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Cooperating constructions

Robert Malouf

1.1 Introduction

Optimality theoretic (OT) syntax (Dekkers et al. 2000, Legendre et al. 2000, Sells 2001) is an important development in the world of constraint based grammar, because it introduces a new way of looking at constraint interactions. The leading idea is that not all constraints are "surface true" – constraints may be violated when they have to be in order to satisfy some more important, higher ranking constraint. This opens up an interesting new way of looking at mismatch phenomena. A mismatch arises when a constraint imposing 'match', a correspondence between grammatical modules or levels, must be violated in order to satisfy some higher ranking module internal constraints.

OT also suggests a natural way for integrating functional motivations into formal theories of grammar. If the constraints are appropriately grounded in functional considerations, then an OT grammar is the consequence of finding a balance among various competing communicative drives. Cases of mismatch that arise out of this competition can be seen as a direct outcome of conflicting functional pressures.

Unfortunately, however, the fit between OT and constraint based grammar is not entirely comfortable. Informally, one can sketch the logic of OT constraint interaction as follows (Prince and Smolensky 1993). First, start with a partial representation of an utterance (say, something like logical form). From this partial representation, generate the complete (usually infinite) set of possible complete representations that can be built from the input. Next, evaluate each of these candidate representations with respect to the highest ranked constraint, and eliminate any

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candidates which violate it from consideration. The competition among representations continues until one least deviant representation is found, and this winner is then declared a grammatical part of the language. The grammar consists of a set of basic representations, a procedure for generating complete representations, and a ranked set of constraints.

This view of grammar is in stark contrast to the approach developed among various convergent constraint based theories of grammar such as Head-Driven Phrase Structure Grammar (Pollard and Sag 1994, Sag and Wasow 1999), Construction Grammar (Zwicky 1994, Goldberg 1995, Kay and Fillmore 1999), Word Grammar (Hudson 2000, Hudson this volume), and in its basic outlines, Cognitive Grammar (Langacker 1987). Under this alternative view, the grammar of a language is a declarative set of constraints, organized into a network, which mutually constrain the relationship between form and meaning. Each grammatical representation, rather than being the winner of Darwinian competition among rival competitors, is licensed by a set of constructions which cooperate to specify its properties.

One of the underlying motivations of this approach to grammar has been to develop a psychologically plausible and computationally tractable theory of grammatical competence. That is, the goal is to develop a theory of grammar which at a minimum is compatible with what we know about human sentence processing, which places no unwarranted constraints on the way grammatical information can be processed, either by people or by machines, and which does not require language users to perform any psychologically implausible operations.

To this end, the grammar is seen as a purely static, purely declarative set of constraints which impose no inherent bias towards production or comprehension and are compatible with a wide range of processing strategies. Since utterances are licensed by the simultaneous satisfaction of a number of constraints, this view fits easily with the results from studies on human sentence processing that indicate that people integrate information from a wide range of sources, some grammatical and some extra-grammatical, in real time. For example, compare the well-known pair:

(1) a. The horse raced past the barn fell.
    b. The landmine buried in the sand exploded.

While these two sentences have the same structure, one lends itself to a garden path reading while the other does not. This suggests that that language is processed incrementally, with syntactic, semantic, encyclopedic, and even frequency information being continuously integrated.

A related trend which has emerged in the various constraint based grammar formalisms is an avoidance of procedural or derivational metaphors. Besides allowing incremental processing, a declarative specification of grammatical constraints frees the framework from a bias towards either language production or language comprehension. This has clearly desirable consequences for both human and computational language processing. The declarative nature of constraint based grammars is in opposition to traditional generative grammar, which defines a procedure for producing grammatical sentences. OT, which offers a procedure for selecting a least-marked surface form corresponding to a given meaning, shares this property of generative grammar, and is difficult to reconcile with an integrated, bidirectional view of language processing (Smolensky 1996, Tesar 2000).

With an eye to psycholinguistic neutrality, constraint based grammar formalisms have also been constructed with a very basic notion of constraint locality: constraints should be local in the sense that whether a candidate satisfies the constraint can be determined by looking at that structure alone. There should not be any transderivational or transstructural constraints that require looking at other, competing structures to determine the validity of a structure. Clearly, constraints in OT are in this sense radically non-local.

So, what do we make of this conflict? On the one hand, OT seems to offer an exciting direction for exploring mismatch phenomena in constraint based grammar formalisms. On the other hand, the procedural metaphor and transderivational constraint evaluation that underlie OT would seem to make it incompatible with the developing consensus on what constraint based grammar formalisms should look like.

Given this dilemma, there are (at least) three reasonable responses. The first response is to simply set it aside. After all, a procedural metaphor is just a metaphor. All theories of linguistic competence, constraint based or otherwise, make crucial reference to a wide range of constructs and operations, many of which have fairly dubious claims to psychological reality. So, perhaps, the best way to reconcile constraint based formalisms with OT is to set aside these methodological assumptions, and to integrate the representations of constraint grammar with the constraint logic of OT. Examples of this approach include Bresnan (2000) and Choi (1999), who augment the basic architecture and representations of Lexical-Functional Grammar with an OT-style competition model of constraint interaction.

