Gradable Comparatives:
Syntax and Syntax-Semantics Interface

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1 Introduction

My aim is to account for the syntax and semantics of comparative constructions, and the way the two combine. Although comparatives have been extensively discussed in the literature, the analysis of their syntax and semantics, and especially the syntax-semantics interface, were not spelled out in enough detail, were not consistent across the different kinds of comparative constructions, and were not incorporated into a large-scale grammar framework such as HPSG (Pollard and Sag, 1994). The goal here is to fill these gaps. This paper will concentrate on comparatives based on gradable adjectives, and the intension is that the approach shown here should be extended to cover the other kinds of comparative constructions.

1.1 Phenomena

Comparisons based on a gradable adjective may use the comparators *more* (or the suffix *-er*) and *less*, and the equative *as*, and they fall into several different cases:

(1) Predicative:
   a. John is more experienced than Bill. (phrasal comparative)
   b. John is taller than Bill is. (comparative deletion)
   c. This box is as tall as that box is long. (comparative subdeletion)

(2) Attributive:
   a. John read a less interesting book than Bill. (phrasal)
   b. John read a longer book than Bill wrote. (comparative deletion)
   c. John read a longer book than he read a magazine. (cmp. subdeletion)
   d. John opened a taller box than he opened a wide one. (cmp. subdeletion)

There may be an explicit specification of the difference between the compared degrees:

(3) a. Box1 is 6 inches taller than Box2 (is (wide)).
   b. John opened a 6 inches longer box than Bill (opened).

There are also cases of direct comparison to a degree:

(4) a. John is taller than 6 feet.
b. ? John saw a taller woman than 6 feet.

Other comparative constructions involve: non-gradable comparatives (such as *different* and *similar*), nominal comparatives, and adverbial comparatives:

(5) a. John read a different book than Bill wrote. (non-gradable)
b. John read more books than Bill wrote magazines. (nominal)
c. John ran faster than Bill walked. (adverbial)

These will not be discussed in this paper for lack of space, but the intension is that the approach shown here should be extended to cover those cases as well.

1.2 Issues

1.2.1 Complement – PP or S?

The *than* phrase in (1)b, (1)c, and (2)b is a sentence missing some part. Is the *than* phrase in (1)a and (2)a a PP or a sentence that has only a subject?

1.2.2 Complement Extraposition

How can the extraposition of the complement be accounted for?

(6) a. The expenses are higher this year than the earnings.
b. John read a longer book than Bill wrote.
[cf: John is an easy man to please.]
[cf: John gave a book to Mary, which he edited last year.]

1.2.3 Adjective Inversion

There are cases of inversion, where a predicative adjective that should head a relative clause after a noun actually appears before the noun:

(7) a. Johh read a longer book than "War and Peace".
⇒ Johh read a book (that is) longer than "War and Peace".
b. John met a taller man than Bill used to be.
⇒ John met a man (that is) taller than Bill used to be.
c. John opened a longer box than Box2 is wide.
⇒ John opened a box (that is) longer than Box2 is wide.

1.2.4 Ellipsis

Is (8)b an elided version of (8)c, and is (8)a an elided version of (8)b? .
Is (9)b an elided version of (9)a?

(8) a. John is taller than Bill.
b. John is taller than Bill is.
c. John is taller than Bill is tall.

(9) a. John read a longer book than Bill.
b. John read a longer book than Bill read.

Evidence against an ellipsis account for (8) will be discussed in section 4.6. But there are also independently-motivated cases of ellipsis that interact with comparatives, such as antecedent-contained ellipsis (10)a and gapping (10)b.

(10) a. John will read a longer book than Bill will (read).
b. John can give a longer book to Mary than Bill (can give) to Sue.

Analyzing such cases is beyond the scope of this paper, but I intend to investigate their interaction with the comparative constructions in a follow-up paper.

1.3 Plan

The plan of this paper is to combine ideas from several analyses. For the **semantics** of gradable adjectives (discussed in section 2), I follow Kennedy (1997) in assuming that it is based on measure functions from individuals to their degrees on a scale related to the adjective, e.g. $tall(x)$ returns the degree of x on the scale of heights.

For the specification of the **syntax-semantics interface**, I use Glue Semantics (Dalrymple, 2001) (see also (Lev, 2005)), and incorporate it into HPSG following Asudeh and Crouch (2001). This approach is similar to MRS (Copestake et al., 2003) in that pieces of semantic terms are accumulated in a (multi)set in each feature structure, and a mother node's set is simply the union of her daughters' sets. The set of terms for the entire sentence constitutes a possibly underspecified description of the sentence's semantics, thus allowing to account for semantic ambiguities (such as scope ambiguities).[1] The framework is presented in section 3.

The analysis of the **syntax** extends Pollard and Sag (1994). The main ideas are:

1. The basic predicative and attributive cases are analyzed using different lexical entries for the comparator, each expecting a different complement. Therefore, the basic analysis assumes there is no ellipsis in these cases.

2. A new non-local feature EXTRA is used for extraposition of the complement expected by the comparative.

Sections 4 and on use the three components together to provide an analysis for comparatives. In section 4, I explore comparatives that use predicative gradable adjectives with an *-er* suffix, including the cases of absolutive, degree comparative, phrasal comparative, comparative deletion and subdeletion. In section 5, the treatment is generalized to account for explicit specification of the difference between the compared degrees, and for the separate comparators *more*, *less*, and *as*. Section 6 goes on to explore the attributive cases. Section 7 compares the present analysis to previous works, including (Kennedy, 1997; Kennedy and Merchant, 1997; Heim, 1985). Section 8 ends the paper with conclusions and mentions further work.

[1] Glue Semantics has some advantages over MRS since it expresses constraints on the combination of model-theoretic semantic entities rather than pieces of logical form (see (Lev, 2005) for an explanation).

2 The Basic Semantics of Gradable Adjectives

Following Kennedy (1997), the basic meaning unit in a gradable adjective is a function from individuals (of type e) to their degree (of type d) on some scale associated with the adjective. Thus, *tall* is a function that given an individual returns its height. Kennedy explains the advantage of this view over a relational analysis where, for example, $tall(x, d)$ is a relation between an individual x and a degree d of tallness. In short, if the relational analysis is used, an existential quantifier must be used to bind d, but this quantifier does not participate in scope ambiguities with other quantifiers, negation, and intensional contexts. In any case, a functional analysis is simpler for our purposes.

The comparison of degrees of individuals will use the following operators that compare two degrees (and so each is of type $d \to d \to t$):

(11)

the comparator	operator	meaning
(absolutive)	ABS	$=$ [2]
more/er (...than)	MORE	$>$
less (...than)	LESS	$<$
as (...as)	AS	$\geq$

Here are the basic meanings of some cases, assuming the adjective is G and the comparator is *more/er* (each will be discussed in more detail in later sections):

(13) a. predicative, direct degree:
$\lambda z \lambda x.\text{MORE}(G(x), z)$
type : $d \to e \to t$
example: John is [taller than 6 feet]:
$G = tall,\ \ z = 6feet$

b. predicative, phrasal:
$\lambda y \lambda x.\text{MORE}(G(x), G(y))$
type : $e \to e \to t$
example: John is [taller than Bill]:
$G = tall,\ \ y = bill$

c. predicative, subdeletion:
$\lambda Q \lambda x.\text{MORE}(G(x), \iota z.Q(z))$
type: $(e \to d) \to e \to t$
example: Box1 is [taller than Box2 is wide]:
$G = tall,\ \ Q = \lambda w.\text{ABS}(wide(box2), w)$

d. predicative, deletion:
$\lambda Q \lambda x.\text{MORE}(G(x), \iota z.Q(\lambda y.\text{ABS}(G(y), z)))$

[2] Examples such as the following have led some to argue that ABS should mean $\geq$ (the following example is cited in (Kennedy, 1997, p.75)):

(12) A: You have to be at least 5 feet tall to be an astronaut.
B: I am 5 feet tall; in fact, I'm over 5 feet tall.

type: $((e \to t) \to t) \to e \to t$
example: John is [more experienced than Bill was]:
$G = experienced,\ \ Q = \lambda P.past(P(bill))$

e. attributive, deletion:
$\lambda Q \lambda P \lambda x.[P(x) \wedge \text{MORE}(G(x), G(\iota z.[P(z) \wedge Q(z)]))]$
type: $(e \to t) \to (e \to t) \to e \to t$
example: John read a [longer book than Bill wrote]:
$G = long,\ \ Q = \lambda z.wrote(bill, z),\ \ P = \lambda x.book(x)$

f. attributive, phrasal:
$\lambda R \lambda y \lambda P \lambda x.[P(x) \wedge \text{MORE}(G(x), G(\iota z.[P(z) \wedge R(y, z)]))]$
type: $(e \to e \to t) \to e \to (e \to t) \to e \to t$
example: John read a [longer book than Bill]:
$G = long,\ \ R = \lambda w \lambda z.wrote(w, z),\ \ y = bill,\ \ P = \lambda x.book(x)$

Note: In the case of subdeletion, the semantics is defined only when the two gradable adjectives are associated with scales whose values can be compared with each other. For example:

(14) a. Box1 is taller than Box2 is wide.
b. # The movie is longer than Box2 is wide.

To account for this, degrees could be divided into kinds (physical lengths measured in meters, time intervals measured in seconds, etc.) and comparators like MORE can be defined to return a truth value only if it is given two degrees of the same kind.

3 Basic Glue Semantics in HPSG

3.1 Overview

Glue Semantics (Dalrymple, 2001) (see also (Lev, 2005)) is a flexible framework for specifying the syntax-semantics interface.

A glue semantics statement has the form $\psi : A$, where ψ is an expression in the meaning language, and A is its type, marked with "handles". For example, the glue statements for the sentence "John loves Mary" are shown in the right column:

(15)

meaning expression	type	Glue Semantics statement
$john$	e	$john : \boxed{1}^e$
$\lambda x \lambda y.loves(x, y)$	$e \to e \to t$	$\lambda x \lambda y.loves(x, y) : \boxed{4}^e \to \boxed{5}^e \to \boxed{3}^t$
$mary$	e	$mary : \boxed{2}^e$

A set of glue statements can be resolved by using combination rules (application, function composition, etc.). If we looked only at the types of the semantic expressions to guide their combination, we could get both the correct result $loves(john, mary)$ and the incorrect result $loves(mary, john)$. But adding structure-sharing equations between the handles on the right-hand side of glue statements can help constrain the way that the semantic expressions may combine. It is the role of Syntax (as explained below) to specify such constraints. In the example here, the constraints

would be $\boxed{4} = \boxed{1}$ and $\boxed{5} = \boxed{2}$. Given these, the statements above can only combine to $loves(john, mary) : \boxed{3}^t$ and not to $loves(mary, john) : \boxed{3}^t$.

