Comparative economy conditions in natural language syntax*

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Contents

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1 Intersentential constraints introduced

The most conceptually drastic change in natural language syntactic theory in recent years is the introduction of *economy conditions* (ECs). Although there is not a unified formal notion of *economy*, the intuition is that natural languages are governed by a general “less is more” principle. Those who take this seriously, and regard it not just as principle guiding the researcher but as something to be implemented directly in grammars, are often led to *comparative economy conditions* (comparative ECs), which select from a set of structures the most economical among them according to some criterion. Such conditions are associated with the Minimalist Program (MP), but they are found also in Optimality Theory (OT) and Lexical-Functional Grammar (LFG).[1] The following is a sample of the prominent works mentioning ‘economy’:

(1)
a. The Minimalist Program (MP): Chomsky 1995, Collins 1997, Fox 2000, Authier 1998, Merchant 2000, Collins 2001
b. Optimality Theory (OT): Grimshaw 2001
c. Lexical-Functional Grammar (LFG): Bresnan 2001, Dalrymple 2001a, Toivonen 2001

I stress that not all of the above authors have the same concept in mind for the term ‘economy’. In particular, the OT conception differs radically from the other two; see section 5 below and also Potts and Pullum 2002. But the intuition seems shared: the idea is that it is likely to prove fruitful to assume that principles minimize structures and operations along certain lines. These might, though they need not, correspond to minimality in other domains (logical, psychological, computational).

Comparative ECs are a special breed of transderivational constraint, of the sort proposed often in the 1970s. To remain theory-neutral, I refer to this larger class of constraints as *intersentential* constraints. The central formal property of intersentential constraints is that their evaluation is relative to a set of unconnected linguistic structures, ones not forming a natural discourse or even, in some cases, composed entirely of well-formed structures.

I believe that a model-theoretic framework is required for the accurate, faithful formalization of comparative ECs. This is perhaps surprising. They

[1] To my knowledge, there are no such proposals within Head-Driven Phrase Structure Grammar (HPSG) at this time.

are members of the class of transderivational constraints, and transderivational constraints arose from work in classical transformational grammar. The first such proposal to make it into print, to my knowledge, is due to Lakoff (1971), who was working in a framework that strongly resembles today's MP. One would think, then, that derivational theories would excel at stating these conditions. But this is not so. Classical transformational grammars consist of rewrite rules and sets of transformations. It is impossible, within such a formalism, to make the derivability of a string x dependent upon the (non)derivability of a distinct string y.[2] That is, intersentential conditions cannot be formulated. As a result, they were always offered as prose descriptions, rather than statements in a grammar formalism.

Thus, I pursue a model-theoretic interpretation. The most important point is recognizing that intersentential constraints are defined only for models that are themselves composed of the models for sentences. This kind of *layered* model is familiar from quantified modal logic, in particular in its applications to natural language semantics. An intensional model consists of a set of worlds, each paired with an interpretation function defined for a fixed signature. One can reason about relations between individuals, as well as relations between interpretation functions. The same flexibility is needed for intersentential constraints in syntax: we require the kind of model that permits us to talk about the internal structure of labeled trees, and to state relationships between trees. Intersentential constraints are, in a sense, the *lifted* versions of regular conditions, an intensionalization of the theory of syntax. However, there are two major differences. The first is that the models for natural language semantics are finite objects, whereas those for intersentential constraints are necessarily infinite, since they must contain all the structures in the language. The second difference is that grammaticality becomes a holistic property, something defined not for individual sentences, but only for entire languages. While it makes sense to define truth holistically, this makes little sense for the property of string-wellformedness. I return to these conceptual points throughout the work below.

In the next section, I define a logic for talking about trees and a class of structures for interpreting it. I assume that this provides the basis for most of linguistic theory. I then layer this logic over a modal logic, thereby providing the means for stating intersentential constraints, including econ-

[2] This is of course possible if x and y are substrings of a single string z. But then the relationship between x and y is not intersentential (interstring).

omy principles. I use the intersentential constraint Optionality (Kornai and Pullum 1990; Pullum and Scholz 2001) to illustrate the need for the second layer for properly interpreting intersentential principles.

Section 3 discusses economy in the MP, concentrating on a formalization of the Coreference rule of Reinhart's (1983) as it is interpreted in Heim (1998). Section 4 addresses the economy condition of Bresnan (2001) and its modifications by Toivonen (2001), who applies it in a detailed account of particles in Swedish. I offer a formalization of this intersentential condition and offer a nonintersentential description of the particle data. After that, I address the subject of economy as it plays out in OT, suggesting that it receives a less objectionable treatment in that theory. Finally, I briefly survey a wide range of past proposals for intersentential conditions, arguing that we have yet to see strong enough motivation for them to embrace the more complicated formalism they require. I do not deny the intuition that thinking in terms of comparative economy is methodologically useful in linguistic work. My skepticism is directed at the assumption that grammatical principles employ such terms.

2 A layered logic for ECs

This section presents the formalism for ECs. It involves a layering of two modal languages. The upper layer is a version of the modal system **S5**. The lower layer is essentially a basic temporal modal logic. It is noteworthy that we can state a large range of intersentential constraints in this logic; both the upper and lower languages are fragments of first-order logic with ancestrals. This indicates that the problematic nature of these constraints is in their semantics — in the class of models over which they are interpreted.

2.1 A language for trees as models

Most work in natural language syntax depends on the idea that phrases and sentences are models in their own right. Constraint-based formalisms conceive of grammars as conditions on these models. Modal logic provides a simple way of defining a full model-theory for these structures. I first define a modal language for trees, $\mathcal{L}^T$ of Blackburn and Meyer-Viol 1997. The layering needed for intersentential work is described in section 2.3.

2.1.1 Atomic propositions (labels)

The class of atomic propositions for the language $\mathcal{L}^T$, called *Prop*, consists of three disjoint subclasses, which reflect the complex ontology of linguistic feature systems.

(2) a. *Term* is the set of *terminal propositions* (e.g., *hippo*, *galloped*). Axiom (10) says that these label all and only terminal nodes in models.

b. *Cat* is the set of *nonterminal propositions* (e.g., N, V, P, I). These label all and only nonterminal nodes in models.

c. *Feature* is the set of *feature propositions* (e.g., *nom*, *pl*). It contains the subset $Bar = \{0, 1, 2\}$ of bar-level propositions, which conjoin with members of *Cat* to define phrases in accordance with X-bar theory.

The full name of the language is $\mathcal{L}^T(Prop)$, but I abbreviate to $\mathcal{L}^T$. In pursuing formalizations of the linguistic ideas discussed below, I freely add to *Prop*, most significantly in section 4, where I add *node-names* in order to achieve a proper mapping from LFG constituent structures into functional structures.

It is worth mentioning a twist introduced by modal logic. Labels are in fact atomic propositions, true at certain nodes and false at others. This permits some rather odd-sounding statements. For instance, it is perfectly defined to say 'bar-level 1 is true at node u'; it is a statement of the form 'p is true at node u'. I attempt to paraphrase the modal logic statements in a natural way, but this conceptual shift should be borne in mind. This choice of 'true at' over labeling seems not to have linguistic significance.

2.1.2 The well-formed formulae

The syntax of the modal language $\mathcal{L}^T$ is given by the set $\mathbf{WFF}_{\mathcal{L}^T}$ of well-formed formulae:

(3)
$$\mathbf{WFF}_{\mathcal{L}^T} = p \mid \neg\varphi \mid \varphi \wedge \psi \mid \varphi \vee \psi \mid \varphi \rightarrow \psi \mid \varphi \leftrightarrow \psi \mid \langle \mathbf{d_1} \rangle\varphi \mid \langle \mathbf{d_1^*} \rangle\varphi \mid \langle \mathbf{d_2} \rangle\varphi \mid \langle \mathbf{d_2^*} \rangle\varphi \mid \langle \mathbf{u} \rangle\varphi \mid \langle \mathbf{u}^* \rangle\varphi$$

In addition to a full set of boolean operators, $\mathcal{L}^T$ has a stock of binary modalities. It has two dominance modalities, each subscripted to indicate which daughter it picks out. $\langle \mathbf{d_1} \rangle \varphi$ asserts that φ holds at the first (left) daughter of the point of evaluation; $\langle \mathbf{d_2} \rangle \varphi$ asserts that φ holds at the second (right) daughter. Both of these have ancestrals (reflexive, transitive closures), distinguished by the Kleene star. The converse of $\langle \mathbf{d} \rangle$ is $\langle \mathbf{u} \rangle$, the dominated-by modality. It also has an ancestral, $\langle \mathbf{u}^* \rangle$.

Some abbreviations: I use $\langle \mathbf{d} \rangle \varphi$ to abbreviate $(\langle \mathbf{d_1} \rangle \varphi \vee \langle \mathbf{d_2} \rangle \varphi)$ and $\langle \mathbf{d}^* \rangle \varphi$ for $(\langle \mathbf{d_1^*} \rangle \varphi \vee \langle \mathbf{d_2^*} \rangle \varphi)$. All of the domination relations are possibility (diamond) modalities: they assert truth at at least one accessible node. So each has a dual, a necessity modality, for which I use square brackets. For instance, $[\mathbf{d}^*]\varphi$ abbreviates $\neg \langle \mathbf{d}^* \rangle \neg \varphi$, and asserts that any node below the point of the evaluation verifies φ.

These informal remarks about the relationship between the syntax and the semantics of $\mathcal{L}^T$ are clarified in section 2.1.4.

2.1.3 The structures

The frames for $\mathcal{L}^T$ are binary, finite ordered tree frames, defined as follows:[3]

(4) A binary, finite ordered tree $\mathcal{T}$ for $\mathcal{L}^T$ is a structure $(T, r, \mathbf{D_1}, \mathbf{D_2}, \mathbf{D_1^*}, \mathbf{D_2^*})$, where

a. $T = \{u, u', u'', u_1, u_2, \dots\}$ is a finite set of nodes.

b. $\mathbf{D_1} \subseteq T \times T$ is the first-daughter relation.

c. $\mathbf{D_2} \subseteq T \times T$ is the second-daughter relation.

d. $\mathbf{D} = \mathbf{D_1} \cup \mathbf{D_2}$

e. $\mathbf{D_1^*}(u, u')$ holds iff there is a finite sequence of nodes $u_1, \dots, u_n$ such that $\mathbf{D_1}(u, u_1) \wedge \dots \wedge \mathbf{D_1}(u_n, u')$.

f. $\mathbf{D_2^*}(u, u')$ holds iff there is a finite sequence of nodes $u_1, \dots, u_n$ such that $\mathbf{D_2}(u, u_1) \wedge \dots \wedge \mathbf{D_2}(u_n, u')$.

g. $\mathbf{D}^* = \mathbf{D_1^*} \cup \mathbf{D_2^*}$

h. T contains a unique node r, the root.

i. Every $u \in T$ that is distinct from the root r has a unique $\mathbf{D}$-predecessor; r has no $\mathbf{D}$-predecessors.

j. $\mathbf{D}$ is acyclic: $\forall u : \neg \mathbf{D}^+(u, u)$.

[3]This definition is adapted from Blackburn and Meyer-Viol 1997:§1.

A model for $\mathcal{L}^T$ is a structure $\mathcal{M} = (\mathcal{T}, \mathbf{V})$, where $\mathbf{V} : \mathit{Prop} \rightarrow \wp(T)$ is a valuation assigning members of *Prop* to subsets of T.

Clause (4h) is *single-rootedness* in most axiomatizations (axiom ***A1*** of Rogers 1998:§3.2; the Single Root Condition of Partee et al. 1993:§16.3.3). It plays a role in getting at the problem intersentential constraints pose for the usual model theory for linguistics.

2.1.4 The satisfaction definition: *grammaticality*

Finally, the three-place satisfaction relation $\vDash$ is the heart of the logic, in turn the heart of the linguistic theory.