The second strategy for resolving this conflict between OT and constraint based frameworks is to take the procedural metaphor of OT seriously, but to try to adapt it to a realistic model of human linguistic performance. Boersma (1998) and Tesar and Smolensky (2000) include promising steps in that direction. It remains to be seen however what form this 'realistic OT' will ultimately take, or how well these results can be integrated with more mainstream results in OT syntax.

Finally, I will argue here for a third approach which adapts some of the strengths of OT analyses to existing constraint based frameworks. After all, both OT and constraint based grammar view language as the product of interacting constraints, so it should in principle be possible to express the key insights of OT analyses without adopting a procedural metaphor.

The basic question any approach needs to answer is: why are some forms allowed to violate some constraints? Or, put another way, why do some constraints not apply to some forms? In the lexical domain, there are a number of different possible solutions. The most primitive would be to simply list all forms, along with the constraints which apply to them. While this would not be a very satisfying solution, it shows that a constraint interaction regime is not strictly necessary for representing lexical information.

For lexical representations, the approach taken in constraint based grammars is to list the existing forms (with redundancies captured by lexical rules or related devices), but with constraints organized into a network or hierarchy to express generalizations at the appropriate level of generality. In this view, the environment of a form in the network determines which constraints must apply to it.

For phrasal constructions, however, this will not work. We cannot list all phrases or utterances of a language, whether or not they are organized into a hierarchy. But, we can list all of the patterns which utterances follow. Each grammatical sentence is licensed by one or more constructions, and constructions are mutually constrained by the different parts of the grammar. So, while we cannot list actual forms, each form corresponds to some collection of constructions acting in concert, and we can list constructions, using the techniques of lexical representation.

The effect of this approach is that conflicts among constraints are resolved at the level of the construction, not the level of the form. For any given construction, we can determine which constraints it satisfies and which it violates, and the relationship between the construction and the forms which it licenses is completely straightforward.

In the following sections, I will outline some of the particulars of constraint interaction in one constraint based framework, Head-Driven Phrase Structure Grammar. Furthermore, I will show how these frameworks that approach constraint interaction as a matter of constructions cooperating to license a particular form can capture the kinds of generalizations that have been used to motivate frameworks that appeal to a competition among forms.

1.2 Head-Driven Phrase Structure Grammar

While there is broad agreement among constraint based grammar formalisms with respect to a number of methodological principles and the general architecture of the grammar, different theories differ dramatically in the particular representations they assume. For concreteness, I will adopt the specifics of Head-Driven Phrase Structure Grammar (HPSG) without loss of generality.

In HPSG, the basic formal device used to represent everything is the typed feature structure, and the basic notation for a feature structure is the attribute value matrix or AVM. We can think of an AVM as a description which picks out a set of satisfiers from a universe of abstract objects. These abstract objects correspond to linguistic objects, namely utterance types, and are what the linguistic theory is about. The theory itself is not made up of actual feature structures but of feature structure descriptions, which place constraints on the range of allowable utterance types.

In addition to pairs of features and values, we assign each feature structure a type, where types group feature structures into classes. Types themselves are organized into a multiple-inheritance hierarchy which expresses subtype relations between types. The type hierarchy, along with appropriateness conditions which state what features an object of a given type may have, make up a type signature.

Roughly following Bouma, et al. (2001), the basic feature architecture is given in (2):

(2)
$$\left[\begin{array}{ll} \textit{sign} & \\ \text{PHON} & \textit{phon} \\ \text{SYNSEM} & \left[\begin{array}{ll} \textit{synsem} & \\ \text{LOCAL} & \left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \textit{head} \\ \text{VAL} & \left[\begin{array}{ll} \text{SPR} & \text{list}(\textit{synsem}) \\ \text{COMPS} & \text{list}(\textit{synsem}) \end{array}\right] \\ \text{DEPS} & \text{list}(\textit{synsem}) \\ \text{ARG-ST} & \text{list}(\textit{synsem}) \end{array}\right] \\ \text{CONT} & \textit{cont} \end{array}\right] \\ \text{GAP} & \text{set}(\textit{loc}) \end{array}\right] \end{array}\right]$$

Each structure in square brackets is an AVM, a matrix of feature names and values. Feature names are in ALL CAPS and type names are in *italics*.

The value of a feature can either be another AVM or it can be an atomic feature structure (indicated by a type name). The types list(α) and set(α) are parametric polymorphic types which represent a list of objects of type α and a set of objects of type α, respectively.

Using this metalanguage, we can start laying out the basic linguistic ontology we will need. First, the most basic linguistic unit is the *sign*, a pairing of a form with a meaning. Signs have two features, PHON and SYNSEM, corresponding to the two poles. At the coarsest level, we can divide signs into two kinds, *word*s and *phrase*s.

The lexicon consists of objects of type *word*, organized into a hierarchy of types and subtypes. Phrases differ from words in that they have internal structure and are built up out of smaller linguistic units (either words or other phrases). So, we can say that *phrases* have an additional feature DTRS, which takes as its value a list of signs. The inventory of constructions are all subtypes of the type *phrase*.

While considerable work in HPSG has focused on examining the hierarchical structure of the lexicon (e.g., Flickinger (1987)), more recent work, including Sag (1997) and Malouf (2000b), has investigated applying the same methods of hierarchical classification to types of phrasal signs, or constructions, building on the insights of Construction Grammar (Fillmore 1985, Fillmore et al. 1988, Goldberg 1995, Fillmore 1999, Kay and Fillmore 1999).