Here is another example for the predicative phrasal case (from now on, we will use structure sharing in the right-hand side of statements without specifying the structure sharing constraints separately):

(16)

"John"	$john : \boxed{2}^e$
"was"	$\lambda x \lambda P.past(P(x)) : \boxed{2}^e \rightarrow (\boxed{2}^e \rightarrow \boxed{1}^t) \rightarrow \boxed{4}^t$
"taller"	$\lambda y \lambda x.\text{MORE}(tall(x), tall(y)) : \boxed{3}^e \rightarrow \boxed{2}^e \rightarrow \boxed{1}^t$
"than"	
"Bill"	$bill : \boxed{3}^e$
"taller than Bill"	$\lambda x.\text{MORE}(tall(x), tall(bill)) : \boxed{2}^e \rightarrow \boxed{1}^t$
"was taller than Bill"	$\lambda x.past(\text{MORE}(tall(x), tall(bill))) : \boxed{2}^e \rightarrow \boxed{4}^t$
"John was taller than Bill"	$past(\text{MORE}(tall(john), tall(bill))) : \boxed{4}^t$

Here the semantics for "taller than Bill" was obtained by simple function application (equivalently, Modus Ponens on the type-expression side) on "taller" and "than Bill". The semantics of the verb phrase was obtained by first changing the order of arguments of the verb's semantics and then applying the result on "taller than Bill". The resulting meaning was finally applied on "John". Such derivations are standard practice and will not be mentioned explicitly in the text below, to save space.

As was said, the constraints on structure sharing between handles come from the syntax. The Glue Semantics framework is compatible with any syntactic framework that can supply such constraints, and it has been adapted to LFG (Dalrymple, 2001), LTAG (Frank and van Genabith, 2001), and Categorial Grammar (Asudeh et al., 2002). In this paper, we will use its version in HPSG following (Asudeh and Crouch, 2001), with minor changes. The starting point for the HPSG framework itself is (Pollard and Sag, 1994).

3.2 Local, Resources, and Glue

The structure of the *local* of a *synsem* is modified as follows:

(17) *local*:
$$\begin{bmatrix} \text{CATEGORY} & category \\ \text{SEM-R} & sem\text{-}r \\ \text{GLUE} & multiset(glue) \\ \text{CONTEXT} & context \end{bmatrix}$$

CATEGORY and CONTEXT remain unchanged but CONTENT is replaced by two new features.[3] An object of type *glue* is a statement in Glue Semantics, i.e. a pair of a formula in the meaning language and a type expression decorated with handles. SEM-R abbreviates SEMANTIC-RESOURCES.[4] A feature-structure of type *semantic-resources* (*sem-r*) contains handles that are used on the right-hand side of glue statements. For easy access, we use the notation:

[3] CONTEXT might also be changed to contain a set of glue statements.

[4] This was called CONT in (Asudeh and Crouch, 2001), but I chose a different name so as not to cause confusion with the standard feature CONT of Pollard and Sag (1994).

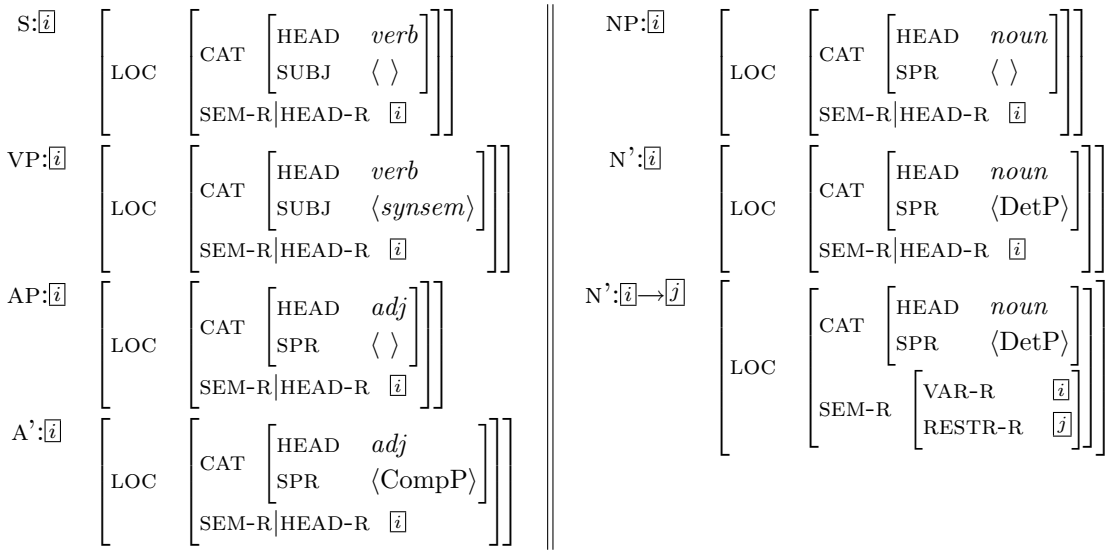


Figure 1: Abbreviations

(18) A feature structure:

$$\underset{synsem}{\boxed{1}}\left[\text{LOCAL}|\text{SEM-R}|\text{HEAD-R}\ \boxed{2}\right]$$

can be written in abbreviated form as: $\boxed{1} : \boxed{2}$. [5]

We also modify abbreviations from (Pollard and Sag, 1994) as shown in Figure 1. The abbreviations will be explained below as they are used. The Semantics Principle from Pollard and Sag (1994:323, (16)) is simplified to:

(19) **Semantics Principle (glue version)**
The SEM-R of a phrase is the SEM-R of its head daughter.
The GLUE of a phrase is the multiset-union of the GLUE values of its daughters.

For example, a phrase with a *head-comp-struc* looks like the one in (20), whereas a *head-mark-struc* and a *head-adjunct-struc* etc. would have just one daughter instead of the list of COMP-DTRS.[6]

(20)
$$\left[\begin{array}{ll}\text{SS}|\text{L} & \left[\begin{array}{ll}\text{SEM-R} & \boxed{1}\\ \text{GLUE} & \boxed{A_1}\oplus\cdots\oplus\boxed{A_n}\end{array}\right]\\ \text{DTRS} & \underset{head\text{-}comp\text{-}struc}{\left[\begin{array}{ll}\text{HEAD-DTR} & \left[\text{SS}|\text{L}\left[\begin{array}{ll}\text{SEM-R} & \boxed{1}\\ \text{GLUE} & \boxed{A_1}\end{array}\right]\right]\\ \text{COMP-DTRS} & \left\langle\left[\text{SS}|\text{L}|\text{GLUE}\ \ \boxed{A_2}\right],\ \ldots,\ \left[\text{SS}|\text{L}|\text{GLUE}\ \ \boxed{A_n}\right]\right\rangle\end{array}\right]}\end{array}\right]$$

These definitions are quite abstract, so to help understand them, let's go through a few basic examples.

[5] Don't confuse this with a glue semantics statement $\psi : A$ which is also written using a colon.
[6] $\oplus$ in (20) is multiset-union.

3.3 Proper Names and Transitive Verbs

(21) "Mary":

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \\ \text{SEM-R} & \left[\text{HEAD-R}\ \boxed{4}[\text{PER}\ \textit{3rd},\ \text{NUM}\ \textit{sing},\ \text{GEND}\ \textit{fem}]\right] \\ \text{GLUE} & \left\langle \textit{mary} : \boxed{4}^{e} \right\rangle \end{bmatrix}$$

Semantic resources of type e have internal features like person, number, and gender, and they correspond loosely to indices in (Pollard and Sag, 1994).[7]

(22) "saw":

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & [\text{VFORM}\ \textit{fin}] \\ \text{SUBJ} & \langle \text{NP}[\textit{nom}]{:}\boxed{2}[\text{PER}\ \textit{3rd},\ \text{NUM}\ \textit{sing}]\rangle \\ \text{COMPS} & \langle \text{NP}{:}\boxed{3}\rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R}\ \boxed{1}] \\ \text{GLUE} & \left\langle \lambda x \lambda y.saw(x,y) : \boxed{2}^{e} \rightarrow \boxed{3}^{e} \rightarrow \boxed{1}^{t} \right\rangle \end{bmatrix}$$

Notice here the structure sharing between $\boxed{3}$ in the glue statements and $\boxed{3}$ in the head resource of the NP on the COMPS list in (22). Inside that NP, the head resource $\boxed{3}$ will also be structure-shared with the type expression in the NP's glue statement, as in (21). The result is that when the GLUE multisets of the verb and its direct object are combined, there will be correct structure sharing between handles in the glue statements:

(23) $$\left\langle \begin{matrix} \lambda x \lambda y.saw(x,y) : \boxed{2}^{e} \rightarrow \boxed{3}^{e} \rightarrow \boxed{1}^{t}, \\ \textit{mary} : \boxed{3}^{e} \end{matrix} \right\rangle$$

The feature structure for the entire sentence will include:

(24) "John saw Mary":

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb}[\textit{fin}] \\ \text{SUBJ} & \langle\ \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R}\ \boxed{1}] \\ \text{GLUE} & \left\langle \begin{matrix} \textit{john} : \boxed{2}^{e}, \\ \textit{mary} : \boxed{3}^{e}, \\ \lambda x \lambda y.saw(x,y) : \boxed{2}^{e} \rightarrow \boxed{3}^{e} \rightarrow \boxed{1}^{t} \end{matrix} \right\rangle \end{bmatrix}$$

Once this structure is obtained, the statements from GLUE are "taken to the side" and combined to form $saw(john, mary) : \boxed{1}^{t}$.

[7] Throughout this paper, type superscripts like e and t are shown on handles only in glue statements but not in the other parts of the feature structure. The difference between $\boxed{1}$ and $\boxed{1}^{e}$ corresponds to the difference between an f-structure and its semantic projection in the s-structure in (Dalrymple, 2001). This point, however, is not crucial for understanding the ideas here.

