DIFFERENT APPROACHES TO THE SEMANTICS OF COMPARISON
ARNIM VON STECHOW, LUBLIN AUGUST 2003

1. FIRST LECTURE: BASIC NOTIONS OF SYNTAX AND SEMANTICS

Plot of the lectures. The traditional Seuren/Stechow semantics for the comparative correctly predicts that negative polarity items (NPIs) are licensed in comparative complements. Furthermore it correctly accounts for the meaning of modals under the comparative. The theory faces problems for quantifiers in the comparative complement. These have to undergo long QR. The traditional theory has challenged recently by Wilkinson & Schwarzschild (W & S) for this reason. W & S offer an “interval semantics” for the comparative. This theory is able to interpret quantifiers within the comparative complement, but it cannot explain the distribution of NPIs. The lectures take up ideas by Irene Heim to overcome the dilemma.
The material for the lectures is taken mostly from handouts from talks given by Irene Heim. Irene kindly permitted me to use the material. In addition I have used material from lectures given by Cecile Meier at the ESSLI summer school last year. Cecile gave me her material as well. My only original contribution is a modification of Meier’s semantics for too and enough. The different handouts by Irene and Cecile are available on the server.

1.1. **Forms of comparison**

1. Comparative
   a. John is taller than Mary is (inequality)
   b. Mary is less tall than Mary is (negative inequality)
   c. Bertha is as tall as Martha (equality)

2. "The degree to which John is tall is greater than the degree to which Mary is tall."
   b. “The degree to which Mary is tall is smaller than the degree to which John is tall."
   c. “The degree to which Bertha is tall is at least as great as the degree to which Martha is tall."

3. a. "The height of John is greater than the height of Mary."
   b. "The height Mary is smaller than the height of John."

4. Positive
   a. The Woolworth Building is tall.
   b. The degree to which the Woolworth Building is tall is greater than the contextually salient standard for tallness of buildings.

5. Measure phrases and differentials
   a. The Woolworth Building is 767 feet tall.
   b. The Empire State Building is 2 feet taller than the Chrysler Building.
   c. The Sears tower is twice as tall as the Woolworth Building.

6. The degree to which the Woolworth Building is tall equals 767 feet.
   b. The degree to which the Empire State Building is tall equals the degree to which the Chrysler Building is tall plus 2 feet."
   c. The degree to which the Sears Tower is tall equals the degree to which the Woolworth Building is tall times 2.

1.2. **Syntax for the examples**

The syntax has not changed since (Bresnan, 1973).

6. Subdeletion is the basic case. Everything else is ellipsis and assumed to look like subdeletion at LF.

7. The knife is longer than the drawer is deep.

8. DS: John is er [than Mary is what-tall]-tall
    SS: John is er [than what3 Mary is t2-tall]-tall
    PF: John is tall-er [than what3 Mary is t2-tall] Subdeletion, extraposition
    John is tall-er [than what3 Mary is t2-tall] Comparative deletion, extraposition
    LF: [-er[what3 Mary is t2-tall]]1 John is t1-tall Obtained from LF by QR-ing the er-Phrase and by wh-movement within that Phrase

9. Comparative construction: DS
Comparative construction: SS (without extraposition and –er-movement)

\( (10) \) than-clause is a wh-clause with a degree gap. Degree-gap is trace of an empty operator interpreted as a \( \lambda \)-abstractor.

\( (11) \) –er and than-clause form a constituent at LF. (Than-clause is obligatorily extraposed at PF and –er is affixed to the adjective or supported by dummy much.)

\( (12) \) –er + than-clause is moved to a clausal scope at LF and leaves behind a degree variable.

1.3. **Semantics**

We start with the traditional Seuren/Stechow semantics.

\( (14) \) Types

e is the type of individuals, \( t \) is the type of truth values, \( s \) is the type of degrees.

If \( \sigma \) and \( \tau \) are types, \( (\sigma t) \) is at type. (Outermost brackets are omitted.)

\( (15) \) Semantic domains
a. $D_e, D_o, D_d$ are the sets of individuals, truth values, and degrees respectively.
b. $D_{ef} = \text{the set of functions with arguments in } D_e \text{ and values in } D_t$.

Gradable adjectives are relations between individuals and degrees.

(16) Measure functions (type ed)

$\text{TALL} = \lambda x \in D_e. \text{x’s height}$

$\text{INTELLIGENT} = \lambda x \in D_e. \text{x’s intelligence}$

$\text{HEAVY} = \lambda x \in D_e. \text{x’s weight}$

Measure functions assign a unique degree to individuals. $\text{TALL}(x)$ is the maximal degree to which $x$ is tall etc. Adjectives relate individuals with sets of degrees:

(17) Degree adjectives

$\left[ \text{tall} \right] = \lambda d \in D_d. \lambda x \in D_e. \text{TALL}(x) \geq d$

$\left[ \text{intelligent} \right] = \lambda d \in D_d. \lambda x \in D_e. \text{TALL}(x) \geq d$

More accurately, the degrees of adjectives must be restricted to particular sorts: $\left[ \text{tall} \right]$ is restricted to spatial distances measured in the vertical dimension. This will be done if needed.

(18) Comparative morpheme

$\left[ \text{-er} \right] = \lambda P \in D_{dt}. \lambda Q \in D_{dt}. P \subset Q$

Equivalent formulations:

(19) a. $\left[ \text{-er} \right] = \lambda P \in D_{dt}. \lambda Q \in D_{dt}. \forall d \in D_d [P(d) = 1 \rightarrow Q(d) = 1] \& \exists d [Q(d) = 1 \& P(d) = 0]$

b. $\left[ \text{-er} \right] = \lambda P \in D_{dt}. \lambda Q \in D_{dt}. \text{the maximal } d \text{ s.t. } P(d) = 1 > \text{the maximal } d \text{ s.t. } Q(d) = 1$

Formulation (19a) is Kennedy’s, formulation (19b) is almost Stechow’s (1984a). Stechow’s analysis is slightly more complicated, because he treats differential comparatives, which are not expressible in the semantics given here.

(20) Proto LF (QR the comparative DegP and wh-move what)
Chomsky’s Principle of Full Interpretation (PFI) says that we delete the semantically uninterpretable material at LF, i.e. *than*, *what* and *is*.

(21) Transparent LF (satisfies PFI)

(22) Interpretation
iff \( \{ d: \text{TALL}(\text{Mary}) \geq d \} \subset \{ d: \text{TALL}(\text{John}) \geq d \} \)

iff \( \text{max } d. \text{John is } d - \text{tall} > \text{max } d. \text{Mary is } d - \text{tall} \)

Exercise.

Give an analysis of the equative in the sentence

(23) Alla is as friendly as Sveta is.

**Hint:** Analyse the first **as** in analogy to the comparative suffix **–er**. Analyse the second **as** as a semantically empty complementizer.

A. Give an interpretation for the equative **as**.
B. Give the precise LF for sentence (23).
C. Give a precise calculation of the truth condition of your LF.

1.4. Licensing of NPIs

NPIs are licensed in downward entailing (DE) contexts; cf. (Ladusaw, 1979).

(24) An expression \( f \) is DE, if for any set \( M \) and \( N \): if \( f(M) \) is true and \( N \subset M \), then \( f(N) \) is true.

(25) **–er** is DE w.r.t. to first argument: suppose \( \text{er}(D)(P) \) is true and \( D' \subset D \).

Then **–er**(D')(P) is true.

Obvious from definition (18)

(26) a. Max is smarter than anyone else.
   b. Max is \([\text{er than whi } \exists x [x \neq \text{Max} \land x \text{ is } t_1\text{-smart}]]\text{-smart}
      = \{ d | \exists x [x \neq \text{Max} \land x \text{ is } d\text{-smart}] \} \subset \{ d | \text{Max is } d\text{-smart} \}

Recall that Ladusaw interprets NPIs as existential quantifiers. The meaning correctly predicts that Max is smarter than any other person.

(27) a. Max does as well as ever before.
   b. Max does \([\text{as whi } \exists i [i < i_0 \land \text{Max does } t_1\text{-well at } i]]\text{-well at } i_0
   c. \{ d | \exists i [i < i_0 \land \text{Max does } d\text{-well at } i] \} \subset \{ d | \text{Max does } d\text{-well at } i_0 \}

NPIs are interpreted within their CP. No long scoping is necessary.