(5) Let p be any member of *Prop* and let φ and ψ be well-formed formulae. Then for any model $\mathcal{M} = (\mathcal{T}, \mathbf{V})$ and nodes u, u' of $\mathcal{M}$,

$$
\begin{array}{lll}
\mathcal{M}, u \vDash p & \textit{iff} & u \in \mathbf{V}(p) \\
\mathcal{M}, u \vDash \neg\varphi & \textit{iff} & \mathcal{M}, u \nvDash \varphi \\
\mathcal{M}, u \vDash \varphi \wedge \psi & \textit{iff} & \mathcal{M}, u \vDash \varphi \textit{ and } \mathcal{M}, u \vDash \psi \\
\mathcal{M}, u \vDash \varphi \vee \psi & \textit{iff} & \mathcal{M}, u \vDash \varphi \textit{ or } \mathcal{M}, u \vDash \psi \\
\mathcal{M}, u \vDash \varphi \rightarrow \psi & \textit{iff} & \mathcal{M}, u \nvDash \varphi \textit{ or } \mathcal{M}, u \vDash \psi \\
\mathcal{M}, u \vDash \varphi \leftrightarrow \psi & \textit{iff} & \mathcal{M}, u \vDash \varphi \textit{ iff } \mathcal{M}, u \vDash \psi \\
 & & \\
\mathcal{M}, u \vDash \langle \mathbf{d_1} \rangle \varphi & \textit{iff} & \exists u' : \mathbf{D_1}(u, u') \textit{ and } \mathcal{M}, u' \vDash \varphi \\
\mathcal{M}, u \vDash \langle \mathbf{d_2} \rangle \varphi & \textit{iff} & \exists u' : \mathbf{D_2}(u, u') \textit{ and } \mathcal{M}, u' \vDash \varphi \\
 & & \\
\mathcal{M}, u \vDash \langle \mathbf{d_1^*} \rangle \varphi & \textit{iff} & \exists u' : \mathbf{D_1^*}(u, u') \textit{ and } \mathcal{M}, u' \vDash \varphi \\
\mathcal{M}, u \vDash \langle \mathbf{d_2^*} \rangle \varphi & \textit{iff} & \exists u' : \mathbf{D_2^*}(u, u') \textit{ and } \mathcal{M}, u' \vDash \varphi \\
 & & \\
\mathcal{M}, u \vDash \langle \mathbf{u} \rangle \varphi & \textit{iff} & \exists u' : \mathbf{D}(u', u) \textit{ and } \mathcal{M}, u' \vDash \varphi \\
\mathcal{M}, u \vDash \langle \mathbf{u^*} \rangle \varphi & \textit{iff} & \exists u' : \mathbf{D}^*(u', u) \textit{ and } \mathcal{M}, u' \vDash \varphi
\end{array}
$$

I said that (5) forms the heart of the theory because I want to maintain the elegant thesis in (6).

(6) A sentence S is grammatical if and only if the structure of S, call it $\mathcal{S}$, satisfies all the constraints of the grammar (is a model). That is, the linguist's claim *S is grammatical according to grammar G* is formalized as $\mathcal{S} \vDash G$.

This premise is the basis for all work on model-theoretic syntax; its naturalness in such a framework means that it is often assumed without comment. The basic idea is arguably traceable back to McCawley (1968). Its first explicit entry into linguistic theorizing is Johnson and Postal 1980:655. It is found also in Kaplan and Bresnan 1982, the original proposal for LFG, and is concisely stated by Kaplan (1995), who writes that it is "the hallmark of LFG" (p. 11). See also Ginzburg and Sag 2002:2–3, a work in HPSG.

As discussed in section 3, some comparative ECs partially abandon the principle in (6), because the models must be populated by ungrammatical structures. That is, the principles regulating the form of individual trees must permit tree models that do not correspond to grammatical sentences, and then distinguish these in some way from those that do represent well-formed sentences.

And it is a fundamental trait of OT that (6) does not hold, a choice that is independent of any considerations of economy, deriving instead from the fact that OT grammars are not satisfiable at all: none of the structures in the language is a model of that language's grammar in the technical sense of validating all its axioms; section 5 pursues this in more detail.

2.1.5 Some axioms

For this presentation, I refrain from specifying the full set of axioms that yield all and only linguistically plausible structures, stating instead just those that are important as the basis for a theory, and attempting also to impart a sense for how a grammar looks in this description language.

Each node in a tree must verify exactly one member of $Cat \cup Term$, so that propositions do the work of category labels. Formally, the condition is (7) (based on the one in Blackburn et al. 1993:23).

(7) Single Labeling

$$\bigvee_{\alpha \in Cat \cup Term} \alpha \;\wedge \bigwedge_{\beta \in ((Cat \cup Term) - \alpha)} \neg\beta$$

'Some terminal or nonterminal α holds at any point u, and no terminal or nonterminal β that is distinct from α holds at u.'

Each nonterminal must have exactly one bar-level, and no terminals have them:

(8) NONTERMINALS HAVE BAR-LEVELS

$$\bigvee_{\mathrm{X} \in Cat} \mathrm{X} \leftrightarrow \bigvee_{n \in Bar} n$$

'A nonterminal proposition holds just in case a bar-level holds.'

(9) BAR-LEVEL UNIQUENESS

$$\bigvee_{i \in Bar} i \rightarrow \bigwedge_{j \in (Bar - i)} \neg j$$

'At most one bar-level per node.'

I abbreviate $(\mathrm{X} \wedge n)$ as X^n.

We must also ensure that terminal propositions hold only at nodes without successors. The formula in (10) achieves this.

(10) TERMINAL LABELING

$$\bigvee_{\theta \in Term} \theta \leftrightarrow \neg \langle \mathbf{d} \rangle \top$$

'A terminal proposition holds at a point u iff u dominates no nodes.'

The symbol $\top$ abbreviates a tautology (say, $p \vee \neg p$), and hence holds at every node. Thus, $\neg \langle \mathbf{d} \rangle \top$ is true at u just in case u has no daughters.

It follows from the conjunction of (7) and (10) that all and only nonterminals (nodes with successors) verify members of the *Cat*.

An important axioms for what follows is (11), which is axiom **B10** of Blackburn and Meyer-Viol 1997:42.

(11) DAUGHTER SEQUENCING

$$\langle \mathbf{d_2} \rangle \top \rightarrow \langle \mathbf{d_1} \rangle \top$$

'If a node has a second daughter, then it has a first daughter.'

It is also useful to have access to the root node in the syntax as well. Thus, I define a special proposition *root* that is true only at the unique node without a mother:

(12) THE ROOT

$root \leftrightarrow \neg\langle \mathbf{u} \rangle \top$

'The proposition *root* holds just in case there is no dominating node.'

A number of other axioms are required; the above suffices to indicate how a grammar could be written in $\mathcal{L}^T$, and also proves useful in the sequel.

2.1.6 Remarks on the use of modal logic

The use of modal logic to talk about trees is perhaps unfamiliar. It is only recently that the potential linguistic applications outside of the semantics of modal verbs and adverbs were recognized. Pioneers include Patrick Blackburn and his coworkers, as well as the founders of Dynamic Syntax (Kempson et al. 2001). See also Gazdar et al. 1988 and the response of Kracht (1989), which might constitute the first entries into linguistics

Though limited, modal logic provides a powerful tool for theorizing. It is possible, using the above logic, to state the entire metatheory of X-bar theory, as expounded in Kornai and Pullum 1990.[4] The move to a modal logic with node-names provides a way to formalize the unbounded dependencies of HPSG, and is arguably appropriate for the MP theory of such constructions as well. As mentioned above, I add node-names to the logic to enforce the mapping principles of LFG.

Blackburn and Meyer-Viol (1997) prove that the above logic is sound and complete on the class of all finite, ordered, binary trees. Presumably, a similar result is available for the version of the language with node-names (Areces and Blackburn 2001:2). Thus, this kind of logic has many advantages, conceptual and computational.

2.2 An attempt at Optionality

In their development of the metatheory for the X-bar theory of phrase structure, Kornai and Pullum (1990) articulate the principle of Optionality, which says that "nonhead daughters are only optionally present" (p. 33). The plausibility of such a principle seems based on common paradigms such as (13), in which *meetings* is the head.

[4]Except for Optionality, as shown in section 2.2.

(13)

			meetings	
		interminable	meetings	
	the	interminable	meetings	
	the		meetings	
			meetings	that I attended
		interminable	meetings	that I attended
	the	interminable	meetings	that I attended
	the		meetings	that I attended
*	the	interminable		that I attended
*	the			that I attended
*		interminable		that I attended
*	the	interminable		
*				that I attended

The Optionality principle is given more precisely in (14).

(14) For any local tree rooted at a node labeled X with daughters labeled $\mathrm{Y}_1, \ldots, \mathrm{Y}_n$, if the node labelled Y_i is a nonhead, then there is a tree rooted at a node labeled X without a daughter labeled Y_i.

This principle is recognized as an intersentential constraint by Pullum and Scholz (2001:§3.2). They observe that Optionality is not a fact about individual trees. It is instructive to see what happens, then, if we attempt to state it in $\mathcal{L}^T$.

The first step is to define headedness:

(15) a. $(\mathit{head} \wedge \langle \mathbf{u} \rangle \mathrm{X}) \rightarrow \mathrm{X}$

b. $(\mathrm{X}^1 \vee \mathrm{X}^2) \leftrightarrow$
$$(\langle \mathbf{d_1} \rangle \mathit{head} \wedge \langle \mathbf{d_2} \rangle \neg \mathit{head}) \vee (\langle \mathbf{d_1} \rangle \neg \mathit{head} \wedge \langle \mathbf{d_2} \rangle \mathit{head}))$$

Since Optionality has an implicit 'everywhere' character, I define a global modality, E, that asserts truth at some point somewhere in a model.

(16) $\mathsf{E}\varphi := \langle \mathbf{u}^* \rangle \langle \mathbf{d}^* \rangle \varphi$

I stress that this is a truly global modality only because the models are connected. Only points related to the point of evaluation by dominance relations are accessible to E. Thus, it is still modal in spirit, in the sense that it 'quantifies' just over accessible nodes.

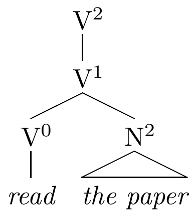
Using these new notions, we can formulate a principle that comes as close as possible, in the present context, to capturing Optionality:

(17) $(\mathrm{X}^i \wedge \langle \mathbf{d} \rangle \neg head) \rightarrow \mathsf{E}(\mathrm{X}^i \wedge [\mathbf{d}] head)$

'If an X^i dominates a nonhead, then somewhere there is an X^i that does not dominate any nonhead.'

This is coherent. But it does not have the intended effect. Consider first the fact that the following model fails to satisfy it:

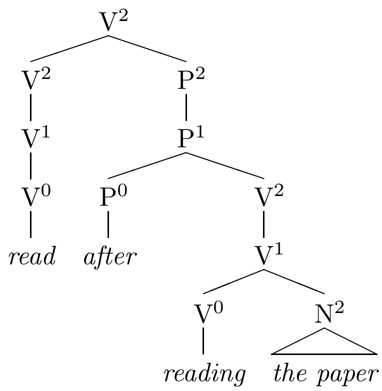
(18)



There is just one V^1 in this structure. It immediately dominates a nonhead. But it is false that, elsewhere in the structure, we can find a V^1 that doesn't dominate a nonhead.

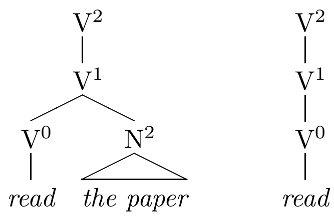
Here is a model that "accidentally" satisfies Optionality as in (17).

(19)



The V^1 inside the prepositional phrase dominates a nonhead. And elsewhere there is a V^1 that dominates only its head V^0. But this is clearly not the intended interpretation; it is a huge mistake to permit this tree but block (18). Rather, Optionality is intended to consider pairs of independent structures such as (20), and is rightly satisfied only relative to such model unions.

(20)



However, this pair of trees is not a model. It is not singly-rooted. Hence, though it satisfies Optionality in the intuitive sense, it is not a model of that principle as stated above. There are two obstacles. The first is that the global modality defined here, E, searches only nodes reachable along some path of dominance relations. This is easily surmounted; we could define a modality that asserted truth at every point, accessible or not. But this reveals a much deeper problem: since the models are connected, this truly global modality would have the same effect as E.