3.4 Nouns Phrases

(25) "student":

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{SPR} & \langle \text{DetP} \rangle \end{bmatrix} \\ \text{SEM-R} & \begin{bmatrix} \text{HEAD-R} & [\textit{3rd,sing}] \\ \text{VAR-R} & \boxed{1} \\ \text{RESTR-R} & \boxed{2} \end{bmatrix} \\ \text{GLUE} & \left\langle \lambda x.\textit{student}(x) : \boxed{1}^{e} \rightarrow \boxed{2}^{t} \right\rangle \end{bmatrix}$$

The HEAD-R here is the same as in (21), and will become the HEAD-R of the entire NP (according to the semantics principle (19)). In addition, since the semantics of the noun "student" is $\lambda x.\textit{student}(x)$ of type $e \rightarrow t$, we need two additional resources in SEM-R. These resources can then be accessed by determiners and by attributive adjectives. For example, (26) can combine with (25) by the Head-Adjunct Principle of (Pollard and Sag, 1994). The GLUE statements of these two would eventually combine in a glue derivation to produce: $\lambda x.\textit{student}(x) \wedge \textit{married}(x) : \boxed{1}^{e} \rightarrow \boxed{2}^{t}$.

(26) "married" (attributive, as in: "John met a married student"):

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{MOD N':} & \boxed{1} \rightarrow \boxed{2} \\ \textit{adj} & \begin{bmatrix} \text{PRD} & - \end{bmatrix} \end{bmatrix} \\ \text{SUBJ} & \langle\ \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{VAR-R } \boxed{3},\ \text{RESTR-R } \boxed{4}] \\ \text{GLUE} & \left\langle \begin{array}{l} \lambda x.\textit{married}(x) : \boxed{3}^{e} \rightarrow \boxed{4}^{t}, \\ \lambda Q \lambda P \lambda x.P(x) \wedge Q(x) : (\boxed{3}^{e} \rightarrow \boxed{4}^{t}) \rightarrow (\boxed{1}^{e} \rightarrow \boxed{2}^{t}) \rightarrow \boxed{1}^{e} \rightarrow \boxed{2}^{t} \end{array} \right\rangle \end{bmatrix}$$

The second element in the GLUE of (26) combines the basic predicate $\lambda x.\textit{married}(x)$ (of type $e \rightarrow t$) with that of the noun to produce a new N' meaning. In the predicative version of the adjective, there is only the basic predicate:

(27) "married" (predicative, as in: "John is married")

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{adj}[\text{PRD } +] \\ \text{SUBJ} & \langle \text{NP:} \boxed{1} \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R } \boxed{2}] \\ \text{GLUE} & \left\langle \lambda x.\textit{married}(x) : \boxed{1}^{e} \rightarrow \boxed{2}^{t} \right\rangle \end{bmatrix}$$

4 Simple Predicative Gradable Adjectives

Now that the basic semantics of gradable comparatives and the basic machinery for the syntax-semantics interface have been introduced, we can proceed with the analysis of comparatives. In this section we will look only at gradable adjectives in predicative position, which are either absolutive ("John is 6 feet tall"), or are comparative marked with a suffix *-er*. In section 5 we will see how to generalize

this analysis to cases where an explicit degree specifies how much more one degree is larger or smaller than the other, and to cases where the comparator is expressed explicitly ("more/less/as expensive"). I do not start with the most general analysis here in order to make the presentation more readable.

4.1 Absolutive

(28) "tall" (as in: "John is 6 feet tall")

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & _{adj}[\text{PRD } +] \\ \text{LCOMPS} & \langle \text{NP}[\text{DEGREE}+]{:}\boxed{3} \rangle \\ \text{SUBJ} & \langle \text{NP}{:}\boxed{1} \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R } \boxed{2},\ \text{VAL-R } \boxed{4}] \\ \text{GLUE} & \left\langle \begin{array}{l} \lambda x.tall(x) : \boxed{1}^e \rightarrow \boxed{4}^d, \\ \lambda G \lambda z \lambda x.\text{ABS}(G(x), z) : (\boxed{1}^e \rightarrow \boxed{4}^d) \rightarrow \boxed{3}^d \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t \end{array} \right\rangle \end{bmatrix}$$

Recall from (11) that ABS means equality. Here *tall* is a function from individuals to their degree along the scale of heights, and the second line in GLUE is the combinator that applies on that function G, a degree z, and an individual x, to produce *true* iff the degree $G(x)$ is equal to z. Thus, if we combine the two GLUE entries to obtain $\lambda z \lambda x.\text{ABS}(tall(x), z) : \boxed{3}^d \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t$, the entry has a structure similar to (27) except that the meaning expects another argument – a direct degree specification (of type d).[8] That degree specification comes from an NP which is expected on the LCOMPS list. This list is similar to the usual COMPS list except that it expects the complements to the left rather than to the right of the head, by a new Head-Lcomp schema.[9] The NP "6 feet" itself can be analyzed as:

(29) "6 feet":

$$\begin{bmatrix} \text{CAT} & \left[\text{HEAD} \quad _{noun}[\text{DEGREE } +]\right] \\ \text{SEM-R} & [\text{HEAD-R } \boxed{5}] \\ \text{GLUE} & \left\langle 6feet : \boxed{5}^d \right\rangle \end{bmatrix}$$

The explicit degree is always optional, and sometimes must actually not be expressed since there are no explicit units for the scales associated with some adjectives:

(30) Mary is (* 200 miliHelens) beautiful.

When the degree is not expressed, a variation of (28) is used that takes $\boxed{3}$ not from the LCOMPS but from some contextually salient standard degree appropriate for the adjective.

[8] In that light, (27) could be revised to have the same structure as (28), where *married* is a function from individuals to $\{true, false\}$, and the degree $\boxed{3}$ is specified implicitly as *true*.

[9] The degree NP is not a specifier (SPR) of the adjective because we do not want to demand that it has a SPEC feature selecting for the adjective. The degree NP is also not a modifier of the adjective but rather an argument of it.

4.2 Degree Comparative

In the case of a comparative, there is no degree NP that specifies the degree of the individual along a scale, but instead there is a comparative expression:

(31) a. John is 6 feet tall.
ABS$(tall(john), 6feet)$
b. John is taller than 6 feet.
MORE$(tall(john), 6feet)$

We need an entry like (28) except that the degree NP appears not on the LCOMPS list but on the COMPS list, inside a PP, and the comparison is done using MORE rather than ABS. Everything else stays the same:

(32) "taller" (as in: "John is taller than 6 feet")

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & _{adj}[\text{PRD } +] \\ \text{SUBJ} & \langle \text{NP:}\boxed{1} \rangle \\ \text{COMPS} & \langle \text{PP}[\textit{than}, \text{COMPS}\langle \text{NP}[\text{DEGREE}+] \rangle] : \boxed{3} \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R } \boxed{2}, \text{ VAL-R } \boxed{4}] \\ \text{GLUE} & \left\langle \begin{array}{l} \lambda x.tall(x) : \boxed{1}^e \rightarrow \boxed{4}^d, \\ \lambda G \lambda z \lambda x.\text{MORE}(G(x), z) : (\boxed{1}^e \rightarrow \boxed{4}^d) \rightarrow \boxed{3}^d \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t \end{array} \right\rangle \end{bmatrix}$$

The *than*-complement is obtained by combining the degree NP, such as (29), with the preposition:

(33) "than" (as in: "than 6 feet", "than Bill"):

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & _{prep}[\text{PFORM } \textit{than}, \text{ PRD -}] \\ \text{SUBJ} & \langle \ \rangle \\ \text{COMPS} & \langle \text{NP}[\text{SEM-R } \boxed{1}] \rangle \end{bmatrix} \\ \text{SEM-R} & \boxed{1} \\ \text{GLUE} & \langle \ \rangle \end{bmatrix}$$

I think there can be no intervening material between the comparative adjective and the *than*-phrase:

(34) * John is taller this year than 6 feet.

This is why the complement PP is on the COMPS list in (32).[10] In contrast, the complements we will see starting in the next subsection need not appear adjacent to the comparator, and will be put on a new nonlocal extraposition list.

[10]But it's not that simple when the comparator is separate – see point number 4 at the end of section 5.

4.3 Phrasal Comparative

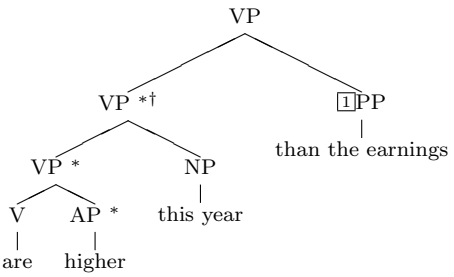
The phrasal comparative case is similar to the degree comparative case (32), except that the argument 3 describes an individual of type e rather than a degree, and therefore the second argument to MORE is obtained by applying the measure function on that individual. Also, the PP complement may be extraposed to the right (see e.g. (6)a), and so it is put not on the COMPS list but on a new non-local EXTRA list:

(35) "taller" (as in: "John is taller than Bill")

$$\begin{bmatrix} \text{LOCAL} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & adj[\text{PRD } +] \\ \text{SUBJ} & \langle \text{NP:}\boxed{1} \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R } \boxed{2},\ \text{VAL-R } \boxed{4}] \\ \text{GLUE} & \left\langle \begin{array}{l} \lambda x.tall(x) : \boxed{1}^e \rightarrow \boxed{4}^d, \\ \lambda G \lambda y \lambda x.\text{MORE}(G(x), G(y)) : (\boxed{1}^e \rightarrow \boxed{4}^d) \rightarrow \boxed{3}^e \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t \end{array} \right\rangle \end{bmatrix} \\ \text{NONLOCAL|INHER|EXTRA} & \{\text{PP}[\textit{than}]\text{:}\boxed{3}\} \end{bmatrix}$$

To demonstrate how the extraposition works, (6)a will get the tree in (36), where "this year" intervenes between "higher" and "than the earnings".

(36)



* INHER|EXTRA 1
† TO-BIND|EXTRA 1

In the tree, the value of the EXTRA appears as an INHERITED non-local feature and propagates up the tree starting from the comparator until it is closed off by also appearing on the TO-BIND|EXTRA list. The propagation of the EXTRA value is achieved by using the Nonlocal Feature Principle of (Pollard and Sag, 1994) as-is since it is stated in a general way on all nonlocal features. For the closing off, we need the following rule:

(37) Head-Extraposition Rule

$$\begin{bmatrix} \text{DTRS} & \begin{bmatrix} \text{EXTRAPOSITION-DTR|SYNSEM } \boxed{1} \\ \text{HEAD-DTR } \boxed{2} & \begin{bmatrix} \text{SYNSEM} & \begin{bmatrix} \text{LOCAL|CAT} & \begin{bmatrix} \text{HEAD } \textit{verb} \\ \text{SUBJ } \langle \textit{synsem} \rangle \\ \text{COMPS } \langle\ \rangle \end{bmatrix} \\ \text{NONLOCAL} & \begin{bmatrix} \text{INHER|EXTRA } \{\boxed{1},\ldots\} \\ \text{TO-BIND|EXTRA } \{\boxed{1}\} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Linear Precedence constraint: $\boxed{2} \prec \boxed{1}$

This rule is similar to the the Head-Filler Rule (Schema 6) in (Pollard and Sag, 1994, p.164) but has some differences: It refers to the EXTRA features rather than the SLASH; the extraposition daughter appears to the right of the head daughter while the filler daughter in Schema 6 appears to the left; and the head daughter has to be a saturated VP because of the following assumptions:

1. The extraposed complement may appear next to the comparative source (the AP, and for attributive comparatives we will see later, the NP) as well as extraposed further to the right after each of the VP's complements:

   (38) a. John was stronger than Bill yesterday in the garden.
   b. John was stronger yesterday than Bill in the garden.
   c. John was stronger yesterday in the garden than Bill.

