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THE MEANING OF *TOO*, *ENOUGH*, AND *SO . . . THAT**

In this paper, I provide a compositional semantics for sentences with *enough* and *too* followed by a *to*-infinitive clause and for resultative constructions with *so . . . that* within the framework of possible world semantics. It is proposed that the sentential complement of these constructions denotes an incomplete conditional and is explicitly or implicitly modalized, as if it were the consequent of a complete conditional. *Enough*, *too*, and *so* are quantifiers that relate an extent predicate and the incomplete conditional (expressed by the sentential complement) and are interpreted as comparisons between two extents. The first extent is the maximal extent that satisfies the extent predicate. The second extent is the minimal or maximal extent of a set of extents that satisfy the (hidden) conditional, where the sentential complement supplies the consequent and the main clause the antecedent. This approach permits to predict (a) the context-dependent interpretation of these constructions and (b) the duality relations between the degree words.

1. Introduction: Sufficiency and Excess

It has often been noticed that constructions with *too* and *enough* and their relatives in other languages have a comparative meaning and therefore have to be analyzed as comparison constructions. Intuitively, the value an object has on a scale associated with the meaning of the adjective or adverb is related to some standard of comparison that is determined by the sentential complement.

Consider, for example, the sentences in (1) with positive polar adjectives.[1, 2]

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[1] Most examples are borrowed from R. Quirk et al.'s *Comprehensive Grammar of the English Language* (Longman, 1985).

[2] I am following the tradition of distinguishing positive polar adjectives from negative polar adjectives. Gradable adjectives often come in pairs of antonyms, for example *old*/*young*, Whereas positive polar adjectives may occur with measure phrases and allow question formation with *how* (*five years old*/*how old*), negative polar adjectives usually don't (**five years young*/**how young*).

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(1) a. Bertha is *old* enough to drive a car.
b. The food is too *good* to throw (it) away.

Sentence (1a) means that the value Bertha has on a scale associated with the dimension of age lies above some critical lower bound of admissibility.

In constructions with *too*, as in example (1b), the standard of comparison is not a lower bound as in the former example, but an upper bound of admissibility, and the value of the object lies above this value. In our example, the actual quality of the food is said to exceed the admissible value determined by the sentential complement.

In constructions with negative polar adjectives, the situation seems to be different, at first sight. The polarity reversal changes not only the ordering relation between the object value and the standard of comparison but also the general characteristics of the standard of comparison as a lower bound or upper bound of admissible values. Consider the sentences in (2).

(2) a. The submarine is *small* enough to pass through the hole.
b. She was too *young* to date.

In a construction with *enough*, as in (2a), the value of the object must *not* exceed the critical value determined by the sentential complement. The actual height of the submarine must be less than a certain upper bound of admissible heights. Whereas the comparison relation is the 'greater than or equal to'-relation in constructions with *enough* and positive polar adjectives, it is the 'smaller than or equal to'-relation in constructions with *enough* and negative polar adjectives. With positive polar adjectives the standard of comparison is a lower bound of admissible values; in constructions with a negative polar adjective it denotes an upper bound of admissible values.

In constructions with *too* and negative polar adjectives, as in (2b), on the other hand, the object value generally lies under an admissible lower bound and is hence not admissible. The age of the person that the speaker refers to with *she* is said to be *less* than a standard of comparison. Whereas in constructions with *too* and positive polar adjectives the comparison relation is the 'greater than'-relation and the standard of comparison is an upper bound of admissible values, it is the 'smaller than'-relation and a lower bound of admissible values in constructions with negative polar adjectives. The main problem for the compositional semantics of these constructions now is to reconstruct the standard of comparison from the surface structure of these sentences.

In this paper, I will propose that the sentential complements of con-

structions with *too* and *enough* implicitly or explicitly contain a modal expression. This strategy is well known for the interpretation of conditionals in general, introduced by Kratzer (1978), but has not been used before to interpret compound sentences.

Evidence for this move is the fact that a modal expression (with existential force) can be added or omitted without changing the intuitive meaning of the sentences. Consider the examples in (3). An explicit modal expression like *be able* or *be allowed* in the sentential complement makes them more precise, but it does not make them unacceptable. In all these sentences we can add a modal expression with existential force. Adding a modal expression with universal force, however, like *is obliged* or *is required*, makes these sentences pragmatically bad or not equivalent to the bare complement versions.

(3) a. Bertha is old enough *to be able* to drive a car.
b. The food is too good for us *to be allowed* to throw it away.
c. The submarine is small enough *to be able* to pass through the hole.
d. She was too young *to be allowed* to date others.

My main hypothesis is that sentences like (1) and (2) have roughly the form in (4).

(4) x is $\left\{\begin{matrix}\text{adj. } \textit{enough} \\ \textit{too} \text{ adj.}\end{matrix}\right\}$ MODAL p.

They denote comparisons between two values. The first value is the value for which the proposition expressed by the main clause is true. In our examples, this is Bertha's actual age ((1a)), the actual quality of the food ((1b)), the dimensions of the submarine ((2a)), or the subject's actual age ((2b)). The second value is the minimal or maximal value of a set of values determined by a hidden conditional, where the sentential complement supplies the consequent and the main clause the antecedent. In constructions with *enough*, as in example (1a), this is the minimal value of the set of values *v* that make the conditional *If Bertha is v-old, she is able to drive a car* true (in a dispositional reading). In the example in (1b) with *too* this is the maximal value of the set of values *v* that make the conditional *If the food is v-good, we are allowed to throw it away* true (in a permissive reading). If the sentential complement is not explicitly modalized, it is assumed that it is implicitly modalized. We might ask ourselves whether explicitly modalized expressions are in addition modalized implicitly by a modal expression with existential force. I believe that this is not

the case. Consider the example in (5). It is not possible to omit or add a modal expression to the sentential complement without changing the meaning of the construction.

(5) Clyde is old enough [to be able/to be allowed/to be permitted] to be required to wear a hat.

I therefore conclude: If the sentential complement is explicitly modalized, this explicit modal determines the modal force of the conditional.

In this spirit, I propose to capture the truth conditions for our examples (1a) and (1b) as in the paraphrases in (6), with an existential modal.

(6) a. "The value *v* such that Bertha is *v*-old is GREATER than or equal to the MINIMUM of all values *v** such that, if Bertha is *v**-old, she *is able* to drive a car."
b. "The value *v* such that the food is *v*-good is GREATER than the MAXIMUM of all values *v** such that, if the food is *v**-good, we *are allowed* to throw it away."

For constructions with negative polar adjectives, too, it seems to be convenient to propose paraphrases that denote comparisons between the actual value an object has and a minimal or maximal value that is determined by the set of values that satisfy a hidden conditional. But in order to get intuitively correct interpretations for constructions with negative polar adjectives we have to (a) reverse the ordering relation between the values compared and (b) change the characteristics of the standard of comparison.

The example in (2a) may be paraphrased with the sentence in (7a). Here the object value is compared to the maximum of a set of values that satisfy the conditional, rather than to a minimum as in the case of constructions with *enough* and positive polar adjectives. For (2b) I propose the paraphrase in (7b).