(28) a. Max is smarter than everyone else.
   b. Max is \([\text{er than whi } \forall x [x \neq \text{Max} \implies x \text{ is } t_1\text{-smart}]]\text{-smart}
      \{ d | \forall x [x \neq \text{Max} \implies x \text{ is } d\text{-smart}] \} \subset \{ d | \text{Max is } d\text{-smart} \}

Wrong prediction. This means that Max is smarter than the least intelligent person different
from him.

(29)  Long QR:
\[ \forall x [x \neq \text{Max} \rightarrow \text{Max is } [\text{er than wh}_1 \ x \text{ is } \text{t}_1\text{-smart}]] - \text{smart} \]
\[ \forall x [x \neq \text{Max} \rightarrow \{d \mid x \text{ is } d\text{-smart} \} \subset \{d \mid \text{Max is } d\text{-smart} \} ] \]

Correct prediction. But we have to scope *everyone else* out of its finite clause, violating an island.

2.  **SECOND LECTURE: ADJECTIVAL POLARITY AND DUALITY RELATIONS**

2.1. **Properties of polar adjectives**

(30)  Converes
a. John is taller than Mary.
b. Mary is shorter than John.

The two mean the same. This must follow from the semantics of polarity plus the comparative.

(31)  a. Max is as old as Ede is.
b. Max is not younger than Ede is.
c. Max is older than Ede or he has the same age as Ede.

(b) follows from (a), (c) means the same as (a).

(32)  Cross-polar anomaly
a. John is 1.80 m tall
b. *John is 1.80 m short
c. *Alice is taller than Carmen is short.

Cf. (Stechow, 1984b), (Bierwisch, 1987), (Kennedy, 2001)

(33)  Less comparatives
a. Ede is less tall than Alla.
b. Ede is shorter than Alla.

2.2. **Semantics of antonyms**

Main idea: the negative pole of an antonym pair is treated as the negation of the positive pole. The account is very similar to that in (Stechow, 1984b) and (Kennedy, 2001). But the elegant formulation in terms of negation is due to Irene Heim.

(34)  Refinement of lexical entries: adjectives are relations that are restricted to certain sorts of degrees.

(35)  Amended entry for *tall*:
[\text{[tall]} = \lambda d: d \in \text{SD. } \lambda x. \text{TALL(x)} \geq d, \text{where SD is the set of spatial distances (e.g. a proper subset of } D_d)\]
i.e., [\text{[tall]}] is undefined (rather than false) for degrees that are not heights.

(36)  John is taller than Mary.
\( \{d \in DS \mid \text{TALL}(m) \geq d\} \subset \{d \in DS \mid \text{TALL}(j) \geq d\} \)

(37) Polarity

\[
\begin{align*}
\llbracket \text{short} \rrbracket &= \lambda d \lambda x. \neg \llbracket \text{tall} \rrbracket (d)(x) = \lambda d: d \in SD. \lambda x. \neg \text{TALL}(x) \geq d \\
\llbracket \text{slow} \rrbracket &= \lambda d \lambda x. \neg \llbracket \text{fast} \rrbracket (d)(x) = \lambda d: d \in VD. \lambda x. \neg \text{FAST}(x) \geq d, \text{where} \ VD \text{is the set of velocity degrees} \\
\llbracket \text{light} \rrbracket &= \lambda d \lambda x. \neg \llbracket \text{heavy} \rrbracket (d)(x) = \lambda d: d \in MD. \lambda x. \neg \text{HEAVY}(x) \geq d, \text{where} \ MD \text{is the set of mass degrees}
\end{align*}
\]

We first deduce some facts about converses.

(38) John is taller than Mary \( \iff \) Mary is shorter than John.

\( \{d \in SD \mid \text{TALL}(m) \geq d\} \subset \{d \in DS \mid \text{TALL}(j) \geq d\} \)

iff \( \{d \in SD \mid \neg \text{TALL}(j) \geq d\} \subset \{d \in DS \mid \neg \text{TALL}(m) \geq d\} \) (set theoretical law)

The set theoretical law used is this:

(39) Let A and B be subsets of U. Then

a. \( A \subset B \iff U \setminus B \subset U \setminus A. \)

b. \( A \subseteq B \iff U \setminus B \subseteq U \setminus A. \)

(40) John is not as smart as Mary \( \iff \) Mary is smarter than John

(41) Law of Comparability

Let \( M \) be a measure function from \( D_e \) into \( S \), \( S \) a subset of \( D_d \). Then for any \( x, y \in D_e \): \( M(x) > M(y) \) or \( M(x) = M(y) \) or \( M(x) < M(y) \).

Equivalently:

Then for any \( x, y \in D_e \): \( \{d \in S \mid M(x) \geq d\} \) or \( \{d \in S \mid \neg M(x) \geq d\} \).

(42) Equative

\[
\llbracket \text{as} \rrbracket = \lambda P. \lambda Q. P \subseteq Q
\]

(43) John is not as smart as Mary

iff \( \neg \{d \in IQ \mid \text{SMART}(m) \geq d\} \subset \{d \in IQ \mid \text{SMART}(j) \geq d\} \)

iff \( \{d \in IQ \mid \text{SMART}(j) \geq d\} \subset \{d \in IQ \mid \text{SMART}(m) \geq d\} \) (by Comparability)

iff Mary is smarter than John

2.3. Little and Less

(44) a. Mary is less tall than John.

b. Mary is shorter than John.

The synonymy of \textit{less tall} and \textit{shorter} follows from Heim’s treatment of \textit{little} as DegP negation. Cf. (Heim and Kennedy, 2002).\(^{1}\)

(45) \textit{little} takes a degree-argument and forms a generalized quantifier over degrees.

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\(^{1}\) More precisely, def. (85) on the printout of October 29, 2002. The lecture was hold by Heim and Kennedy, but I am sure that Heim presented the semantics of little a couple of years earlier in a talk.
(type d(dt,t)) \quad (H & K, 83)

\[[\text{l Little}]\equiv \lambda d. \lambda P_{dt}. P(d) = 0.\]

Intuitively: 'd-little' means 'not d' or 'not to degree d' (cf. 'not John': \(\lambda P_{ct}. P(j) = 0\))

(46) LF for 'Mary is less tall than John':

\[-\text{er than wh}_1 \begin{bmatrix} \text{t}_1 \text{little} \quad \text{J is t}_3 \text{ tall} \end{bmatrix} \text{2} \begin{bmatrix} \text{t}_2 \text{little} \quad \text{M is t}_4 \text{ tall} \end{bmatrix} \]

Heim comments: "The comparative quantifier is [-er than CP]. \text{little} is left behind inside the clause over which the comparative quantifier takes scope. Because \text{little} is left behind in the matrix clause, we expect a matching \text{little} in the elliptical 'than'-clause. \text{t little} itself is also a degree-quantifier, so this too needs to take scope at an interpretable position. (The required movement may be very short – just enough for interpretability. In the example, I have moved to the edge of the minimal clause, but there may be lower possible landing sites.)

(47) Interpretation:

\[[3 \text{ John is t}_3 \text{ tall}] = \{d: \text{TALL}(j) \geq d\} \quad \text{t}_1 \text{ little}][t] = \lambda P_{dt}. P(g(1)) = 0 \\
[[\text{t}_1 \text{ little 3 John is t}_3 \text{ tall}]] = 1 \text{ iff } \neg\text{TALL}(j) \geq g(1) \\
[[\text{wh}_1 [\text{t}_1 \text{ little} \quad \text{J is t}_3 \text{ tall}]] = \{d: \neg\text{TALL}(j) \geq d\} \]

by analogous calculation:

\[[2 [\text{t}_2 \text{ little} \quad \text{M is t}_4 \text{ tall}]] = \{d: \neg\text{TALL}(m) \geq d\} \]

using entry for -er, the complete structure is true iff

\{d: \neg\text{TALL}(j) \geq d\} \subset \{d: \neg\text{TALL}(m) \geq d\}

equivalently, \{d: \text{TALL}(m) \geq d\} \subset \{d: \text{TALL}(j) \geq d\},

i.e., Mary is shorter than John

Correct predictions for examples problematic for (Rullmann, 1995) 2:

(48) John is less tall than any of the girls.

