \end{bmatrix} \\ \text{FRAMES} & F_1 \oplus F_2 \end{bmatrix} \rightarrow \begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \text{PHON} & P_1 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{prep} \\ \text{VAL} & \left\langle X \right\rangle \end{bmatrix} \\ \text{FRAMES} & F_1 \end{bmatrix} X{:}\begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON} & P_2 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{GAP} & G \end{bmatrix} \\ \text{FRAMES} & F_2 \end{bmatrix}$$

Thus, combining (32) and the AVM in Figure 13 via (33) yields the AVM in Figure 14. In the constructions discussed so far in the present grammar fragment, the mother's semantic representation is simply the concatenation of the semantic representations of the daughters, but that need not be always the case, of course. As already discussed in §3, some constructions make a semantic contribution over and above the contributions of the daughters. Thus, semantic composition is construction-specific, and can range from the completely transparent to the highly irregular.

Let us move on to the verb *introduce*, shown in (34). As in the case of *laugh*, this verb is compatible with many different uses, and therefore its frame and

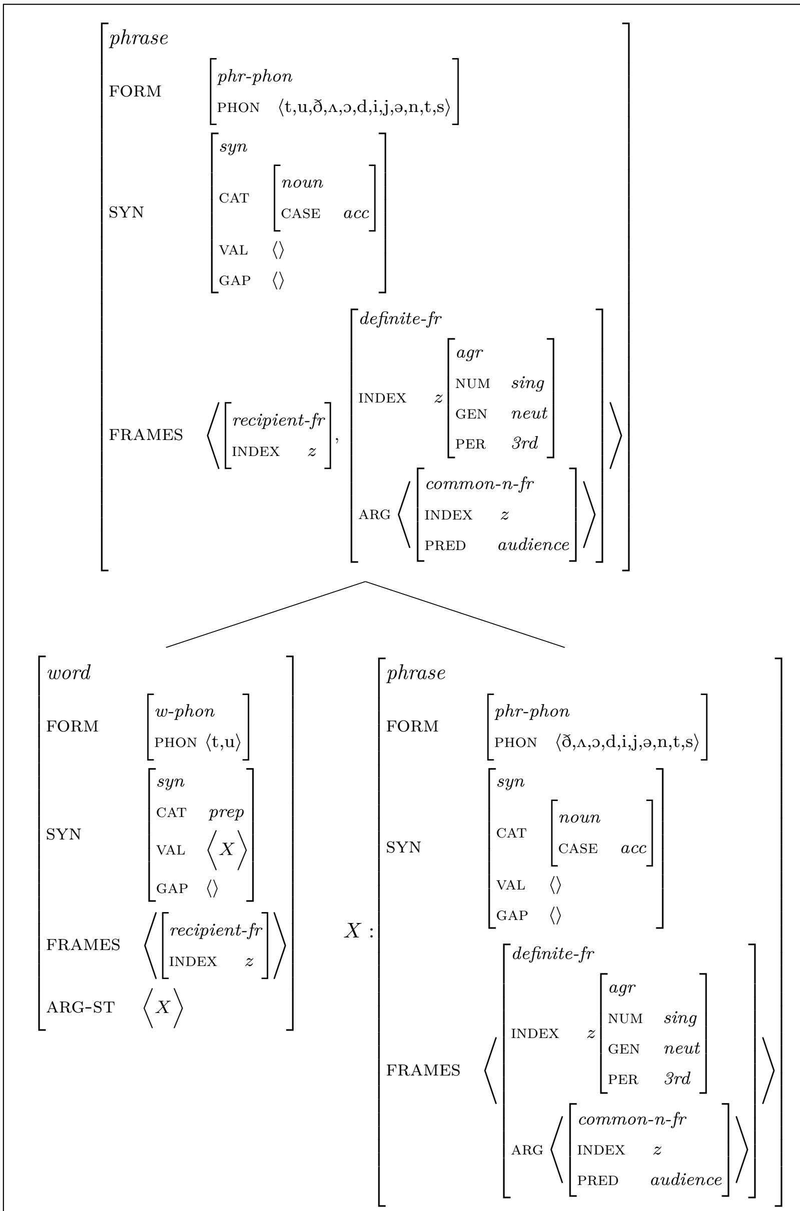

Fig. 14: The representation of *to the audience*

argument structure will be further instantiated by linking constructions, as long as they are mutually compatible.

(34) THE 'INTRODUCE' LEXICAL CONSTRUCTION

$$
\begin{bmatrix}
\textit{word} & \\
\text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{STEM} & \langle \text{ɪ,n,t,ɹ,o,d,u,s} \rangle \end{bmatrix} \\
\text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{INV} & - \end{bmatrix} \end{bmatrix} \\
\text{FRAMES} & \left\langle \begin{bmatrix} \textit{cause-poss-fr} & \\ \text{PRED} & \textit{introduce} \\ \text{INDEX} & e \\ \text{ACTOR} & x \\ \text{THEME} & y \\ \text{RECIPIENT} & z \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix} \right\rangle \\
\text{DTRS} & \langle \rangle
\end{bmatrix}
$$

Among the linking constructions that are compatible with the frame type introduced by (34) are those responsible for the dative alternation. Thus, if (34) is combined with (35a) we obtain the use of the verb in which the recipient is an NP, and if combined with (35b) we obtain the use of the verb in which the recipient is an oblique. Which frame is chosen depends on the speaker's intentions, and which constellation of frames are syntactically, semantically, and pragmatically compatible with the verb.