(7) a. "The value *v* such that the submarine is *v*-small is SMALLER than or equal to the MAXIMUM of all values *v** such that, if the submarine is *v**-small, it *is able* to pass through the hole."
b. "The value *v* such that she is *v*-young is SMALLER than the MINIMUM of all values *v** such that, if she is *v**-young, she *is allowed* to date."

In order to derive these paraphrases in a rather straightforward way, I adopt a version of the extent semantics of von Stechow (1984b). The basics are presented in section 2. It is characteristic for this theory that representations of measurement are modeled as intervals on a scale

(= extents) and not as points with respect to a certain ordering relation, as is assumed in the tradition of Cresswell (1976). This view has the advantage of capturing the antonymy relation between gradable predicates, as well as the duality relations between comparative operators, in an intuitively appealing way.[3] In section 3, I introduce the syntax and semantics of comparative clauses with *enough* and *too* on the basis of the semantics of ordinary conditionals and illustrate the role of context in these definitions with examples from Karttunen (1971).[4] I will argue that the implicative and non-implicative uses of sentences with *enough* and *too* discovered by Karttunen are solely dependent on the context in which these constructions are used. In section 4, I provide the definition of resultative *so* and compare result clause constructions with constructions with *enough*. In section 5, I discuss the duality relations between *too* and *enough*/*so*. In section 6, I compare my proposal to previous proposals from the literature.

2. Comparisons of Extents

2.1. *Remarks on the Ontology*

The main characteristic of von Stechow's theory consists in his taking gradable adjectives to be relations between objects and intervals on a scale associated with the adjective (following Seuren 1984). These intervals he calls extents.[5] Scales are linear ordered sets of degrees with a minimal element but without a maximal element. Degrees may be treated as positive (real) numbers closed under addition (e.g. Hellan 1981). Extents are dense, convex subsets of scales. However, not every subset of the scale is an extent. We may propose to define extents by means of a measure function φ based on an empirical comparison relation, and assume that it assigns to every object a degree *n* on the scale specified by the adjective. This degree is a limiting value for extents. Intervals starting with 0, the minimal element of the scale, and ending with *n* are called positive extents. Negative extents are intervals beginning with *n* and ending nowhere. No other subset of the set of all degrees counts as an extent.

This idea is illustrated in (8).

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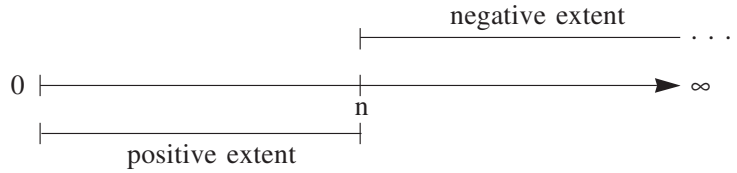
[3] Kennedy (1999, 2001) used a similar approach in order to explain so-called cross-polar anomalies.

[4] I thank Chris Kennedy for having drawn my attention to these examples.

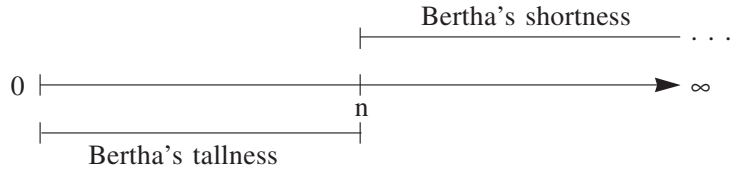
[5] This approach is different from what Schwarzschild and Wilkinson (2002) call 'interval semantics'.

(8)



Hence, every object can be related to a scale in two ways: on the one hand by its positive extent and on the other hand by its negative extent. Whereas the positive extent represents, for example, the tallness of an individual, the negative extent represents the tallness that the individual does *not* have, i.e., its shortness. This intuition can be illustrated for Bertha's height by (9), for any degree *n* that is assigned to Bertha by the measure function φ.

(9)



Von Stechow formalizes extents as indexed ordered pairs of the form $\langle_A 0, n\rangle$ and $\langle_A n, \infty\rangle$, with *n* being some real number. The first element defines the starting point of the interval or stretch on the scale, and the scone element characterizes the ending point. The index determines the dimension (size, beauty, etc.), a (possibly abstract) unit of measurement (meters, years, etc.), and a direction of the scale (length, height, etc.).

(10) a. The positive extent of an object *o* on a scale identified by an adjective A: $\langle_A 0, n\rangle$

b. The negative extent of an object on a scale identified by an adjective A: $\langle_A n, \infty\rangle$

where $n = \varphi(o)$ and *n* in the set of positive real numbers plus ∞.

Positive gradable adjectives are thought to be functions that relate positive extents and objects, and negative gradable adjectives relate negative extents and objects.

Before I go on and give the truth conditions for adjectives, let me say something about the logical language used here to express truth conditions. I am assuming an extensional typed language in the style of Gallin's (1975) language Ty2. In addition to the common basic semantic types *e* (for entities), *t* (for truth values 0), and *s* (for possible worlds), I propose to introduce a type *d* for negative and positive extents. The denotation of

expressions in D_d is the set of all sets of degrees (= extents). The interpretation of an expression depends merely on the conventions of the English language, the expression's morphosyntactic structure, and contextual facts. The input for semantic interpretation I assume to be phrase structure trees that conform to the requirements of Principles and Parameters Theory. The interpretation of terminal nodes is specified by the lexicon, the interpretation of unary nodes is equal to that of their daughter nodes, and the branching nodes are interpreted by functional application. Logical representations are interpretable if every node is interpretable. In addition, lambda abstraction is needed in some cases. In order to secure a strictly compositional interpretation, I assume with Heim and Kratzer (1991) and von Stechow (1993) that traditional Logical Forms must be enriched with arguments that are implicit at the ordinary surface of the sentences. All predicates take an extra world argument. These enriched syntactic representations are called Transparent Logical Forms.

2.2. *Positive and Negative Polar Adjectives*

Under these assumptions, positive and negative gradable adjectives such as *tall* and *short*, for example, get lexical entries, such as those in (11) and in (12). They are partial functions of type $\langle s, \langle d, \langle e, t\rangle\rangle\rangle$ which assign a truth value to a possible world, an extent, and an individual.

(11) $[\![\textbf{tall}]\!]^g = f : D_{\langle s, \langle d, \langle e, t\rangle\rangle\rangle}$
For any world $w \in W$, extent $e \in D_d$, and entity $a \in D_e$: f is defined if e is a positive extent of the form $\langle 0, n\rangle$.
If defined, $f(w)(e)(a) = 1$ iff φ_{tall} assigns n to a in w on the scale associated with tallness.

(12) $[\![\textbf{short}]\!]^g = f : D_{\langle s, \langle d, \langle e, t\rangle\rangle\rangle}$
For any world $w \in W$, extent $e \in D_d$, and entity $a \in D_e$: f is defined if e is a negative extent of the form $\langle n, \infty\rangle$.
If defined, $f(w)(e)(a) = 1$ iff φ_{short} assigns n to a in w on the scale associated with shortness.