2. The extraposed complement cannot be discharged inside the AP (and later, for attributive comparatives, inside the NP). Without this assumption we would get a spurious structural ambiguity for (38)a because the complement could be discharged either at the AP or the VP levels.

3. The extraposed complement cannot be discharged at the S level. It is hard to give examples of ungrammatical sentences that would result from not adopting this assumption. But this assumption also prevents a spurious structural ambiguity for (38)c.

I also assume that the extraposed complement cannot be discharged outside the S level, although it is again hard to give examples of ungrammatical sentences that would result from not adopting this assumption. This restriction is achieved by revising Schema 1 (which combines a saturated VP with its subject to form a sentence):

(39) Schema 1

The standard schema from (Pollard and Sag, 1994, p.402), together with the restriction: The SYNSEM|NONLOCAL|INHERITED|EXTRA of the HEAD-DAUGHTER is empty.

4.4 Comparative Subdeletion

In the case of comparative subdeletion shown here, and comparative deletion in the next subsection, the *than*-complement is a sentence missing a degree, or an adjective phrase, respectively. (A discussion of whether this fact requires us to revise the phrasal comparative case to also expect a sentence rather than a PP will be taken up in section 4.6). So we get an entry similar to (35) but with a different value expected on the EXTRA list and a different semantics:

(40) "wider" (as in: "Box1 is wider than Box2 is tall")

$$\left[\begin{array}{l}\text{LOCAL}\left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & _{adj}[\text{PRD }+]\\ \text{SUBJ} & \langle \text{NP:}\boxed{1}\rangle\end{array}\right]\\ \text{SEM-R} & [\text{HEAD-R }\boxed{2},\ \text{VAL-R }\boxed{4}]\\ \text{GLUE} & \left\langle\begin{array}{l}\lambda x.wide(x) : \boxed{1}^e \rightarrow \boxed{4}^d,\\ \lambda G\lambda Q\lambda x.\text{MORE}(G(x), \iota z.Q(z)) :\\ (\boxed{1}^e \rightarrow \boxed{4}^d) \rightarrow (\boxed{5}^d \rightarrow \boxed{6}^t) \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t\end{array}\right\rangle\end{array}\right]\\ \text{NONLOCAL|INHER|EXTRA}\ \left\{\text{S}\left[\begin{array}{l}\text{MARKING } \textit{than},\\ \text{NL|INHR|SLSH }\{\text{NP}[\text{DEGREE+}]:\boxed{5},\ldots\}\end{array}\right]:\boxed{6}\right\}\end{array}\right]$$

This entry expects (via EXTRA) a sentence marked with *than* and which is missing (via SLASH) a degree ($\boxed{5}$) – how such a sentence is obtained is explained in §4.4.1 below. The semantics of that marked sentence is a predicate that, given a degree, returns a truth value. For example, in "Box1 is wider than Box2 is tall", $Q = \lambda d.\text{ABS}(tall(box2), d)$, and so $Q(d)$ is true iff Box2 is d-tall. The semantics of *wider* then says that the width of x is more than the degree d that satisfies Q.[11] So the type of Q is $\boxed{5}^d \rightarrow \boxed{6}^t$, where $\boxed{5}$ is the handle of the missing degree NP, and $\boxed{6}$ is the head resource of the complement sentence.

4.4.1 The *than* Clause

How is the sentence that is marked with *than* obtained? First, instead of combining an absolutive gradable adjective like (28) with a degree NP like (29), a lexical extraction rule applies on (28) to move the degree NP from LCOMPS to SLASH (this rule is similar to other lexical extraction rules that move an argument from the COMPS list to the SLASH which are mentioned in (Pollard and Sag, 1994, ch.9)):

(41) "tall" (predicative, with degree extracted to SLASH):

$$\left[\begin{array}{l}\text{LOCAL}\left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & _{adj}[\text{PRD }+]\\ \text{LCOMPS} & \langle\ \rangle\\ \text{SUBJ} & \langle \text{NP:}\boxed{1}\rangle\end{array}\right]\\ \text{SEM-R} & [\text{HEAD-R }\boxed{2},\ \text{VAL-R }\boxed{4}]\\ \text{GLUE} & \left\langle\begin{array}{l}\lambda x.tall(x) : \boxed{1}^e \rightarrow \boxed{4}^d,\\ \lambda G\lambda z\lambda x.\text{ABS}(G(x), z) : (\boxed{1}^e \rightarrow \boxed{4}^d) \rightarrow \boxed{5}^d \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t\end{array}\right\rangle\end{array}\right]\\ \text{NONLOCAL|INHER|SLASH }\{\text{NP}[\text{DEGREE+}]:\boxed{5}\}\end{array}\right]$$

This entry combines as usual with "Box2 is" to form a slashed sentence "Box2 is _ tall". The *than* is simply a marking on that sentence (similar to the marking *that* on relative clauses), which is obtained by combining the sentence with (42) using the head-marker schema, to form (43).

[11] Or the maximal degree d that satisfies Q, if ABS is taken to mean $\geq$.

(42) "than" (as in: "than Box2 is tall", "than Box2 used to be"):

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{mark}[\text{SPEC S}[\textit{fin}]\ ] \\ \text{MARKING} & \textit{than} \end{bmatrix} \\ \text{GLUE} & \langle\ \rangle \end{bmatrix}$$

(43) "than Box2 is _ tall" (with missing degree):

$$\begin{bmatrix} \text{LOCAL} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb}[\textit{fin}] \\ \text{MARKING} & \textit{than} \\ \text{SUBJ} & \langle\ \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R } \boxed{6}] \\ \text{GLUE} & \left\langle \begin{array}{l} \textit{box}2 : \boxed{1}^e, \\ \lambda x \lambda P.\textit{present}(P(x)) : \boxed{1}^e \to (\boxed{1}^e \to \boxed{2}^t) \to \boxed{6}^t, \\ \lambda x.\textit{tall}(x) : \boxed{1}^e \to \boxed{4}^d, \\ \lambda G \lambda z \lambda x.\text{ABS}(G(x), z) : (\boxed{1}^e \to \boxed{4}^d) \to \boxed{5}^d \to \boxed{1}^e \to \boxed{2}^t \end{array} \right\rangle \end{bmatrix} \\ \text{NONLOCAL|INHER|SLASH} & \{\text{NP}[\text{DEGREE}+]{:}\boxed{5}\} \end{bmatrix}$$

If we combine the statements in GLUE just to see what we get, the result is: $\lambda z.\textit{present}(\text{ABS}(\textit{tall}(\textit{box}2), z)) : \boxed{5}^d \to \boxed{6}^t$, i.e. a predicate that is true of d iff Box2 is d-tall.

4.5 Comparative Deletion

(44) "taller" (as in: "John is taller than Bill was")

$$\begin{bmatrix} \text{LOCAL} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{adj}[\text{PRD } +] \\ \text{SUBJ} & \langle \text{NP}{:}\boxed{2} \rangle \end{bmatrix} \\ \text{SEM-R} & [\text{HEAD-R } \boxed{1},\ \text{VAL-R } \boxed{4}] \\ \text{GLUE} & \left\langle \begin{array}{l} \lambda x.\textit{tall}(x) : \boxed{2}^e \to \boxed{4}^d, \\ \lambda G \lambda Q \lambda x.\text{MORE}(G(x), \iota z.Q(\lambda y.\text{ABS}(G(y), z))) : \\ (\boxed{2}^e \to \boxed{4}^d) \to ((\boxed{5}^e \to \boxed{6}^t) \to \boxed{7}^t) \to \boxed{2}^e \to \boxed{1}^t \rangle \rangle \end{array} \right\rangle \end{bmatrix} \\ \text{NONLOCAL|INHER|EXTRA} & \left\{ \text{S}\begin{bmatrix} \text{MARKING } \textit{than}, \\ \text{NL|INHR|SLSH } \{\text{AP}{:}[\text{PRD}+, \text{SUBJ}\langle \text{NP}{:}\boxed{5} \rangle]{:}\boxed{6}, \ldots\} \end{bmatrix}{:}\boxed{7} \right\} \end{bmatrix}$$

The idea here is similar to comparative subdeletion, except that the EXTRA expects a sentence (with a *than* marking) that has a slashed AP. In the case of "John is taller than Bill was", the AP argument of *was* is moved from the verb's COMPS list to its SLASH set by the usual lexical extraction rule. Intuitively, the semantics for "(than) Bill was" is $Q = \lambda P.\textit{past}(P(\textit{bill}))$ of type $(e \to t) \to t$, i.e. a predicate that, given another predicate P of type $e \to t$, says whether Bill was P. If we take P to be $\lambda y.\text{ABS}(\textit{tall}(y), z)$ then $Q(P)$ would return *true* iff Bill was z-tall. So the semantics of *taller* in (44) claims that the tallness of x is more than this z.

A note about the use of SLASH inside the marked sentence: This is required because the missing AP could be deeply embedded, as shown in (45)a. Whether this is also true for the subdeletion case (45)b remains to be investigated.

(45) a. John is taller than I thought Bill was.
b. John is taller than I thought Bill was wide.

4.6 Why There Are Four Different Cases

We presented above four different lexical entries for *taller*: degree comparative (32), phrasal comparative (35), comparative subdeletion (40), and comparative deletion (44). The question arises what are the connections between the four cases, for example, among the following four:

(46) a. John is taller than 6 feet.
b. John is taller than Bill.
c. John is taller than Bill is.
d. John is taller than Bill is tall.

4.6.1 Degree Comparative vs. Phrasal Comparative

The first question is whether (46)b is simply a "sloppy" way of saying (46)a, in other words, is (46)b a way to say "John is taller than [some relevant property of Bill]", where the relevant property is "the tallness of"? For some evidence against that view, notice the following differences:

(47) a. John is 3 inches taller than Bill.
b. ? John is 3 inches taller than 6 feet.