(35) a. THE DITRANSITIVE ARGUMENT-STRUCTURE CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{caused-poss-fr} & \\ \text{INDEX} & e \\ \text{ACTOR} & x \\ \text{THEME} & y \\ \text{RECIPIENT} & z \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix} \right\rangle \\ \text{ARG-ST} & \left\langle \text{NP}_x, \text{NP}_z, \text{NP}_y, \text{XP}_t, \text{XP}_k, ..., \text{XP}_z \right\rangle \end{bmatrix}$$

b. THE TRANSITIVE ARGUMENT-STRUCTURE CONSTRUCTION

$$\begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} \end{bmatrix} \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{caused-poss-fr} & \\ \text{INDEX} & e \\ \text{AGENT} & x \\ \text{THEME} & y \\ \text{RECIPIENT} & z \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix} \right\rangle \\ \text{ARG-ST} & \left\langle \text{NP}_x, \text{NP}_y, \text{PP}_z, \text{XP}_t, \text{XP}_k, ..., \text{XP}_z \right\rangle \end{bmatrix}$$

By unifying (34) with the argument-structure construction in (35b), the valence construction, the lexical phonology construction, the past tense inflection construction, the active voice construction, and the case construction, we obtain uses like the one in Figure 15.

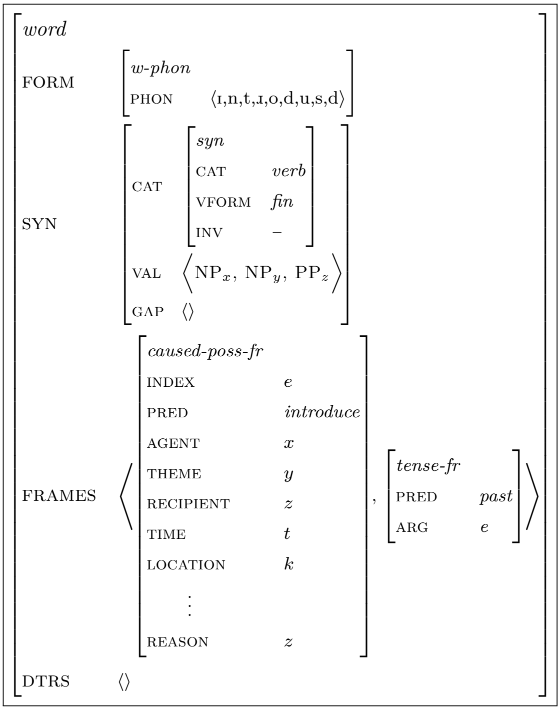

Fig. 15: Possible unification of (34) with linking, valence, voice, and inflection cxs

Let us assume that the direct object is the reflexive pronoun *herself* in (36). The type *reflx* is a sub-type of *definite-fr*, so this nominal can directly function as an NP.[19] This semantic representation in FRAMES is equivalent to $\iota_x(x = ...)$.

19 As in HPSG and SBCG, Binding Theory is stated at the *word* level, as a constraint on ARG-ST. For example, Principle A states that if an ARG-ST list L has a non-*pro* member K with a reflexive nominal index x, then K must be preceded in L by some other non-*pro* element that is co-indexed with x.Recall that *pro* phrases are not allowed to reside in VAL or GAP, and as per the Valence Construction in (21) are suppressed. Hence, Binding Theory ignores such members of ARG-ST, as intended.

(36)

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{h,ɹ,s,ɛ,l,f} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & \textit{acc} \end{bmatrix} \\ \text{VAL} & \langle\rangle \\ \text{GAP} & \langle\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{reflx-fr} & \\ \text{INDEX} & x \begin{bmatrix} \textit{agr} & \\ \text{NUM} & \textit{sing} \\ \text{GEN} & \textit{fem} \\ \text{PER} & \textit{3rd} \end{bmatrix} \\ \text{ARG} & \langle\rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

Uninverted verbs combine with whatever complements they lexically select in VAL via the ‘VP → XP_1 ... XP_n’ construction formalized in (37). This construction requires that all subcategorized valents of the first daughter (except the subject) be unified with its sisters $X_1 ... X_n$. All their phonologies are concatenated, as are their frames and gaps.[20]

(37) THE PREDICATE-COMPLEMENT CONSTRUCTION

$$\begin{bmatrix} \textit{phrase} & \\ \text{FORM} & \begin{bmatrix} \textit{phr-phon} & \\ \text{PHON} & P_0 \oplus P_1 \oplus ... \oplus P_n \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & K \\ \text{VAL} & \langle X_0 \rangle \\ \text{GAP} & G_0 \cup ... \cup G_n \end{bmatrix} \\ \text{FRAMES} & F_0 \oplus ... \oplus F_n \end{bmatrix} \rightarrow \begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \text{FORM} & P_0 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & K{:}\begin{bmatrix} \textit{verb} & \\ \text{INV} & - \end{bmatrix} \\ \text{VAL} & \left\langle X_0, X_1, ..., X_n \right\rangle \\ \text{GAP} & G_0 \end{bmatrix} \\ \text{FRAMES} & F_0 \end{bmatrix}$$

$$X_1 \begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON} & P_1 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{GAP} & G_1 \end{bmatrix} \\ \text{FRAMES} & F_1 \end{bmatrix} \;\ldots\; X_n \begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON} & P_n \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{GAP} & G_n \end{bmatrix} \\ \text{FRAMES} & F_n \end{bmatrix}$$

---

20 I assume that the symbol ‘∪’ is a non-deterministic operator that treats lists as if they were sets. Thus, $\langle NP_x \rangle \cup \langle NP_y \rangle$ can be resolved as $\langle NP_x, NP_y \rangle$ or as $\langle NP_z \rangle$ (where $x = y = z$). The former is necessary when there are multiple gaps linked to different fillers as in *Robin is someone who I never know what to say _ to _*, and the latter is necessary when there are multiple gaps linked to the same filler, as in *Robin was the client who we forgot to send pictures of _ to _.*

If the verb in Figure 15 is unified with the first daughter of (37) then its VAL list will consist of an NP and a recipient PP, which must appear in that order. If the NP is (36) and the PP is the one in Figure 14, we obtain the VP below.