[-er than wh}_1 [[\text{t}_1 \text{ little} \quad \text{any of the girls are t}_3 \text{ tall}]] \text{2} [[\text{t}_2 \text{ little} \quad \text{J is t}_4 \text{ tall}]]

\{d | \neg\exists x [\text{girl}(x) \& \text{TALL}(x) \geq d]\} \subset \{d | \neg\text{TALL}(j) \geq d\}

equivalently: \{d | \text{TALL}(j) \geq d\} \subset \{d | \exists x [\text{girl}(x) \& \text{TALL}(x) \geq d]\}

'he is shorter than the shortest girl'

2.4. Crosspolar anomaly

(49) a. John is 1.80 m tall.

b. *John is 1.80 m short.

(Stechow, 1984b): positive extents measure the finite length of an interval starting with 0. 1.80 m of tallness is the length of the interval \{d \in m \mid 1.80 \text{ m} \geq d\}. Negative extents should measure the length of an interval starting with \(\propto\). But there is no such start; the interval \{d \in m \mid \neg 1.80 \text{ m} \geq d\}, i.e. \{d \in m \mid 1.80 \text{ m} < d\} has no finite length.

(50) 1.80 m is of type (dt)t. \[[1.80 \text{ m}]\equiv \lambda P_{dt}. P\text{ is a set of meters & P has a finite length}. P(1.80 \text{ m}) = 1.\]
(51) LF for (49a): $\textbf{1.80m}_1 \textbf{ John is } t_1 \textbf{ tall}$
    John's height $\geq 1.80 \text{ m}$
(52) LF for (49a): $\textbf{1.80m}_1 \textbf{ John is } t_1 \textbf{ short}$
    undefined
(53) *Alice is taller than Carmen is short.
(54) (Stechow, 1984b)
    the max d.Alice is d-tall > the max d.Carmen is d-short (= the max d.Carmen is not d-tall)
There is no maximal degree of shortness!
(55) (Kennedy, 2001)
    $\{d \mid \neg \text{TALL}(c) \geq d\} \subset \{d \mid \text{TALL}(a) \geq d\}$
This is logically false, because a proper initial segment of a scale can never be subset of a proper final segment of a scale.

3. **Third Lecture: Modals in Comparatives**

3.1. **Modals and intensional semantics**

Literature: (Kratzer, 1977), (Kratzer, 1981), (Kratzer, 1991). The intensional semantics given here is in the style of (Heim and Kratzer, 1998: ch. 12)

(56) a. John must leave.
    b. John may come.
(57) $[[\textbf{must}]] = \lambda w \in D_s. \lambda p \in D_{st}. \forall w' \in \text{Acc}(w) : p(w') = 1.$
    $[[\textbf{can}]] = \lambda w \in D_s. \lambda p \in D_{st}. \exists w' \in \text{Acc}(w) : p(w') = 1.$

**must** means "true in every accessible world". **can** means "true in some accessible world". The kind of accessibility is determined by the context. Every modal expressing necessity is a universal quantifier over worlds and every modal expressing possibility is an existential quantifier of worlds. Modals are intensional operators and require an intensional semantics.

(58) Types
a. $e$ is the type of individuals, $t$ is the type of truth values, $d$ is the type of degrees, $s$ is the type of worlds.
    b. If $\alpha$ and $\beta$ are types, $(\alpha \beta)$ is at type. (Outermost brackets are omitted.)
    c. If $\alpha$ is a type, then $s \alpha$ is a type.

(59) Semantic domains
a. $D_e, D_t, D_d, D_s$ are the sets of individuals, truth values, degrees, and worlds respectively.
    b. $D_{st}$ is the set of functions with arguments in $D_s$ and values in $D_t$.
    c. $D_{sw}$ is the set of functions from $W$ in $D_{sw}$ to $W$ the set of worlds.

The interpretation $[[\ldots]]$ depends on a world parameter $w$, the world of evaluation or index world. For any expression $\alpha$, $[[\alpha]]_w$ is the extension of $\alpha$ w.r.t. $w$ and $[[\lambda w. [[\alpha]]_w]]$ is the intension of $\alpha$. 


(60) Lexical entries as intensions
a. $\llbracket \text{John}_e \rrbracket = \lambda w \in D_s. \text{John}$
b. $\llbracket \text{leaves}_{et} \rrbracket = \lambda w \in D_s. \lambda x \in D_c. \text{John leaves in } w$

Evaluation of the LF for the sentence *John leaves*:

(61) $\llbracket \text{John}_e \; \text{leaves}_{et} \rrbracket_w$
    
    $= \llbracket \text{leaves}_{et} \rrbracket_w(\llbracket \text{John}_e \rrbracket_w)$, by functional application (FA)
    
    $= \lambda w. \lambda x. x \text{ leaves in } w(w)$ ($\llbracket \text{John}_e \rrbracket_w$) meaning of *leaves*
    
    $= \lambda x. x \text{ leaves in } w (\llbracket \text{John}_e \rrbracket_w)$ function conversion (FC)
    
    $= \llbracket \text{John}_e \rrbracket_w \text{ leaves in } w$ FC
    
    $= [\lambda w \in D_s. \text{John}(w)] \text{ leaves in } w$ meaning of *John*
    
    $= \text{John leaves in } w$

(62) LF for *John must leave*

```
          I
          |   I
must     VP
        / \\
   must   VP
      /   \\
DP  V  John
     /   \\
     et
   leave
```

*must* operates on a proposition and has a truth value $t$ as argument in LF. We need a special principle of composition that operates on the VP-intension, not the VP-extension.

(63) Intensional functional application (IFA) (Heim and Kratzer, 1998: 308)³

Let $\alpha$ be a branching node of type $\tau$ whose daughters are $\{\beta, \gamma\}$, $\beta$ of type $(s \sigma) \tau$ and $\gamma$ of type $\tau$. Then $\llbracket \alpha \rrbracket_w = \llbracket \alpha \rrbracket_w(\lambda w'. \llbracket \beta \rrbracket_{w'})$.

(64) Evaluation of (62)

$\llbracket \text{must John leave} \rrbracket_w$

$= \llbracket \text{must} \rrbracket_w(\lambda w'. \llbracket \text{John leave} \rrbracket_{w'})$ by IFA

$= \llbracket \text{must} \rrbracket_w(\lambda w'. \text{John leaves in } w')$ see (61)

$= [\lambda w \in D_s. \lambda p \in D_{st}. \forall w' \in \text{Acc}(w): p(w') = 1](w) (\lambda w'. \text{John leaves in } w')$

meaning of *must*

$= [\lambda p \in D_{st}. \forall w' \in \text{Acc}(w): p(w') = 1](\lambda w'. \text{John leaves in } w')$ FC

$= \forall w' \in \text{Acc}(w): [\lambda w'. \text{John leaves in } w'](w') = 1$ FC

$= \forall w' \in \text{Acc}(w): \text{John leaves in } w'$ FC

3.2. *Modals in comparative complements*

Modal verbs cannot move at LF. The predictions of the traditional theory outlined here are these:

(65) Prediction 1. A necessity in the complement gives rise to a "minimum" reading, a possibility gives rise to a "maximum" reading. These predictions are borne out by the facts.

³ This is a metalinguistic version of Montague's $^\wedge$-operator.
Literature: (Stechow, 1984a), (Rullmann, 1995), (Heim and Kennedy, 2002).

(66) Intensional entry for adjectives

\[[\text{long}]_w = \lambda w. \lambda d. \lambda x. \text{LONG}(w)(x) \geq d\]

where \(\text{LONG}(w)(x)\) is the length of \(x\) in \(w\).

\[[\text{short}]_w = \lambda w. \lambda d. \lambda x. \neg \text{LONG}(w)(x) \geq d\]

where \(\text{LONG}(w)(x)\) is the length of \(x\) in \(w\).

\[= \lambda w. \lambda d. \lambda x. \text{LONG}(w)(x) < d\]

(67) a. The paper is longer than required.

'The length of the paper exceeds the minimal length required'

b. The paper is longer than allowed.