(48) a. Who is John taller than?
b. ? How many feet is John taller than?
c. It is Bill that John is taller than.
d. ? It is 6 feet that John is taller than.

(49) a. John was taller last year than Bill.
b. ? John was taller last year than 6 feet.

4.6.2 Phrasal Comparative vs. Clausal Comparative

There is a lot of evidence that (46)b is not an elliptical form of (46)c or (46)d, i.e. that "than Bill" is a PP and not a sentence where everything except the subject has been elided.

The first argument, following Kennedy (1997) and Hankamer (1973), is this: a reflexive cannot be the subject of a clausal comparative, as shown in (50)b. This is because of Condition A of the Binding Theory in both GB and HPSG. In contrast, the NP in a phrasal comparative can be a reflexive anaphor, as shown in (50)a. The conclusion is that the *than*-complement must be a PP and not a clause, and that (50)a is not an ellipsis of (50)b.

(50) a. No star is brighter than itself.
b. * No star is brighter than itself is.

I can add that this can also be shown for reciprocals:

(51) a. John and Bill think that they are taller than each other.
b. * John and Bill think that they are taller than each other is/are.

The second argument of Kennedy and Hankamer is this: Suppose you agree with the assumption that if sentence A is an elided version of sentence B then for the purpose of extraction, A behaves the same as if it actually were B. Now, if (52)a were really an elided version of (52)b then extracting "Jorge" should be grammatical for one iff it is grammatical for the other. But as (52)c and (52)d show, this is not the case (the latter is ungrammatical because clausal-*than* imposes an extraction island). The same happens in (53). An account that assumes ellipsis in the phrasal case would have to explain the complicated interaction of the ellipsis with the other phenomena shown in (52) and (53), and so the non-ellipsis account is preferable.

(52) a. You're taller than Jorge.
b. You're taller than Jorge is.
c. You finally met somebody$_i$ you're taller than $\__i$.
d. * You finally met somebody$_i$ you're taller than $\__i$ is.

(53) a. Neptune is as bright as Uranus.
b. Neptune is as bright as Uranus is.
c. Which planet$_i$ is Neptune as bright as $\__i$?
d. * Which planet$_i$ is Neptune as bright as $\__i$ is?

Hankamer (1973) also points out that other languages (classic Latin and Greek, as well as Hungarian and Serbo-Croatian) have two clearly distinct constructions – a phrasal and a clausal, where the latter always uses a (conjunctive) word parallel to *than*, and the former is either marked with a specific case or uses a different (prepositional) word. The extraction restrictions shown above have parallels in those languages, implying that English also has two different *than*'s.

We can add further arguments: If (54)a were really obtained by ellipsis from the clausal case, we would expect (54)b to be acceptable, but it isn't. Conversely, if the VP in a clausal comparative as in (54)c could simply be elided, we would expect (54)d to be acceptable, but it isn't (or at least it is much less acceptable).

(54) a. John is taller than me.
b. * John is taller than me am.
c. John is taller than I am.
d. * John is taller than I.

Finally, the semantics we saw for (55)a and (55)b is different, as shown in (56), and it seems that this prediction is a correct.

(55) a. John was taller than Bill.
b. John was taller than Bill was.

(56) a. $past(\textsc{more}(tall(john), tall(bill)))$
$\Rightarrow$ at some time $t < t_{now}$, John's height at t was more than Bill's height at t.
b. $past(\textsc{more}(tall(john), \iota z.past(\textsc{abs}(tall(bill), z))))$
$\Rightarrow$ t some time $t < t_{now}$, John's height at t was more than Bill's height at some $t' < t_{now}$.

4.6.3 Comparative Deletion vs. Comparative Subdeletion

Kennedy (1997) shows evidence that (46)c is not an elliptical form of (46)d, i.e. that "than Bill is" does not have an ellipsis of the AP "tall".

First, assume to the contrary that (46)c is an elided form of (46)d, shown again here:

(57) John is [$_{\text{AP}}$ taller than [$_{\text{S}}$ Bill is [$_{\text{AP}}$ tall]]].

The problem is that if (46)c has an ellipsis, the elided AP should be *taller*, like the antecedent, rather than *tall*. It cannot be argued that the ellipsis mechanism can ignore this difference because such leniency does not appear in other cases of ellipsis. For example, in (58), the missing material can only be "more useful" and not just "useful".

(58) The space telescope was more useful this year, and the gamma ray satellite was $\triangle$, too.

Similarly, if the comparative is modified by a degree (as will be discussed in section 5.1), we get the same problem:

(59) a. Smith wants the novel to be 100 pages longer than her editors do.
b. Smith wants the novel to be 100 pages longer than her editors want it to be (long).

If we assume that (59)a is an elided form of (59)b then the problem is that the elided AP should ignore the degree modifier "100 pages". But leaving out such degrees cannot be done in general: the missing material in (60) can only be "300 pages long" and not just "long".

(60) Smith's novel will be 300 pages long, and Jones' will be $\triangle$, too.

The second argument points out that VP ellipsis can in principle take its antecedent from anywhere in the prior discourse. For example, Kennedy claims that (61)a has two possible interpretations: (61)b and (61)c:

(61) a. Marcus read every book I did and I bought every book Charles did.
b. Marcus read every book I read and I bought every book Charles bought.
c. Marcus read every book I read and I bought every book Charles read.

In contrast, (62)a can only have the interpretation (62)b but not (62)c.

(62) a. The table is wider than this rug is, but this rug is longer than the desk is.
b. The table is wider than this rug is wide, but this rug is longer than the desk is long.
c. The table is wider than this rug is wide, but this rug is longer than the desk is wide.

Kennedy claims that the reason for this difference is that "wider than this rug is" in (62)a is not obtained by ellipsis of an AP "wide", and so such an AP is not available as an antecedent for an ellipsis in the second conjunct.

This also explains why the following sentence does have both interpretations (62)b and (62)c:

(63) The table is wider than the rug is wide, but this rug is longer than the desk is.

In this sentence, the second conjunct is structurally ambiguous. One structure is the usual comparative deletion, giving the interpretation (62)b. But now since the first conjunct in (63) has comparative subdeletion and the AP "wide" is explicitly available there, the second conjunct of (63) can be obtained from the comparative subdeletion case (62)c through VP-ellipsis that elides the AP "wide" in the second conjunct.

4.6.4 Speculation

Why do we have all these cases of comparative constructions? Is there a commonality to all of them? The common thing is that the *than*-complement is a description of a degree, which can either be direct, as in the degree comparative (32), or indirect. Given an indirect description, one wants to get a degree out of it. We can speculate that if an object of type τ is expected by some operator but an object of another type is given, some general (cognitive) process can convert the latter object to an object of type τ. We can only demonstrate this here by reviewing again the three cases. The operator MORE is expecting a degree. If an individual is given instead of a degree (35), the obvious thing is to apply the gradable adjective on the individual to get its degree; if a degree predicate is given (40), the obvious thing is to assume that exactly one degree satisfies this predicate and use that degree; and if a higher-order predicate Q is given, which describes a set of properties, perhaps a better definition than the one given in (44) would say that we can assume there is exactly one individual that has exactly these properties in Q, and we can find that individual by intersecting the properties in Q, and get his degree, as shown in (64)a:

(64) a. $adj(\iota z.\{z\} = \cap Q)$
this means: $adj(\iota z.\forall P \in Q.\ z \in P)$
b. $tall(\iota z.\{z\} = \cap \lambda P.past(P(bill)))$
$\Rightarrow tall(\iota z.\{z\} = \{\textit{past-version-of-bill}\})$
$\Rightarrow tall(\textit{past-version-of-bill})$ (i.e. the height that Bill had)
c. $\iota z.Q(\lambda y.\text{ABS}(tall(y), z))$

Applying the idea in (64)a, we get the particular (64)b, which turns out to give us the same result as (64)c, which is the semantics we gave in (44).

5 Variations

We need to generalize the lexical entries seen so far to account for: (a) an explicit specification of the difference between the two compared values, and (b) a separate specification of the comparator *more*, *less*, or *as*.

5.1 Specification of Degree Difference

For the various entries shown above (except, perhaps, the degree comparative (32)), there is a more general version that has a specification of the comparative difference. For example, we generalize the phrasal comparative case (35) to:

(65) "taller" (as in: "John is 3 inches taller than Bill")

$$\left[\begin{array}{ll}
\text{LOCAL} & \left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & {}_{adj}[\text{PRD } +] \\
\text{SUBJ} & \langle \text{NP}:\boxed{1} \rangle \\
\text{LCOMPS} & \langle \text{NP}[\text{DEGREE}+]:\boxed{5} \rangle
\end{array}\right] \\
\text{SEM-R} & [\text{HEAD-R } \boxed{2},\ \text{VAL-R } \boxed{4}] \\
\text{GLUE} & \left\langle \begin{array}{l} \lambda x.tall(x) : \boxed{1}^{e} \rightarrow \boxed{4}^{d}, \\ \lambda z \lambda G \lambda y \lambda x.\text{MORE}(G(x), G(y), z) : \\ \boxed{5}^{d} \rightarrow (\boxed{1}^{e} \rightarrow \boxed{4}^{d}) \rightarrow \boxed{3}^{e} \rightarrow \boxed{1}^{e} \rightarrow \boxed{2}^{t} \end{array} \right\rangle
\end{array}\right] \\
\text{NONLOCAL|INHER|EXTRA} & \{\text{PP}[\textit{than}]:\boxed{3}\}
\end{array}\right]$$

Here, $\text{MORE}(a, b, c) \equiv [a = b + c]$. Therefore, the operator we saw in (11) is a shorthand, where $\text{MORE}(a, b) \equiv \exists c > 0.\text{MORE}(a, b, c)$. Similarly, $\text{LESS}(a, b, c) \equiv [a = b - c]$ and $\text{LESS}(a, b) \equiv \exists c > 0.\text{LESS}(a, b, c)$. In contrast, a degree difference cannot be specified for *as*, because it doesn't make any sense semantically ($\text{AS}(a, b) \equiv [a = b]$):

(66) * Book1 is 10 dollars as expensive as Book2.

So the more basic entry is (65), and (35) is derived from it by adding $\exists c$ to the semantics, and making the LCOMPS list empty. Similarly with all the other comparative cases.

There are in fact other variations along the same lines:

(67) a. John is three times taller than Bill.
b. John is at least three but not more than four times taller than Bill.

These require a less trivial shift in the analysis, but the discussion is beyond the scope of this paper.