In order to show how this system works, I will consider constructions containing measure phrases like *six feet*, in a first step.

2.3. *Measure Phrases*

This type of construction is considered to be fundamental for all comparative constructions. Von Stechow (1984b) treats measure phrases generally as names for positive extents, i.e., expressions of type d. The lexical entry

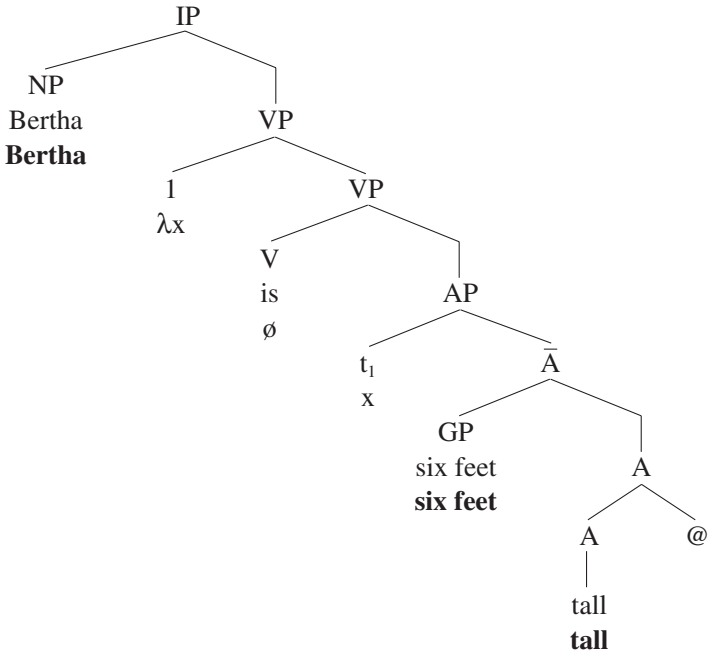
for *six feet*, for example, is assumed to be something like (13) – that is, the set of degrees from 0 to 6 in length. The sortal restriction *feet* determines the unit of measurement.

(13) $[\![\textbf{six feet}]\!]^g = \langle_{feet}\ 0,\ 6\rangle$

A sentence such as (14a) gets the LF in (14b), represented by the tree in (14c).[6]

(14) a. Bertha is six feet tall.
b. **tall**(@)(**six feet**)(**Bertha**)

c.



The interpretation of this formula is only defined if the condition in (15) is satisfied.

(15) $[\![\textbf{tall}(@)(\textbf{six feet})(\textbf{Bertha})]\!]^g$ is defined iff $[\![\textbf{six feet}]\!]^g$ is a positive extent of the form $\langle 0, v\rangle$, where n is any positive real.

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[6] Basically, I assume that measure phrases are base-generated as specifiers of the AP, following Bresnan (1973) and disregarding more recent proposals by Abney (1983) and Kennedy (1999) on the syntactic nature of the AP. The symbol '@' is a free world variable of type *s* in this configuration and is designated to refer to the actual world of the utterance. The trace of the case-driven movement operation of the subject expresses a variable and the movement index the lambda-abstractor over this variable (Heim and Kratzer 1998).

If defined, the interpretation of (14) can be directly read off the tree, as in (16).

(16) If defined, then: $[\![\textbf{tall}(@)(\textbf{six feet})(\textbf{Bertha})]\!]^g = 1$
iff φ_{tall} assigns Bertha the value 6 in feet on a scale associated with tallness in the world @.

It has often been noticed that measure phrases are only compatible with positive polar adjectives, but not with negative polar adjectives. The sentence *Clyde is four feet short* is odd. This fact receives a straightforward explanation in this system; see von Stechow (1984b). A similar remark may already be found in Cresswell (1976). Since measure phrases denote positive extents and negative polar adjectives are only defined for a negative extent, no interpretation is available for such constructions combining negative polar adjectives and measure phrases.

2.4. *Comparatives*

In this framework, comparatives are comparisons between extents. The sentence in (17a) is supposed to express the formula in (17b).

(17) a. Bertha is taller than Clyde.
b. **-er**(λe.**tall**(@)(e)(**Clyde**))(λe.**tall**(@)(e)(**Bertha**))

The comparative operator *-er* expresses a relation between two extent predicates and is of type $\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle$ – that is, an extent quantifier.[7] In order to derive the formula in (17b), I assume the representation in (18). This representation has the following characteristics. The *than*-phrase is assumed to be elliptical at S-structure. The comparative morpheme and the *than*-phrase form one constituent at the level of LF. And this constituent is adjoined to IP or CP by (type-driven) quantifier movement.[8] This assumption presupposes that the *than*-phrase is (a) base-generated as a complement of the degree morpheme, (b) raised by extraposition to the right periphery of the sentence in order to derive the surface position, and (c) lowered again from its sentence-final position on the surface to a complement position adjacent to the comparative operator *-er* (its base position before extraposition). The quantifier movement at LF leaves a trace in the specifier

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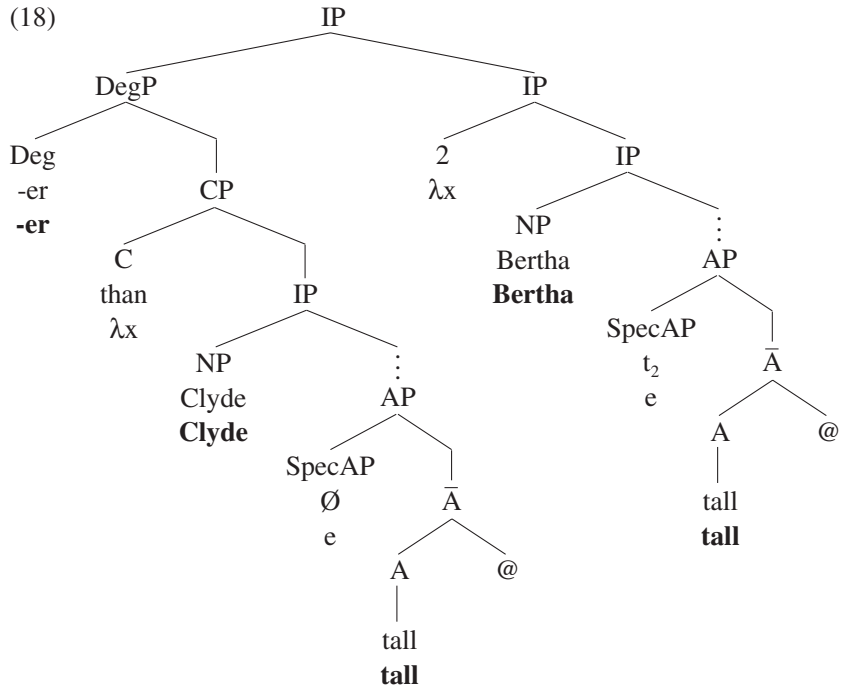
[7] In this respect I am following Cresswell (1976). See von Stechow (1993) for an alternative. In von Stechow's theory the *than*-clause denotes a definite description and not a predicate.
[8] The discontinuous interpretation of the comparative operator and the adjective may also be found in Cresswell (1976), Heim (1985), and von Stechow (1993) and was recently disputed by Kennedy (1999).

position of the adjective, which is expressed by a variable of type *d*. The index of the movement introduces lambda abstraction.[9]

(18)



For the interpretation of this structure, we still need the definition of the truth conditions for *-er*. I define the denotation of the comparative morpheme as in (19).