Phrases can be divided into two types: endocentric *headed* phrases and exocentric *non-headed* phrases. Since syntactic constraints are stated as constraints on particular types of signs, the Head Feature Principle can be represented as (3), a constraint on all signs of the type *headed.*

(3) $$\textit{headed} \rightarrow \begin{bmatrix} \text{HEAD} & \boxed{1} \\ \text{HD-DTR} & \begin{bmatrix} \text{HEAD} & \boxed{1} \end{bmatrix} \end{bmatrix}$$

This type constraint can be interpreted as an implication. Anything that is either of type *headed* or some more specific type must satisfy the given constraint. Boxed numbers, or tags, indicate structure sharing, so this constraint means that the HEAD value of a phrase is token-identical to the HEAD value of its head daughter.

Headed phrases are in turn classified by the kind of grammatical dependency expressed by the construction, either non-locally in an unbounded dependency construction, or locally according to type of subcategorization dependency they discharge (specifier or complement). The Valence Principle can be formalized as a constraint on headed constructions as follows, if we define '$-$' in terms of Reape's (1994) domain union operator '$\bigcirc$': $X - Y = Z \leftrightarrow Y \bigcirc Z = X$:

(4) *headed* $\rightarrow$

$$\begin{bmatrix} \text{SYNSEM}\,|\,\text{CAT}\,|\,\text{VAL} & \begin{bmatrix}\text{SPR} & \boxed{2} - \langle\boxed{1}\rangle \\ \text{COMPS} & \boxed{3} - \langle\boxed{1}\rangle\end{bmatrix} \\ \text{HD-DTR}\,|\,\text{SYNSEM}\,|\,\text{CAT}\,|\,\text{VAL} & \begin{bmatrix}\text{SPR} & \boxed{2} \\ \text{COMPS} & \boxed{3}\end{bmatrix} \\ \text{NON-HD-DTR}\,|\,\text{SYNSEM} & \boxed{1} \end{bmatrix}$$

Individual constructions place constraints on the non-head daughter, but do not need to mention the valence of the mother:

(5) *head-comp* $\rightarrow$

$$\begin{bmatrix} \text{HD-DTR}\,|\,\text{COMPS} & \langle\boxed{1}\,|\,\boxed{2}\rangle \\ \text{NON-HD-DTR}\,|\,\text{SYNSEM} & \boxed{1} \end{bmatrix}$$

This constraint ensures that undischarged valence requirements get propagated from the head of a phrase. In the case of, say, a head-modifier phrase, the non-head daughter 1 will not be a member of the SPR or COMPS value of the head, and so the valence values will be passed up unchanged. In the case of, say, a head-complement phrase, 1 will be on the head's COMPS list 3, so the mother's COMPS value is the head's COMPS value minus the discharged complement.

In addition to the valence features, two additional features specify the dependents that a head can occur with. The ARG-ST feature lists the dependents which are semantically selected for by the head; these are the direct arguments of the head and are coindexed with semantic roles in the head's CONT. The DEPS list, on the other hand, lists all the syntactic dependents of the head. In the simplest case, the DEPS list is identical to the ARG-ST. However, the Argument Structure Extension principle allows any number of modifiers to be added to the DEPS list, with the appropriate semantic consequences:

(6) Argument Structure Extension:
verb $\rightarrow$

$$\begin{bmatrix} \text{HEAD} & \boxed{3} \\ \text{DEPS} & \boxed{1} \oplus \textsf{list}\left(\begin{bmatrix}\text{MOD}\begin{bmatrix}\text{HEAD} & \boxed{3} \\ \text{KEY} & \boxed{2}\end{bmatrix}\end{bmatrix}\right) \\ \text{ARG-ST} & \boxed{1} \\ \text{CONT}\,|\,\text{KEY} & \boxed{2} \end{bmatrix}$$

Each adjunct is constrained to modify the semantic content of the head, but nothing is said about the particular relation introduced by the adverbial phrases. In English, the content of the modifier is introduced in the lexical entry of the preposition or adverb that heads the modifier, so there is no need for Argument Structure Extension to say anything about the content of the modifier. In some languages with semantic case, semantic cases behave very much like morphologically bound prepositions, while in other languages the relationship is more complex (Bratt 1996, Tseng 1999, Malouf 2000a).