5.2 Separating the Comparator

Some adjectives cannot have the *-er* suffix form and need to combine with the explicit comparator MORE. Moreover, there are two other possible comparators: LESS and AS. This means that the variety of the cases originates in the comparators rather than the adjective, and that all the entries that were shown above are actually obtained by a *lexical inflection* rule.

First, here is an example for the separation. For a phrasal comparative, instead of having an entry such as (65), we have the following two:

(68) "expensive" (as in: "Book1 is more expensive than Book2")

$$\left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & {}_{adj}[\text{PRD } +,\ \text{COMP-ER } -] \\
\text{SPR} & \langle \text{CompP} \rangle \\
\text{SUBJ} & \langle \text{NP}:\boxed{1} \rangle
\end{array}\right] \\
\text{SEM-R} & [\text{HEAD-R } \boxed{2},\ \text{VAL-R } \boxed{4}] \\
\text{GLUE} & \left\langle \lambda x.expensive(x) : \boxed{1}^{e} \rightarrow \boxed{4}^{d} \right\rangle
\end{array}\right]$$

(69) "more" (as in: "Book1 is 10 dollars more expensive than Book2")

$$\left[\begin{array}{ll}
\text{LOCAL} & \left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & \underset{comp}{\left[\begin{array}{ll}\text{SPEC A'} & \left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{l}\text{HEAD}|\text{COMP-ER } - \\ \text{SUBJ } \langle \text{NP:}\boxed{1}\rangle\end{array}\right] \\ \text{SEM-R } [\text{HEAD-R } \boxed{2},\ \text{VAL-R } \boxed{4}]\end{array}\right]\end{array}\right]} \\
\text{LCOMPS} & \langle \text{NP}[\text{DEGREE}+]\text{:}\boxed{5}\rangle
\end{array}\right] \\
\text{GLUE} & \left\langle \begin{array}{l}\lambda z\lambda G\lambda y\lambda x.\text{MORE}(G(x), G(y), z) : \\ \boxed{5}^d \rightarrow (\boxed{1}^e \rightarrow \boxed{4}^d) \rightarrow \boxed{3}^e \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t\end{array}\right\rangle
\end{array}\right] \\
\text{NONLOCAL}|\text{INHER}|\text{EXTRA} & \{\text{PP}[\textit{than}]\text{:}\boxed{3}\}
\end{array}\right]$$

A comparator word like *more* is of category *comp*. Notice the separation of the material in (65) between the two entries, in particular, the LCOMPS degree specification and the EXTRA complement are now located in the comparator *more*, whereas the adjective's entry becomes very simple, with a semantics that is just the measure function from individuals to their degree. (Although $\boxed{2}$ is mentioned but not used in (68), it is necessary there because the consumer of the AP, such as a raising verb, makes use of that handle – compare with, e.g., (27)). We will now have a version of (69) also for the cases of a degree comparative (32), comparative subdeletion (40), and comparative deletion (44). We will also have versions with LESS and with AS (the latter must always use a default $0 : \boxed{5}^d$ and have an empty LCOMPS).[12]

The adjective may pose restrictions on its comparator in SPR just as a noun selects for its determiner (agreement features). The adjective comes with a feature COMP-ER which specifies whether its base form could combine with the suffix *-er* or has to combine with *more*, as with *less* and *as*. Thus we have COMP-ER− in (68) because *expensiver* is ill-formed, but we have + in:

(70) "tall" (as in: "John is tall<u>er</u> than ...")

$$\left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & \underset{adj}{}[\text{PRD } +,\ \text{COMP-ER } +] \\ \text{SPR} & \langle \text{CompP}\rangle \\ \text{SUBJ} & \langle \text{NP:}\boxed{1}\rangle\end{array}\right] \\
\text{SEM-R} & [\text{HEAD-R } \boxed{2},\ \text{VAL-R } \boxed{4}] \\
\text{GLUE} & \left\langle \lambda x.\textit{tall}(x) : \boxed{1}^e \rightarrow \boxed{4}^d \right\rangle
\end{array}\right]$$

Note that thanks to the SPEC|CAT|HEAD|COMP-ER− in (69), that entry cannot combine with (70) to form the incorrect "more tall". Therefore, (70) can combine only with *less* and with *as*.

Now, here is the lexical rule:

[12] The comparator itself may be modified, as in "[[much more] expensive]". This can be achieved by generalizing (69) through abstracting over MORE in the semantics and adding appropriate handles in SEM-R, so that the modifier "much" could access them and modify the semantics: $(\text{MUCH}(\text{MORE}))(\textit{expensive}(x), \textit{expensive}(y))$, where $(\text{MUCH}(\text{MORE}))(a, b) \equiv a \gg b$.

(71) Lexical Inflection Rule for Predicative Adjectival Comparative *-er*:

$$\text{IF}\left[\begin{array}{l}\text{PHON } \langle \boxed{8} \rangle \\ \text{SYNSEM|LOCAL } \boxed{7}\left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & _{adj}[\text{PRD } +,\ \text{COMP-ER } +] \\ \text{SPR} & \langle \boxed{5}\text{CompP} \rangle \\ \text{SUBJ} & \langle \text{NP:}\boxed{1} \rangle\end{array}\right] \\ \text{SEM-R} & \boxed{2} \\ \text{GLUE} & \boxed{G_1}\end{array}\right]\end{array}\right]$$

$$\text{AND}\left[\begin{array}{l}\text{PHON } \langle more \rangle \\ \text{SYNSEM } \boxed{5}\left[\begin{array}{ll}\text{LOCAL} & \left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{ll}\text{HEAD} & _{comp}\left[\text{SPEC A}',\left[\begin{array}{l}\text{CAT|SUBJ } \langle \text{NP:}\boxed{1} \rangle \\ \text{SEM-R } \boxed{2}\end{array}\right]\right] \\ \text{LCOMPS} & \boxed{6}\end{array}\right] \\ \text{GLUE} & \boxed{G_2}\end{array}\right] \\ \text{NONLOCAL} & \boxed{9}\end{array}\right]\end{array}\right]$$

$$\text{THEN}\left[\begin{array}{l}\text{PHON } \langle \boxed{8}+er \rangle \\ \text{SYNSEM}\left[\begin{array}{ll}\text{LOCAL} & \left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{ll}\text{SPR} & \langle\ \rangle \\ \text{LCOMPS} & \boxed{6}\end{array}\right] \\ \text{GLUE} & \boxed{G_1} \oplus \boxed{G_2}\end{array}\right] / \boxed{7} \\ \text{NONLOCAL} & \boxed{9}\end{array}\right]\end{array}\right]$$

The notation A/B in the THEN clause is the unification of A and B, where collisitions between values are resolved according to A (i.e.: A overrides B). The lexical rule takes an adjective that has a COMP-ER− and combines it with one of the versions of *more*, effectively emulating the workings of the Head-Specifier Schema. An example application of this rule is: from (70) and (69) produce (65).

A few remarks about this chapter:

1. This rule is stated in a general way so that it will work with the several versions of *more* that correspond to the different comparative cases discussed above.

2. The absolutive case (28) could also be derived from the base case (70) by an inflection rule similar to (71), effectively as if we had a phonologically-null comparator with semantics ABS rather than MORE, and gave it as the second premise to the rule (71).

3. We need a similar rule for attributive comparatives (which are discussed in section 6), and for adverbial comparatives. But the three rules are really based on the same principle, and it's only the mode of combination of the adjective (or adverb) to the N' (or VP) that is different. So there might be a way to abstract the commonality between these three rules.

4. There is a slight problem with cases like "This present is more expensive than 30 dollars." This is a case of degree comparatives, as in (32), except that the comparator is separate from the adjective. The problem is that "than 30

dollars" should on the one hand be specified by the comparator and not the adjective, but on the other hand, this cannot be done by the EXTRA mechanism as it was presented above because, as discussed in section 4.2, the complement cannot extrapose farther than the adjective. One solution is to make the extraposition mechanism more fine grained by allowing the comparator to specify on the expected complement its highest possible discharging position. Another idea is for the comparator to somehow put the complement on the adjective's COMPS list.

5. For pairs of gradable adjectives that are antonyms of each other, and are associated with the same scale but with opposite polarities, the use of *less* is dispreferred. For example, for *tall* and *short*, "taller" is preferred to "less short" and "shorter" to "less tall". It's unclear to me whether the longer forms should be disallowed by the grammar or by some other language component.

6 Attributive Gradable Adjectives

After the interlude about explicit specification of degree difference and separate comparators, we return to comparative adjectives with an *-er* suffix, but turn to the attributive cases where the adjective modifies a noun.

6.1 Absolutive

Just as the binary adjective "married" had predicative and attributive versions in (27) and (26), so does the gradable adjective "tall" have two such versions. The predicative one was shown in (28), and the attributive one is:

(72) "tall" (as in: "John met a 6 feet tall man")

$$\left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & _{adj}\left[\begin{array}{l}\text{MOD N': } \boxed{1}\rightarrow\boxed{2} \\ \text{PRD } - \end{array}\right] \\
\text{LCOMPS} & \langle \text{NP}[\text{DEGREE}+]:\boxed{6}\rangle \\
\text{SUBJ} & \langle\ \rangle
\end{array}\right] \\
\text{SEM-R} & [\text{VAR-R } \boxed{3},\ \text{RESTR-R } \boxed{4},\ \text{VAL-R } \boxed{5}] \\
\text{GLUE} & \left\langle\begin{array}{l}
\lambda x.tall(x) : \boxed{3}^e \rightarrow \boxed{5}^d, \\
\lambda G\lambda z\lambda x.\text{ABS}(G(x), z) : (\boxed{3}^e \rightarrow \boxed{5}^d) \rightarrow \boxed{6}^d \rightarrow \boxed{3}^e \rightarrow \boxed{4}^t, \\
\lambda Q\lambda P\lambda x.P(x) \wedge Q(x) : (\boxed{3}^e \rightarrow \boxed{4}^t) \rightarrow (\boxed{1}^e \rightarrow \boxed{2}^t) \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t
\end{array}\right\rangle
\end{array}\right]$$

The first two items in GLUE are just like in the predicative version (28), and they combine to form: $\lambda x.\text{ABS}(tall(x), z)$, the property of being z-tall. The third item in the GLUE list is simply the combinator that connects this property with the noun's semantics, just as we saw in the attributive adjective in (26).

6.2 Comparative Deletion

The semantics we want:

(73) John read a longer book than Bill wrote.
$\exists x.book(x) \wedge$
$\quad \textsc{more}(long(x), long(\iota z.[book(z) \wedge wrote(bill, z)])) \wedge$
$\quad read(john, x)$
i.e.: John read a book which was longer than the book Bill wrote.