(19) $[\![\textbf{-er}]\!]^g = f : D_{\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle}$
For any extent predicates D_1 and $D_2 \in D_{\langle d, t\rangle}$:
$f(E_2)(E_1) = 1$ iff $MAX(E_1) > MAX(E_2)$

The comparative operator *-er* applied to the extent predicates D_1 and D_2 is true if and only if the maximal extent that satisfies the first predicate and the maximal extent that satisfies the second predicate stand in the 'greater than'-relation. This relation is assumed to compare sets of degrees.

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[9] In order to ensure proper movement of the comparative morpheme I have to assume that pied-piping of the adjectival material is involved in a first step and reconstruction of the pied-piped material in a second step. I have neglected these complications here to simplify matters. I refer the reader to my dissertation (Meier 2000) for extensive discussion of these points. See also Beck (1996) for analogous assumptions entering the derivation of the meaning of *how many*-questions.

Therefore, we can adopt set-theoretical operations to define it, as in (20) (Kennedy 2001).

(20) For any extents e_1 and e_2:
$e_1 > e_2$ iff $e_1 \cap e_2 = e_2$ and $e_1 \neq e_2$, where e_1 and e_2 have the same polarity.

Note that this relation is only defined for extents with the same polarity. For pairs with different polarity it is not defined.[10]

Maximality is defined standardly on the basis of the 'greater than or equal'-relation as in (21).

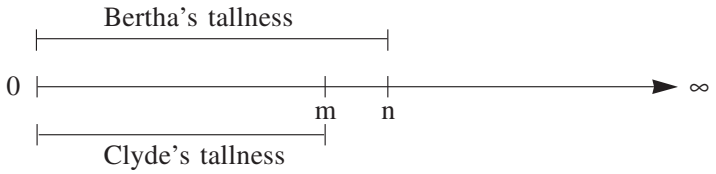
(21) $MAX(E) = \iota e[e \in E \,\&\, \forall e' \in E \Rightarrow e > e' \vee e = e']$

Using these definitions, the interpretation of our formula in (17b) can be stated as in (22). The sentence in (17a) is true if the maximal extent that Bertha has on the scale of height is greater than the maximal extent that Clyde has on this scale.

(22) a. $[\![\textbf{-er}(\lambda e.\textbf{tall}(@)(e)(\textbf{C}))(\lambda e.\textbf{tall}(@)(\textbf{B}))]\!]^g = 1$
b. iff MAX($[\![\lambda e.\textbf{tall}(@)(e)(\textbf{Bertha})]\!]^g$>
MAX($[\![\lambda e.\textbf{tall}((@)(e)(\textbf{Clyde})]\!]^g$)

For illustration of these truth conditions consider the diagram in (23). Sentence (17a), represented by the formula in (17b), is true in a situation where the extent $\langle 0, n\rangle$ covers the tallness of Bertha and the extent $\langle 0, m\rangle$ the tallness of Clyde if n is a higher real number than m. (23) depicts such a situation.

(23)



Constructions with comparisons containing negative polar adjectives are analyzed and interpreted analogously. The sentence in (24a), for example, is translated by the formula in (24b).

(24) a. Clyde is shorter than Bertha.
b. **-er**(λe.**short**(@)(e)(**Bertha**))(λe.**short**(@)(e)(**Clyde**))

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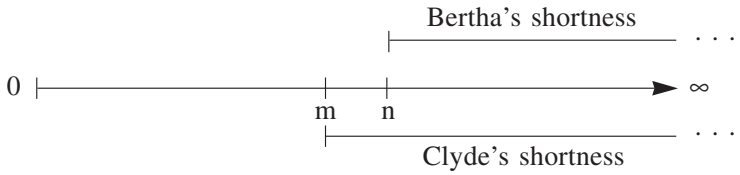
[10] This explains why constructions with so-called cross-polar anomalies are unacceptable. Consider the example from Kennedy (2001) in (i).

(i) *Bertha is taller than Clyde is short.

I skip the derivation of this formula. It parallels the derivation in (18). The sentence is true if Clyde's shortness exceeds the shortness of Bertha. Only negative extents are elements of the extent predicates in this example, since the negative polar adjective *short* is only defined for negative extents. Assume that the (negative) extent $\langle m, \infty\rangle$ covers the maximal shortness of Clyde and that $\langle n, \infty\rangle$ covers the maximal shortness of Bertha. If m is a smaller positive real n, Clyde's shortness includes Bertha's shortness and the sentence in (24a) is true. Such a situation is illustrated in (25).

(25)



Note that on this account it is easily derived that (17a) and (24a) are converses of each other and indeed equivalent. (17a) and (24a) compare complementary extents.

The mobility of the degree phrase has been motivated by examples where the extent operator appears to be embedded in intensional and modal contexts. I refer the reader to von Stechow (1993) and especially Heim (2000).

2.5. *Equatives*

Equatives differ from comparatives only in that the comparison relation is the 'greater than or equal'-relation instead of the 'greater than'-relation. Like *-er*, *as* has the semantic type $\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle$. The meaning of *as* is defined in (26).

(26) $[\![\textbf{as}]\!]^g = f : D_{\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle}$
For any extent predicates D_1 and $D_2 \in D_{\langle d, t\rangle}$:
$f(D_2)(D_1) = 1$ iff $MAX(D_1) \geq MAX(D_2)$

The 'greater than or equal'-relation may be stated in Boolean terms, as in (27).

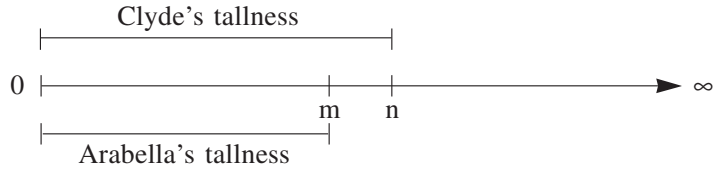
(27) For any extents e_1 and e_2:
$e_1 \geq e_2$ iff $e_1 \cap e_2 = e_2$,
where e_1 and e_2 have the same polarity.

An equative as in (28a) has to be formalized as in (28b).

(28) a. Clyde is as tall as Arabella.
b. **as**(λe.**tall**(@)(e)(**Arabella**))(λe.**tall**(@)(e)(**Clyde**))

The derivation of this formula and its interpretation perfectly parallel the derivation and interpretation of comparatives. (28a) is true if Clyde is at least as tall as Arabella. (29) illustrates these truth conditions.