Members of a head's DEPS list, either arguments or adjuncts, can either be realized locally as a subject or a complement by means of the head's valence features, or non-locally via the GAPS feature. The Argument Realization Principle governs this:

(7) Argument Realization:

$$word \Rightarrow \left[\text{SYNSEM}\,|\,\text{LOCAL}\,|\,\text{CAT} \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SPR} & \boxed{1} \\ \text{COMPS} & \boxed{2} \ominus \text{list(gap-ss)} \end{bmatrix} \\ \text{DEPS} & \boxed{1} \oplus \boxed{2} \end{bmatrix}\right]$$

The first dependent is realized as the subject, while additional dependents can be realized either as a complement or as a gap. Gap synsems (objects of type *gap-ss*) introduce dependencies onto the head's GAP list which must eventually be expressed by a corresponding phrase in an unbounded dependency construction.[1]

In addition to the classification of phrase by the type of dependency expressed, constructions inherit constraints from the cross-cutting classification of phrases into either *clause*s or *non-clause*s. Among other things, clauses are subject to the following constraint:

(8) *clause* →

$$\left[\text{SYNSEM}\,|\,\text{LOCAL} \begin{bmatrix} \text{CAT}\,|\,\text{VAL}\,|\,\text{SPR} & \text{list}(\textit{non-canonical}) \\ \text{CONT} & \textit{psoa} \end{bmatrix}\right]$$

This constraint states that the SPR list of a clause must be a list of zero or more *non-canonical* synsem objects. This ensures that either the clause contains an overt subject (and so the SUBJ list is empty) or the unexpressed subject (e.g., in control constructions) is either a PRO or a *gap-ss*. PRO is a special type of synsem object whose purpose is

[1]For a more thorough explication of unbounded dependency constructions in HPSG, see Bouma, et al. (2001) and Ginzburg and Sag (2001).

only to put constraints on the argument structure of a verb in a control structure, and it does not correspond to a phonologically unrealized position in the phrase structure. *Gap-ss* is a synsem object whose GAP set contains its LOCAL value as a member. In addition, the constraint in (8) restricts the semantic type of a clause's content: the CONT value of a clause must be a *psoa* object (roughly speaking, an event).

These two hierarchies define a set of constraints on phrasal signs. Since a construction licenses a type of complex sign, it must include information about how both the form and the meaning are assembled from the form and the meaning of its component parts. A construction may inherit some aspects of its meaning from its supertypes. In contrast to the strictly head-driven view of semantics presented by Pollard and Sag (1994), a construction may also have idiosyncratic meaning associated with it.

1.3 Word order in San Dionicio Zapotec

The framework sketched in the previous section provides a basis for a general construction-oriented model of constraint interaction which has been applied to a wide variety of problems involving an apparent mismatch between grammatical levels of description: West Greenlandic noun incorporation (Malouf 1999), English verbal gerunds (Malouf 2000b), English auxiliary contraction (Bender and Sag 2000), and English *do* support (Sag 2000), among many others.

With this background, the abstract discussion of the first section may become clearer with a concrete example. Broadwell (1999a, 1999b, 2001) discusses a challenging construction in San Dionicio Zapotec (SDZ), an Otomanguean language spoken in Oaxaca, Mexico. As Broadwell argues, consideration of this construction leads naturally to a model of constraint interaction based on competition among forms. However, I will argue that a constructional model can account for the facts of SDZ at least as well as a competition model, while preserving the methodological desiderata alluded to in section 1.

1.3.1 Broadwell's OT analysis

First, some background: SDZ is generally head initial, and as one would expect in such a language the verb precedes its dependents, prepositions precede their objects, and nouns precede their specifiers. Within the clause, subject NPs precede object NPs, which in turn precede adjuncts (examples are drawn from Broadwell (1999b)):

(9) Ù-díny	Juààny	bèh'cw	re'	cùn	yàg
COM-hit	John	dog	that	with	stick

'John hit that dog with a stick.'

We can account for these word order facts with a number of linear precedence constraints:

(10)	Comp final:	H $\prec$ Comp
	Spec final:	H $\prec$ Spec
	Obliqueness:	Subj $\prec$ Obj $\prec$ Adj

Along side the unmarked word order seen in (9), SDZ also allows a single constituent to be fronted to a preverbal topic or focus position, given the appropriate discourse context:

(11) a. Juààny ù-díny bèh'cw cùn yàg
John com-hit dog with stick
'*John* hit the dog with a stick.'

b. Bèh'cw ù-díny Juààny cùn yàg
dog com-hit John with stick
'John hit the *dog* with a stick.'

In most cases, this marked word order is optional. However, in the case of *wh* questions, fronting of the *wh* word is obligatory:

(12) a. ¿Túú ù-díny Juààny cùn yàg?
what.anim com-hit John with stick
'What did John hit with a stick?'

b. *¿Ù-díny Juààny túú cùn yàg?
com-hit John what.anim with stick

If we assume that constituent fronting is always an option, then we can account for the contrast in (12) by means of an additional constraint:

(13) Wh initial: A *wh* word must be sentence initial.

To this point, the facts about SDZ are completely unsurprising, and can easily be accounted for by any reasonable approach to word order and extraction.

Things get more interesting, however, when we look at what happens if the questioned element is not itself an argument of the verb but is embedded inside another constituent. When the *wh* element is not the head of the fronted constituent, the constraints in (10) and (13) come into conflict, and the conflict is resolved in favor of the constraint in (13). That is, the general constraints on word order in (10) relaxed just in case they come into conflict with the stronger constraint on *wh* elements in (13).

For example, when the object of a preposition is a *wh* word, the constraints requiring the *wh* word to occur sentence initially come into conflict with the constraint requiring a proposition to precede its object. The result is that only the former constraint applies, and the result is obligatory 'pied piping with inversion':

(14) a. ¿Xhíí cùn ù-díny Juààny bèh'cw?
what with COM-hit John dog
'What did John hit the dog with?'

b. *¿Cùn xhí ù-díny Juààny bèh'cw?
with what COM-hit John dog

c. *¿Xhí ù-díny Juààny bèh'cw cún?
what COM-hit John dog with

d. *¿Ù-díny Juààny bèh'cw cún xhí?
hit John dog with what

The entire PP is fronted, but the expected order of elements within the PP is reversed.