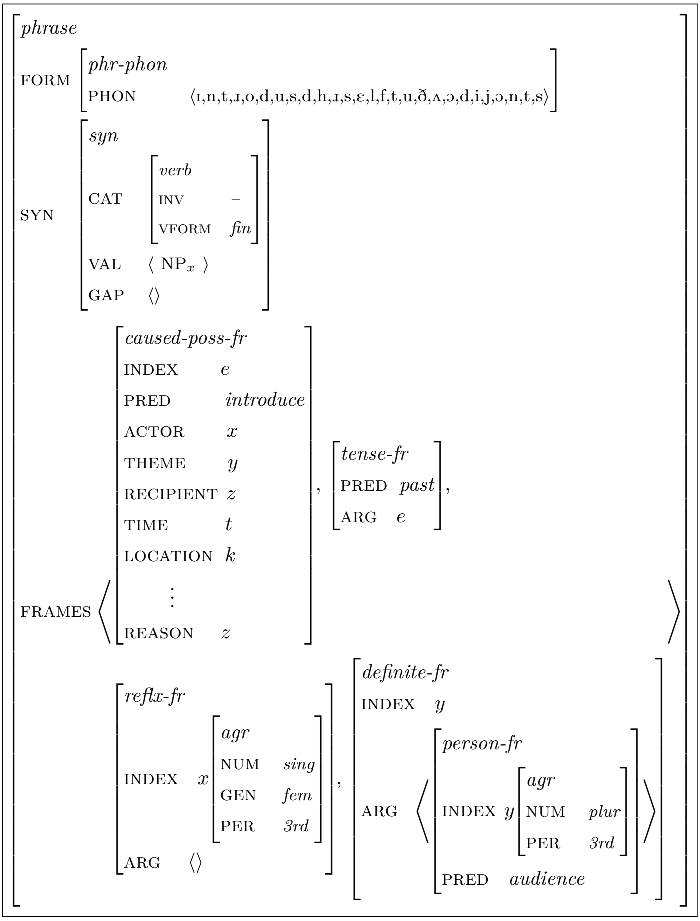

Fig. 16: The VP *introduced herself to the audience* (daughter nodes omitted)

The construction that allows VPs to combine with their subjects is of the form ‘S → X VP’, as shown in (38). This construction requires that the verbal daughter’s unsaturared valent X is unified with the first daughter.[21]

(38) The Subject-Predicate Construction

$$\begin{bmatrix} \textit{phrase} & \\ \text{FORM} & \begin{bmatrix} \textit{phr-phon} \\ \text{PHON}\ P_1 \oplus P_2 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & K \\ \text{VAL} & \langle\,\rangle \\ \text{GAP} & G_1 \cup G_2 \end{bmatrix} \\ \text{FRAMES} & F_1 \oplus F_2 \end{bmatrix} \rightarrow X{:}\begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON}\ P_1 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{GAP} & G_1 \end{bmatrix} \\ \text{FRAMES} & F_1 \end{bmatrix} \begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON}\ P_2 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT}\ K{:}\begin{bmatrix} \text{INV}\ - \end{bmatrix} \\ \text{VAL}\ \langle X \rangle \\ \text{GAP}\ G_2 \end{bmatrix} \\ \text{FRAMES} & F_2 \end{bmatrix}$$

The fact that the second daughter has the attribute INV means that it must be verbal, as no other part-of-speech bears that attribute. The phrase licensed by combining the lexical entry for *Mary* in (39) with the VP in Figure 16 via (38) is shown in Figure 17.

(39)

$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} \\ \text{PHON}\ \langle \text{m,ɛ,ɹ,ɪ} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{noun} \end{bmatrix} \\ \text{VAL} & \langle\rangle \\ \text{GAP} & \langle\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{definite-fr} & \\ \text{INDEX} & x \begin{bmatrix} \textit{agr} & \\ \text{NUM} & \textit{sing} \\ \text{GEN} & \textit{fem} \\ \text{PER} & \textit{3rd} \end{bmatrix} \\ \text{ARG} & \left\langle \begin{bmatrix} \textit{name-fr} & \\ \text{INDEX} & x \\ \text{PRED} & \textit{mary} \end{bmatrix} \right\rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

21 As in many phrasal constructions, the mother’s GAP values are a combination of the GAP values of the daughters, allowing gaps to propagate from/to the subject phrase (e.g. [*Which president*] *would* [*the impeachment of* _] *have caused the most outrage?*), the object phrase (e.g. [*Which president*] *would you have welcomed* [*the impeachment of* _]*?*), both subject and objects (e.g. [*Which president*] *would* [*the impeachment of* _] *have surprised* _ *the most?*), or neither, depending on the GAP values of each daughter.

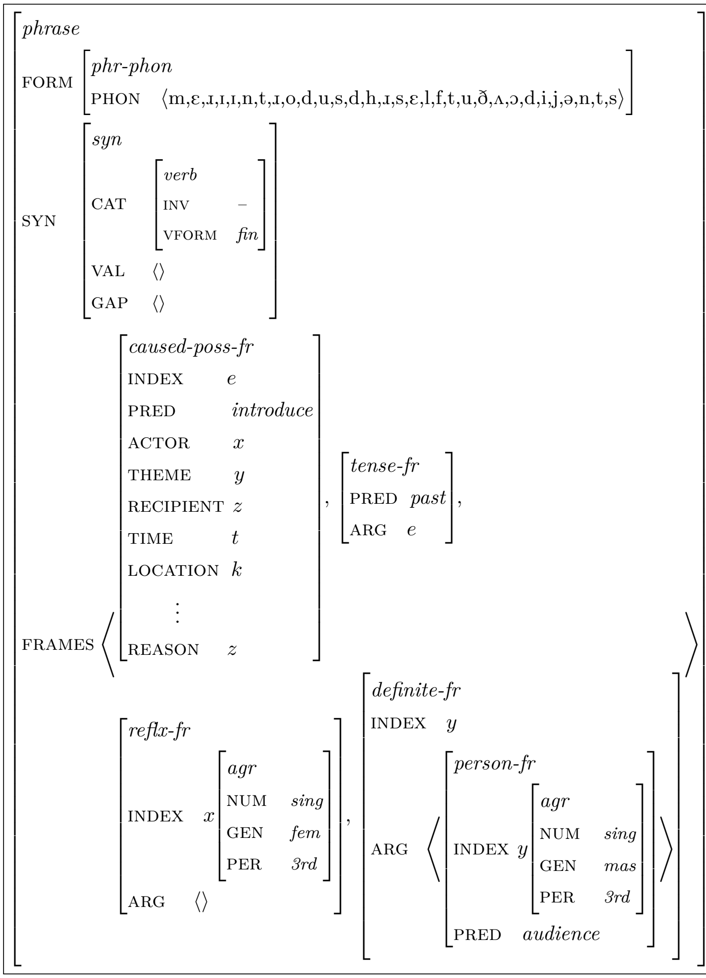

Fig. 17: Representation of *Mary introduced herself to the audience* (daughters omitted)