To obtain a statement of Optionality, we need a new class of models, ones that do not correspond to individual linguistic objects in the accepted sense.[5]

2.3 A language for trees as points in a model

The reason $\mathcal{L}^T$ and the tree models defined above are not equipped to handle intersentential constraints is that the relation $\vDash$ that formally models grammaticality is defined, in (5), as a relation between a model, a point in that model, and a formula. There is no room for sets of models to be considered. The tree model is the largest object we have, and $\vDash$ sees just one of them.

So we need a new logic, $\mathcal{L}^S$ ('S' mnemonic for 'sentence'), whose structures have their domain in sets of trees (qua points). This logic is not right for most of the theory — we lose the ability to state constraints and relations like those in section 2.1.5, which require trees. But if we layer $\mathcal{L}^S$ over $\mathcal{L}^T$ to form the layered language $\mathcal{L}^S(\mathcal{L}^T)$ then we can adopt a trees-as-points perspective, allowing us to define properties of sets of trees. The layering is accomplished in two steps.

Syntactically, the atomic formula of $\mathcal{L}^S$ are defined to be the full set $\mathbf{WFF}_{\mathcal{L}^T}$ of formulae of the tree language, as in (21). (As usual, φ and ψ are metavariables over well-formed formulae.)

(21) $$\mathbf{WFF}_{\mathcal{L}^S} = \mathbf{WFF}_{\mathcal{L}^T} \mid \neg\varphi \mid \varphi \wedge \psi \mid \varphi \vee \psi \mid \varphi \rightarrow \psi \mid \varphi \leftrightarrow \psi \mid \Diamond\varphi \mid \Box\varphi$$

[5] One might think that simply allowing unconnected structures like (20) would suffice to do intersentential formalization. But on this model-union approach, there would be no way to prevent opportunistic selection of the model. Many intersentential conditions have the form 'Structure $\mathcal{S}$ is grammatical only if there is no structure of the form $\mathcal{S}'$'. The negative consequent would be easily satisfied by just excluding structures of the form $\mathcal{S}'$. Required here is a model that contains every structure. I develop such a structure in the next section.

The models for $\mathcal{L}^S$ are familiar: their frames are those characterized by the well-known modal logic **S5**; see (22). It is crucial that the set of nodes be infinite, and in turn that the models themselves be of infinite size, since we need to associate nodes uniquely with the structures of the languages, which form an infinite set.

(22) A model $\mathcal{M}_S$ for $\mathcal{L}^S$ is a relational structure (S, R, V), where

a. $S = \{s, s', s'', s_1, s_2 \ldots\}$ is a denumerably infinite set of points.

b. R is an equivalence relation on S (R is reflexive, transitive, and symmetric).

c. $V : \mathbf{WFF}_{L^S} \to \wp(S)$ is a valuation function from atomic propositions to sets of states in S.

The semantic part of the layering is the base step of the satisfaction relation:

(23) For any model $\mathcal{M}_S$ and point s of $\mathcal{M}_S$,

$$
\begin{array}{lll}
\mathcal{M}_S, s \models t \in \mathbf{WFF}_{L^T} & \textit{iff} & D(s), d(s) \models t \\
\mathcal{M}_S, s \models \neg\varphi & \textit{iff} & \mathcal{M}_S, s \not\models \varphi \\
\mathcal{M}_S, s \models \varphi \wedge \psi & \textit{iff} & \mathcal{M}_S, s \models \varphi \textit{ and } \mathcal{M}, s \models \psi \\
\mathcal{M}_S, s \models \varphi \vee \psi & \textit{iff} & \mathcal{M}_S, s \models \varphi \textit{ or } \mathcal{M}, s \models \psi \\
\mathcal{M}_S, s \models \varphi \to \psi & \textit{iff} & \mathcal{M}_S, s \not\models \varphi \textit{ or } \mathcal{M}, s \models \psi \\
\mathcal{M}_S, s \models \varphi \leftrightarrow \psi & \textit{iff} & \mathcal{M}_S, s \models \varphi \textit{ iff } \mathcal{M}, s \models \psi \\
\mathcal{M}_S, s \models \Diamond\varphi & \textit{iff} & \exists s' : R(s, s') \textit{ and } \mathcal{M}_S, s' \models \varphi \\
\mathcal{M}_S, s \models \Box\varphi & \textit{iff} & \forall s' : R(s, s') \textit{ implies } \mathcal{M}_S, s' \models \varphi
\end{array}
$$

The only twist is in the evaluation of a formula of $\mathcal{L}^T$ at a point in a model $\mathcal{M}_S$ for $\mathcal{L}^S$. This relies on two functions: D maps a point s in the model for $\mathcal{L}^S$ to a model of $\mathcal{L}^T$; $d(s)$ maps s to a designated member of $D(s)$, which we assume to be invariably the root of $D(s)$. So the function D moves us from the sentence model to the tree models; the function d is necessary because of the internal perspective of modal logic — formulae are always evaluated at specific points, rather than with respect to the entire model.[6]

[6]Blackburn and his colleagues have a useful way of getting at the intuition behind

2.4 Back to Optionality

Using $\mathcal{L}^S$ interpreted over layered models we can state Optionality as it was intended; see (24). (For simplicity, let m range over $\{1, 2\}$ and assume that X is a member of *Cat*.)

(24) $(\mathrm{X}^i \wedge \langle \mathbf{d} \rangle \neg head) \rightarrow \Diamond(\mathrm{X}^i \wedge [\mathbf{d}] head)$

'If a point s maps to a tree in which a node labeled X^i dominates a nonhead, then somewhere there is a point s' that maps to a tree in which a node labeled X^i does not dominate any nonhead.'

This is syntactically identical to the attempted statement of Optionality in (17), except that the global modality E that searches searches tree models is replaced by the modality $\Diamond$ which is able, via the layering technique, to in effect move between trees.

To illustrate, suppose we have the model $\mathcal{M}$ represented graphically in (25), in which the dashed line represents the $\mathcal{L}^S$ accessibility relation.

(25)

$$\begin{array}{c} s \\ \mathrm{V}^1 \rightarrow (\langle \mathbf{d_1} \rangle(\mathrm{V}^0 \wedge head) \wedge \langle \mathbf{d_2} \rangle \mathrm{N}^2) \\ reads \rightarrow \langle \mathbf{u} \rangle \mathrm{V}^0 \\ novels \rightarrow \langle \mathbf{u} \rangle \mathrm{N}^2 \end{array}$$

$$\begin{array}{c} s' \\ \mathrm{V}^1 \rightarrow (\langle \mathbf{d_1} \rangle(\mathrm{V}^0 \wedge head) \wedge \neg\langle \mathbf{d_2} \rangle \top) \\ reads \rightarrow \langle \mathbf{u} \rangle \mathrm{V}^0 \end{array}$$

To evaluate the truth of

$$\mathcal{M}_S, s \models \mathrm{V}^1 \rightarrow (\langle \mathbf{d_1} \rangle \mathrm{V}^0 \wedge \langle \mathbf{d_2} \rangle \mathrm{N}^2)$$

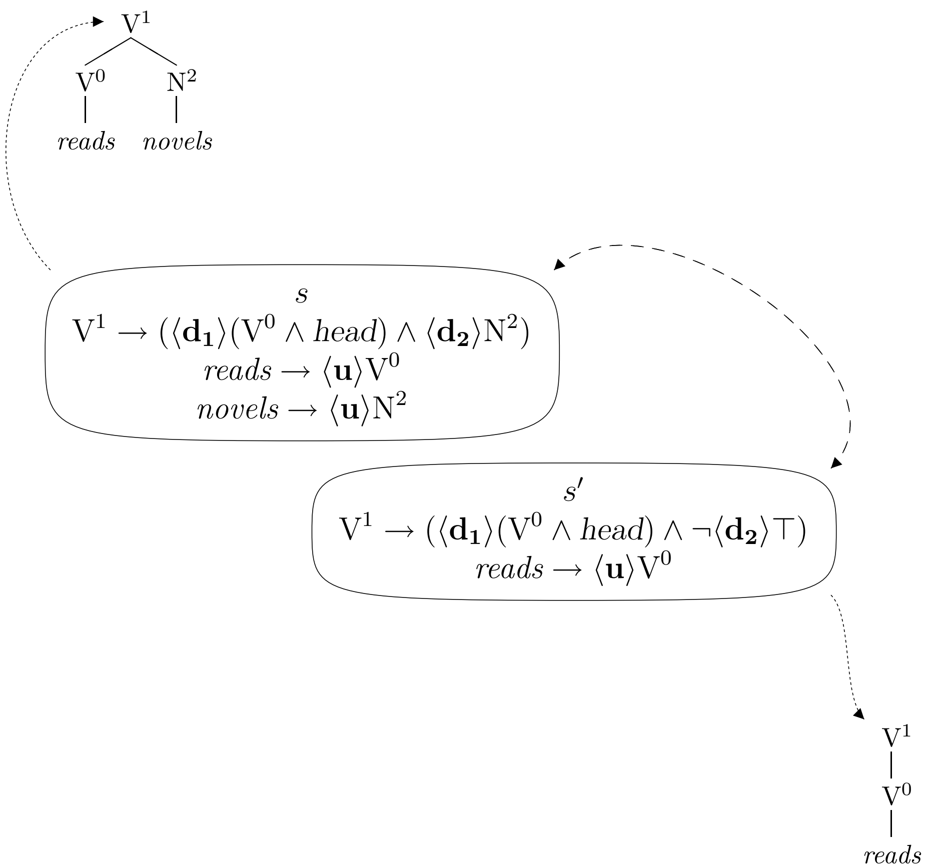
we must move to the model $D(s)$ and the root of $D(s)$, since

$$\mathrm{V}^1 \rightarrow \langle \mathbf{d_1} \rangle \mathrm{V}^0 \wedge \langle \mathbf{d_2} \rangle \mathrm{N}^2$$

this layering. Imagine you are looking at a window on the display of a computer with a graphical interface. The window is covered with icons. From the point of view of this window, the icons appear atomic. But double-clicking any one of them reveals another window (another model). The mapping D is the "double-click" mapping. In addition if, when you open a window by double-clicking, your system highlights a particular icon by default, then it has something like a d mapping.

is a formula of $\mathcal{L}^T$ and hence atomic from the perspective of $\mathcal{L}^S$. Similarly for the others formulae given. A perspicuous way to represent the layered model implicit in the above is as in (26), in which the dotted line represents the action of D and the dashed line is again the relation between points in the model for $\mathcal{L}^S$ and nodes of $\mathcal{L}^T$.

(26)



This model satisfies Optionality. The point s maps to a model containing a nonhead daughter, and s finds a $\Diamond$-accessible point s' whose model lacks a nonhead daughter but is otherwise the same.

Some remarks are in order. First, it is not a virtue of the logic that it can state Optionality. Kornai and Pullum (1990) observe that it is essentially never followed to the letter, and for good reason: there are plenty of instances in which a nonhead daughter is required. Subjects (nonhead daughters of I^2) are a prominent case not reducible to selectional restrictions on predicates, which presumably account for the obligatory nonhead N^2 in phrases like *trounce the opposition* and *at the summit*. For further discussion, see Kornai and Pullum 1990:35 and Pullum and Scholz 2001:§2.3.

Furthermore, even if we required Optionality, it would not justify $\mathcal{L}^S(\mathcal{L}^T)$ and its associated model theory. Potts 2001 shows that principles of this kind can be recast as constraints on grammars, rather than directly on natural language objects.[7] This kind of interpretation is arguably more faithful to the intuition behind Optionality anyway; Kornai and Pullum's (1990:33) statement is actually a constraint on context-free grammars.

But the example is important, because it shows that at least some intersentential constraints can be given entirely model-theoretic interpretations. The statement of Optionality in (24) is consistent with the principle in (6) equating satisfaction and grammaticality. The class of structures is much different, but the grammar is still conceivable as a set of conditions on those structures.