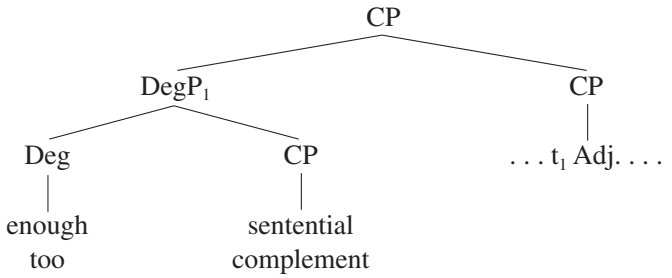
(29)



3. THE MEANING OF *ENOUGH* AND *TOO*

In order to derive the truth conditions of constructions with *too* and *enough*, I adopt the basic representation at the level of LF given in (30).

(30)



Basically, there are two steps to derive the tree in (30) from S-structure.

In a first step, the sentential complement is assumed to be reconstructed at LF from the sentence-final position at S-structure to its base position within the Adjective Phrase. Hence, *enough* forms a constituent with the sentential complement, and so does *too*. This constituent is raised to the head of the sentence in a second step, leaving a trace in the base position in analogy to comparative and equative constructions. (See the remarks in footnote 9).

The core idea now is that *enough* and *too* express three-place relations that relate an (implicit) world argument to the denotation of the sentential complement and the denotation of the main clause. I propose that the sentential complement expresses an incomplete conditional construction. To begin, it might help to consider the semantic composition of complete conditional sentences. Then we will see how incomplete conditionals incorporate into the semantics of sentences with *too* and *enough*.

3.1. *Interlude: Compositional Semantics for Conditionals*

For conditionals, I adopt a semantics in the spirit of Kratzer (1981, 1991) and a syntax in the spirit of Iatridou (1991).

Kratzer assumes that conditional sentences are always modalized sentences. That is, they explicitly or implicitly contain a modal word in the main clause. This modal essentially expresses necessity or possibility and may be accompanied by a phrase like *in view of . . .* or *given that . . .* that specifies the kind of modality that is involved in the interpretation of modal sentences. It depends on the properties of the *in view of*-phrase whether a modalized sentence has an epistemic, deontic, or dispositional reading. If there is no such phrase, this information is provided by the context of use; that is, the meaning of modalized sentences can be dependent on contextual information.

The *in view of*-phrase characterizes a set of propositions, i.e. premises, from which conclusions are drawn. This set of propositions is called a conversational background.

In the framework of possible world semantics conversational backgrounds can be modeled as functions that assign a set of propositions to a world. What we know, for example, depends on the world we inhabit. (31) is a definition for an epistemic conversational background and (32) for a deontic background.

(31) Epistemic conversational background ("what is known"):
An epistemic conversational background is that function f such that $\forall w \in W : f(w) = \{p | p$ is established knowledge in $w\}$

(32) Deontic conversational background ("what the law requires"):
A deontic conversational background is that function f, such that $\forall w \in W : f(w) = \{p | p$ is a law in $w\}$

In conditional sentences, the proposition that is expressed by the *if*-clause is assumed to restrict the conversational background further, i.e., it is added to the set of premises to form a new (hypothetical) conversational background.

Slightly departing from Kratzer's so-called standard analysis (see Kratzer 1991), I propose to treat modals in conditionals as a four-place relation that relates a world argument w, a conversational background h, and two propositions p and q.[11]

---

[11] The conjunction *if* is thought to be meaningless in this approach. In this respect I follow a suggestion of Heim and Kratzer (1991).

The lexical entries for *can* and *must* are defined as in (33). The type p abbreviates the type $\langle s, t\rangle$ of propositions, and the type h of conversational backgrounds abbreviates the type $\langle s, \langle p, t\rangle\rangle$.

(33) $[\![\mathbf{can}^R]\!] = f : D_{\langle s, \langle h, \langle p, \langle p, t\rangle\rangle\rangle\rangle}$
For any world $w \in W$, conversational background $h \in D_h$, and propositions $p, q \in D_p$:
$f(w)(h)(q)(p) = 1$ iff $\bigcap(h(w) \cup \{p\}) \cap q \neq \varnothing$.

(34) $[\![\mathbf{must}^R]\!] = f : D_{\langle s, \langle h, \langle p, \langle p, t\rangle\rangle\rangle\rangle}$
For any world $w \in W$, conversational background $h \in D_h$, and propositions $p, q \in D_p$:
$f(w)(h)(q)(p) = 1$ iff $\bigcap(h(w) \cup \{p\}) \subseteq q$.

A conditional of the form 'If p (then) can q' is true in a world w, with respect to a conversational background h, iff the conversational background restricted by the *if*-clause is compatible with the proposition q expressed by the main clause. A conditional of the form 'If p (then) must q' is true in a world w, with respect to a conversational background h, iff the conversational background restricted by the *if*-clause entails the proposition q expressed by the main clause.

These truth conditions are based on the first version of Kratzer's dissertation, which lays out a premise semantics for conditionals. The definitions deviate from the Kratzer's original proposal in that they treat the conversational background as an argument of the modal rather than as an interpretational parameter. This move has the advantage that iterated modals may be evaluated with respect to different conversational backgrounds.[12]

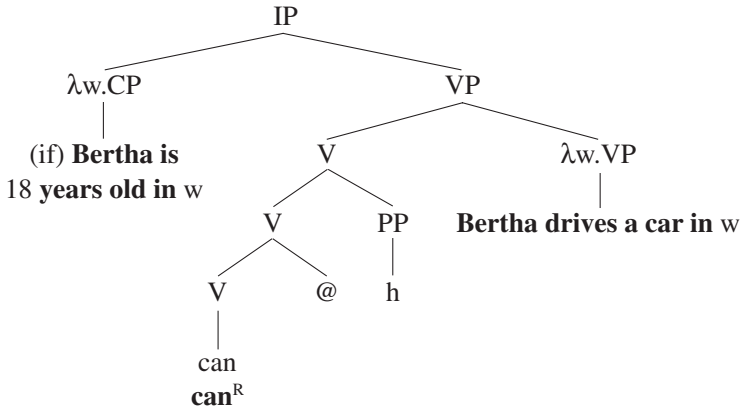
For a conditional clause as in (35a) I propose the LF in (35b). The *if*-clause is assumed to be base-generated sentence initially and denotes a proposition, as in (35c).

---

[12] For shortcomings of this version and a motivation of ordering semantics for conditionals, I refer the reader to Kratzer (1991, pp. 643f.). Consequently, in my framework doubly relative *must* is formalized as a five-place relation, as in (i), where h stands for the modal base and g for the ordering source involved.

(i) $[\![\mathbf{must}^{R2}]\!] = f : \widehat{D_{\langle s, \langle h, \langle g, \langle p, \langle p, t\rangle\rangle\rangle\rangle\rangle}}$
For any world $w \in W$, conversational backgrounds h and $g \in D_h$, and propositions $p, q \in D_p$:
$f(w)(h)(g)(q)(p) = 1$ iff $q(w^*) = 1$ for all w^* such that three conditions are met:
1. $w^* \in \bigcap h(w)$
2. $p(w^*) = 1$
3. $\neg\exists w^{**}[w^{**} \in \bigcap (h(w)) \;\&\; p(w^{**}) = 1 \;\&\; w^{**} <_{g(w)} w^*]$

(35) a. If Bertha is 18 years old, she can drive a car.
b. $\mathbf{can}^{R}_{h,@}$(λw. Bertha drives a car in w)(λw. Bertha is 18 years old in w)
c.