'The length of the paper exceeds the maximal length allowed'

(68) LF for (67a)

\[\text{er wh}_1 \text{ required the paper is } t_1 \text{ long; the paper is } t_2 \text{ long}\]

\[\{d | \forall w' \in \text{Acc}_w: \text{LONG}_{w'}(\text{the paper}) \geq d\} \subset \{d | \text{LONG}_w(\text{the paper}) \geq d\}\]

(69) LF for (67b)

\[\text{er wh}_1 \text{ allowed the paper is } t_1 \text{ long; the paper is } t_2 \text{ long}\]

\[\{d | \exists w' \in \text{Acc}_w: \text{LONG}_{w'}(\text{the paper}) \geq d\} \subset \{d | \text{LONG}_w(\text{the paper}) \geq d\}\]

### 3.3. Less comparatives under modals

#### 3.3.1. Data

(70) a. The paper is shorter than required.

'The length of the paper is smaller than the minimal length required'

b. The paper is less long than required.

'The length of the paper is smaller than the maximal length required'

Rullmann's (1995) observation: less-comparatives are ambiguous between a minimal and a maximal reading. –er-comparatives of the corresponding negatively polar adjectives are not.

(71) Lucinda is driving less fast than is allowed on this highway. (from Rullmann 1995a)

a. she's driving below the speed limit

b. she's driving below the minimum speed

(72) Lucinda is driving faster than is allowed on this highway.

a. she's driving above the speed limit

b. *she's driving above the minimum speed

(73) in monastery scenario:

a. I slept more than was allowed.

(true if, e.g., I slept 7 hours)

b. #I prayed more than was allowed.

(cannot be true in this scenario)

(74) John is less strong than he could be.

(75) Students spend less than a professor can spend.

(76) The helicopter was flying less high than a plane can fly.  

Rullmann
(77) I got more than I could ever pay back.
(78) I got less than I could ever live on.

- existence presuppositions for each reading:

Only the less<min reading is available when no maximum exists, and only the less<max reading is available when no (non-trivial) minimum exists.

(79) The monastery scenario: Praying is good, sleeping is bad.
You are required to pray at least 6 hours a day, and the more you pray, the better.
You are allowed to sleep at most 6 hours a day, and the less you sleep, the better.

(80) I slept less than was allowed.
(true if, e.g., I slept 5 hours; less<max reading)

(81) I prayed less than was allowed.
(true if, e.g., I prayed for 5 hours; less<min reading)

(82) *Mary is taller than John isn’t

3.3.2. Ambiguity of less as a scope ambiguity

The covert little in the than-clause can take scope either below or above the modal operator. This is Heim’s implementation of Rullemann.

allowed. This will give us the two readings:

(83) little above allowed: below-maximum reading
little below allowed: below-minimum reading

(84) Lucinda drove less fast than she was allowed to.

(85) LF-(i): [-er than wh1 [t1 little]3 was allowed L to drive t3 fast]2
[t2 little]4 L drove t4 fast

interpretation:
{d: ¬∃w ∈ Acc: L drives d-fast in w} ⊆ {d: ¬L drives d-fast}
equivalently:
{d: L drives d-fast} ⊆ {d: ∃w ∈ Acc: L drives d-fast in w}
i.e., her actual speed is below her highest allowable speed

(86) LF-(ii): [-er than wh1 was allowed [t1 little]3 L to drive t3 fast]2
**3.4. too and enough**

Reading: (Meier, 2003)

(87) Bertha is *old* enough to drive a car.
'The age of Bertha is greater of equal to the age which Bertha must have to be allowed to drive a car.'
'Bertha's age is greater of equal to the minimal age that B. has in every world where she is allowed to drive a car'

(88) The food is too *good* to throw (it) away.
'The quality of the food exceeds the maximal quality which the food can have and be thrown away'
'The quality of the food is greater than the maximal quality which the food has in some world where it is allowed to be thrown away'

(89) a. The submarine is *small* enough to pass through the hole.
'The seize of the submarine doesn't exceed the maximal seize that enables the submarine to pass through the hole'
b. She was too *young* to date.
'Her age was below the the minimal age which she must have in order to date.'

(90) $[[\text{too}]]^\prime = \lambda_{P_{st}} \cdot \lambda_{P_{(sd)}} \cdot \{d \mid \exists w' \in \text{Acc}(w): p(w') \& P(w')(d) \} \subseteq P(w)$

(91) $[[\text{enough}]]^\prime = \lambda_{P_{st}} \cdot \lambda_{P_{(sd)}} \cdot \{d \mid \forall w' \in \text{Acc}(w): p(w') \rightarrow P(w')(d) \} \subseteq P(w)$

A semantics for *too* along these lines is sketched in (Heim, 2001); there only more simple constructions are considered.

(92) Mary is tall enough to look over the wall.
$\{d \in SD \mid \forall w' \in \text{Acc}(w): \text{TALL}(w')(m) \geq d \rightarrow \text{Mary looks over t.w. in } w' \} \subseteq \{d \in SD \mid \text{TALL}(w')(m) \geq d \}$

iff $\{d \in SD \mid \forall w' \in \text{Acc}(w): \text{Mary looks over t.w. in } w' \rightarrow \text{TALL}(w')(m) \geq d \} \subseteq \{d \in SD \mid \text{TALL}(w')(m) \geq d \}$

(93) SS for (87)
(94) LF for (87)

The combination of enough with its complement requires IFA. The object *a car* should QR at LF, which is neglected.

(95) Bertha is old enough to drive a car.
\[
\{ d \in SD \mid \forall w' \in Acc(w): B \text{ drives a car in } w' \rightarrow OLD(w')(B) \geq d \}
\subseteq \{ d \in SD \mid OLD(w')(M) \geq d \}
\]
‘The minimal age Bertha has in every world where she is allowed to drive a car is smaller or equal to her actual age’

So Bertha has reached the minimal age whence she may drive.

(96) Bertha is too old to drive a car.
\[
\{ d \in SD \mid \exists w' \in Acc(w): M \text{ drives a car in } w' \land OLD(w')(M) \geq d \}
\subseteq \{ d \in SD \mid OLD(w')(M) \geq d \}
\]
‘The maximal age B has in some word where she is allowed to drive a car is smaller than her actual age’

So Bertha has passed the highest age where one is allowed to drive.

(97) *too* + CP and *enough* + CP are duals (cf. (Bierwisch, 1987), (Meier, 1999).
a. Bertha is old enough to drive a car.
a’. Bertha is not too young to drive a car.
b. Bertha is too old to drive a car.
b’. Bertha is not young enough (anymore) to drive a car.
c. Bertha is young enough to participate at the Tour de France.
c’. Bertha is not too old to participate at the Tour de France.
d. Bertha is too young to participate at the Tour de France.
d’. Bertha is not old enough to participate at the Tour.

Exercise:
1. Convince yourself by calculation that a/a’, b/b’, c/c’ and d/d’ mean the same.
2. Give a precise LF for at least one of these in your mother tongue, e.g. Polish, Ukrainian, Czech, Russian.
3. Formulate a semantics for too and enough that achieves lexical control for the PRO-subject in the CP-complement and give a detailed LF.

Hints.
a. Infinitivals have to be interpreted in the style of Heim & Kratzer as abstracts created by a semantically empty PRO. Consider PRO to drive a car
   SS: PRO₁ [t₁ drive a car]
   LF: 1 [1 drive a car] (Erase PRO by the Principle of Full Interpretation, interpret the movement index as \( \lambda_1 \). The LF is of type.)
b. Subject control enough/too must operate the subjectless adjective and the (subjectless) infinitival. The semantic rule for enough will be something like this:
   \[ \text{enough} \text{ (w)(P)(R)(x)} \iff \{d \mid \forall w' \in \text{Acc}(w): P(w')(x)\} \subseteq \{d \mid R(w)(d)(x)\}, \] where P is the meaning of the CP-complement, R the one of the adjective and x is the subject.
4. Write an LF with all nodes and types.
5. Calculate the proposition expressed by a too- or an enough-construction.