3 Economy in the Minimalist Program

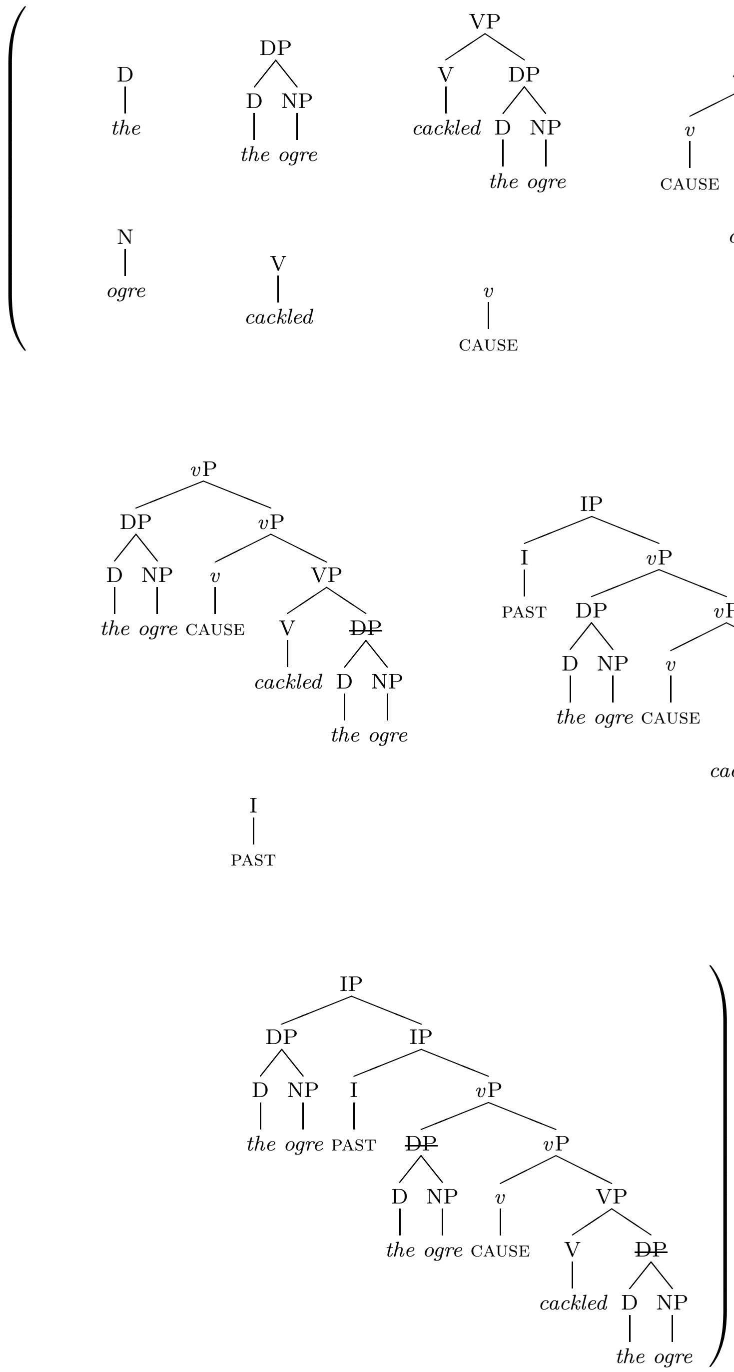
A defining thesis of the MP is that comparative ECs regulate structures, supplementing — in some versions replacing — the constraints of the immediately preceding incarnations of transformational theory (Government & Binding, Principles & Parameters). Writing in a prominent handbook for syntactic theory, Collins (2001) summarizes the current perspective on MP grammars:

(27) "An important theme in recent generative grammar is that linguistic operations, derivations, and representations are subject to economy conditions which guarantee that they are optimal in some sense [...]" (Collins 2001:45)

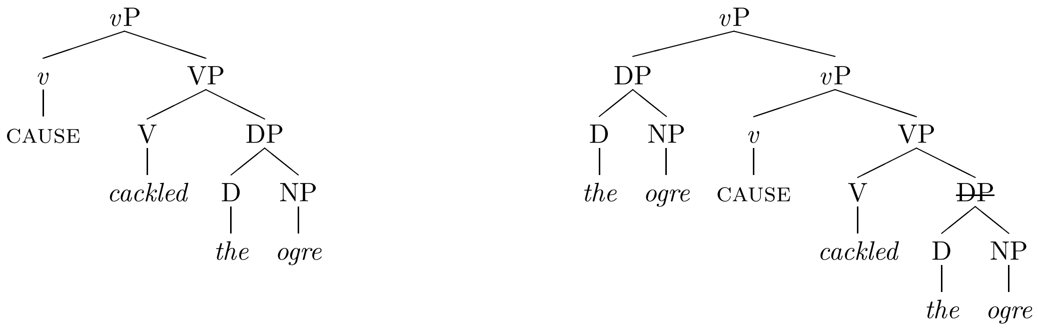
The objects of the MP are *derivations*. Viewed model-theoretically, these are finite, partially-ordered sequences of trees with relations defined on them called *transformations*. Thus, a typical object in the theory is (28).

[7] A similar approach is taken by Rogers (1996, 1997), who uses higher-order predicates to capture many overarching principles of Generalized Phrase Structure Grammar (GPSG).

(28)


D
the
N
ogre
DP
D NP
the ogre
V
cackled
VP
V DP
cackled D NP
the ogre
v
CAUSE
vP
v VP
CAUSE V DP
cackled D NP
the ogre
vP
DP vP
D NP v VP
the ogre CAUSE V ~~DP~~
cackled D NP
the ogre
I
PAST
IP
I vP
PAST DP vP
D NP v VP
the ogre CAUSE V ~~DP~~
cackled D NP
the ogre
IP
DP IP
D NP I vP
the ogre PAST ~~DP~~ vP
D NP v VP
the ogre CAUSE V ~~DP~~
cackled D NP
the ogre

Objects like (28) formally reconstruct of the notion 'sentence'. The relationships between adjacent trees are regulated by a stock of primitive relations, transformations. The two-place relation MERGE takes two trees and forms a connected tree structure from them; COPY takes a subtree and forms a duplicate of it; and MOVE is the composition of COPY and MERGE, i.e., MERGE ∘ COPY. It copies a subtree tree of a tree $\mathcal{T}$ and merges it elsewhere in $\mathcal{T}$ to form a new tree. Although these definitions sound dynamic, they can be interpreted as a static relation between trees. For example, the trees



may appear adjacent to each other because this pair is in the relation MOVE. One could write constraints that define the sets of adjacent trees and in this way interpret even 'derivations' as static, model-theoretic objects.[8]

A comparative EC, then, has as its models *sets* of these tree sequences. Comparative ECs are scrutinized in Johnson and Lappin 1999,[9] an excellent but largely overlooked critique of the MP. Johnson and Lappin's focus is the loosely formulated ECs in Chomsky 1995, which they show to be formally unsound. In some cases, their efforts to fix the technical problems reveal descriptively equivalent noncomparative formulations. The simplifications in turn reveal grave empirical problems, ones not evident when the proposals are couched in terms of the (undefined) economy metric. In Potts 2002a:§5, related charges are levelled against Chomsky's (1995:130, 151) principle of Full Interpretation. In that case, the EC is shown to succeed in certain cases, but only because of its false premise that syntactic systems tolerate only semantically necessary elements. (Section 4.1 below offers similar criticisms.)

A prominent and influential example of an economy condition is Rule H of Fox (2000), which revises the pragmatic principle on coreference that is due

[8]The basic insight that derivations need not be procedural is probably due to Lakoff (1971). Soames (1974) challenges the coherence of Lakoff's particular conception.

[9]An expanded version of Johnson and Lappin 1998.

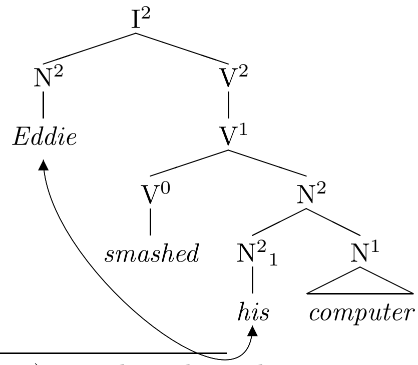
to Reinhart (1983) and is reinterpreted as narrowly grammatical (nonpragmatic) by Heim (1998).[10] Since Fox's (2000) statement interacts in complex ways with the other principles he offers, I discuss here the version of Heim (1998), which is as follows:

(29) **Coreference rule**: α cannot corefer with β if an indistinguishable interpretation can be generated by (indexing and moving β and) replacing α with a variable A-bound by the trace of β.
(Heim 1998:209, (7))

The parenthetical condition on indexing and moving is an indirect reference to quantifiers in nonsubject position, which must move by Quantifier Raising, leaving a bound variable in their origin site, in order to combine by function application with their sisters. A node u A-binds a node u' just in case u c-commands and is coindexed with u' and u is in an argument (A-) position (e.g., a subject, not a topicalized or question, position). I attempt to sidestep these details in what follows, focussing on simple cases.

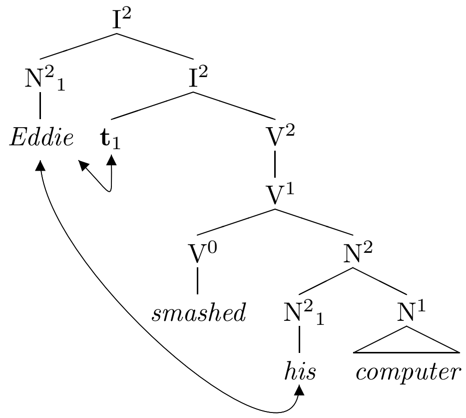
To get a feel for how the Coreference rule works, I consider first a simple case in which coreference is disallowed. The tree in (30a) is blocked by the tree in (30b), because (30b) is a grammatical structure in which legitimate binding occurs and which has an interpretation indistinguishable from (30a).

(30) a.



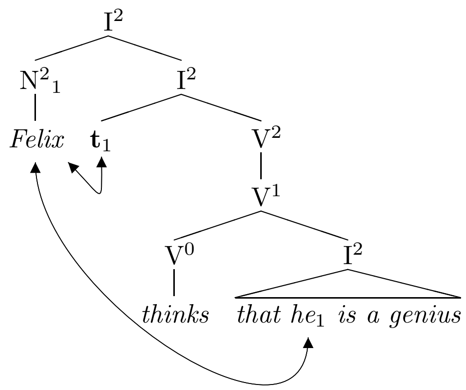
[10] Reinhart (1983) is explicit about the pragmatic nature of the principle, saying that it follows "from Gricean requirements on the rational use of language" (p. 75). In Reinhart 1998, her view of such conditions seems to have shifted to a narrowly grammatical one.

b.

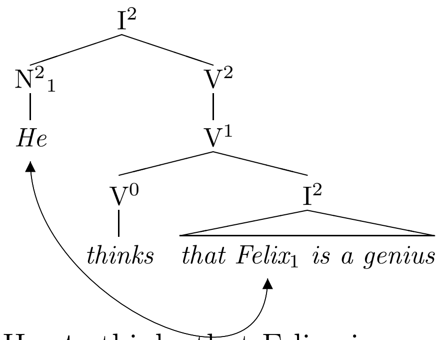


The intuition behind this principle is that binding is a better method for signalling coreference, and thus the grammar forces this choice. Cases like the above indicate how the principle is supposed to work, but they cannot motivate it, since there is no way to distinguish the two representations in isolation. What is more, one could ensure that the only logical form was (30b) by making quantifier raising of the subject obligatory. The true motivation for the principle comes from cases like the following, which are due to Reinhart (1983):

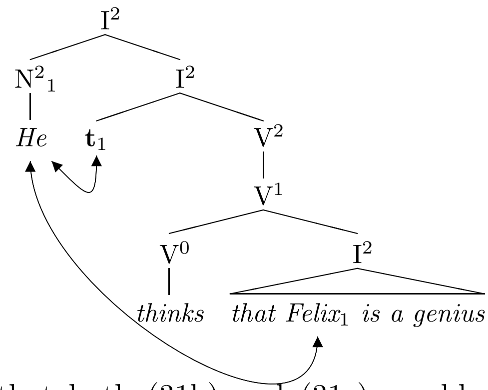
(31) a. Felix$_1$ $\mathbf{t}_1$ thinks that he$_1$ is a genius.



b. $^{\#}$He$_1$ thinks that Felix$_1$ is a genius.



c. $^{\#}$He$_1$ $\mathbf{t}_1$ thinks that Felix$_1$ is a genius.