When we look at the location of specifiers with the noun phrase, we see a similar pattern. Specifiers normally follow the head noun, following (10):

(15) a. Juààny cù'á x-pèh'cw Màríí
John COM.grab POSS-dog Mary
'John grabbed Mary's dog.'

b. *Juààny cù'á Màríí x-pèh'cw
John COM.grab Mary POSS-dog

When the specifier is a *wh* word, however, the entire NP is fronted but the the order is inverted:

(16) a. ¿Túú x-pèh'cw cù'á Juààny?
who POSS-dog COM.grab John
'Whose dog did John grab?'

b. *¿X-pèh'cw túú cù'á Juààny?
POSS-dog who COM.grab John

c. *¿Túú cù'á Juààny bèh'cw?
which COM.grab John POSS-dog

Again, pied piping is obligatory, but the usual head-initial word order is inverted, placing the *wh* word in sentence initial position.

		Const	Wh-init	C-final	S-final
	Prep N		*!		
☞	N Prep			*	
	N	*!			
	in situ		*!		

FIGURE 1 Pied piping with inversion

Broadwell's observation is that, while this pied piping with inversion is rather puzzling if we assume a movement-based analysis of *wh* questions, it actually falls out quite naturally given an Optimality Theoretic view of constraint interactions. Suppose SDZ is subject to the following undominated constraint:

(17) Constituency: A dependent of a verb must form a constituent.

This constraint rules out stranding of prepositions and nouns and accounts for the ungrammaticality of (14c) and (16c). The word order inversion follows then if we assume the constraints are ranked as in (18).

(18) Constituency ≫ Wh initial ≫ Comp final, Spec final

Since Constituency is ranked highest (it is, in fact, undominated), any sentence which violates it will be ruled out and thus pied piping is obligatory. The constraints Comp final and Spec final are ranked lowest,[2] so they will be violable just in case a violation would be necessary to satisfy a higher constraint. In particular, either constraint could be violated if doing so would then allow Wh initial to be satisfied. This is what both allows and requires the inversion seen in (14a) and (16a). A tableau showing the constraint interactions which yield the pattern in (14) is shown in Figure 1.

1.3.2 A constructional alternative

As Broadwell shows, the properties of the SDZ pied piping with inversion construction discussed above fall out naturally from a competition model of constraint interaction. However, this is not to say that a competition model is required in order to account for these facts. Indeed, from a constructional point of view, default inheritance allows us to capture the same intuitions in a purely declarative constraint based formalism.

For constraint based frameworks, the grammar is a network of construction types which specify the inventory of combinatoric patterns

[2] We will return to their relative ordering in §1.3.3.

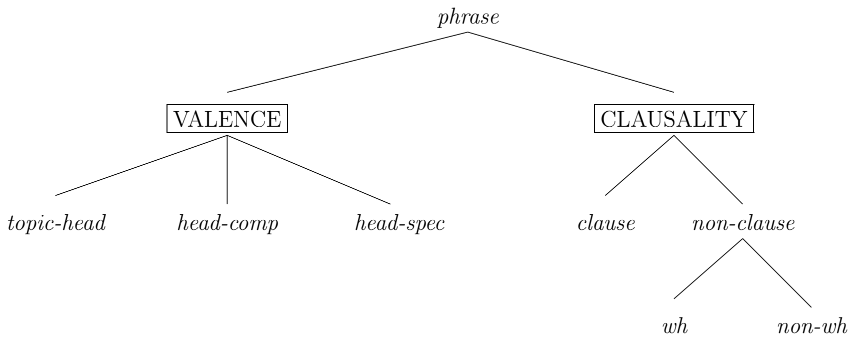


FIGURE 2 A hierarchy of construction types

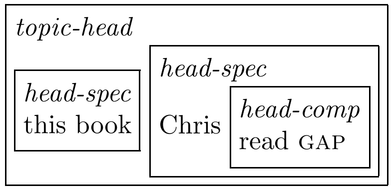
allowed by the language. These constructions are subject to constraints which specify their syntactic, semantic, and pragmatic properties. Some of these constraints specify idiosyncratic properties of individual constructions, but many constraints apply generally to broad class of constructions. In order to capture these generalizations, constructions are organized into an inheritance hierarchy.

A partial hierarchy of construction types for SDZ is given in figure 2. Phrasal constructions are classified along two orthogonal dimensions. The first dimension expresses the type of the syntactic dependency between the daughters, and the second indicates whether or not one of the daughters is a *wh* word.

While the constraints on SDZ *wh* constructions are language particular, the inventory of dependency types expressed by the VALENCE dimension are in no way specific to SDZ, and are common to most (if not all) languages. Instances of the *head-comp* construction type, which combine a head with its complements, include prepositional phrases and verb phrases, while noun phrases and finite clauses (in English) are instances of the *head-spec* (head/specifier) construction type .