(98) Laws of duality cf.
a. Predicate Logic
\[\exists x \varphi \leftrightarrow \neg \forall x \neg \varphi\]
\[\forall x \varphi \leftrightarrow \neg \exists \neg \varphi\]
\[\exists x \neg \varphi \leftrightarrow \neg \forall \varphi\]
\[\forall \neg \varphi \leftrightarrow \neg \exists \varphi\]

b. Modal Logic\(^4\) (L for “necessarily”, M for “possibly”)
\[M \varphi \leftrightarrow \neg L \neg \varphi\]
\[L \varphi \leftrightarrow \neg M \varphi\]
\[M \neg \varphi \leftrightarrow \neg L \varphi\]
\[L \neg \varphi \leftrightarrow \neg M \varphi\]

c. schon (already, uzhe, juz) – noch (eshche)
\[\text{schon } \varphi \leftrightarrow \neg \text{mehr } \neg \varphi\]
(mehr is the NPI-variant of noch)
\[\text{noch } \varphi \leftrightarrow \neg \text{ schon } \neg \varphi\]

d. enough/too
\[\text{enough } \varphi \ D \leftrightarrow \neg \text{too } \varphi \lambda d \neg D(d)\]
\[\text{too } \varphi \ D \leftrightarrow \neg \text{enough } \varphi \neg \text{too } \varphi \lambda d \neg D(d)\]

3.4.1. Comparison with (Meier, 2003)

(99) (Meier, 2003): LF for (95):

\[\text{The CP-complement is a can-conditional by stipulation.}\]

(100)

\[(33)\quad \text{[can}^R\text{]} = f : D(s, \varphi, \varphi, \varphi, t))\]
For any world \(w \in W\), conversational background \(h \in D_h\), and
propositions \(p, q \in D_p\):
\[f(w)(h)(q)(p) = 1 \text{ iff } \bigcap (h(w) \cup \{p\}) \cap q \neq \emptyset.\]

(101) Meier’s enough

\(^4\) (Aristoteles, 1996: see end of the book)
Translation in our terms

\[ [[\text{enough}]]_w = \min_d \lambda d. Q(w)(P(d)) \leq \max_d \lambda d. P(w)(d) \]

(103) \[ \min_d \exists w' \in \text{Acc}(w) \{ \text{Bertha drives a car in } w' \& \text{Mary is } d-\text{old in } w' \} \leq \max_d \text{Bertha is } d-\text{old in } w \]

Remarks. 1. It is not possible to express this in terms of intervals, because the \text{Q}-argument of \text{enough} contains an invisible conditional \textit{can}. But \[ \{ d \mid \exists w' \in \text{Acc}(w) \{ \text{Bertha drives a car in } w' \& \text{Mary is } d-\text{old in } w' \} \} \] is a maximal age of permission.

2. If the \text{CP-complement} did contain an invisible conditional \textit{must}, we would obtain a wrong result. The presence of the \textit{can} in the \text{CP complement} \textit{must} be stipulated, which makes the semantics non-compositional.

Meier's too

\[ [[\text{too}]] = f : D_{(s, \langle s, (p, t) \rangle, \langle (d, p), t \rangle)} \]

For all \( w \in W, Q \in D_{(s, (p, t))} \) and \( P \in D_{(d, p)} \):

\[ f(w)(Q)(P) = 1 \iff \max(\lambda e. P(e)(w)) > \max(\lambda e^*. Q(w)(P(e^*))) \]

Comment: Since the \text{CP-complement} contains a conditional \textit{can}, we have to compare two maximal degrees, whereas we compared a minimal and a maximal in the former rule.

(105)
Conclusion: The main disadvantage of Meier's account is the syntactic stipulation that the CP-
Complement must be a can-statement

4. LECTURES FOUR AND FIVE: ON QUANTIFIERS AND NPIs IN COMPARATIVE
Clauses

With some tiny changes the following material is taken literally from a handout for a talk given
by Irene Heim in Tübingen in June 2003; cf. (Heim, 2003).

4.1. A. The Generalized Quantifier analysis of degree clauses

This analysis is a descendant of Larson (1988) and is arguably equivalent to the proposal of
(Schwarzschild and Wilkinson, 2002) (=S&W) for all relevant cases. (See appendix for more
precise information.)

adjective meanings:

(106) Adjectives relate individuals to sets of degrees.
    \[ \text{x is D-tall iff } x\text{'s height } \in \text{ D} \]

Adjectives now have the type (dt)(et). S&W call a set of degrees an interval.

LF-syntax: Exactly as before modulo type changes.

(107) \[ \text{wh-movement and ellipsis in than-clause; } \text{er + than-clause a constituent} \]
    \[ \text{John is taller than Mary is.} \]
    \[ \text{LF: John is [-er than wh₁ Mary is } t_{1\_tall}] \text{ tall} \]

interpretation of the than-clause:

(108) \[ \text{than vacuous, wh = λ-abstraction} \]
    \[ \text{than wh₁ Mary is } t_{1\_tall} \]
    \[ \text{interpreted as: } \lambda D. \text{ Mary is D tall} \]
    \[ = \lambda D. \text{ Mary's height } \in \text{ D} \]
    \[ \text{semantic type: a predicate of sets of degrees, i.e., a generalized quantifier over} \]
    \[ \text{degrees} \]
meaning for the comparative morpheme:

\begin{equation}
-er(D_{\text{than}})(d_{\text{matrix}}) \iff \{d': d > d'\} \in D
\end{equation}

(a relation between a degree and a generalized quantifier over degrees)

(110) Note: this is a type-shifted variant of the 'greater'-relation between degrees. -er = >* (in PTQ notation) The analogy is quantifier in object position that is interpreted in situ: Normally, the verb love is of type e(et). Thus, Mary loves a policeman must have the LF representation a policeman $\lambda_1$ Mary loves $t_1$. The object-lifted version love* has the type ((et)t)(et), and the verb has the meaning $\lambda Q \in D_{(et)t}\lambda x.Q(\lambda y.\text{love}(y)(x))$. Now you can represent the sentence as Mary loves* a policeman with the DP in situ.

element:

(111) John is taller than Mary is.

LF: John is [-er than wh1 Mary is $t_1$ tall] tall

interpretation:

\[
\begin{aligned}
\text{John's height} & \in \{d: d > \text{Mary's height}\} \\
& = \text{John's height} > \text{Mary's height}
\end{aligned}
\]

It follows from remark (110) that we can work with the unlifted comparative relation as defined in (18) and QR the than-clause along these lines.

Exercise: Indicate an LF for the example that is constructed along these lines.

\subsection*{4.1.1. Predictions about quantifiers in the than-clause}

(112) I am stronger than everyone else is.
I am [-er than [wh₁ everyone else is t₁ strong]] strong

interpretation:

than wh₁ everyone else is t₁ strong = \{D: \forall x \neq I: x's strength \in D\}

er than wh₁ everyone else is t₁ strong
= \{d: \{d': d > d'\} \in \{D: \forall x \neq I: x's strength \in D\}\}
= \{d: \forall x \neq I: x's strength \in \{d': d > d'\}\}
= \{d: \forall x \neq I: d > x's strength\}

predicted equivalence:

I am stronger than everyone else is
\iff everyone else λx. I am stronger than x is

This generalizes to all kinds of quantificational elements and connectives in the than-clause.

They all get the equivalent of matrix scope.

x is Adj-er than [Q ζ]
\iff Q λy. x is Adj-er than [y ζ]

x is Adj-er than [φ and ψ]
\iff x is Adj-er than [φ] and x is Adj-er than [ψ]

Confirming examples (from S&W)

H is taller than at least one of the others is.
'for at least one x \neq H, H is taller than x'

H is taller than exactly five of the others are.
'for exactly five x \neq H, H is taller than x'

Lucy paid more for her suit than they both paid in taxes last year. (S&W)
'for both x, Lucy paid more for her suit than x paid in taxes last year'

Frequency adverbs (adverbial quantifiers over times):

It is warmer in Stony Brook today than it usually is in New Brunswick. (S&W)
'for most times t, it is warmer in Stony Brook today than it is in New Brunswick at t'

I have to admit – it's cleaner here than it sometimes is in my house.
'there are times when my house is less clean than this'

modals (verbal quantifiers over possible worlds):

It is warmer today than it might be tomorrow. (S&W)
'today's temperature is such that, for all I know, tomorrow's might be less than that'
= 'for some epistemically accessible w, today's actual temperature exceeds tomorrow's temperature in w'

Note: The example is not equivalent to 'It might be warmer today than tomorrow'. But this is not what we obtain if we only extend the scope of the modal operator to the matrix. It also differs from the original by creating a new binding relation, i.e., 'might' now binds the evaluation world for the matrix clause.

iteration: several scopal elements in the than-clause:
(122) conjunction + quantifier in conjunct:
Alice is richer than George was and most of his children will ever be. (S&W)
'A is richer than G was & for most of G's children x, A is richer than x will ever be'

(123) attitude verb + quantifier:
Bill did better than John predicted that most of his students would do. (S&W)
'for every w that conforms to John's prediction:
for most students x: Bill did better in the actual world than x did in w'

(124) situations considered by Schwarzschild & Wilkinson:
(i) John: "Most students will get between 70 and 80". Bill gets 83.
   intuition: sentence is true
(ii) John: "Most students will get between 70 and 80". Bill gets 76.
   intuition: sentence is false

Note: As S&W stress, the example is not read as equivalent to: 'for most of John's students x, Bill did better than John predicted x would do'
John may have made no prediction about any individual – see scenario (i) above. One might think that this shows that the desired semantics should not treat all quantifiers as if they had matrix scope. This is the wrong conclusion, however. The correct conclusion is that the paraphrase fails because it reverses the scopes of the two quantifiers 'most' and 'predict'. If both are scoped to the matrix, with their order preserved (and no new binding relations created), the paraphrase is again correct.