The CxG analysis of raising and control is similar to that of Categorial Grammar, Lexical-Functional Grammar, and Head-driven Phrase Structure Grammar (see this volume). Basically, the auxiliary selects a VP complement and requires that the subject X subcategorized by that VP be unified with the subject subcategorized by the auxiliary. As shown in (40), the lexical entry of an auxiliary verb like *have* requires that the X subject valent of the VP complement is unified with the valent of the auxiliary.

(40)
$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} & \\ \text{PHON} & \langle \text{h,\ae,d} \rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{fin} \end{bmatrix} \\ \text{VAL} & \left\langle X, \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \textit{fin} \end{bmatrix} \\ \text{VAL} & \langle X \rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \text{INDEX} & e \end{bmatrix}, \ldots \right\rangle \end{bmatrix} \right\rangle \\ \text{GAP} & \langle\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{tense-fr} & \\ \text{PRED} & \textit{past} \\ \text{ARG} & e \end{bmatrix} \right\rangle \end{bmatrix}$$

Thus, in a sentence like *She had met him* the matrix subject is co-indexed with the subject required by the embedded VP *met him* as depicted in Figure 18 using familiar abbreviations for the respective AVMs, where ‘S’ and ‘VP’ stands for any AVM of part-of-speech *verb* with an empty VAL list and with a singleton VAL list, respectively. As before, the subject combines with the matrix verb phrase via the subject-predicate construction in (38), and the auxiliary combines with its VP complement via the predicate-complement construction in (37). The latter construction is also responsible for combining *met* with *him*.

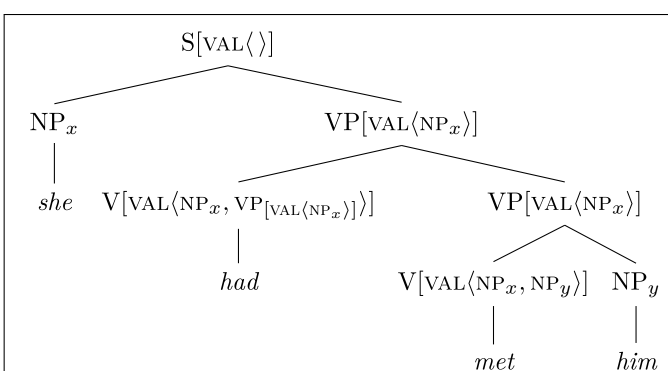

Fig. 18: Structure of the S *she had met him* (AVMs abbreviated)

In a more complex structure like *a man that she had met before* various constructions are at play. The Valence Construction causes the object of *met* to appear in GAP instead of VAL, which in effect prevents it from appearing *in situ*, and the phrasal constructions discussed above force it to be percolated in the tree structure.

(41)
$$\begin{bmatrix} \textit{word} & \\ \text{FORM} & \begin{bmatrix} \textit{w-phon} \\ \text{FORM}\ \langle \text{m,}\varepsilon\text{,t}\rangle \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{syn} & \\ \text{CAT} & \textit{verb} \\ \text{VFORM} & \textit{fin} \\ \text{INV} & - \end{bmatrix} \\ \text{VAL} & \left\langle \text{NP}_x,\ \text{PP}_z \right\rangle \\ \text{GAP} & \left\langle \text{NP}_y \right\rangle \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{action-process-fr} & \\ \text{INDEX} & e \\ \text{PRED} & \textit{meet} \\ \text{AGENT} & x \\ \text{THEME} & y \\ \text{TIME} & t \\ \text{LOCATION} & k \\ \vdots & \\ \text{REASON} & z \end{bmatrix}, \begin{bmatrix} \textit{tense-fr} & \\ \text{PRED} & \textit{past} \\ \text{ARG} & e \end{bmatrix} \right\rangle \end{bmatrix}$$

An NP_i containing a relative pronoun such as *which*, *who*, and *that* bears an attribute-value specification [REL $\{x\}$] where x is the variable of said pronoun. Like PHON, GAP, and FRAMES, the value of REL is assumed to be percolated in the tree structure by phrasal constructions. In most cases, the value of the mother's REL is the union of the daughters' REL values (Sag, 1997, 2010; Kay and Michaelis, 2016), and in generall a REL-bearing filler phrase combines with a gapped clause via the construction in (42).