Left dislocation constructions, such as topicalization and *wh* questions, are instances of the *topic-head* construction type. This construction type combines a clause with a GAP-SS on its DEPS list with an extra dependent that satisfies the constraints on the gap. For example, the English sentence *This book Chris read* might have the following structure:[3]

[3] Here we use the box notation familiar from Construction Grammar (Fillmore 1999, Kay and Fillmore 1999), which has a fairly direct mapping to both trees and feature structures.

(19) 

The *topic-head* construction combines the NP *this book* with the clause *Chris read* in such a way that the topic NP is linked with the argument structure position corresponding to the missing constituent in the main clause.

Using the construction types specified in the hierarchy in figure 2, we can state a few of the constraints that define the grammar of SDZ *wh* constructions:

(20) a. *phrase* → Head initial (default)
b. *topic-head* → Head final
c. *wh* → an immediate daughter is a *wh* word, which occurs initially
d. *non-wh* → No *wh* word

Here we mean "head" in the technical sense of the sign selecting for a dependent in a valency construction. These constraints are roughly equivalent to the constraints in (10) and (13).

The constraint on the type *phrase*, which requires that all phrases be head initial, is a default constraint. Default constraints on a supertype are inherited by all subtypes, unless overridden by a conflicting constraint on a more specific type. In particular, it is overridden by constraints on the types *topic-head* and *wh*, which deviate from the general head initial word order pattern found in most of the constructions in the language.

Note that in the construction hierarchy, specificity ordering plays the role that constraint ranking plays in Optimality Theory, but with an important difference. In constraint based formalisms, conflicts between constraints are resolved at the construction level, rather than at the utterance level.

The hierarchy in figure 2 defines a set of general construction types. In order to account for the details of SDZ grammar, we also need an inventory of specific constructions which SDZ sentences are instances of. The elaborated hierarchy in figure 3 can be derived if we posit a construction type which inherits from every possible combination of types in the two orthogonal dimensions in figure 2. The relationships indicated with dotted lines are completely predictable, and can be inferred

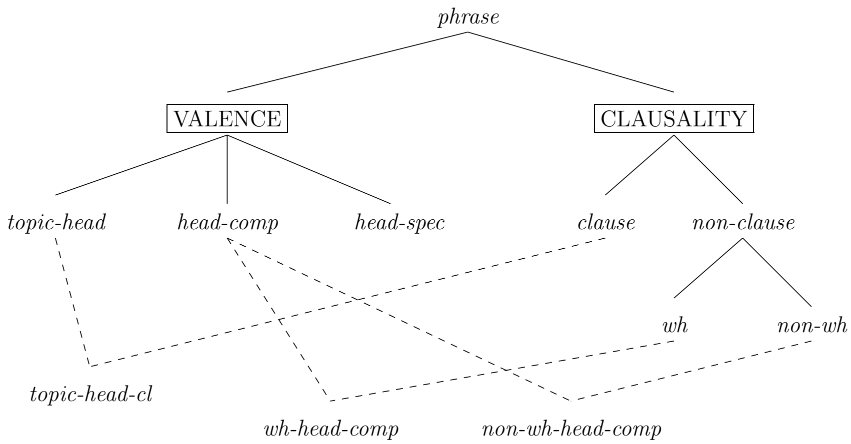


FIGURE 3 A partial elaborated hierarchy of construction types

via ON-LINE TYPE CONSTRUCTION (Koenig 1999). The completed hierarchy is in essence the result of taking the cross-product of the most specific types in the VALENCE and CLAUSALITY dimensions. Any types so constructed which would inherit conflicting non-default constraints are deleted, while conflicts between default constraints are resolved according to specificity.[4]

The completed inventory of constructions includes two constructions for expressing each of the basic dependency types, one for *wh* expressions and one for non-*wh* expressions. In the case of non-*wh* expressions, the constructions are uniformly head initial, with the exception of the *topic-head-cl* construction, which is uniformly head final. In the case of constructions which combine *wh* expressions, the word order is subject to the constraint (20c), which requires that the *wh* appear first in the phrase.

To see how these constructions interact to predict the behavior of SDZ *wh* constructions, consider the examples (11b) and (14a), repeated here:

(21) a. Bèh'cw ù-díny Juààny cùn yàg
dog COM-hit John with stick

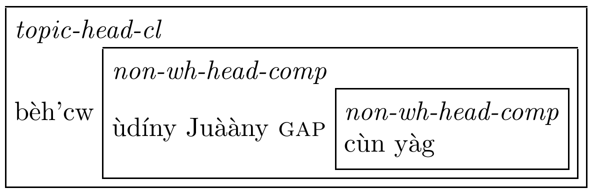
[4]Here I adopt the analysis of head-initial languages proposed by Borsley (1995), Wintner and Ornan (1996), and others, in which the verbal and nominal heads combine with subjects, possessors, and complements via a single application of a head/complement construction. Thus, language specific constraints on the syntax and semantics of head/specifier constructions drasticly limit their distribution in VSO languages like SDZ.

'John hit the *dog* with a stick.'

b. ¿Xhíí cùn ù-díny Juààny bèh'cw?
what with COM-hit John dog
'What did John hit the dog with?'