4.1.2. Predictions about NPI-licensing

(125) \( er \) is UE (upward entailing):
    If \( D \subseteq D' \) and \( er(D)(d) \), then \( er(D')(d) \).

(126) Proof: obvious from definition of \( er \):
    If \( D \subseteq D' \) and \( \{d': d > d'\} \in D \), then \( \{d': d > d'\} \in D' \).

Complex DE (downward entailing) contexts:

(127) The following complex operators, however, are DE:
    (a) \( \lambda P. -er \_wh1 [t1 often P] \) where \( P \) is a predicate of times
    (b) \( \lambda P. -er \_wh1 [t1many P are \alpha] \) where \( P \) is a predicate of individuals
    (c) \( \lambda P. -er \_wh1 [t1many \alpha are P] \)
    (d) \( \lambda p. -er \_wh1 [t1likely p] \) where \( p \) is a proposition (pred. of worlds)

(128) Sample proof for (c):
Assumed lexical entry for many:
D-many A are B ⇔ |A ∩ B| ∈ D
Hence λP. -er wh₁ [t₁ many α are P]
= λP. -er({D: |α ∩ P| ∈ D})
= λP. {d': d > d'} ∈ {D: |α ∩ P| ∈ D}
= λP. d > |α ∩ P|

Need to show: If P ⊆ P' and d > |α ∩ P'|, then d > |α ∩ P|. – obvious.

Suppose that NPI-licensing doesn't require a single DE operator, but can be done by a complex DE context. Then the facts in (22) will suffice to account for the following NPIs, henceforth called "embedded" NPIs:

(129) Cows fly more often than he lifts a finger to help. (Linebarger)
(130) He frowned more often than he said anything.
(131) More people took deductions than contributed anything to charity.
(132) More people enroll than will ever be able to finish.
(133) Many more people enroll than have a hope in hell of finishing.

"Unembedded" NPIs in the than-clause:

(134) I am stronger now than I ever was before.
(135) predicted meaning:
ever-before₁ [my strength now > my strength at t]
= ? ∃t [t is before now & my strength now > my strength at t]
(136) two problems with this:
(a) ever is not in a DE environment
(b) Standard existential interpretation of ever gives wrong truth conditions.
   To obtain correct meaning, ever has to be universal.
(137) Das ist schon sauberer, als es zu sein braucht.
   that is already cleaner than it to be need(NPI)
   'that's already cleaner than it needs to be'
(138) Dort bezahlst du viel mehr, als du bei uns zu bezahlen brauchst.
   there pay you much more than you with us to pay need(NPI)
   'there you'll pay a lot more than you need to pay with us''
(139) LF and predicted meaning for (32):
   ... than wh₁ need [it to be t₁ clean]
   = ? ∀w ... [its actual degree of cleanness > its degree of cleanness in w]
(140) two problems, analogous to case of ever:
   (a) brauchen ('need', NPI) ends up with widest scope,
       hence it should not be licensed.
   (b) Interpretation of brauchen as necessity gives wrong truth conditions;
       it would have to be interpreted as possibility.
(141) ... daß du nicht zu kommen brauchst
that you not to come need(NPI)
'it is not necessary for you to come'
Possibly ambiguous between "embedded" and "unembedded" NPI:

(142) He told me more jokes than I cared to write down.  (Rullmann)
(143) Floyd broke more glasses than most people could stand.  (Ross)

Other instances of "unembedded" NPIs?
any?

(144) He is taller than anyone else in his class is.
(145) I made it longer than I made any other handout.

These could be Free Choice any: universal meaning, matrix scope.  If so, maybe no problem.  But what about licensing conditions for FC any (whatever exactly those are)?
even?

(146) This works better than even the most expensive alarm system.

4.1.3. Predictions about indefinites

(151) John is richer than a professor is.

(152) logical structure:
a professor (λx. John's wealth > x's wealth)
(a) existential reading of indefinite:
   ∃x [professor(x) & John's wealth > x's wealth]
(b) generic reading of indefinite:
   for every typical professor x: John's wealth > x's wealth
Generic reading preferred, but existential reading can be facilitated:

(153) John is richer than a professor who I am friends with is.

Correct prediction:

(154) A professor makes a lot of money.  
    (generic reading available)

(155) One of my colleagues makes a lot of money.  
    (only existential)

(156) John makes more money than one of my colleagues does.  
    'there is a colleague of mine x such that John makes more money than x does'

Conjecture: Readings of indefinites in comparatives match readings that they can have independently.

Indefinites trapped below an NPI:

(157) Er stieg höher, als je zuvor jemand gestiegen war.  
    he climbed higher than ever before someone climbed had  
    'he climbed higher than anyone had ever climbed before'

(158) also with wh-indefinites or with irgende-indefinites:  
    Er stieg höher, als je zuvor wer gestiegen war.  
    irgendjemand  
    irgendwer  
    'wer' = 'who'  
    (same meaning)

To generate correct truth conditions, we need a universal interpretation not only for je zuvor('ever before'), but also for the indefinites (irgende)jemand and (irgende)wer. But these indefinites don't have any attested generic or universal readings elsewhere.

4.1.4. Wrong truth conditions for certain modals

(159) I stayed longer than I had to.  
    than I needed to.  
    than (was) necessary.  
    predicted to mean: 'it was necessary for me to stay less long than I did'  
    correct meaning: 'it was allowed/possible for me to stay less long than I did'

(160) I stayed longer than I was allowed to.  
    predicted to mean: 'I could have stayed less long than I did'  
    correct meaning: 'I ought to have stayed less long than I did'

4.1.5. Negation and decreasing quantifiers in the than-clause

(161) *John is taller than Mary isn't.

(162) x is Adj-er than [not φ]  
    ⇔ not [x is Adj-er than [φ]]

(163) not [John's height > Mary's height],  
    i.e., John is not taller than Mary is  
    No obvious reason why this is not good.
(164) ??John is taller than nobody else is.
(165) ??John is taller than few people are.

**Conclusion:** S & W has serious problems with the interpretations of modals in CP-complements and NPI-licensing. (Zepter, 2003) tries to overcome the latter by proposing a different theory for NPIs, but I have no idea how modals can correctly be treated in S&W's theory. Non-NPI-quantifiers are treated better in S&W's theory than in classical theories. The classical theory overgenerates, but S&W's theory undergenerates, which is worse.

### 4.2. B. An alternative to explore?

#### 4.2.1. Background: familiar accounts of NPI licensing in comparatives

Seuren's (1973) analysis:

(166) John is taller than Mary is.

means:

'John is tall to some degree to which Mary isn't tall'

\[ \exists d \ [ \text{John is } d\text{-tall} \land \neg \text{Mary is } d\text{-tall}] \]

assumptions about adjective meanings required to make this work:

(167) (a) Adjectives denote relations between individuals and degrees.

(b) "monotonicity" ("at least" interpretation) of adjectives:

If John is 6' tall, he is also 5' tall, 4' tall etc.; but not 7' tall, 8' tall etc.

(168) If \( x \) is \( d\)-tall & \( d' < d \), then \( x \) is \( d'\)-tall.