The claim is that both (31b) and (31c) are blocked by (31a). All three representations have the same semantics, but (31b) involves coreference, and (31c) cannot involve binding because *Felix* cannot translate as a variable. Only (31a) permits the relevant binding relation.

This principle is clearly irreducibly intersentential. It is an economy condition on the assumption that binding is more economical than coreference (Fox 2000:4).

In order to state this principle, we need to be able to access notions of meaning and lexical identity. The next two subsections show how to do this with only small adjustments to $\mathcal{L}^S(\mathcal{L}^T)$. But first, I note a simplifying assumption: since the only trees relevant to this principle are the final ones in derivations (logical forms, henceforth LFs), I reduce the structures to single trees. This makes it possible to use $\mathcal{L}^T$ as defined above, and makes it much easier to state the relevant principles, since it is not necessary to distinguish the LF and relativize all principles to that representation alone.[11]

[11]This is not to say that the choice of derivations over representations is irrelevant to the issue of intersentential proposals. Potts 2002c is a demonstration that the status

3.1 Equivalent numerations

Comparative ECs should consider only sentences with identical lexical items — identical *numerations* in the parlance of the MP. Using $\mathcal{L}^S(\mathcal{L}^T)$, we can define a relation that asserts truth at an accessible node verifying the same terminal propositions as the node of evaluation. I use $\langle\sim_{lex}\rangle$ to symbolize the relation, which is defined in (32), for $\theta \in \mathit{Term}$.

(32) $\langle\sim_{lex}\rangle\varphi := (\mathit{root} \wedge \langle\mathbf{d}^*\rangle\theta) \wedge \Diamond(\mathit{root} \wedge \langle\mathbf{d}^*\rangle\theta \wedge \varphi)$

Thus, $\langle\sim_{lex}\rangle\varphi$ is a diamond modality, but one that asserts truth only at points with identical lexical content, in the sense made precise in $\mathcal{L}^S(\mathcal{L}^T)$.

To work properly, the view of terminal node labeling must be somewhat abstract. For instance, the comparative EC on in situ *Wh*-words of Reinhart (1998) depends heavily on the idea that the examples in (33) are related:

(33) a. Who bought which book?

b. *Which book$_1$ did who buy t$_1$?

But we have the following true statements about the models of (33a,b):

(34) a. $\mathcal{M}_{(33\mathrm{b})}, r \models \langle\mathbf{d}^*\rangle \mathit{did}$

b. $\mathcal{M}_{(33\mathrm{a})}, r \not\models \langle\mathbf{d}^*\rangle \mathit{did}$

So these points are not related by $\langle\sim_{lex}\rangle$ as presently defined. However, internal to the MP, this is not a serious problem. Terminal elements in the syntax are not items with phonological information. They are syntactic-feature bundles, which are interpreted by a phonological component. Thus, as long as the notion of terminal element is general enough, examples like (33) do not pose a problem.

A technical glitch is that the relation $\langle\sim_{lex}\rangle$ reduces the lexical items in a sentence to a set, whereas numerations are assumed to be multi-sets. So we end up comparing *Sally burped* and *Sally burped Sally.* This is strange, but, as reviewed in section 3.2, ECs take meaning identity into account as well, so this feature of $\langle\sim_{lex}\rangle$ seems harmless.

Not all proposed ECs are assumed to compare only structures related by $\langle\sim_{lex}\rangle$. Chomsky's (1995) Have an Effect on Output Condition, formulated

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of Fox's (2000) Scope Economy as intersentential is contingent upon just this decision: a derivational theory can give it a nonintersentential statement, whereas one in which sentences are syntactically represented only by LFs cannot.

by Johnson and Lappin (1999:34) as "α enters the numeration only if it has an effect on output", compares representations with identical meanings but different numerations. But the lexical identity premise is widely regarded as valid. For instance, Aoun et al. (2001) go to great lengths to maintain it despite the fact that their proposal seems at first to be inconsistent with it.

3.2 Meaning identity

A second important factor in forming the comparison class for ECs is meaning identity. For present purposes, I assume that this is truth-functional equivalence. To state such a relation, we need access to semantic denotations.

The layering technique provides a way of integrating semantic information into syntactic structures. Again, the layering has both a syntactic and a semantic component, though the differences between the semantic translation language and the modal languages $\mathcal{L}^T$ and $\mathcal{L}^S$ entail certain changes in the layering.

Syntactically, we assume that the atomic propositions of $\mathcal{L}^S(\mathcal{L}^T)$ include the set of well-formed formulae of a higher-order lambda calculus of the kind used in most semantic analysis. Call this language $\mathcal{L}^\lambda$. In the interest of space, I do not provide the full syntax and semantics of $\mathcal{L}^\lambda$; a detailed exposition is Carpenter 1997:§2,3. The new language is $\mathcal{L}^S(\mathcal{L}^T(\mathit{Prop} \cup \mathcal{L}^\lambda))$, which has atomic propositions N, V, *hippo*, etc., but also the full set of formulae of $\mathcal{L}^\lambda$.

For the semantics, the new clauses are in the base component of the satisfaction relation. We define two valuation functions: $\mathbf{V}_L$ is a familiar valuation, assigning members of $\mathit{Prop} \cup \mathcal{L}^\lambda$ to subsets of the nodes in $\mathcal{L}^T$ models. The second, symbolized ℓ, is defined only for the set $\mathbf{WFF}_{\mathcal{L}^\lambda}$ of formulae of the lambda calculus. Its function is the expected one: it applies to an expression of $\mathcal{L}^\lambda$ to yield its semantic interpretation. Thus, $\ell(\lambda x[\mathbf{hippo}(x)])$ treats $\lambda x[\mathbf{hippo}(x)]$ as a characteristic function, and yields the set of hippos in the domain of the model for the linguistic semantics.

Formally, the clauses are as in (35), where τ is a variable over formulae of $\mathcal{L}^\lambda$ and φ is a variable over $\mathit{Prop} \cup \mathcal{L}^\lambda$.

(35) For any structure $\mathcal{M}$ of $\mathcal{L}^S(\mathcal{L}^T(\mathit{Prop} \cup \mathcal{L}^\lambda))$ and point s of $\mathcal{M}$,

a. $\mathcal{M}, s \vDash \varphi \quad \mathit{iff} \quad s \in \mathbf{V}_L(\varphi)$

b. $\ell(\lambda x[\tau]) \quad = \quad \tau$

With this new layer, we can state the principle of semantic identity using the same strategy used for lexical identity. Let τ range over semantic denotations. Then we define the binary relation $\langle\sim_{sem}\rangle$ as follows:

(36) $\langle\sim_{sem}\rangle\varphi := (\mathit{root} \wedge \tau) \wedge \Diamond(\mathit{root} \wedge \tau \wedge \varphi)$

This condition enforces meaning identity by treating $\mathcal{L}^\lambda$ formulae as atomic. The function ℓ on these formulae yields identical model-theoretic denotations. Importantly, $\langle\sim_{sem}\rangle$ relates only nodes whose semantic translations have *exactly the same syntactic form*. Thus, a tree rooted at a node verifying $\forall x[\mathbf{hippo}(x) \vee \mathbf{mouse}(x)]$ and another rooted at a node verifying $\forall x[\mathbf{mouse}(x) \vee \mathbf{hippo}(x)]$ would not be related, despite the model-theoretic equivalence of these formulae. If we are to calculate whether non-syntactically-equivalent formulae have identical truth-conditions, then issues of decidability arise. The mutual entailment problem is not generally decidable for *first-order* sentences (with or without equality), to say nothing of higher-order sentences. Since natural languages contain quantifiers that are not first-order definable, the semantic denotations of phrases and sentences will involve non-first-order sentences. Once again, this is a worrisome aspect of ECs, one made evident by the attempt to define them in a logic.

Once again, certain ECs are intended to compare structures that are not related by $\langle\sim_{sem}\rangle$. Chomsky's (1995) Smallest Derivation Principle is sensitive only to $\langle\sim_{lex}\rangle$, favoring derivations with the fewest number of operations (perhaps fewest number of trees, it is hard to say). Presumably, shortness could be at the expense of meaning identity. But the proposals in the literature that attempt to analyze specific phenomena, in particular that of Reinhart (1998), maintain semantic equivalence for the structures compared.

3.3 The comparison class

The two relations $\langle\sim_{lex}\rangle$ and $\langle\sim_{sem}\rangle$ are the identity conditions that form the class of trees to be compared by ECs. Thus, it is useful to define their intersection (conjunction).

(37) $\langle\sim\rangle\varphi := (root \wedge \tau \wedge \langle \mathbf{d}^{*}\rangle\theta) \wedge \Diamond(root \wedge \tau \wedge \langle \mathbf{d}^{*}\rangle\theta \wedge \varphi)$

The definition is clumsier than one would like, because the modal language we are working in at present is not capable of naming points. Thus, the formula $\langle\sim_{lex}\rangle\varphi \wedge \langle\sim_{sem}\rangle\varphi$ does not have the intended effect, since it does not pick out only nodes related by lexical identity *and* semantic content: for truth, it would suffice to have two accessible points, on lexically related and verifying φ, and other semantically related and verifying φ.

My guess is that a theory of ECs can be formulated coherently only if $\langle\sim\rangle$ is the relevant relation. Reinhart (1998) does not mention a need for $\langle\sim_{lex}\rangle$. One might think its effects obtainable from $\langle\sim_{sem}\rangle$, since identity of meaning usually entails identity of lexical items. However, active–passive pairs are related by $\langle\sim_{sem}\rangle$, but no EC should favor one over the other. Since they differ in their lexical content, they are not related by $\langle\sim_{lex}\rangle$, hence not by $\langle\sim\rangle$.

Conversely, as Johnson and Lappin (1999:61, nt. 55) observe, identity of lexical items does not suffice either. Sentences like *Eddie likes Ali* and *Ali likes Eddie* should not be in competition, though they are related by $\langle\sim_{lex}\rangle$. Thus, the more specific relation $\langle\sim\rangle$ is needed for ECs, notwithstanding the above-noted exceptions to this practice.

3.4 Back to the Coreference rule

We are now essentially in position to state the intersentential Coreference rule. The remaining lacuna is a specification of QR structures — those in which a quantifier is adjoined to an IP node and binds elements inside its c-command domain. The abstract specification of such structures would, in this context, require the introduction of a GPSG-style slash categories mechanism, or else the introduction of a new relation to represent coindexing. In order to keep the discussion focussed, I refrain from taking this step. Instead, I simply assume that we have access to a defined proposition **QR** that is true at a node just in case it is a member of a structure meeting the conditions for quantifier raising. With this issue settled, the Coreference rule is easily stated:

(38) $\mathbf{QR} \rightarrow \neg\langle\sim\rangle\neg\mathbf{QR}$
'If **QR** is true in a structure associated with a point s, then every $\langle\sim\rangle$-accessible point verifies **QR**.'

This statement is in keeping with (6). It crucially depends on the ability to reason about the relations between full tree-models (interpreted as sentences), and access their associated semantic denotations. Thus, it demands the power of $\mathcal{L}^S(\mathcal{L}^T(\mathit{Prop} \cup \mathcal{L}^\lambda))$.

When stated in full, it seems that the Coreference rule is not fully consistent with (6) (which equates satisfaction with grammaticality) since it seems to require that we have some ungrammatical structures in the model. A case illustrating this is the following, from Heim 1998:210–211:

(39) a. *John$_1$ saw him$_1$

b. *John$_1$ $\mathbf{t}_1$ saw him$_1$.

The representation in (39b) is ungrammatical because, according to Heim, "it would have to derive from a Condition B violation" (p. 210–211). Hence, one might think that we cannot generate an indistinguishable binding structure. This would permit (39a), according to the logic of the Coreference rule. But Heim assumes that (39b) does in fact block (39a). For this to work — for principle (38) to capture these cases too — we must have substructures in the model that represent ungrammatical sentences. That is, some things that are deemed ungrammatical must satisfy the rules of the grammar. Heim (1998:fn. 8) comments on this, and suggests an alternative in which the competing representation in (39) is the grammatical *John saw himself*. There is not space to pursue this further. I note merely that if we were to follow Heim's first proposal, this would mark the first departure from purely model-theoretic thinking that we have seen in the realm of comparative economy.