This solution has the following basic characteristics. The modal expression **can** with a superscript *R* indicates that it takes two prepositional arguments. However, **can**^{R} is assumed to combine first with a world variable. The @-symbol is a free world variable that is designated to refer to the actual world of utterance. Second, **can**^{R} combines with a variable for a suitable conversational background to give a two-place relation. The referent of this variable may also be spelled out by a prepositional phrase like *in view of*. . . . Whether the modal is interpreted deontically, epistemically, or circumstantially, or for some mixture of these backgrounds, depends entirely on some variable assignment *g*.

In a third step, **can**^{R} combines with the proposition expressed by the main clause – that is, the consequent of the conditional – and in a fourth step it combines with the proposition expressed by the *if*-clause to give a truth value. *If* is thought to be semantically vacuous in this approach.

Note that modals first combine with the first part of the restriction (the conversational background), second with the nucleus (the denotation of the main clause), and third with the second part of the restriction (the denotation of the *if*-clause).

In this view, structures with quantifiers over possible worlds are quadripartite structures, rather than tripartite structures as is traditionally assumed (e.g. Partee 1991).

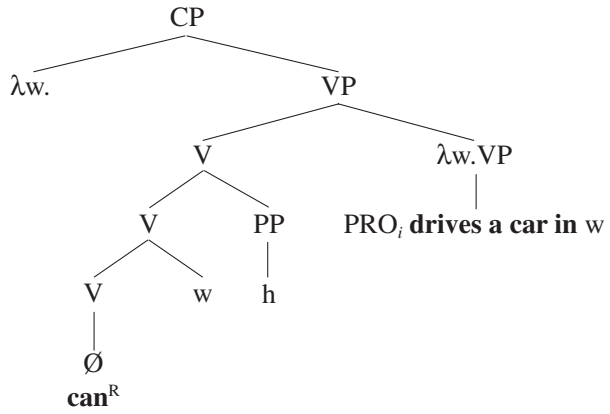
3.2. *Constructions with* Enough

Reconsider now our examples with *enough*. I assume that in all these examples the sentential complement is modalized and that these modals are considered to be four-place relations in the standard version of modal interpretation, as if they occurred in a conditional. The denotation of the sentential complement is then not a proposition, as one would assume at first sight, but a function from worlds to sets of propositions.

The LF for the sentential complement of example (1a) is given in (36b). In this example the modal is implicit. I assume here a syntactic operation that adjoins an additional VP-shell to the basic sentential complement and inserts a modal word with existential force, for example *can*. Let us work our way upward from the bottom of the tree. The trees for genuine conditional clauses (see (35c)) and for the sentential complement of *enough*-constructions are identical up to the highest VP-node. But, whereas the second prepositional argument is saturated in conditional clauses, this argument remains unsaturated in the sentential complement of the *enough*-construction.

(36) a. . . . PRO_i to drive a car

b.



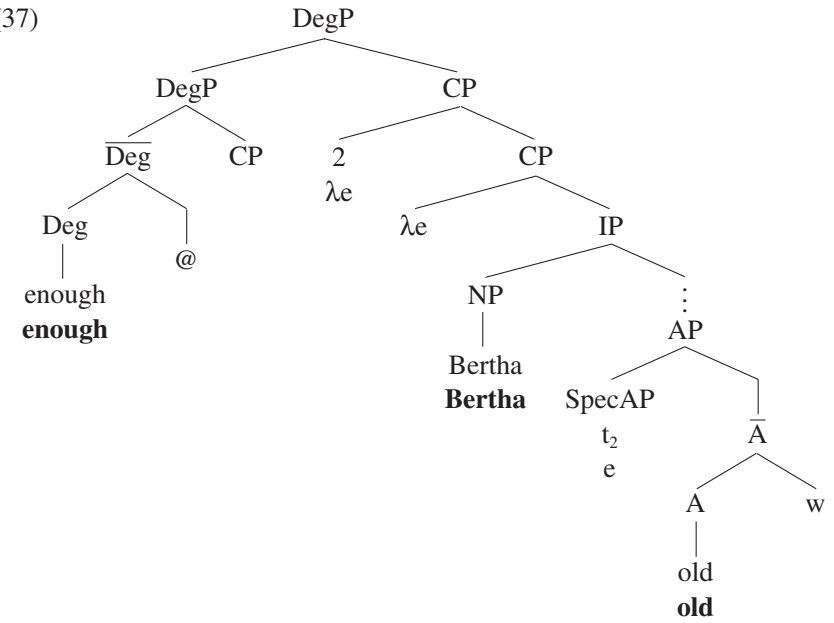
It is essentially the task of the operator *enough* to supply this argument in doubling the information provided by the main clause.[13]

What remains to be worked out now is the denotation of the main clause. I assume that, analogous to comparative constructions, the main clause denotes an open proposition, as in (37). The degree phrase is moved to the left periphery of the sentence, leaving a trace of type *d*. This is a

[13] This analysis supposes an approach with flexible types for operators with wide scope over the modal (Wolfgang Sternefeld, p.c.).

suitable argument for the adjective. Additionally, we abstract from the world variable. The index of the adjoined degree phrase is interpreted as introducing lambda abstraction on the extent variable. This process makes an extent predicate out of the open proposition that is expressed by the main clause.

(37)



If we put all this together we get the logical representation in (38b) for our example in (1a).[14]

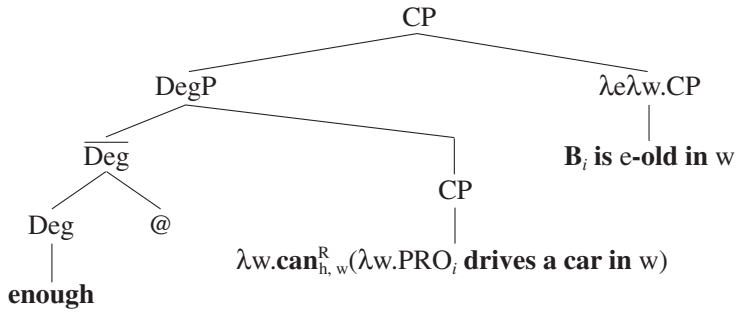
(38) a. Bertha is old enough to drive a car.

[14] In sentences where PRO is interpreted to be a bound variable, as in (i), we additionally have to assume that the binder raises to a position that c-commands the Degree Phrase at the level of LF.

(i) Bill gave everyone enough money to survive for a week.

I am thankful to Roger Schwarzschild for pointing out this complication to me.

b.