(42) THE WH-RELATIVE CONSTRUCTION

$$\begin{bmatrix} \textit{phrase} & \\ \text{FORM} & \begin{bmatrix} \textit{phr-phon} \\ \text{PHON}\ P_1 \oplus P_2 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & K \\ \text{VAL} & \langle\rangle \\ \text{GAP} & G \end{bmatrix} \\ \text{FRAMES}\ F_1 \oplus F_2 & \end{bmatrix} \rightarrow X{:}\begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON}\ P_1 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{REL} & \{x\} \end{bmatrix} \\ \text{FRAMES}\ F_1 & \end{bmatrix} \begin{bmatrix} \text{FORM} & \begin{bmatrix} \text{PHON}\ P_2 \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT}\ K{:}\begin{bmatrix}\text{INV}\ -\end{bmatrix} \\ \text{VAL}\ \langle\rangle \\ \text{GAP}\ \langle \text{X}\rangle \bigcirc G \end{bmatrix} \\ \text{FRAMES}\ F_2 & \end{bmatrix}$$

The resulting clause $S_{[REL\{x\}]}$ can then combine with an NP via a construction that unifies the REL index of the clause with the index of the modified NP, i.e. '$NP_{[REL\{\}]} \rightarrow NP_y\ S_{[REL\{x\}]}$', as in Figure 19.[22]

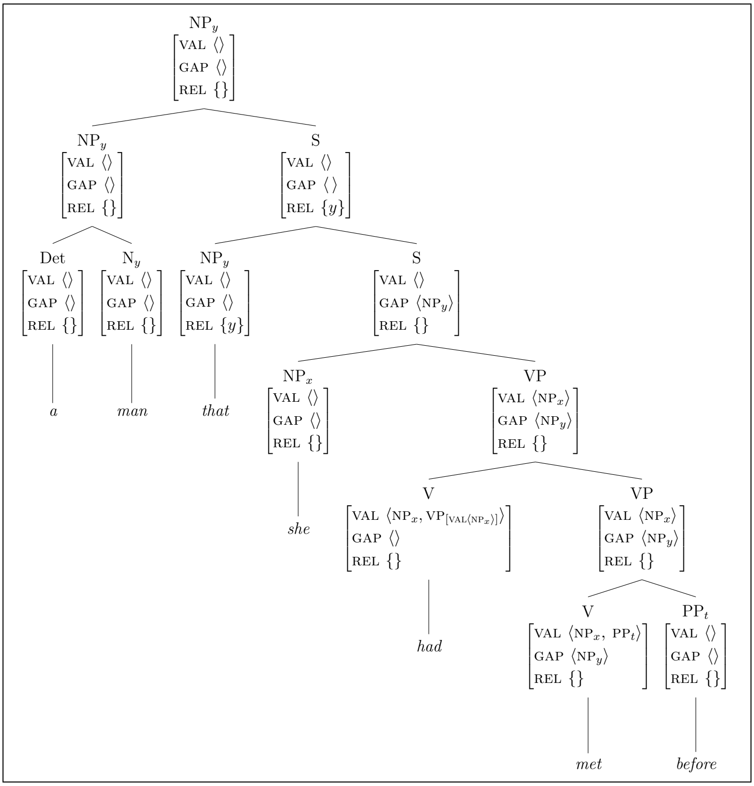

Fig. 19: Structure of the NP *a man that she had met before* (AVMs abbreviated)

In a sentence like *After Mary introduced herself to the audience, she turned to a man that she had met before*, the fronted clause is extracted from the main verb

22 I assume relatives combine with NPs because of examples like those below.
i. [[The man and the woman] [(that) the priest married]] were Tim and Sue.
ii. [[Every man and every woman] [who appeared in the same picture]] exchanged numbers.

turned and consists of a preposition that selects a clause like the one discussed in Figure 18 as its complement. The fronted phrase combines with the matrix via the construction '$S_{[\text{GAP}\langle\rangle]} \rightarrow XP_x\ S_{[\text{GAP}\langle XP_x\rangle]}$' based on Sag (2010). Finally, the linking construction that the verb *turned* combines with require that it selects a directional PP complement. In this case, the PP includes the NP already shown in Figure 19 above. The structure of the entire sentence is depicted below. Only the attribute GAP is shown, for perspicuity.

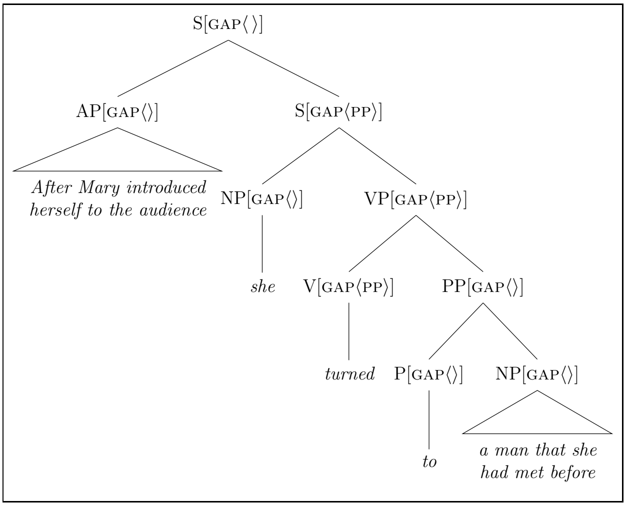

Fig. 20: Structure of the S *After Mary introduced herself to the audience, she turned to a man that she had met before* (abbreviated AVMs)

7 Conclusions

Construction Grammar is a surface-driven, non-modular, generative, non-derivational, and monostratal approach to linguistic theory, which aims at cognitive plausibility and full coverage of the facts of any language under study without loss of generalization, within and across languages. The empirical commitment of construction grammar is that grammatical theory must in principle account for the totality of facts of any language, not recognizing a priori any theoretically privileged set of core grammatical phenomena, as the data appear to demand a cline of constructions, from the relatively productive to the relatively frozen. The non-modular character of constructivist approaches assumes that form and meaning are part of each grammatical element, rather than located in separate components of the grammar. Construction Grammar aims to identify all the generalizations potentially available to the speaker of a language, though it is not assumed that the internal representation of the language in the mind of each speaker contains every generalization inherent in the data, as different speakers plausibly arrive at different generalizations and different grammars, and may regard different compositional structures as chunks, depending on the frequency to which they are exposed to such expressions during their daily life.

Acknowledgements

I am very grateful to Laura Michaelis, Adele Goldberg, Jean-Pierre Koenig and Erika Bellingham for comments and discussion about an earlier draft, and to the editors and reviewers for their feedback. I am responsible for the views reflected here and for any errors that remain.