(169) relation between Seuren's adjective meanings and those from S&W and above:

\( x \) is \( D\)-tall \iff \max \{d: x \text{ is } d\text{-tall (in Seuren's sense)}\} \in D

(170) \(-\text{er}(P_{\text{than}})(Q_{\text{matrix}}) \iff \exists d \ [d \in Q \land \neg d \in P]\)

(a relation between two sets of degrees)

(171) **Downward entailment:**

If \( \exists d \ [d \in Q \land \neg d \in P] \) and \( P' \subseteq P \), then \( \exists d \ [d \in Q \land \neg d \in P'] \).

von Stechow's analysis (see also Rullmann)

(172) John is taller than Mary is.

means:

'John is tall to some degree which exceeds the maximal degree to which Mary is tall'

\[ \exists d \ [\text{John is } d\text{-tall} \land d > \max_{d'}.\text{Mary is } d'\text{-tall}] \]

(173) \(-\text{er}(P_{\text{than}})(Q_{\text{matrix}}) \iff \exists d \ [d \in Q \land d > \max_{d'}.d' \in P]\)

(a relation between two sets of degrees)

assumption about adjective meanings:

(174) relations between individuals and degrees

(i) option 1: as above ("at least" meanings)

(ii) option 2: "exactly" meanings:

\[ x \text{ is } d\text{-tall} \iff x\text{'s (maximal) height} = d \]
Both options work with (172) in almost every case. Exception: for examples with necessity operators (*need*, *brauchen*), we need "at least" meanings.

(175) Downward entailment:
If $\exists d \in Q \& d > \max d'.d' \in P$ and $P' \subseteq P$, then $\exists d \in Q \& d > \max d'.d' \in P'$.

(Proof: follows from the fact that, if $P' \subseteq P$, then $\max d.d \in P \geq \max d.d \in P'$.)

Bad predictions about quantifiers in the *than*-clause

(176) I am stronger than everyone else is.

predicted readings:

(177) Seuren analysis & v. Stechow analysis with "at least" option:
'I am strong to a degree to which not everyone else is strong'
= 'there is at least one other person that I am stronger than'
  clearly inadequate

(178) v. Stechow analysis with "exactly" option:
  presupposition: everyone else has the same strength;
  assertion: I am stronger than that
  defensible as one reading, but apparently is not the only one

(179) I am stronger than someone else is.

predicted reading:

(180) Seuren analysis & v. Stechow analysis with both options:
'I am strong to a degree to no-one else is strong'
= 'everyone else is such that I am stronger than them'
  clearly inadequate

Scoping out the quantifier:

The desired readings can be obtained by QR-ing the quantifier out of the *than*-clause, and only in this way.

Problems:

(181) Under-generation problem:
  wide scope for things which otherwise don't QR, i.e. have frozen surface scope
  (see S&W's examples above):
  • floated quantifiers
  • adverbial quantifiers
  • verbal quantifiers (modals and attitude verbs)
  • connectives (*and*)

(182) Over-generation problem:
  How to block predicted surface scope readings?
4.2.2. A tentative approach to the under-generation problem

Re over-generation problem: for now, a mere stipulation:

(183) wh-movement in comparative clauses is blocked by negation and by all intervening quantifiers except certain modal verbs and NPIs.

I follows that the intervener undergoes long QR at LF in order to make wh-movement possible. The logic is similar to that in Beck's dissertation. Cf. (Beck, 1996).

Re under-generation: At least some apparent wide scope readings are "non-quantificational" readings.

What is "quantificational"?

(184) If \(\alpha\) is a quantifier, then there are predicates P such that:
    either [neither \(\alpha P\) nor \(\alpha \neg P\)] or [both \(\alpha P\) and \(\alpha \neg P\)].

familiar examples:

(185) proper names, variables, and other terms of type e:
    \([\alpha P\) or \(\alpha \neg P]\) always holds ("law of excluded middle");
    [not both \(\alpha P\) and \(\alpha \neg P\)] also always holds ("law of contradiction").

(186) existential quantifiers:
    violate law of contradiction
    (e.g.: somebody smokes and somebody doesn't smoke)

(187) universal quantifiers:
    violate law of excluded middle
    (e.g.: neither does everybody smoke nor does everybody not smoke)

(188) "specific" indefinites:
    Fodor & Šag referential analysis, choice function analyses make indefinites of type e.

more interesting cases:

(189) distributive plurals with homogeneity presupposition (Löbner):
    the boys\(\text{Dist}\) smoke
    true if every boy smokes,
    false if no boy smokes,
    undefined if some boys smoke and some don't.
    Presupposition precludes violation of excluded middle.

(190) generics with homogeneity presupposition (v.Fintel):
    dogs\(\text{Gen}\) shed
    true if every typical dog sheds,
    false if no typical dog sheds,
    undefined if some typical dogs shed and some don't.

Homogeneity presuppositions in comparative clauses:

(191) Mary is taller than the boys are.
(192) ... than \(\lambda d.\) the boys\(\text{Dist}\) are d-tall
the boys\textsubscript{Dist} are d-tall will generally be undefined for some values of d, namely those between the height of the shortest and the height of the tallest boy.

Suppose this causes presupposition failure for the whole comparative.

(193) How presupposition failure is avoided:
(a) All the boys are the same height, or
(b) the degree scale is coarse-grained enough to exclude the "offending" degrees.

Allowing scales to be variously coarse, dependent on context, is an important ingredient that this approach borrows from S&W.

How plausible are non-quantificational analysis for various types of quantifiers?

Definite plurals and generics

(194) Mary is taller than the boys are.
(195) John is taller than a pony is.
Conjunction (\textit{and})

(196) John is taller than Bill and Mary are.
see Szabolcsi et al. (2003) for independent evidence for homogeneity presup. in \textit{and}.

(197) This program doesn't work with system 6 and system 7.1.
preferred reading: 'neither with system 6 nor with system 7.1'
but: quantificational reading appears to be preferred with \textit{both} ... \textit{and}

(198) This program doesn't work both with system 6 and system 7.1.
'not (...) & (...)' 

(199) John is taller than both Mary and Bill are.
still only "wide scope" for conjunction -- problem!

Floated quantifiers

(200) Mary is stronger than the boys both/all are.
(201) The boys aren't both/all that tall.
-- problem!

Universals (every)

(202) I don't think that everyone else is that tall.
-- same problem!

But also consider:

(203) He isn't older than everyone else here is.
(a) at least one other one is at least as old as him
(b) everyone else is at least as old as him
reading (b) is not expected on S&W's analysis;
\textit{every} seems to outscope not just \textit{er} but also the negation

(204) Er ist auch nicht schneller als es jeder andere hier ist.
he is also not faster than it everyone else here is
A related problem?

Universals and floated quantifiers allow pair-list readings in questions. Maybe they have more liberal scopal possibilities after all?

(205) What do you think that every teacher said?
What do you think that the teachers both/all/each said?

Most, usually\(^5\)

(206) preliminary note: truth-conditional difference between 'most not ' and 'not most' is small.

'most A are not B' = 'more than half of the As are not B'

'not most A are B' = 'at least half of the As are not B'

(207) clearer difference with the vast majority:

'the vast majority of As are not B' =

'all but an insignificant minority of the As are not B'

'not the vast majority of As are B' = 'at least a significant minority of the As are not B'

(208) I doubt that the vast majority of them even noticed.
preferred reading: 'I think the vast majority didn't notice'

(209) I don't think that the vast majority of them will even show up.

(210) Es ist unwahrscheinlich, dass das die allermeisten auch nur bemerkt haben.
it is improbable that the all-most even(NPI) noticed have

'it's unlikely that the vast majority even noticed that'

understood as: the vast majority probably didn't notice

So there may be some evidence for a nonquantificational reading of most, the vast majority.

(211) adding a homogeneity presupposition to most:

'mosthom A are B' is true if more A are B than A are not B,
false if more A are not B than A are B, and
undefined if exactly as many A are B as A are not B.

(212) alternative: a choice function analysis

'most A' = 'a majority of As' with "specific" reading for 'a'

(213) He isn't usually this friendly.
means: 'usually not' ? (hard to tell)

(214) (a) *Er ist nicht gewoehnlich so freundlich
he is not usually so friendly
(b) *Er ist nicht meistens so freundlich.
he is not mostly so friendly

(215) Die Hotels, in denen wir gewoehnlich abgestiegen sind, waren ziemlich billig
the hotels in which we usually stayed were fairly cheap

'most of the hotels in which we stayed were fairly cheap'

Attitude verbs

\(^5\) See also Horn's paper on neg raising.
Basic prediction would be that apparent wide scope in comparatives arises with just the "neg-raising" verbs. This is probably problematic.

(216) We didn't predict that we would run out of tickets.
    doesn't mean 'we predicted that we wouldn't run out',
    but does tend to imply that we expected that we wouldn't.