This view leads us to the assumption that *enough* is a three-place predicate that relates a world argument, an unsaturated modalized expression, and an extent predicate. I propose to construe the denotation of *enough* as a function that first combines with a hidden world argument, then with the intension of an incomplete conditional, and in a third step with an extent predicate, before it finally gives a truth value. This operator has essentially two functions. On the one hand it makes the incomplete conditional complete, and on the other hand it introduces a suitable comparison relation. The definition of *enough* is given in (39). Q stands for the incomplete conditional that is the interpretation of the sentential complement, and P for the degree predicate expressed by the main clause.

(39) $[\![\textbf{enough}]\!] = f : D_{\langle s, \langle\langle s, \langle p, t\rangle\rangle, \langle\langle d, p\rangle, t\rangle\rangle}$
For all $w \in W$, $Q \in D_{\langle s, \langle p, t\rangle\rangle}$, and $P \in D_{\langle d, p\rangle}$:
$f(w)(Q)(P) = 1$ iff
$MAX(\lambda e.\mathrm{P}(e)(w)) \geq MIN(\lambda e^*.Q(\mathrm{w})(P(e^*)))$

That is, *enough* is meant to relate the extent that satisfies the degree predicate expressed by the main clause and the minimal extent of the set of extents for which the conditional completed by the denotation of the main clause is true.

The maximality operator is defined in (21). The minimality operator for any set E of extents is defined as in (40). It picks out the smallest extent of a set of extents.

(40) $MIN(E) = \iota e[e \in E \;\&\; \forall e' \in E \Rightarrow e' \geq e]$

The representation in (38b) allows us to calculate the meaning of example (38a) as in (41). In order to simplify matters, for ease of comprehension, I use the standard version of Kratzer's theory of modality.

(41) $[\![$**enough**(@)(λw.**can**^{R}(w)(h)(λw.PRO$_i$ **drives a car in** w))
(λeλw.**Bertha**$_i$ **is** e-**old in** w)$]\!]^g$ = 1
iff *MAX*(λ*e*.Bertha is *e*-old in @) ≥
MIN(λ*e**.(⋂(*g*(*h*)(@) ∪ {{*w*| *g*(x_i) drives a car in *w*}}) ∩
{*w*| Bertha is *e**-old in *w*} ≠ Ø)

I will not go through (41) step by step. The variable assignment *g* is assumed to assign Bertha to the variable *x* with the index *i*. Furthermore, *g* assigns to the background variable *h* a function that gives for every evaluation world the set containing the proposition in (42).

(42) ∀*w*, *g*: *g*(*h*)(*w*) = {Every driver is older than 16}

With this assumption, the result of the calculation is the paraphrase in (43), given a situation in which *can* is evaluated against a deontic background.

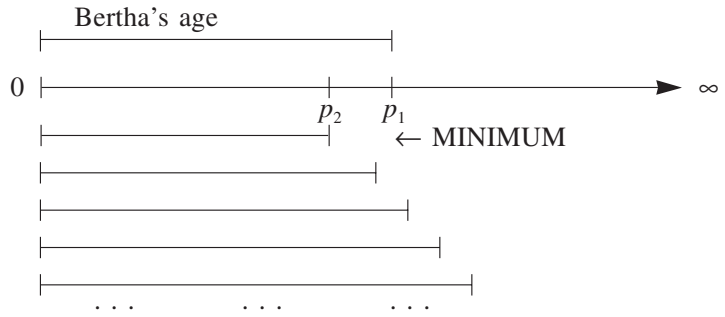
(43) The maximal *e* such that Bertha is *e*-old is greater than or equal to the minimal *e** such that, if Bertha is *e**-old, she can drive a car in the view of the law."

Here, the string "the minimal *e**" is used as a shorthand for the definite description defined by the minimality operator. This definite description must satisfy the usual presuppositions of existence and uniqueness. In order to find the minimal *e** such that Bertha can drive a car if she is *e**-old in view of (42), we collect all values *e** that satisfy the conditional given the law. If Bertha is younger than 16, it is not compatible with the law that she drives a car.

Since *old* is a positive polar adjective, *e* and *e** abbreviate in this calculation for positive extents of the form $\langle_A 0, n\rangle$. The 'greater than or equal'-relation is defined as in (27) above.

The sentence *Bertha is old enough to drive a car* is assumed to be true in the situation illustrated in (44). Suppose the stretch from zero to p_1 represents Bertha's actual age and the stretch from zero to p_2 the age limit in a relevant country. Then stretches that satisfy the conditional are longer than or equally long as the age limit stretch. The shortest of these stretches is required to be shorter than or equally short as the extent to which Bertha is old. This situation is characteristic for a permissive conversational background.

(44)



Note also that we can capture the idea that the standard of comparison in examples with *enough* and a positive polar adjective is a lower bound.

However, this approach seems to be too coarse-grained in at least one respect.[15] It is possible, for example, to utter a sentence like (45a) in a situation where we know that Bertha meets the age requirement but not the height requirement to get a certain part in a play. Assume that Bertha is 18 years old and 5 feet tall and that she must be at least 16 years old and at least 6 feet tall in order to qualify for the role.

If we derived the paraphrase of (45a) as in the previous example, inserting *can* and interpreting *can* with respect to an deontic conversational background, we would come up with the meaning in (45b).

(45) a. Bertha is old enough to get the part (although she is not tall enough).

b. "The maximal *e* such that Bertha is *e*-old is greater than the minimal *e** such that, if Bertha is *e**-old, she can get the part, in view of the law."

However, that Bertha gets the part is not compatible with what we know in the first place. Bertha is too small. The conditional in (46), for example, seems to be intuitively false because we cannot disregard Bertha's dispositions, that is, her actual height.

(46) If Bertha is 18 years old, she can get the part (in view of the requirements).

Therefore, the set of extents that satisfy the standard of comparison in (45b) is empty and we predict (45a) to be undefined, contrary to our intuitions. This reasoning shows that sentences with *can* always have (partly) dispositional or factual interpretations. (46) must be interpreted with respect

[15] I would like to thank Delia Graff and Karina Wilkinson for bringing this point to my attention.

to all relevant requirements and given what Bertha's actual properties are, apart from her height.

The solution to this puzzle is to assume that in some cases it seems to be more appropriate to insert counterfactual *could* and not *can*. *Could* seems to allow backgrounds where we abstract away from Bertha's other actual properties, not only from her age. The paraphrase in (47) seems to capture the truth conditions of (45a) more accurately than (45b).[16]

(47) "The maximal e such that Bertha is e-old is greater than (or equal to) the minimal e^* such that, if Bertha is e^*-old, she could get the part (in view of the requirements)."

For counterfactual *could* I assume the truth conditions in (48). *Could* is evaluated with respect to a modal base and an ordering source.

(48) $[\![\textbf{could}^{R2}]\!] = f : D_{\langle s, \langle h, \langle g, \langle p, \langle p, t\rangle\rangle\rangle\rangle\rangle}$
For any world $w \in W$, conversational backgrounds h and $g \in D_h$, and propositions $p, q \in D_p$:
$f(w)(h)(g)(q)(p) = 1$
iff $q(w^*) = 1$ and there is a w^* such that three conditions are met:
1. $w^* \in \bigcap h(w)$
2. $p(w^*) = 1$
3. $\neg\exists w^{**}[w^{**} \in \bigcap(h(w)) \;\&\; p(w^{**}) = 1 \;\&\; w^{**} <_{g(w)} w^*]$

For the relevant example, I assume the modal base h to be empty and the ordering source g to be the rules for the cast, as in (49).