In (21a), the non-*wh* topic *bèh'cw* 'dog' combines with the main clause by means of the *topic-head-cl* construction, and fills the direct object role of main verb *ùdíny* 'hit'. The main clause itself is in this case an instance of the *non-wh-head-comp* construction, which in turn contains a prepositional phrase, which is itself an instance of the *non-wh-head-comp* construction:

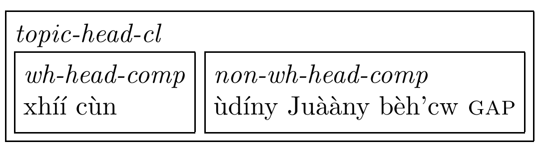
(22)



Since all of these phrases are instances of non-*wh* constructions, they are all head initial with the exception of the *topic-head* construction, which is always head final.

The structure of (21b) is very similar, with two important differences. The first is that the left-dislocated topic is a prepositional phrase which fills a modifier role in the main clause. The second is that the topic contains a *wh* word and so is an instance of the head-final *wh-head-comp* construction:

(23)



In this way, we can derive the 'pied piping with inversion' construction from an interaction of constraints in the type hierarchy.

While the analysis outlined in this section is similar in many respects to Broadwell's OT analysis, it is important to note that the two approaches differ radically in the logic of constraint interactions that they assume. In the case of OT, it is assumed that all possible forms are in competition with each other, with the least marked form surfacing. Thus the challenge is not to account for the grammaticality of the attested forms, but instead to account for the ungrammaticality of all non-attested forms. The mismatch between word order and syntactic structure seen in (14a) arises from the ungrammaticality of (14b) and other alternate expressions.

In the constraint based approach, on the other hand, the range of attested forms depend on the cooperation of the constructional resources available in the grammar of the language. If we see an apparent mismatch between two levels, it is because some construction requires it. Through the use of multiple default inheritance, the constraints on construction can be organized in such a way that the perhaps surprising properties of constructions like the *wh-head-comp* construction can be accounted for without stipulation.

1.3.3 A complication

Despite these differences, the analyses presented in the previous sections are quite similar in spirit and can both account for the word order of SDZ sentences containing a preposition or a specifier fronted by pied piping. However, when we look at sentences in which both a preposition *and* a specifier are fronted, the predictions of the two analyses diverge.

First, the facts. In a *wh* question where the *wh* element is the specifier of the object of a preposition, two possibilities are attested:

(24) a. ¿Cùn túú x-cyàg ù-dýny Juààny bèh'cw?
with whose POSS-stick COM-hit John dog
'With whose stick did John hit the dog?'

b. ¿Túú cùn x-cyàg ù-dýny Juààny bèh'cw?
whose with POSS-stick COM-hit John dog

c. *¿Túú x-cyàg cùn ù-dýny Juààny bèh'cw?
whose POSS-stick with COM-hit John dog

d. *¿X-cyàg túú cùn ù-dýny Juààny bèh'cw?
POSS-stick whose with COM-hit John dog

e. *¿Túú x-cyàg ù-dýny Juààny bèh'cw cùn?
whose POSS-stick COM-hit John dog with

In (24a), the usual head-specifier order is reversed and the *wh* element *túú* 'whose' appears phrase initially. The unmarked head-complement order in the prepositional phrase, however, is preserved. In (24b), the *wh* element is 'liberated' out of the object of the preposition and appears sentence initially.

So, how can we account for these facts? From an OT perspective, we do not need to explain why (24a) and (24b) are grammatical. We only need to explain why every other candidate is ungrammatical. When that is done, only (24a) and (24b) will remain as possible outputs.

	Const	C-&S-final	Const-θ	Wh-init	C-final	S-final
N Spec Prep				*	*!	
N Prep Spec			*	*!		
☞ Prep Spec N				*		*
Prep N Spec				**!		
Spec N Prep		*!				
☞ Spec Prep N			*			*
Spec N	*!					
Spec	*!					

FIGURE 4 Liberation out of object of prepositions

In order to rule out the other candidates, Broadwell introduces two new constraints:

(25) Constituency-θ: A dependent of a preposition must form a constituent.
Comp final & Spec final

The first constraint, a relative of the undominated constraint in (17), prohibits liberation or extraction of the object of a preposition. This constraint must be stated separately from (17) since, as we will see shortly, it is not undominated and in fact is violated by forms such as (24b).

The second constraint in (25) is not, strictly speaking, a new constraint. It is a conjunction of two constraints introduced earlier. However, by stating this compound constraint separately, Broadwell is able to rank the conjunction of the two constraints separately from either of the two constraints individually:

(26) Const $\gg$ Comp final & Spec final $\gg$ Const-θ, Wh initial $\gg$ Comp final $\gg$ Spec final

In this constraint ranking, the conjunction Comp final & Spec final is more highly ranked than either of the conjuncts. The effect of this is that a form that violates both Comp final and Spec final is more marked than a form that violates Const-θ, but a form that violates either conjunct individually is not. This is required to rule out (24c), which otherwise would be less marked than either of the attested orders. Finally, while Comp final and Spec final were unranked with respect to each other in (18), the ungrammaticality of (24d) shows that Comp final must be ranked higher than Spec final. (The complete tableau is given in figure 4.)

So, while the first version of Broadwell's OT analysis does not directly predict the pattern of grammaticality shown in (24), it is easily extended to cover these additional facts. This extension, however, significantly complicates the interaction among constraints, and calls into question the claim that the grammar consists of a set of simple constraints totally or partially ordered.