The entry is shown in (74). We have not shown explicitly all the items of GLUE but combined them together locally, to save space.

(74) "longer" (as in: "John read a longer book than Bill wrote")

$$\left[\begin{array}{ll} \textsc{local} & \left[\begin{array}{ll} \textsc{cat} & \left[\begin{array}{ll} \textsc{head} & adj\left[\begin{array}{l} \textsc{mod n'}:\boxed{1}\rightarrow\boxed{2} \\ \textsc{prd} - \end{array}\right] \\ \textsc{subj} & \langle\ \rangle \end{array}\right] \\ \textsc{glue} & \left\langle \begin{array}{l} \lambda Q\lambda P\lambda x.[P(x) \wedge \textsc{more}(long(x), long(\iota z.[P(z) \wedge Q(z)]))] : \\ (\boxed{6}^e \rightarrow \boxed{7}^t) \rightarrow (\boxed{1}^e \rightarrow \boxed{2}^t) \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t \end{array} \right\rangle \end{array}\right] \\ \textsc{nonlocal}|\textsc{inher}|\textsc{extra} & \left\{ \mathrm{S}\left[\begin{array}{l} \textsc{marking}\ \textit{than}, \\ \textsc{nl}|\textsc{inhr}|\textsc{slsh}\ \{\textsc{np}:\boxed{6},\ldots\} \end{array}\right]:\boxed{7} \right\} \end{array}\right]$$

Just as with comparative deletion and subdeletion in the predicative case, the entry simply specifies that it is expecting a sentence, marked with *than*, which is missing an NP. Thus, "Bill wrote" will get the semantics $\lambda x.wrote(bill, x) : \boxed{6}^e \rightarrow \boxed{7}^t$, and this predicate will be given to Q. The resulting semantics of "longer book than Bill wrote" would be $\lambda x.book(x) \wedge \textsc{more}(long(x), long(\iota z.[book(z) \wedge wrote(bill, z)]))$.

If the noun is in plural form, as in "John read longer books than Bill wrote", the semantics is more complicated, and a discussion of it is beyond the scope of this paper, but very similar ideas would work for the syntax-semantics interface.

An entry for a separate comparator similar to (69), and a lexical rule for *-er* similar to (71), can be written straightforwardly also for the attributive case (e.g., "a more expensive book than Bill wrote").

6.3 Comparative Subdeletion

Sentences like (75) and (76) are judged by some people as unacceptable, although they have perfectly good semantics, as shown here.

(75) John read a longer book than Bill read a magazine.
$\exists x.book(x) \wedge$
$\quad \textsc{more}(long(x), long(\iota z.[magazine(z) \wedge read(bill, z)])) \wedge$
$\quad read(john, x)$
i.e.: John read a book which was longer than the magazine Bill read.

(76) John opened a taller box than Bill opened a wide basket.
$\exists x.book(x) \wedge$
$\quad \textsc{more}(long(x), long(\iota z.[\exists b.basket(b) \wedge \textsc{abs}(wide(b), z) \wedge opened(bill, b)])) \wedge$
$\quad opened(john, x)$

i.e.: John opened a box which was taller than the width of the basket that Bill opened.

Nonetheless, Kennedy and Merchant (1997) mention that there is disagreement about judgements, and that the elided counterpart of (75) is much more acceptable, especially when the sentence's subject and the comparative clause's subject corefer, as shown in (77)a; and I think this is true for (77)b as well.

(77) a. John read a longer book than he did a magazine.
b. John opened a taller box than he did a wide one.

Furthermore, subdeletion is is also perfectly acceptable for other kinds of comparatives:

(78) a. John read more books than Bill read magazines. (nominal)
b. Mary spoke more enthusiastically than John spoke angrily. (adverbial)

I will therefore simply assume that the above subdeletion cases should be given entries, and that further factors of processing explain the varying degrees of naturalness. We do not show the lexical entries here, but appropriate subdeletion entries for (75) and (76) could be given along the lines of (74), following (40).

6.4 Direct Object Comparison – Inversion

The sentence (79)a is ambiguous between the two readings (79)b and (79)c. In this subsection we discuss the first reading, and in the next subsection, the second reading.

(79) a. John met a taller woman than Mary.
b. John met a woman (which was) taller than Mary.
c. John met a taller woman than Mary met.

(79)b in itself is not problematic – it is simply a reduced relative clause with the predicative phrasal-comparative version of *taller* from (35). In contrast, (79)a carries with it a presupposition that is absent from (79)b, namely that Mary is a woman. This can be seen by contrasting (79) with:

(80) a. # John met a taller woman than Bill. ($\rightsquigarrow$ Bill is a woman)
b. John met a woman (which was) taller than Bill. ($\not\rightsquigarrow$ Bill is a woman)

I think that inversion also applies to the other two cases of predicative comparatives, deletion and subdeletion:

(81) a. John met a woman (which was) taller than Mary used to be.
b. John met a taller woman than Mary used to be.

(82) a. John opened a box (which was) taller than box2 is wide.
b. John opened a taller box than box2 is wide.

A thorough analysis of where inversion is possible, what causes it, and how the result is related to the non-inverted version is beyond the scope of this paper. We can, however, give a preliminary entry in (83) for cases like (79)a. The entry has a similar semantics to the phrasal predicative case (35), except that it also has the combinator that combines the added semantics, such as MORE($tall(x), tall(mary)$), to the meaning P of the noun. Moreover, the entry specifies the appropriate presupposition in the CONTEXT attribute. The cases (81) and (82) can be handled similarly.

(83) "taller" (as in: "John met a taller woman than Mary", meaning "a woman taller than Mary")

$$\left[\begin{array}{ll}
\text{LOCAL} & \left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & adj\left[\begin{array}{l}\text{PRD -}\\ \text{MOD N':}\boxed{1}\rightarrow\boxed{2}\end{array}\right]\\
\text{SUBJ} & \langle\ \rangle
\end{array}\right]\\
\text{SEM-R} & [\text{VAR-R } \boxed{3},\ \text{RESTR-R } \boxed{4},\ \text{VAL-R } \boxed{5}]\\
\text{GLUE} & \left\langle\begin{array}{l}\lambda x.tall(x) : \boxed{3}^e \rightarrow \boxed{5}^d,\\ \lambda G\lambda y\lambda x.\text{MORE}(G(x), G(y)) : (\boxed{3}^e \rightarrow \boxed{5}^d) \rightarrow \boxed{6}^e \rightarrow \boxed{3}^e \rightarrow \boxed{4}^t,\\ \lambda Q\lambda P\lambda x.P(x) \wedge Q(x) : (\boxed{3}^e \rightarrow \boxed{4}^t) \rightarrow (\boxed{1}^e \rightarrow \boxed{2}^t) \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t\end{array}\right\rangle\\
\text{CONTEXT} & \left\langle P(y), \text{ where } P : \boxed{1}^e \rightarrow \boxed{2}^t \text{ and } y : \boxed{6}^e\right\rangle
\end{array}\right]\\
\text{NONLOCAL|INHER|EXTRA} & \{\text{PP}[\textit{than}]:\boxed{6}\}
\end{array}\right]$$

6.5 Phrasal Comparative

The semantics we want:

(84) John owns a faster computer than David.
$\exists x.computer(x) \wedge$
MORE($fast(x), fast(\iota z.[computer(z) \wedge \underline{own}(david, z)])) \wedge$
$own(john, x)$

The entry should be similar to (74), but with a slightly different semantics:

(85) "faster" (as in: "John owns a faster computer than David")

$$\left[\begin{array}{ll}
\text{LOCAL} & \left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & adj\left[\begin{array}{l}\text{MOD N':}\boxed{1}\rightarrow\boxed{2}\\ \text{PRD } -\end{array}\right]\\
\text{SUBJ} & \langle\ \rangle
\end{array}\right]\\
\text{GLUE} & \left\langle\begin{array}{l}\lambda R\lambda y\lambda P\lambda x.[P(x) \wedge \text{MORE}(fast(x), fast(\iota z.[P(z) \wedge R(y, z)]))] :\\ \textbf{?} \rightarrow \boxed{3}^e \rightarrow (\boxed{6}^e \rightarrow \boxed{7}^t) \rightarrow (\boxed{1}^e \rightarrow \boxed{2}^t) \rightarrow \boxed{1}^e \rightarrow \boxed{2}^t\end{array}\right\rangle
\end{array}\right]\\
\text{NONLOCAL|INHER|EXTRA} & \{\text{PP}[\textit{than}]:\boxed{3}\}
\end{array}\right]$$

Now we are faced with a puzzle: On the one hand, arguments similar to those given in section 4.6.2 seem to indicate that the complement "than Bill" is a PP and not a sentence that has a completely empty VP. In particular, reflexives and reciprocals can appear after "than":

(86) John cannot possibly own a faster computer than himself.
i.e.: John cannot possibly own a computer which is faster than the computer that John owns.

(87) John and Bill read a longer book than each other.
i.e.: John read a longer book than a book that Bill read, and vice versa.[13]

But on the other hand, how can the adjective know about the relation *own*? If we at least had an indication of an (antecedent contained) ellipsis in the *than*-complement, that would be easier:

(89) a. John owns a faster computer than David does (own).
b. John will own a faster computer than David will (own).

We do not have space here to discuss the analysis of sentences like (89), but preliminary investigation shows that the antecedent-contained ellipsis here behaves in exactly the same way as in other cases (such as with a relative clause), and the desired results are obtained from the interaction of such an ellipsis mechanism with a comparative deletion entry like (74).

My best guest currently is that (85) is the wrong solution, and (84) in fact has an ellipsis akin to stripping, as in:

(90) John owns a computer, but not David.

And although "than David" in (84) is a clause and not a phrase, a reflexive is allowed there because of a special exception to Condition A of the binding theory, namely that if the VP is completely elided, a reflexive is allowed in subject position and is allowed to be anaphoric to an item outside its minimal domain. But a more detailed investigation of this puzzle awaits further work.