3.5 Is the Coreference rule accurate?

As noted, Reinhart (1983) originally stated the Coreference rule in pragmatic terms. Later work by Heim (1998) and Fox (2000) reinterpreted it as a syntactic–semantic condition (a constraint on logical forms). There is a growing body of evidence suggesting that the pragmatic viewpoint is the correct one. The following examples indicate that the possibility of binding does not necessarily preclude coreference. The (a) examples involve coreference; the (b) examples show that binding is possible between the two positions in question. (I use quantifiers rather than names to ensure that that the structure involves binding, not coreference.)

(40) a. I only get them_1 presents on the twins'_1 birthday. (Bouma et al. 2001:44)

b. I get [every friend of $\text{mine}]_1$ presents on his_1 birthday.

(41) a. Ann_1 told Mary than Ann_1's mother is a spy. (Bresnan 2001:221)

b. Every investigator_1 told Chuck that her_1 mother is a spy.

(42) a. He_1 gets angry whenEVER the people Sandy_1 loves criticize him. (Bouma et al. 2001:44)

b. Every linguist_1 gets angry when the people she_1 loves criticize her.

Additional examples of this form are found in the works cited. It should be noted that Heim (1998) and Fox (2000) are aware that the principle is complicated, and conclude that the relevant sense of "indistinguishable interpretation"' must be very fine grained. For instance, Heim (1998) argues persuasively that examples of the form in (43) involve the name *Lucullus* mapping first to a *guise* and then to the entity named Lucullus.

(43) " "It is precisely when I am alone," the great gourmet [Lucullus] answered icily, "that you require to pay special attention to the dinner. At such times, you must remember, Lucullus dines with Lucullus."
—M. F. K. Fisher. On dining alone. In *The Art of Eating*, p. 96.

Using Heim's terms, one might sat that in *Lucullus dines with Lucullus*, the name *Lucullus* maps to the guise 'Lucullus-qua-dinner-guest' and to the guise 'Lucullus-qua-emperor'. Since the guise is the relevant sense of 'reference' for the Coreference rule, the example is not blocked by the LF $\textit{Lucullus}_1\ \mathbf{t}_1$ *dines with* $\textit{him}_1$.

The notion of guise is surely important to the semantics of cases like this. But it does not suffice to explain the full range of prima facie counterexamples to the Coreference rule. In the following attested examples, there is no intuitive motivation for invoking distinct guises for the names in question:

(44) a. "He told Peter_1 that whatever Peter_1 might have thought about Auschwitz, it was clear that he had never made a serious moral judgment about Auschwitz [. . .]"
—Jane Kramer. *The Politics of Memory*, p. 92.

b. "They groomed Victoria Vigo — their ace, their bombshell, their sexual Terminator — to give Kepler exactly what Kepler wanted."
—Neal Stephenson. *Cryptonomicon*, p. 133.

The fact that the condition is so easily violated strongly suggests that it is a pragmatic condition, and hence violable. It is uncontroversial that intersentential reasoning occurs in pragmatics. After all, the heart of the Gricean theory of discourse is that when a hearer interprets an utterance of the form 'p or q', he reasons that since the speaker did not choose 'p and q', he means to exclude the case where p and q are both true or does not have evidence for that stronger claim. So Gricean pragmatics is inherently and robustly comparative. To the extent that the Coreference rule is valid, it is as a condition of this class. It is true that binding generally, but not invariably, precludes coreference, just as it is true that uttering "or" generally, but not invariably, implicates "not and". Both are useful and important generalizations that admit of too many counterexamples to be syntactic or semantic constraints (see Bouma et al. 2001:44, Bresnan 2001222ff and references therein).

3.6 A change of substance

In sum, this section shows that the MP's basis in economy conditions is a change to the theory of the most fundamental kind. I hope it dispels any sense that intersentential conditions are somehow 'notational variants' of regular linguistic principles. Such a position seems at least partially endorsed by the following quotation from Roberts 2001, which contrasts the constraint-based formalism of GB with today's MP:[12]

(45) "[...] it remains as true in the MP as it was in GB (one of the many deep commonalities between the two extant versions of principles-and-parameters theory) that either approach is technically feasible and that the two are not empirically distinguishable. [...] we should not confuse notations with reality"
(Roberts 2001:887)

The final bit of the quotation seems to suggest that the addition of intersentential conditions is an issue of notation. To the contrary: I have shown

[12]This is from a reply to Lappin et al. 2000 and is criticized in Lappin et al. 2001.

that it is the models that must be changed. Since the models are the formal reconstruction of linguistic reality, this is as far from a notational issue as one can get in this field.

4 Economy in Lexical-Functional Grammar

4.1 Bresnan 2001

Among the most important generalizations in Bresnan's (2001) comprehensive textbook on LFG is the economy condition in (46).[13]

(46) All syntactic phrase structure nodes are optional and are not used unless required by independent principles (completeness, coherence, semantic expressivity).

(Bresnan 2001:91)

For the purposes of the present study, this principle is of considerable interest. A slight restatement of it is useful:

(47) If a structure contains a node u, then u is required by at least one of the following:

a. completeness

b. coherence

c. semantic expressivity

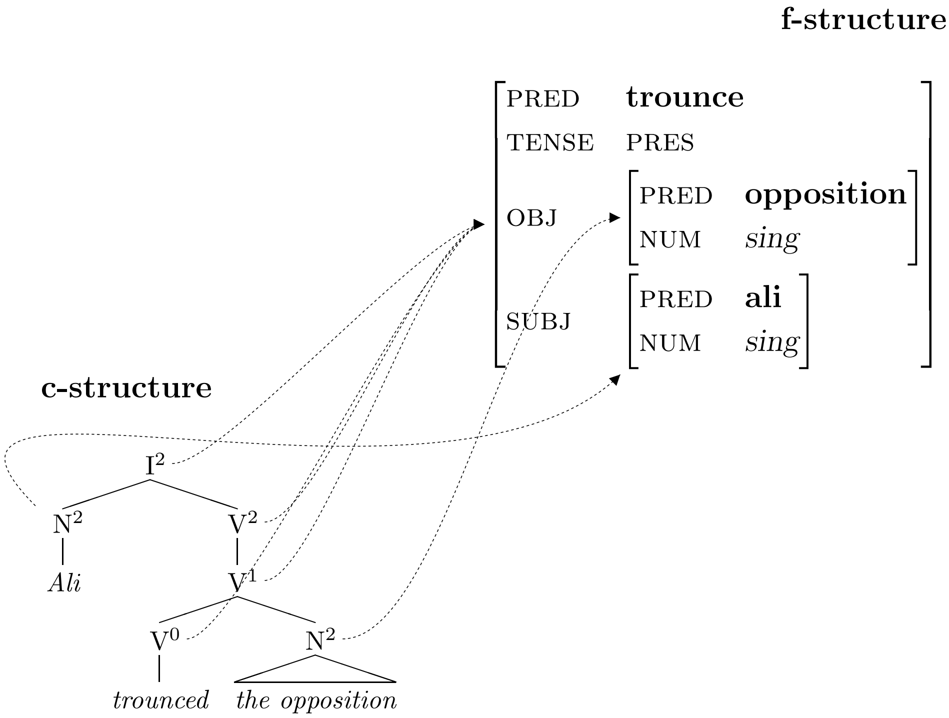
Completeness and coherence are central LFG conditions. In the interest of space, I give a somewhat general overview of LFG. Much fuller introductions are given in two recent, comprehensive textbooks: Bresnan 2001 and Dalrymple 2001a.

To start, the LFG reconstruction of 'sentence' is a triple consisting of a tree-model such as the ones defined in (4), called a constituent structure (c-structure), an attribute value matrix (AVM), called a functional structure (f-structure), and a semantic structure (σ-structure), which I here assume is

[13] Bresnan (2001:91) excludes terminal nodes and their mothers from the extension of 'syntactic phrase structure nodes'. The distinction doesn't play a role in my discussion.

just the name of a function of intensional logic.[14] Thus, a typical LFG model is that represented graphically in (48).

(48)



$^\wedge$[**trounce**(*ali*, *the-opposition*)]

The verb *triumph* determines an f-structure with a subject attribute, a tense attribute, and a PRED attribute with a value that is the meaning of *triumph*, here represented in boldface.

A language very similar to the one defined above for trees suffices for describing AVMs, an insight developed fully in Blackburn 1993. For present

[14]In more complete versions, the objects are 5-tuples: a functional structure, a constituent structure, a semantic structure, an argument structure, and a prosodic structure. Only the first three are directly relevant here, so I simplify, most dramatically with the semantics. Sophisticated work has been done to link LFG with linear logic, in a program called Glue semantics. There, σ-structures are sequent-style, resource-sensitive proofs. A prominent reference is Dalrymple 2001b.

purposes, it suffices to define a multi-modal logic with full boolean expressivity and in addition a set of modalities, one for each attribute in an f-structure. The set of well-formed formula of the AVM language $\mathcal{L}^{\text{AVM}}$ is given as in (49), in which a is an atomic proposition, φ and ψ are well-formed formulae, and $\langle \text{F} \rangle$ is a variable over the set of modalities $\{\langle \text{SUBJ} \rangle$, $\langle \text{PRED} \rangle$, $\langle \text{OBJ} \rangle$, $\langle \text{TENSE} \rangle \ldots\}$.

(49) $$\mathbf{WFF}_{\mathcal{L}^{\text{AVM}}} = a \mid \varphi \wedge \psi \mid \varphi \vee \psi \mid \varphi \rightarrow \psi \mid \varphi \leftrightarrow \psi \mid \langle \text{F} \rangle \varphi$$

The semantics for this language is given in the obvious way. Each modality $\langle \text{F} \rangle$ is paired with a binary relation on nodes $\mathbf{f}$, constrained to be a partial function from nodes into nodes (Blackburn and Gardent 1995; Kaplan 1995:11; Bresnan 2001:47). The models are representable as structures similar to trees, more accurately, as multidominance structures with labels only on their terminal nodes (Kracht 2001), since a single node can have more than one mother. In keeping with the usual practice in the LFG literature, I represent the models as AVMs.

To illustrate, the AVM in (48) verifies the proposition

$$\langle \text{OBJ} \rangle \langle \text{NUM} \rangle \textit{sing}$$

because we can move via OBJ and NUM attributes to a *sing* attribute. This modal description language provides an elegant way of talking about LFG's basis in partial functions.

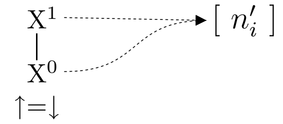
Finally, we need a way to link the c-structures with the f-structures. An efficient way to do this is to add a designated set of node-names[15], which are stipulated to be true at exactly one point in a model. So let $\{n_1, n_2, \ldots\}$ be a set of propositions in *Prop*, the propositions of the tree language, such that each is true at exactly one tree node, and all nodes verify one of these propositions. Let $\{n'_1, n'_2, \ldots\}$ perform the same function in the AVM language $\mathcal{L}^{\text{AVM}}$. Assume that the mapping from c-structures to f-structures is accomplished by the function $\mathbf{M}$, paired with the binary modality $\langle \text{M} \rangle$. Within this language, one can state the kind of path-equality conditions that are the heart of the LFG mapping. For instance:

[15]These are often called 'nominals', a term best not used here because of possible confusion with natural language nominal phrases.

(50) $(\mathrm{X} \wedge \langle \textsc{m} \rangle n'_i \wedge \langle \mathbf{u} \rangle \mathrm{X}) \rightarrow \langle \mathbf{u} \rangle \langle \textsc{m} \rangle n'_i$

‘If X labels a node u that maps to an AVM node named n'_i and u is immediately dominated by a node u' labeled X, then u' maps to the AVM node named n'_i.’

This is just the standard sort of LFG principle stated using functional equations like ↑=↓, which assert that the attribute paired with the mother node is the same as the one paired with the node at which this equation is true. Graphically:

(51)


The insight that this can be done is due to Blackburn and Gardent (1995), a pioneering work in the formal foundations of LFG.[16]

With this language, we can begin to address the crucial features of LFG.

The completeness principle says, in effect, that every attribute specified by a predicate must be present in that predicate’s f-structure representation. Thus, completeness ensures that nothing is missing; since the PRED *trounce* determines an OBJ value, the absence of an object entails a violation of completeness (**Ali trounced*).