How does the constructional analysis fare in the face of this new data? The first order, [Prep Spec N], follows immediately given the inventory of constructions in figure 2. Under this analysis, the structure of (24a) would be:

(27) [*topic-head-cl* [*non-wh-head-comp* cùn [*wh-head-spec* túú xcyàg]] [*non-wh-head-comp* ùdíny Juààny bèh'cw GAP]]

The preposed PP is an instance of the head-initial *non-wh-head-comp* construction whose complement is an instance of the head-final *wh-head-spec* construction, and the observed falls out directly from the cooperation of these two construction types.

To account for the second possible order, we can appeal to the notion of ARGUMENT ATTRACTION proposed to account for similar phenomena in Germanic languages (Hinrichs and Nakazawa 1989, Hinrichs and Nakazawa 1990). Consider the lexical rule in (28).

(28)
$$\begin{bmatrix}\text{HEAD} & \textit{prep}\\ \text{COMPS} & \left\langle \boxed{1}\begin{bmatrix}\text{HEAD} & \textit{noun}\\ \text{VAL}\,|\,\text{SPR} & \langle\boxed{2}\textit{wh}\rangle\end{bmatrix}\right\rangle\end{bmatrix} \Rightarrow \begin{bmatrix}\text{HEAD} & \textit{prep}\\ \text{COMPS} & \langle\boxed{1},\boxed{2}\rangle\end{bmatrix}$$

This rule ensures that for every preposition which selects for a noun phrase complement, there is also a preposition which selects for a noun and for the *wh* specifier selected for by the noun. This is a lexical version of argument raising which has the effect of 'liberating' the noun's specifier so that it becomes a syntactic dependent of the preposition.

With this rule in place, the second attested order also follows directly given the proposed inventory of constructions. The structure of (24b) would be:

(29) [*topic-head-cl* [*wh-head-comp* túú [*non-wh-head-comp* cùn xcyàg]] [*non-wh-head-comp* ùdíny Juààny bèh'cw GAP]]

If we assume that the lexical entry for the preposition *cùn* 'with' has undergone the lexical rule in (28), then it selects for a noun and a specifier. First, it combines with its first complement, and this combination is an instance of the head-initial *non-wh-head-comp* construction. Next, this partially saturated phrase combines with the second complement, *túú* 'whose', via the head-final *wh-head-comp* construction, yielding the observed word order. Thus, with only a minimal modification, the constructional analysis can be adapted to account for the facts seen in (24).[5]

1.4 Conclusion

The complexities of word order in San Dionicio Zapotec provide a challenge to any grammatical framework, and at first glance they seem to fit most naturally into a model in which grammatical behavior is the product of competition among alternative linguistic forms. However, as the previous sections have attempted to show, these facts can also be very naturally accounted for in a purely declarative constraint based framework such as HPSG, using devices such as default inheritance hierarchies which have strong independent motivation.

In conclusion, it should be noted that there are two key differences between the constructional analysis and the OT analysis. First, while the inheritance hierarchy plays the role of the specificity ranking in OT, the use of a hierarchy does not require that the specificity ranking constitute a partial order. This may seem like one is giving up an important generalization. However, the appearance of parameterized constraints and conjoined constraints in Broadwell's analysis suggests that the requirement that the constraints form a partial order in OT is actually too strict a requirement.

Second, the lexical rule in (28) was added to the inventory of SDZ specifically to deal with the facts in (24). This may seem somewhat ad hoc, but in fact similar lexical rules have been proposed for many different constructions in a wide range of languages. A strength of constructional frameworks is that they are able to capture both broad generalizations and very specific details. After all, not *everything* in language needs to follow directly from the interaction of universal constraints. Default inheritance hierarchies let us represent both the major patterns of

[5] As an anonymous reviewer points out, these facts, like the corresponding phenomena in Germanic languages, would also be amenable to an analysis in terms of LINEARIZATION (Reape 1994, Kathol 2000). Under this view, 'liberation' involves composition of word order domains rather than argument structures. While this distinction is not important for the present discussion, it is likely that evidence analogous to the constituency data adduced by Kathol (1998) for German and Dutch could be used to argue for one of these two possible analyses over the other.

languages and the historical accidents equally well.

In addition, recall that we have only considered a small corner of SDZ syntax. Any analysis of pied piping will have to be compatible with the comprehensive grammar of the language. Since the effects of constructions are generally quite local, it seems likely that the constraint based analysis could be easily extended to cover a larger fragment SDZ grammar.

Finally, the construction-based analysis presented here captures the fundamental insight of the OT, that grammatical mismatch derives from compromises between conflicts among functionally motivated grammatical constraints. However, the basic mechanism of constraint interaction is default overriding and cooperation among constructions, rather than competition among full forms. It thereby preserves the goals of psycholinguistic plausibility that underlie constraint based grammars. In this respect, the analysis presented here is very similar to the default inheritance analysis offered by Hudson (this volume), though the two analyses differ in the particular grammatical constructs posited. This indicates that in fact a variety of different default overriding schemes could be applied to this problem, further strengthening the claim that competition is not a necessary feature of linguistic theory.

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