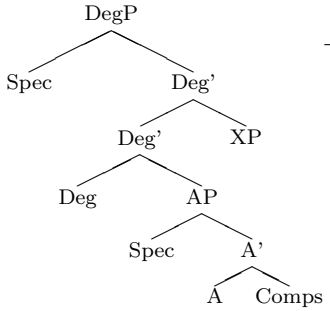
7 Comparison to Previous Work

7.1 Comparison to (Kennedy, 1997)

Kennedy works within a GB-like framework. He assumes a syntactic structure which is an extended projection of an adjective:

[13]This shows that the semantics we gave above for the attributive cases should be revised to use an existential rather than a definite for the second object given to MORE. Compare also to the similar:

(88) The four wheels are turning at a different rate than each other.
i.e.: Each wheel is turning at a rate different from the rates that the other wheels are turning at.



part	role	example
A	the adjective	*long*
Comps	complements	*(easy) to please*
Spec;AP	not used	
Deg	the degree modifier	*more/er*, *less*, *as*, ø
XP	comparative phrase/clause	*than Bill (is (wide))*
Spec;DegP	amount	*six feet*

In the absolutive case, Deg is ø (phononlogically null), and its semantics is:

(91) $\lambda G \lambda d \lambda x.\mathbf{R}(G(x), d)$
where G is the gradable adjective (from A), and d is a degree obtained from Spec;DegP (or from some salient standard value if there is no Spec;DegP) and $\mathbf{R} = \text{ABS} = \lambda z \lambda w.[z \geq w]$

If Deg is *more/er*, *less*, or *as*, and XP is not empty, then Deg may have the following interpretations, depending on the structure of XP:

(92) a. $\lambda G \lambda d \lambda x.\mathbf{R}(G(x), d)$ (comparative subdeletion)
b. $\lambda G \lambda Q \lambda x.\mathbf{R}(G(x), Q(G))$ (comparative deletion)
c. $\lambda G \lambda y \lambda x.\mathbf{R}(G(x), G(y))$ (phrasal comparative)

where **R** is determined according to the following table:

(93)

the Deg word	**R**	**R**'s value
more/er	MORE	$>$
less	LESS	$<$
as	AS	$\geq$

Semantic composition for the absolutive and phrasal cases is clear. For the others:

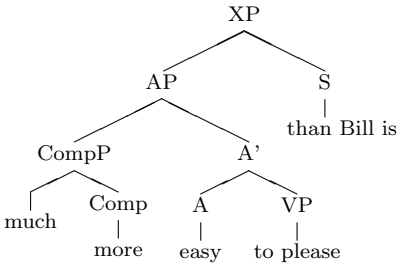
1. Comparative subdeletion:
   - Box1 is $[_{\text{DegP}}$ er $[_{\text{AP}}$ tall$]$ $[_{\text{PP}}$ than $[_{\text{CP}}$ Op_x Box2 is $[_{\text{DegP}}$ e_x ø wide$]]]]$
     e_x is bound by Op_x, possibly by "movement".
   - Then, a *covert* maximality operator turns $\lambda z.\text{ABS}(wide(box2), z)$ into $\max[\lambda z.\text{ABS}(wide(box2), z)]$.
   - Finally, this can be given to d in (92)a.
2. Comparative deletion:
   - John is $[_{\text{DegP}}$ er $[_{\text{AP}}$ tall$]$ $[_{\text{PP}}$ than $[_{\text{CP}}$ Op_x $[_{\text{C}'}$ Bill was $[_{\text{DegP}}$ e$]_x]]]]$
     e_x is bound by Op_x.
   - This time, Op_x has a meaning: $\lambda P \lambda G.\max[\lambda d.P(\lambda x.\text{ABS}(G(x), d))]$
   - If this operator is applied on the meaning of the comparative clause $\lambda D.past(D(bill))$, we get the semantics of the CP:
     $\lambda G.\max[\lambda d.past(\text{ABS}(G(bill), d))]$

- Finally, this can be given to Q in (92)b.

(Kennedy uses the maximality operator rather than the iota operator because he assumes ABS means $\geq$ rather than equality.)

Kennedy has good intuitions about the semantics (i.e. using measure functions rather than the other alternatives), as well as about assuming separate cases of comparative constructions which are not related to each other via ellipsis (as was discussed in sections 4.6.2 and 4.6.3). However, there are several problems with his analysis.

First, some syntactic issues. Why use DegP? Kennedy's DegP can appear anywhere that AP can, so it should be AP. Simply renaming the category won't help – the phrase structure rules for AP would need to be extended to account for Kennedy's tree structure above, but then the grammar would over-generate. Our analysis, in contrast, assumes that CompP is subordinate to AP:



The top here is written as XP because there might be material intervening between the AP and the *than*-complement (not shown here).

Also, Kennedy assumes that the *than*-complement is inside DegP, and does not discuss its extraposition. Presumably, he would do it in terms of "movement". Such a procedural specification has well-known problems with it, and a declarative treatment is preferred, as the one given in this paper using HPSG's nonlocal feature mechanism.

Furthermore, Kennedy's specification of the syntax-semantics interface is quite mysterious. According to him, parts of the semantics come from covert and other phonologically null operators (ø, $\mathrm{Op_x}$, ...). It is unclear whether such operators are independently motivated and may appear in other constructions, what the full details of his account are, and how one can calculate the semantics in general. In contrast, the account given in this paper, while building on Kennedy's semantics, does not assume any unnecessary empty entities: everything is specified lexically in the various entries for the comparatives. (Kennedy also did not deal with cases such as "John is 6 feet taller than Bill", where both his Spec;DegP and XP exist, but I did analyze such cases in section 5.1.)

7.2 Comparison to (Kennedy and Merchant, 1997)

Kennedy (1997) does not analyze the attributive cases. Kennedy and Merchant (1997) extend the analysis to the clausal attributive cases (but not the phrasal case).

The important difference between my analysis of attributive comparative deletion (as discussed in section 6.2) and theirs is that I do not assume any ellipsis, but they do. In other words, in a case such as (94)a, I assume that the clause "than Bill wrote" simply has a slashed NP, as shown in (94)b, and such a clause is expected on

the EXTRA list of *more* and used correctly by its semantics. In contrast, they assume that the NP in (94)a is elided. Moreover, that elided NP has the structure shown in (94)c, where it is the DegP (or, in our terms, the comparative AP), and not the NP, that is bound by a higher operator.[14]

(94) a. John read a more interesting book than Bill wrote.
b. John read a more interesting book than Bill wrote [NP].
c. John read a more interesting book than Bill wrote (a [DEGP] book).

The advantage of my analysis is its simplicity: it is simpler, if possible, to assume that the comparator expects a certain complement than to rely on ellipsis which assumes empty elements. This idea has guided the analysis of the different cases that were discussed in this paper.

Moreover, (94)a does not have VP-ellipsis, so presumably, there should be some special ellipsis of a NP – an unmotivated assumption since it's unclear that such an ellipsis can happen in other constructions. Moreover, even if that were the case, the elided NP should have been parallel to the antecedent NP "a more interesting book" – Kennedy himself relies on such an assumption when he argues that (predicative) comparative deletion is not obtained from comparative subdeletion (see the argument about (57) in section 4.6.3). To address this issue, Kennedy and Merchant (1997) need to resort to a device called "vehicle change". Leaving aside the merit of this device for other cases of ellipsis, their resorting to it and claiming that "a more interesting book" changes into "a [DEGP] book" is ad-hoc and not similar to the other cases of "vehicle change" they mention.

A complete comparison of the present analysis to theirs is beyond the scope of this paper because most of their analysis has to do with VP-ellipsis, which has not been covered here. But I'll just mention that even when there is VP-ellipsis in a case like (94)a, as shown in (95), I believe, in contrast to Kennedy and Merchant, that this is an elided form of (94)b and not of (94)c.

(95) John read a more interesting book than Bill did.

7.3 Comparison to (Heim, 1985)

Heim (1985) considers cases like the following:

(96) a. I have introduced better drummers to you than Karl.
b. I have introduced better drummers to you than to Karl.
c. I have introduced better drummers than bassists to you.

According to her analysis, "the two compared items ... somehow form a pair that is assigned scope as a pair":

(97) a. $\langle I, Karl\rangle$ $\lambda x.$[x has introduced better drummers to you]
b. $\langle you, Karl\rangle$ $\lambda x.$[I have introduced better drummers to x]
c. $\langle drummers, bassists\rangle$ $\lambda x.$[I have introduced better x to you]

[14] It is in fact not completely clear from their paper that this is their analysis, because they only claim in their section 4.1 that a sentence such as (94)a has ellipsis, but they spell out their analysis and arguments only for cases with VP-ellipsis, such as when "wrote" is replaced by "did".

The comparator then takes scope at the same level of that pair, leaving an open variable:

(98) *-er* $\langle drummers, bassists\rangle$ $\lambda x.\imath y.$[x has introduced y-good drummers to you]

The comparator is defined to take a pair of compared elements and a degree function f by which they are compared:

(99) *-er* $\langle a, b\rangle$ f is true iff $f(a) > f(b)$

The case (96)a is what we called attributive phrasal comparative in section 6.5. Obviously, Heim's analysis cannot be extended to the attributive clausal cases, because the clausal predicate may be different from the main predicate:

(100) I have introduced better drummers to you than Karl met.

Her analysis is also very different from the analysis of all the other cases shown in this paper as she assumes a quite complex and idiosyncratic syntax-semantics interface: some item from the main sentence is paired with the item from the comparative phrase by some unknown mechanism; and the *-er* is a scope taking operator (independently of the NP in which it is located). Such an analysis is therefore inconsistent with the rest of the grammar and the usual syntax-semantics interface.

Moreover, Heim conflates the ellipsis in (96)a with those in (96)b and (96)c, although the latter two are of a very different kind. I think they are a variant of argument-cluster coordination, similar to (101)a, where the verb is deleted but (some of) its arguments remain. In contrast, as explained in section 6.5, the deletion in (96)a is more similar to stripping, as in (101)b, where the entire VP is deleted, and so there is no remaining "hint" to its existence, making it harder to reconstruct. So (96)a should be given a different account than (96)b and (96)c.

(101) a. John introduced drummers to you, and bassists to Karl. (ACC)
b. John introduced drummers to you, but not Karl. (stripping)

8 Conclusion and Further Work

This paper presented a systematic account of the syntax and syntax-semantics interface of comparative constructions that are based on gradable adjectives. The main contribution is a thorough coverage of the central body of cases, putting different prior accounts into a unifying picture of entries that expect on their extraposition list exactly the complements they want, which sometimes have a slashed value inside them, and casting them in the declarative constraint-based framework of HPSG combined with Glue Semantics. The analysis was compared to previous works and shown to be more consistent and straightforward.

Further work includes extending the analysis here to non-gradable comparatives, nominal comparatives, and adverbial comparatives, as well as investigating how independently-motivated accounts of different kinds of ellipsis interact with the comparative constructions. Finally, a related phenomenon that should be investigated is superlatives.

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