Coherence ensures that nothing extra is present: if a predicate specifies only a SUBJ attribute, then it cannot occur in an f-structure with an OBJ attribute (**Ali triumphed the opponent*). The coherence principle enforces a kind of economy of f-structure; as Toivonen (2001:68) observes, it needn’t be included in the economy principle because “both punish superfluous material”.

Let the language obtained by linking $\mathcal{L}^T$ and $\mathcal{L}^{\textsc{avm}}$ via the $\langle \textsc{m} \rangle$ modality be denoted by $\mathcal{L}^{T+\textsc{avm}}$. If we layer $\mathcal{L}^{T+\textsc{avm}}$ over $\mathcal{L}^S$, then we can state the economy principle using the upper language $\mathcal{L}^S$, as follows: let Φ be a set of formulae in $\mathcal{L}^{\textsc{avm}}$, σ a semantic representation, and i the name of a node in a tree-structure. Then (52) is a statement of Bresnan’s economy condition (46) in $\mathcal{L}^S(\mathcal{L}^{T+\textsc{avm}}(Prop \cup \mathcal{L}^\lambda))$.

[16] Blackburn and Gardent (1995) use a path-equality relation, rather than node-names, for the c-structure to f-structure mapping.

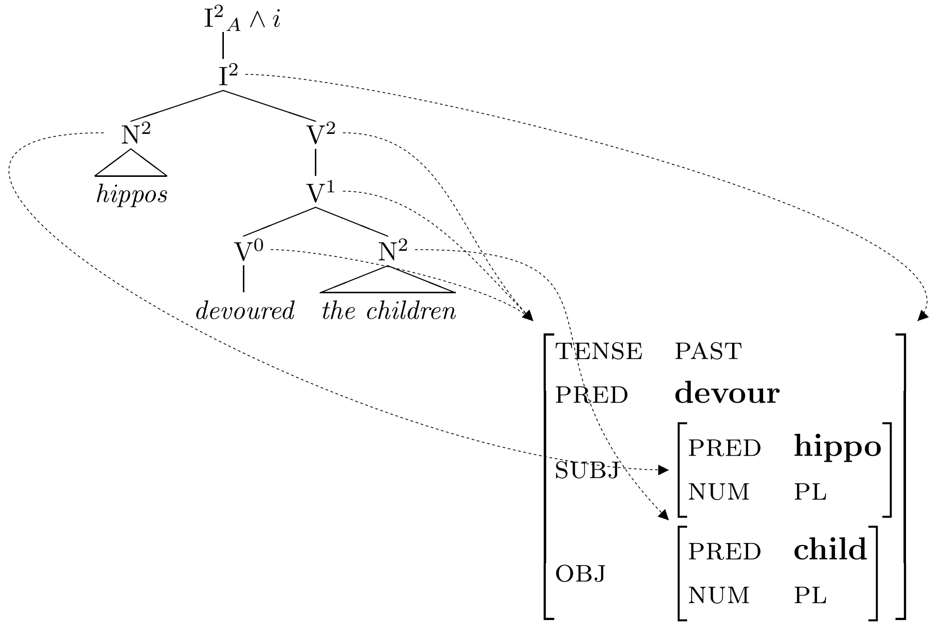
(52) $((\Phi \wedge \sigma \wedge i) \rightarrow \Box(\Phi \wedge \sigma \rightarrow i)$

‘If a node named verifies formulae describing a model with a node named i verifying the set of AVM propositions Φ and the semantic denotation σ, then every accessible node that verifies Φ and σ also verifies formulae describing a model with a node named i.’

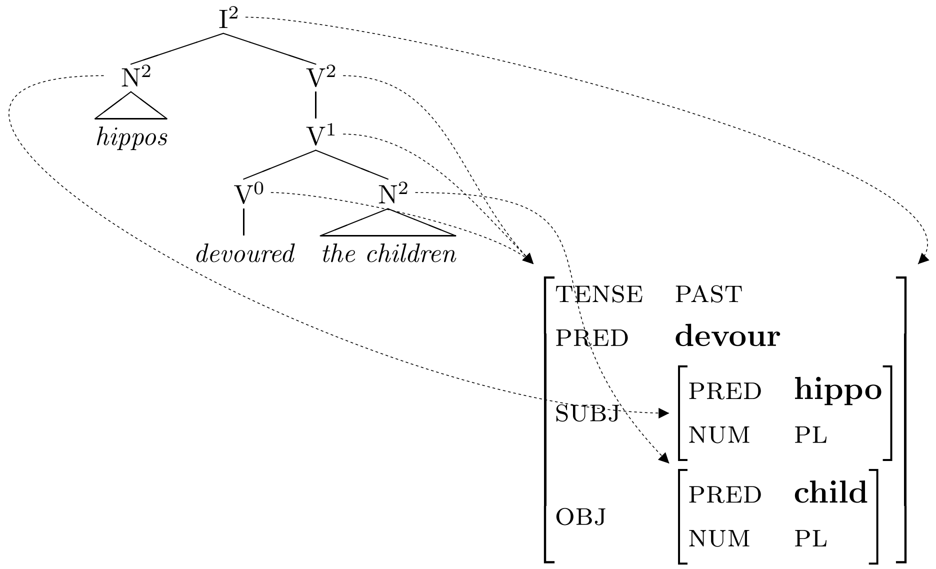
To illustrate, consider the violation of (47a) in (53a), alongside a structure that satisfies the principle.

(53) a. Hippos devoured the children.

b. $^\wedge$[**devour**(*the-hippos*, *the-children*]



c. $\wedge[\mathbf{devour}(\textit{the-hippos}, \textit{the-children}]$



Assume that these two models are associated with points s, s', and that these two are mutually accessible (as are all points; recall the models for $\mathcal{L}^S$ involve an equivalence accessibility relation). Points s and s' verify the same AVM formulae and are associated with the same semantic representation. But (53b) verifies i, while (53c) does not. Since we assume there is a bijection from nodes to node-names, it will always be the case that if a c-structure contains an extra node, it will violate the economy principle.

But is this intersentential interpretation the one we want?

Importantly, there is nothing comparative about completeness or coherence. This is fairly evident from the original statement of the principle (Kaplan and Bresnan 1982:65) and Blackburn and Gardent (1995) develop a description language for LFG and use it to state completeness and coherence using standard LFG models.

Similarly, there need not be anything comparative about the first two clauses of (47). A fruitful way to view this is as the requirement that the function from nodes in constituent-structure trees to attributes in the f-structure be a total function, with the result being completeness and coherence of the entire mapping:

(54) Let C be the set of c-structure nodes, and F the set of nodes in the f-structure. Then for any structure $\mathcal{M}$ of LFG, the binary relation

$\mathbf{M} : C \to F$ is a total function.

This ensures a tight mapping from the trees to the AVMs. There is, though, a residue of cases not accounted for by (54), but I am confident that these do not require comparison. For instance, Bresnan (2001:91ff) seeks to block structures like (55a) because of options like (55b).

(55) a.
$$\begin{array}{c} \mathrm{N}^2 \\ | \\ \mathrm{N}^1 \\ | \\ \mathrm{N}^0 \\ | \\ e \end{array}$$

b.
$$\begin{array}{c} \mathrm{N}^2 \\ | \\ e \end{array}$$

But this is easily handled by a condition that demands all nonterminals to branch. A statement of this principle is (56).

(56)
$$\left(\langle \mathbf{d} \rangle \bigvee_{i \in Bar} i\right) \to \langle \mathbf{d_2} \rangle \top$$

'A node with a daughter verifying a bar-level proposition has a second daughter.'

Axiom (8) says that all and only nonterminals have bar-levels. Axiom (11) says that a node has a second daughter only if it has a first. Hence, this enforces branching. It follows that (55a) is not a model of the grammar. If nothing more is said, (55a) is a model. The sought-after notion of economy is a theorem.

This is an important point given the developments reviewed in section 4.2. As discussed there, Toivonen (2001) modifies Bresnan's economy condition so that it is tempered by X-bar theoretic constraints. Her proposal requires intermediate bar-level structures such as (55a), and hence she must allow them. In Toivonen's theory, it seems that the statement in (54) is the desired one. And it makes no explicit reference to economy, opting instead to obtain the 'economy' results by entailment.

Finally, I address the third clause of (47): the semantic expressivity condition. It seems clearly intersentential; it is possible to determine whether or not a node satisfies this condition only by comparing the structure containing it to ones that lack that node. But is the clause required at all?

As discussed above, completeness and coherence enforce a certain minimality of f-structure representations. If we assume that every node in the tree must map to some node in the f-structure, then the tree structures enjoy a degree of economy as well. Conditions such as (56) will combine with assumptions about phrase structure to prevent useless nodes. So the syntax is economical without being comparative.

When might we need to compare structures along semantic lines? There are two possible situations: (i) there is something in the semantics than has no reflex either in the f-structure or the c-structure; and (ii) the issue is one of optional modification.

Situation (i) is unlikely. If there is no way to detect the presence of a meaning in the syntax, then it is hard to see how it could be expressed. Situation (ii) is apparently the real worry. To illustrate, consider the instance of optional attributive modification in (57b).

(57) a. the dog
b. the happy dog

Since nothing requires *happy* to be present in the syntax in this case, one might worry that the economy principle would step in to block (57b) in favor of (57a), which involves fewer c-structure nodes and an f-structure that is properly contained by the f-structure for (57b). But since *the happy dog* is semantically distinguished from *the dog*, the expressivity condition allows both. In sum, since these noun phrases do not share a semantics, they are not in competition.

But this condition is founded in a worry that does not arise in theories that employ economy only at the level of investigation, rather than building it into grammars. If we say nothing about competition and economy in the grammar, but allow for noun phrases to contain attributive modifiers, then both examples in (57) can represent models of the grammar.

This solution seems preferable. As discussed in Potts 2002a, natural language syntax is replete with meaningless elements and alternations. Consider the following pairs of cases. Each pair has exactly the same truth conditions, yet the (a) examples contain more material than the (b) examples.

(58) a. Ed said that it's snowing.
b. Ed said it's snowing.

(59) a. At no time did Sue see Ed.
b. Sue saw Ed at no time.

(60) a. They can help you to sail the boat.
b. They can help you sail the boat.

(61) a. How long of a book did she assign?
b. How long a book did she assign?

(62) a. I have no rice
b. I do not have rice.

(63) a. Ed doesn't have a red cent.
b. Ed doesn't have a cent.

Presumably, the economy condition must be supplemented by principles allowing this kind of optionality to slip by. The preferable solution seems to be to eschew an economy principle entirely, deriving 'economy' effects, where they arise, from the usual sort of principles.

4.2 Toivonen 2001

Perhaps the best-supported and most precise economy proposals is Toivonen's (2001) analysis of particles in Swedish. Toivonen seeks to explain (inter alia) contrasts such as the one in (64).

(64) a. Jan sparkar upp bollen.
Jan kicks up ball.the
'Jan kicks the ball up.'

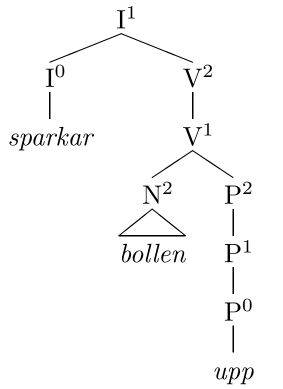
b. *Jan sparkar bollen upp.
Jan kicks ball.the up
'Jan kicks the ball up.'

Toivonen shows independently that both Swedish particles can either be nonprojecting words, or else head full PPs.[17] The question, then, is what

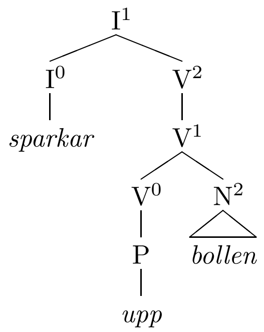
[17] Among Toivonen's innovations is a distinction between a node of bar-level 0 and one without a bar-level at all, the latter providing her formal characterization of particles. This is in violation of axiom (8), which says that all nonterminals have bar levels. The distinction does not play a role in what follows, but the condition is simply a denial of (8).

blocks (64b). Toivonen, building on Bresnan's (2001) economy condition, given in (46) above, claims that this is an instance in which the two structures in (65), her (5.49) with a slightly fuller representation, are pitted against each other, with the more economical (65b) favored over (65a).[18]

(65) a.



b.