Bibliography

Abbot-Smith, Kirsten and Tomasello, Michael. 2006. Exemplar-learning and schematization in a usage-based account of syntactic acquisition. *The Linguistic Review* (23), 275–290.

Alegre, Maria and Gordon, Peter. 1999. Frequency effects and the representational status of regular inflections. *Journal of Memory and Language* 40, 41–61.

Bannard, Colin and Matthews, Danielle. 2008. Stored word sequences in language learning: the effect of familiarity on children's repetition of four-word combinations. *Psychological Science* 19, 241–248.

Bergen, Benjamin K. and Chang, Nancy. 2005. Embodied Construction Grammar in simulation-based language understanding. In J.-O. Östman and Mirjam Fried (eds.), *Construction Grammar(s): Cognitive and Cross-Language Dimensions*, John Benjamins.

Bod, Rens. 2009. From Exemplar to Grammar: A Probabilistic Analogy-Based Model of Language Learning. *Cognitive Science* 33(5), 752–793.

Boland, Julie. 1993. The role of verb argument structure in sentence processing: Distinguishing between syntactic and semantic effects. *Journal of Psycholinguistic Research* 22, 133–152.

Booij, Geert. 2010. Compound construction: schemas or analogy? A construction Morphology perspective. In Sergio Scalise and Irene Vogel (eds.), *Compounding*, Amsterdam / Philadelphia: Benjamins.

Borsley, Robert D. 2004. An Approach to English Comparative Correlatives. In Stefan Müller (ed.), *Proceedings of the HPSG-2004 Conference, Center for Computational Linguistics, Katholieke Universiteit Leuven*, pages 70–92, Stanford: CSLI Publications. http://cslipublications.stanford.edu/HPSG/5/.

Borsley, Robert D. 2012. Don't move! *Iberia* 4(1), 110–139.

Borsley, Robert D. and Newmeyer, Frederick J. 2009. On Subject-Auxiliary Inversion and the Notion 'Purely Formal Generalization'. *Cognitive Linguistics* 20(1), 135–143.

Botha, Rudolph P. 1988. *Forma and meaning in word formation: a study of Afrikaans reduplication*.

Bryant, John Edward. 2008. *Best-Fit Constructional Analysis*. Ph.d. dissertation, University of California at Berkeley.

Brysbaert, Marc, Stevens, Michaël, Mandera, Pawel and Keuleers, Emmanuel. 2016. How many words do we know? Practical estimates of vocabulary size dependent on word definition, the degree of language input and the participant's age. *Frontiers in Psychology* 7.

Bybee, J. 2006. From usage to grammar: The minds response to repetition. *Language* 82, 711–733.

Bybee, Joan. 2013. Usage-based theory and exemplar representation. In T. Hoffmann and G. Trousdale (eds.), *The Handbook of Construction Grammar*, pages 49–69, Oxford University Press.

Carpenter, Bob. 1992. *The Logic of Typed Feature Structures*. Cambridge University Press.

Chaves, Rui P. 2014. On the disunity of Right-Node Raising phenomena: extraposition, ellipsis, and deletion. *Language* 90(4), 834–888.

Chomsky, Noam. 1957. *Syntactic Structures*. The Hague: Mouton.

Chomsky, Noam. 1965. *Aspects of the theory of syntax*. Cambridge, Massachusetts: The MIT Press.

Chomsky, Noam. 1975. *The Logical Structure of Linguistic Theory*. University of Chicago Press, Chicago.

Chomsky, Noam. 1981. *Lectures on Government and Binding*. Foris: Dordrecht.

Chomsky, Noam. 1989. Some notes on economy of derivation and representation. *MIT Working Papers in Linguistics* 10, 43–74.

Clark, Alexander and Eyraud, Rémi. 2007. Polynomial Identification in the Limit of Substitutable Context-free Languages. *Journal of Machine Learning Research* (8), 1725–1745.

Clark, Alexander and Lappin, Shalom. 2011. *Linguistic Nativism and the Poverty of the Stimulus*. Wiley-Blackwell, Oxford.

Corrigan, Roberta, Moravcsik, Edith A. and Wheatley, Kathleen M. 2009. *Formulaic language. Volumes I-II*. Amsterdam/Philadelphia: John Benjamins.

Croft, William. 2001. *Radical Construction Grammar – Syntactic Theory in Typological Perspective*. Oxford University Press.

Culicover, Peter and Jackendoff, Ray. 1999. The view from the periphery: The English comparative correlative. *Linguistic Inquiry* 30, 543–571.

Culicover, Peter and Jackendoff, Ray S. 2005. *Simpler Syntax*. Oxford University Press.

Davis, Anthony. 2001. *Linking by Types in the Hierarchical Lexicon*. Stanford, CA: CSLI Publications.

Diessel, Holger. 2015. Usage-based construction grammar. In Ewa Dabrowska and Dagmar Divjak (eds.), *Handbook of Cognitive Linguistics*, pages 295–321, Berlin: Mouton de Gruyter.

Dryer, Matthew S. 1997. Are grammatical relations universal? In Joan Bybee, John Haiman and Sandra Thompson (eds.), *Essays on Language Function and Language Type: Dedicated to T. Givon*, pages 115–143, Amsterdam: John Benjamins.

Elman, Jeff .L. 1999. Origins of language: A conspiracy theory. In B. MacWhinney (ed.), *The emergence of language*, Hillsdale, NJ: Lawrence Erlbaum Associates.

Enard, Wolfgang, Przeworski, Molly, Fisher, Simon E., Lai, Cecilia S. L., Wiebe, Victor, Kitano, Takashi, Monaco, Anthony P. and Pääbo, Svante. 2002. Molecular evolution of FOXP2, a gene involved in speech and language. *Nature* 418, 869– 872.

Engdahl, Elisabeth and Vallduví, Enric. 1996. Information Packaging in HPSG. In Claire Grover and Enric Vallduví (eds.), *Edinburgh Working Papers in Cognitive Science, Vol. 12: Studies in HPSG*, Chapter 1, pages 1–32, Scotland: Centre for Cognitive Science, University of Edinburgh.