Indefinites, existential quantifiers

Basic prediction: wide scope effect in comparatives for just those that have independently attested "specific" readings (taking exceptionally wide scopes, for whatever reason: special scopal properties, choice function semantics, referential analysis).

(217) Hubert is taller than at least one other person is.

(218) (a) Hubert ist groesser als mindestens ein anderer.
    Hubert is taller than at least one other one
    (non-clausal than-phrase)
    (b) ??Hubert ist groesser, als es mindestens ein anderer ist.
        Hubert is taller than it at least one other one is
        (clausal than-phrase -- hard to understand)

Monotone decreasing and non-monotone quantifiers

For monotone decreasing quantifiers, it is already commonly claimed that they are not good in (clausal) comparatives. (See above.) What about non-monotone ones?

(219) Hubert is taller than exactly five of the others are. (example in S&W)

(220) Hubert ist groesser, als es genau zwei andere sind.
    (judgment?)

(221) #Heute ist es warmer, als es genau einmal letzten Winter war.
    today is it warmer than it exactly once last winter was
    very hard to understand

(222) ??Hubert ist besser, als nur du es bist.
    Hubert is better than only you it are

Consider also:

(223) Bill did better than John predicted that exactly five of his students would do.
    meaning predicted by S&W:
    for every world w that conforms to J's prediction,
    there are exactly 5 students who did worse in w than Bill did in the actual world

(224) John predicted that exactly five of his students would get between 80 and 90 points. Bill got 92. So he did better than John predicted that exactly five of his students would do.

If you think (224) is sound, then you are not reading (223) as S&W predict.
4.2.3. Appendix: GQ analysis and S & W

(1) S&W, p. 26:
-er($P_{\text{than}}$)($Q_{\text{matrix}}$) ⇔ $[\mu I. [\mu K. \text{Diff}(I - K)] \in P] \in Q$
(a relation between two sets of intervals)

(2) Diff stands for the differential phrase. If there is no overt one, Diff(I - K) is equivalent to K > I.

Special case with null differential:
-er($P_{\text{than}}$)($Q_{\text{matrix}}$) ⇔ $[\mu I. [\mu K. K < I] \in P] \in Q$

The following addresses only the question of equivalence for examples without overt differentials. More will have to be said about the cases with differentials, especially about differentials with 'exactly'-interpretation.

definitions:

(3) intervals:
A set of degrees D is an interval iff
for all d, d', d'': if d $\in$ D & d' $\in$ D & d $\leq$ d'' $\leq$ d', then d'' $\in$ D.
(If d'' is between two elements of an interval, it is itself in the interval.)

(4) $\prec$-relation among intervals:
I $\prec$ K iff for all d, d': if d $\in$ I & d' $\in$ K, then d $<$ d'.
(I is wholly below K.)

(5) $\mu$-operator (S&W, p. 23)
$[\mu I. \phi[I]] := \{ I. \forall I'(I' \neq \emptyset & I' \subseteq I \rightarrow \phi[I']) \land \forall I''(I \subset I'' \rightarrow \exists I'(I' \subseteq I'' \land \neg \phi[I']))$

(6) $\mu$-operator, corrected
$[\mu I. \phi[I]] := \{ I. \forall I'(I' \neq \emptyset & I' \subseteq I \rightarrow \phi[I']) \land \forall I''(I \subset I'' \rightarrow \exists I'(I' \neq \emptyset & I' \subseteq I'' \land \neg \phi[I']))$
("the largest interval all of whose non-empty subintervals are $\phi$")

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6 The prose formulation that S&W use throughout the paper suggests the definition in (), where the second condition uses exactly the negation of the first. The absence of the non-emptiness requirement in the second clause of () seems not to be intended. It has the consequence that the $\mu$-term is not always well-defined, e.g., in a situation where there exist people and $P$ is the denotation of than nobody is tall. (Problem: the definition is met for smaller intervals than the intended one as well.)
abbreviations:

(7) \( d < I \) abbreviates \( \{ d \} < I \).

\[<I := \{ d : d < I \}\]

\[<d := \langle \{ d \}\]

\[P(I) := 1 \in P\]

I will first remove a superficial difference in the semantic types for -er that GQ and S&W assume. In GQ, \( er + than \)-clause was interpreted in situ, S&W assume it to be moved to the edge of the matrix clause. Their semantics, however, effectively reconstructs it back. They could therefore just as well have assumed in-situ interpretation and the following meaning for -er.

An equivalent reformulation of (2):

(8) \(-er(P_{\text{than}})(d_{\text{matrix}}) \iff d \in [\mu I. [\mu K. K < I] \in P]\)

A further equivalent reformulation of (8):

(9) \(-er(P_{\text{than}}))(d_{\text{matrix}}) \iff d \in [\mu I. P(<I)]\)

(10) Proof that \([\mu I. K < I] = <I\):

Need to show that \( <I \) meets both clauses in the definition of \( \mu \).

1st clause: Take \( K' \subseteq <I \) and show that \( K' < I \). Obvious.

2nd clause: Take \( K' \supset <I \), define \( K'' := K' - <I \), and show that not \( K'' < <I \). By def., \( K'' \) contains a \( d' \) such that \( d' \geq d'' \) for some \( d'' \in I \). This contradicts \( K'' < <I \).

Now are my GQ analysis and (9) equivalent?

(11) Full equivalence would mean:

For all \( d \) and \( P_{<dt,t>} \):

\[P(<d) \iff d \in [\mu I. P(<I)]\]

One direction is straightforward:

(12) If \( d \in [\mu I. P(<I)] \), then \( P(<d) \).

(13) Proof: Assume \( d \in [\mu I. P(<I)] \). I.e., \( \{d\} \subseteq [\mu I. P(<I)] \). By definition of \( \mu \), therefore \( P(<\{d\}) \). And \( <\{d\} = <d \). QED

For the other direction, I can currently prove special cases if I can assume a discrete scale:

(14) If \( P \) is mon↑, mon↓, or a conjunction of mon↑ and mon↓ properties, and if every non-empty interval contains a lowest point, then:

\[P(<d) \Rightarrow d \in [\mu I. P(<I)]\]
Proof: Assume $P(<d)$. Define $I := \{d': P(<d')\}$ and show that this $I$ fulfills (i) as well as the following three conditions required by the definition of $\mu$:

(i) $d \in I$.
(ii) $I$ is an interval.
(iii) $\forall I' \ [I' \neq \emptyset \& I' \subseteq I \rightarrow P(<I')]$
(iv) $\forall I'' \ [I \subseteq I'' \rightarrow \exists I' \ [I' \neq \emptyset \& I' \subseteq I'' \& \neg P(<I')]]$

Re (i): Follows directly from def. of $I$ and premise that $P(<d)$.

Re (ii): Take $d_1, d_2, d_3$ such that $d_1, d_3 \in I$ and $d_1 \leq d_2 \leq d_3$. It follows that $P(<d_1)$ and $P(<d_3)$ and that $<d_3 \subseteq <d_2 \subseteq <d_1$.

1st case: $P$ is mon↑. Then $P(<d_3)$ and $<d_3 \subseteq <d_2$ imply $P(<d_2)$.

2nd case: $P$ is mon↓. Then $P(<d_1)$ and $<d_2 \subseteq <d_1$ imply $P(<d_2)$.

3rd case: $P = Q \& R$, where $Q$ is mon↑ and $R$ is mon↓. Then, by reasoning as in 1st and 2nd case, we get $Q(<d_2)$ and $R(<d_2)$. Thus $P(<d_2)$.

In all three cases, we have $P(<d_2)$, therefore $d_2 \in I$ by def. of $I$.

Re (iii): Let $I'$ be a non-empty subset of $I$. Let $d'$ be the minimal element of $I'$. Since $d' \in I$, we know $P(<d')$. By definition of $d'$, we also know $<d' = <I'$. Hence $P(<d')$.

Re (iv): Let $I''$ be a proper superset of $I$. Define $I' := I'' - I$. (This is non-empty and a subset of $I''$.) Let $d'$ be the minimal element of $I'$. Since $I'$ is disjoint from $I$, we know $\neg P(<d')$. Therefore, since $<d' = <I'$, also $\neg P(<I')$.

REFERENCES


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7 This is the only part of the proof where monotonicity properties of $P$ are used.
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