Evidence for an economy-based account is provided by examples in which *upp* is modified. In such cases, post-verbal realization is allowed:

(66) Jan sparkar bollen rakt upp.
Jan kicks ball.the straight up
'Jan kicks the ball straight up.'

But in this case, we do not have the meaning equivalence that is required for comparison by the economy principle. Since *rakt* contributes something, post-verbal realization (in a full PP rather than a nonprojecting word) is permitted.

Thus, Toivonen, wishing to maintain a rigid version of X-bar theory, proposes (67), a modification of Bresnan's (46) above.

[18]The verb *sparkar* is in I^0, reflecting the verb-second nature of Swedish.

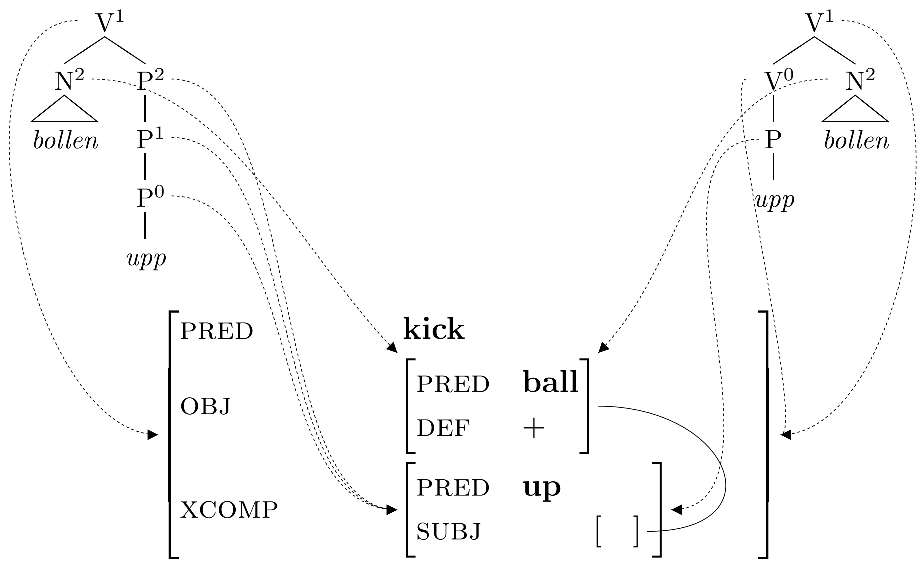
(67) **Economy of Expression (Toivonen)**

All syntactic phrase structure nodes are optional and are not used unless required by X′-constraints or completeness.

(Toivonen 2001:69)

She furthermore, and following Bresnan, says that "Economy only holds over c-structures with identical f-structure, semantic interpretation, and lexical forms" (p. 68). Thus, the structures in (65) are in competition because we have the following:

(68)



The idea is that the inclusion of *rakt* ('right') entails a change in the f-structure and semantic denotation, and hence (67) does not compare the representations.

The fact that nodes required by X-bar theory are allowed (in contrast to Bresnan's statement) means that we need to exempt such nodes from the economy condition. This is easily done, by weakening the antecedent requirements of (52).

But we can give this a nonintersentential statement using roughly the strategy employed above to reanalyze part of Bresnan's condition. In effect, we want to force a P^2 node that is dominated by a V^1 node to be a branching node. The following axiom achieves this:

(69) $P^2 \wedge \langle \mathbf{u} \rangle V^1 \rightarrow \langle \mathbf{d_2} \rangle \top$

'A P^2 that is the daughter of a V^1 has a second daughter.'

This kind of low-level principle seems preferable in this domain. As Toivonen shows, there is considerable variation in Germanic with regard to the handling of particles. It seems likely that these correspond not to sweeping design changes related to economy, but rather the presence or absence of basic conditions of this form.

5 Economy in Optimality Theory

In Optimality Theory (OT), claims concerning economy and comparison are formulated differently from apparently similar claims in LFG and the MP. The model theory for OT is discussed at length in Potts and Pullum 2002. In this section, I briefly address the notion of economy in OT, using the ideas presented by Grimshaw (2001) as a guide. The proposals of Grimshaw are very much in harmony with the perspective adopted here. She begins by saying that "economy of structure is a theorem of the theory of phrase structure" (p. 1) and proceeds to attempt to derive economy effects using standard kinds of OT constraints.

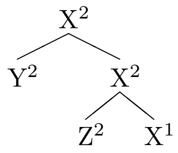
The point I wish to emphasize is that individual constraints in OT, as standardly construed, are not comparative in the sense defined here. As a simple illustration, I show that markedness constraints are interpreted exactly as one would expect them to be interpreted in a constraint-based framework. Though the models are more complex, standard correspondence relations work the same way, in that they enforce conditions that are true or false of individual candidates. The content of OT constraints involves no comparison.

Suppose that we have a condition with the effect of ensuring that a specifier is always leftmost in its phrase — roughly, Grimshaw's SpecLeft constraint. This is achievable with (70), a formula of $\mathcal{L}^T$, which, as we have seen, cannot enforce intersentential conditions.

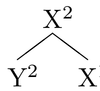
(70) SpecLeft: $\mathrm{X}^2 \rightarrow \neg\langle \mathbf{u} \rangle(\mathrm{X} \wedge \langle \mathbf{d_2} \rangle \top)$

'An X^2 node is not dominated by a branching X node.'

We can determine the truth-conditions of this statement by inspecting individual models. As indicated, it is false (invalid) in the first tree in (71), but true (valid) in the second.

(71) a. 

$\not\models \mathrm{X}^2 \rightarrow \neg\langle \mathbf{u}\rangle(\mathrm{X} \wedge \langle \mathbf{d_2}\rangle\top)$

b. 

$\models \mathrm{X}^2 \rightarrow \neg\langle \mathbf{u}\rangle(\mathrm{X} \wedge \langle \mathbf{d_2}\rangle\top)$

The result is a minimization of structures along one dimension. Gratuitous adjunction to a maximal projection results in violations of (70).

As I mentioned above, the constraint set in an OT grammar is usually held to be unsatisfiable — no (nonnull) object satisfies all of its members, and hence equating model-theoretic satisfaction with grammaticality is impossible. This is where the extra apparatus of OT becomes crucial. The theory is based in constraints, and is at that level indistinguishable from, for example, HPSG or LFG. The OT innovation is that the the grammar keeps a record of the number and kind of violations each structure incurs. This information is then used to determine which candidate model is the grammatical output. All this is "laid atop" a model-theoretic foundation, which helps to explain why OT has been so fruitfully and easily combined with existing frameworks; both the MP and LFG have been used as the basis for OT proposals.

The overall effect of the theory is a kind of comparison. But the individual constraints are not comparative in any sense, as illustrated in (71). This is in stark contrast with economy conditions and other truly intersentential proposals, which center around statements that cannot receive their intended interpretation in terms of the structures for individual linguistic objects.

As discussed in Potts and Pullum 2002, this picture is disturbed by the introduction of OT constraints that truly are comparative. These include Sympathy constraints, which are satisfied or not only by pairs of independent structures, and output–output conditions, which, to determine whether a given candidate structure is optimal or not, usually appeal to an independently occurring grammatical object. Such conditions are not easily integrated into standard OT grammars.

6 The track record of intersentential proposals

The above sections provide the tools necessary to state intersentential conditions precisely in the MP and LFG. But I have left largely unaddressed the question of whether we need this new machinery. I have surveyed the literature on intersentential constraints and found none that are both empirically accurate and necessarily intersentential. Here is a brief summary of the current state of affairs in this area:[19]

(72) a. GAPPING:

Hankamer 1973, 1979; criticized in Langendoen 1976; McCloskey 1977; Manaster-Ramer 1977

b. WORD ORDER VARIATION UP TO AMBIGUITY:

Hetzron 1972:252-253; Johnson and Postal 1980:684, nt. 9; criticized in Pullum and Scholz 2001:§2.3 and references therein (note also Chomsky 1965:126-127)

[19] As far as I know, the 'analogical rules' of Hankamer (1972) have never been discussed in the literature. These are intersentential, but not serious evidence that such constraints exist. To illustrate: Hankamer (1972) says that (iia) manifests no island violation because it has a paraphrase in (iib).

(i) a. Who did Ed make the claim that we should hire?

b. Who did Ed claim that we should hire.

That is, since *make the claim* is synonymous with *claim*, the *claim* structures can step in to save the day. *make the claim* can act as though it were *claim* if need be.

Not so, goes the claim, for things like (ii).

(ii) *Who did Ed offer the proposal that we should hire?

But, of course, one wants to know why *propose publicly/aloud* can't save (ii):

(iii) Who did Ed propose publicly/aloud that we should hire?

One might be able to find a difference between *propose publicly/aloud* that makes this unable to fill in for *offer the proposal*. Fine. But the task for a proponent of an analogical theory is to show that there does not exist, anywhere in the language, a word or phrase with the meaning of *propose publicly*. (Also, *make the claim* is an island for adverbial extraction, whereas *claim* is not. Postal (1998:§A.1) discusses this contrast.)

c. Comparative/superlative marking:

Di Sciullo and Williams 1987; Williams 1997; the basic generalization is falsified in Huddleston and Pullum 2002:§18

d. Condition B/C effects:

Reinhart 1983; Heim 1998; criticized in Lasnik 1989

e. Superiority effects:

Reinhart 1998; criticized extensively and reanalyzed in Potts 2002b.

f. True resumption in Lebanese Arabic:

Aoun et al. 2001; criticized extensively and reanalyzed in Potts 2002b.

g. Conditions on VP-ellipsis resolution (Scope Economy):

Fox 2000; already counterexemplified in Johnson and Lappin 1999 and Jacobson 1997; see also Potts 2001 and Asudeh and Crouch 2002

One might object that this is unfair, on grounds that a list like this could be constructed for essentially every linguistic proposal. For instance, there have been numerous attempts to accurately describe the conditions on *Wh*-movement using conditions on trees, and all could be paired with a published set of objections. But we do not conclude that it is fundamentally wrongheaded to attempt to describe movement with a set of conditions on trees.

The situation represented in (72) is different. In all of the above cases, the responses offer nonintersentential replacements. They do not attempt to refine the intersentential proposal, or offer an entirely different one of that same formal class. Rather, they reject the fundamental intuition. Where solutions are offered, they are always in terms of constraints on individual objects.

The conclusion I draw from this miserable track record is that natural language syntactic systems do not work the way intersentential constraints require them to work.[20] My informal conjecture is that intersentential con-

[20]The situation is the same in phonology, it seems. Potts and Pullum 2002 is an extensive discussion, from a model-theoretic perspective, of intersentential proposals in OT phonology.

straints place overly stringent demands on the design of the language. This is perhaps because they make grammaticality a holistic property, defined only for entire languages. It is no longer sensible to ask whether a single tree is or is not a model (grammatical). Rather, one must ask, in effect, whether it is a member of a set of trees that satisfy the full set of (intersentential) constraints. This flies in the face of linguists' intuitions and everyday practices and also seems an implausible notion about how natural languages should be expected to operate. Neither cultural nor biological systems typically display such global properties defined over an infinite domain.

7 Summary remarks

Section 2 is devoted to formulating a logic for stating ECs and other intersentential constraints. The essential feature of this layered logic that allows statement of these constraints is its uppermost layer, in which trees are points linked by an equivalence accessibility relation. I show that $\mathcal{L}^S(\mathcal{L}^T)$ is capable of stating the basic intersentential constraint Optionality (section 2.4), though there are factual reasons not to adopt the principle. Sections 3 and 4 formulate leading economy conditions in the MP and LFG. Section 5 is a brief review of the distinct conception of economy that follows quite readily from the basic design of OT grammars. Finally, section 6 shows that the track record for intersentential conditions is disasterous. My conclusion is that while comparison occurs in the realm of pragmatics, we have yet to see convincing evidence for it in syntax. A logic is there to formalize such notions, but we have yet to see decisive evidence that constraints on tree models cannot do the job satisfactorily.

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