Feldman, J. and Narayanan, S. 2004. Embodied Meaning in a Neural Theory of Language. volume 89, pages 385–392.

Feldman, Jerome, Dodge, Ellen and Bryant, John. 2009. Embodied Construction Grammar. In Bernd Heine and Heiko Narrog (eds.), *The Oxford Handbook of Linguistic Analysis*, Oxford.

Fillmore, Charles. 1982. Frame semantics. In The Linguistic Society of Korea (ed.), *Linguistics in the Morning Calm*, pages 111–137, Soeul: Hanshin.

Fillmore, Charles. 1999. Inversion and constructional inheritance. In G. Webelhuth, J.-P. Koenig and A. Kathol (eds.), *Lexical and Constructional Aspects of Linguistic Explanation*, pages 113–128, Stanford: CSLI Publications.

Fillmore, Charles. 2009. Berkeley Construction Grammar. In Bernd Heine and Heiko Narrog (eds.), *The Oxford Handbook of Linguistic Analysis*, Oxford.

Fillmore, Charles, Kay, Paul and O'Connor, Catherine. 1988. Regularity and Idiomaticity in Grammatical Constructions: The Case of let alone. *Language* 64, 501–538.

Fillmore, Charles J. 1985. Frames and the semantics of understanding. *Quadernie di Semantica* 2(6), 222–254.

Fillmore, Charles J. and Baker, Colin. 2010. A Frames Approach to Semantic Analysis. In B. Heine and H. Narrog (eds.), *The Oxford Handbook of Linguistic Analysis*, pages 313–340, Oxford: Oxford University Press.

Fillmore, Charles J. and Kay, Paul. 1996. Construction Grammar Coursebook, unpublished manuscript, UC Berkeley.

Fillmore, Charles J., Lee-Goldman, Russell R. and Rhomieux, Russell. 2012. The FrameNet construction. In Hans Boas and Ivan A. Sag (eds.), *Sign-Based Construction Grammar*, Stanford: CSLI Publications.

Fodor, Janet D. and Sakas, William. 2001. The structural triggers learner. *Language acquisition and learnability* pages 172–233.

Gazdar, Gerald. 1982. Phrase structure grammar. In Pauline Jacobson and Geoffrey K. Pullum (eds.), *The Nature of Syntactic Representation*, pages 131–186, D. Reidel, Dordrecht, Netherlands.

Ghomeshi, Jila, Jackendoff, Ray, Rosen, Nicole and Russell, Kevin. 2004. Focus reduplication in English (the salad-salad paper). *Natural Language and Linguistic Theory* 22, 307–357.

Ginzburg, Jonathan and Sag, Ivan A. 2000. *Interrogative Investigations: the form, meaning and use of English interrogative constructions*. Stanford: CSLI Publications.

Goldberg, Adele E. 1995. *Constructions: A Construction Grammar Approach to Argument Structure*. Chicago: University of Chicago Press.

Goldberg, Adele E. 2006. *Constructions at Work: the nature of generalization in Language*. Oxford: Oxford University Press.

Goldberg, Adele E. 2009. Constructions Work. *Cognitive Linguistics* 20(1), 201–224.

Goldberg, Adele E. in press. *Explain me this: Creativity, Competition, and the Partial Productivity of argument structure constructions*. Princeton University.

Hagoort, P. 2003. Interplay between syntax and semantics during sentence comprehension: Erp effects of combining syntactic and semantic violations. *Journal of cognitive neuroscience* 15, 883–899.

Hagoort, P. 2005. On broca, brain, and binding: a new framework. *Trends in Cognitive Sciences* 9, 416–423.

Harris, Zellig S. 1951. Methods in Structural Linguistics .

Haspelmath, Martin. 2007. Pre-established categories don't exist: consequences for language description and typology. *Linguistic Typology* 11(1), 119 – 132.

Hawkins, John A. 2004. *Efficiency and Complexity in Grammars*. Oxford.

Hoffman, Thomas and Trousdale, Graeme. 2013. *The Handbook of Construction Grammar*. Oxford University Press.

Inkelas, Sharon and Zoll, Cheryl. 2005. *Reduplication: Doubling in morphology*. Cambridge: Cambridge University Press.

Jackendoff, Ray. 2010. The Ecology of English Noun-Noun Compounds. In *Meaning and the Lexicon: The Parallel Architecture, 1975–2010*, pages 413–451, Oxford University Press.

Jackendoff, Ray and Audring, Jenny. 2014. Relational Morphology in the Parallel Architecture. The Oxford Handbook of Morphological Theory, Oxford University Press.

Jackendoff, Ray S. 2002. *Foundations of Language: Brain, meaning, grammar, evolution*. Oxford University Press.

Johnson, David and Lappin, Shalom. 1999. *Local Constraints vs Economy*. Stanford Monongraphs in Linguistics, Stanford: CSLI Publications.

Kathol, Andreas. 2000. *Linear Syntax*. Oxford University Press.

Kay, Paul. 2002. An informal sketch of a formal architecture for construction grammar. *Grammars* 5, 1–19.

Kay, Paul and Fillmore, Charles J. 1999. Grammatical Constructions and Linguistic Generalizations: the *What's X Doing Y?* Construction. *Language* 75(1), 1–33.

Kay, Paul and Michaelis, Laura A. 2016. A few words to do with multiword expressions. In C. Condoravdi and T. Holloway King (eds.), *Festschrift for Lauri Karttunen*, Stanford: CSLI Publications.

Kay, Paul and Zimmer, Karl. 1990. On the semantics of compounds and genitives in English. In S. L. Tsohatzidis (ed.), *Meanings and Prototypes*, London: Routledge.

Koenig, J.-P. 1999. *Lexical Relations*. CSLI Publications, Stanford.

Koenig, Jean-Pierre and Davis, Anthony. 2003. Semantically Transparent Linking in HPSG. In Stefan Müller (ed.), *Proceedings of the HPSG-2003 Conference, Michigan State University, East Lansing*, pages 222–235, Stanford: CSLI Publications.

Langacker, Ronald W. 1987. *Foundations of Cognitive Grammar, Volume 1: Theoretical Prerequisites*. Stanford CA: Stanford University Press.

Lee-Goldman, Russell. 2011. *Context in Constructions*. Ph.d. dissertation, University of California, Berkeley.

Liu, Xiling, Somel, Mehmet, Tang, Lin, Yan, Zheng, Jiang, Xi, Guo, Song, Yuan, Yuan, He, Liu, Oleksiak, Anna, Zhang, Yan, abd Yuhui Hu, Na Li, Chen, Wei, Qiu, Zilong, Pääbo, Svante and Khaitovich, Philipp. 2012. Extension of cortical synaptic development distinguishes humans from chimpanzees and macaques. *Genome Research* 22(4), 611 – 622.

Marcus, Garry F. and Fisher, Simon E. 2003. FOXP2 in focus: What can genes tell us about speech and language? *Trends in Cognitive Sciences* 7, 257–262.

Marcus, Gary F. 2001. Plasticity and nativism: Towards a resolution of an apparent paradox. In S. Wermter, J. Austin and D. Willshaw (eds.), *Emergent neural computational architectures based on neuroscience*, pages 368 – 382, Springer-Verlag.

Marr, David. 1982. *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. New York: Freeman.

Masini, Francesca and Thornton, Anna M. 2008. Italian VeV lexical constructions. In Angela Ralli, Geert Booij, Sergio Scalise and Athanasios Karasimos (eds.), *On-line Proceedings of the 6th Mediterranean Morphology Meeting (MMM6)*, pages 146–186.

McCawley, James D. 1968. Concerning the base component of a transformational grammar. *Foundations of Language* 4(1), 55–81, reprinted in *Meaning and Grammar*, 35–58. New York, NY: Academic Press (1976).

Michaelis, Laura. 2003. Headless Constructions and Coercion by Construction. In E. J. Francis and L. A. Michaelis (eds.), *Mismatch: Form-Function Incongruity and the Architecture of Grammar*, pages 259–310, Stanford: CSLI Publications.

Michaelis, Laura. 2012. Making the Case for Construction Grammar. In Hans Boas and Ivan A. Sag (eds.), *Sign-Based Construction Grammar*, pages 31–69, Stanford: CSLI Publications.

Müller, Stefan. 2005. Resultative Constructions: Syntax, World Knowledge, and Collocational Restrictions: Review of Hans C. Boas: A Constructional Approach to Resultatives. *Studies in Language* 29(3), 651–681.

Newmeyer, Frederick J. 2004. Against a parameter-setting approach to typological variation. In Pierre Pica, Johan Rooryck and Jeroen Van Craenenbroeck (eds.), *Linguistic Variation Yearbook*.

Newmeyer, Frederick J. 2005. *Possible and Probable Languages: A Generative Perspective on Linguistic Typology*. Oxford University Press.

Reape, Mike. 1994. Domain Union and Word Order Variation in German. In John Nerbonne, Klaus Netter and Carl J. Pollard (eds.), *German in Head-Driven Phrase Structure Grammar*, pages 151–197, CSLI Lecture Notes, number 46. Stanford: CSLI Publications.

Ruppenhofer, Josef and Michaelis, Laura A. 2014. Frames and the Interpretation of Omitted Arguments in English. In S. Katz Bourns and L. Myers (eds.), *Linguistic Perspectives on Structure and Context: Studies in Honor of Knud Lambrecht*, pages 57–86, Amsterdam: Benjamins.

Sag, Ivan A. 1997. English relative clause constructions. *Journal of Linguistics* 33(2), 431–484.

Sag, Ivan A. 2010. English filler-gap constructions. *Language* 86(3), 486–545.

Sag, Ivan A. 2012. Sign-Based Construction Grammar: An informal synopsis. In Hans Boas and Ivan A. Sag (eds.), *Sign-Based Construction Grammar*, pages 69 – 202, Stanford: CSLI Publications.

Shieber, Stuart M. 1986. *An Introduction to Unification-Based Approaches to Grammar*. volume 4 of CSLI Lecture Notes Series. Center for the Study of Language and Information, Stanford, CA.

Steels, Luc. 2011. *Design Patterns in Fluid Construction Grammar*. John Benjamins, Amsterdam.

Steels, Luc and Beule, Joachim De. 2006. Unify and Merge in Fluid Construction Grammar. In P. Vogt and et al. (eds.), *Symbol Grounding and Beyond: Proceedings of the Third International Workshop on the Emergence and Evolution of Linguistic Communication*, Lecture Notes in Computer Science, pages 197–223, Springer.

Stefanowitsch, Anatol and Gries, Stefan T. 2005. Covarying collexemes. *Corpus Linguistics and Linguistic Theory* 1(1), 1–43.

Traugott, Elizabeth Closs and Trousdale, Graeme. 2014. *Constructionalization and Constructional Changes*. Oxford University Press.

Trueswell, John C. and Kim, Albert E. 1998. How to prune a garden path by nipping it in the bud: Fast priming of verb argument structure. *Journal of Memory and Language* (39), 102–123.

Vargha-Khadem, F., Watkins, K., Alcock, K., Fletcher, P. and Passingham, R. 1995. Praxic and nonverbal cognitive deficits in a large family with a genetically transmitted speech and language disorder. *Procedures of the National Academy of Science USA* 92, 930–3.

Wechsler, Stephen. 1995. Preposition Selection Outside the Lexicon. In Raul Aranovich, William Byrne, Susanne Preuss and Martha Senturia (eds.), *Proceedings of the Thirteenth West Coast Conference on Formal Linguistics*, pages 416–431, Stanford, CA: CSLI Publications.

Wetta, Andrew. 2014. *Construction-based Approaches to Flexible Word Order*. Ph. D.thesis, Ph.D. thesis, University at Buffalo.