(49) $\forall w, g$: $g(w) = \{\exists!x\exists d_1\exists d_2[x$ is $\langle 0, d_1\rangle$-old and $\langle d_2, \infty\rangle$-tall and $d_1 \geq 16$ and $d_2 \leq 6]\}$

The ordering source partitions all possible worlds into two sets, a set of worlds (type 1) where there is a part to play and a set of worlds (type 20 where there is no part to play. Type 2 worlds obviously come closer to the ordering source. In all those worlds, Bertha either has a certain age or she has no counterpart at all. Bertha may now be younger than 16, or exactly 16, or older than 16. Take the set of worlds where she has her actual age, 18. In all these worlds Bertha's height can differ from her actual height. This reasoning presupposes that age and height are not essential properties (see Lewis 1968 for discussion of this point). The truth conditions for doubly relative *could* and *enough* tell us to pick out the set of extents e such that Bertha plays the part and Bertha is e-old. In all worlds in which she plays the part she is smaller than her actual height and the minimal extent

[16] Note that the antecedent of the conditional is still in indicative mood.

that satisfies the conditional is the extent ⟨0, 16⟩. This extent is smaller than the extent that represents her actual age, and so the *enough*-construction is predicted to be true.

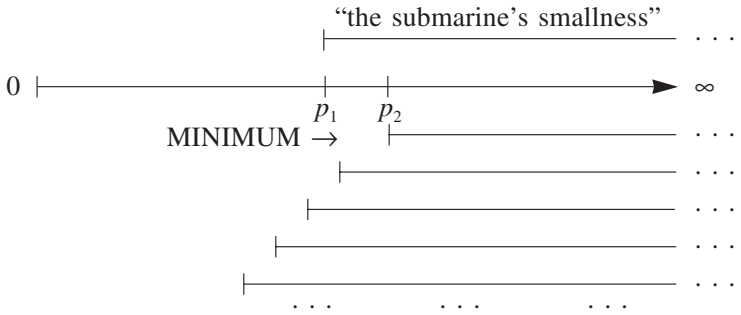
Choosing the wrong modal expression or the wrong background may lead to misunderstandings.

So far, our account is limited to constructions with positive polar adjectives, but it is easily shown to cover constructions with negative polar adjectives like *small*, as in (2a) and repeated in (50a), without changing the truth conditions for *enough*. (50a) is true in a world if the negative extent that satisfies the proposition 'The submarine is *e*-small', expressed by the main clause, in this world is greater than or equal to the minimal (negative) extent for which the corresponding conditional is true in this world. These truth conditions are represented by (50b).

(50) a. The submarine is small enough to pass through the hole.
b. "The *e* such that the submarine is *e*-small ≥ the minimal *e** such that, if the submarine is *e**-small, it can pass through the hole, given what we know."

These conditions predict the sentence to be true in the situation in (51), where the stretch representing the extent of the smallness of the submarine is longer than the minimal stretch of the set of stretches that represent the relevant conditionals.

(51)



If we change the perspective and consider the complements of the negative extents, the minimal negative extent turns out to be a maximal positive extent. With this move we can capture the intuition that the object value in *enough*-constructions with negative adjectives is compared to an upper bound of admissible values.

The compositional derivation of truth conditions relies on the insight that *enough* forms a quantifier together with the sentential complement, analogous to comparative and equative constructions. However, it seems not so easy to observe scope phenomena that corroborate the assumption of

QR at the level of LF. We predict the sentence in (52) to be ambiguous between a narrow scope reading and a wide scope reading. In the second reading the reason for Mary to marry Harry is his predisposition to earn or spend a lot of money. Only men with this disposition qualify to marry Marry.[17] In the first reading Harry is said to have necessarily more money than he would need to marry Mary.

(52) Harry needs (to have) enough money to marry Mary.
   a. "It is necessary that the extent *e* such that Harry has *e*-much money ≥ the minimal extent *e** such that, if Harry has *e**-much money, it is possible that he marries Mary."
   b. "The maximal extent *e* such that Harry needs (to earn/spend) *e*-much money ≥ the minimal extent *e** such that Harry can marry Maria if he needs (to earn/spend) *e**-much money."

3.3. *Constructions with* Too

Constructions with *too* differ from constructions with *enough* in only two respects. First the comparison relation 'greater than or equal to' is replaced by 'greater than'. And second, the actual extent that an object has is not compared to the *minimal* extent that satisfies the corresponding conditional, but to the *maximal* extent.

The degree word *too* is assumed to have the truth conditions in (53).

(53) $[\![\textbf{too}]\!] = f : D_{\langle s, \langle\langle s, \langle p, t\rangle\rangle, \langle\langle d, p\rangle, t\rangle\rangle\rangle}$
For all $w \in W$, $Q \in D_{\langle s, \langle p, t\rangle\rangle}$ and $P \in D_{\langle d, p\rangle}$:
$f(w)(Q)(P) = 1$ iff
$MAX(\lambda e.P(e)(w)) > MAX(\lambda e^*.Q(w)(P(e^*)))$

Maximality is defined as in (21).

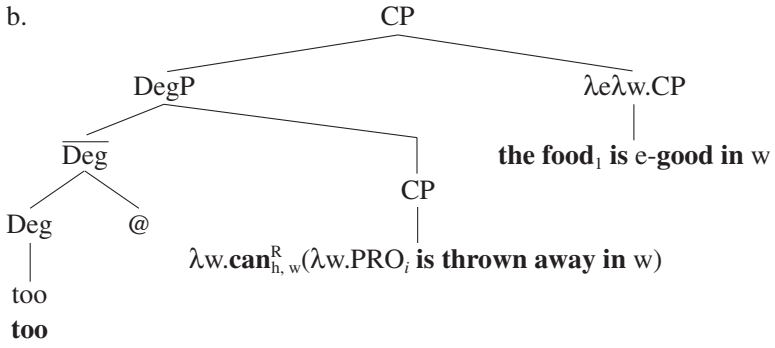
Informally, the *too*-construction is true in a world if the extent that satisfies the extent predicate expressed by the main clause is greater than the maximal extent that satisfies the conditional corresponding to the infinitival clause. (54b) shows the interpreted Logical Form of (1b). This LF is analogous to the LF proposed for constructions with *enough*.

---

[17] Problematic for this account is the fact that the first maximality operator is only defined if Harry earns/spends the same amount of money in all worlds that are accessible. But, intuitively, we want to compare the minimal extent that satisfies the relevant conditional to the minimal amount of money that Harry needs. Heim (2000) suggested overcoming this difficulty with a monotonicity assumption for the meaning of adjectives.

(54) a. The food is too good to be thrown away.

b.

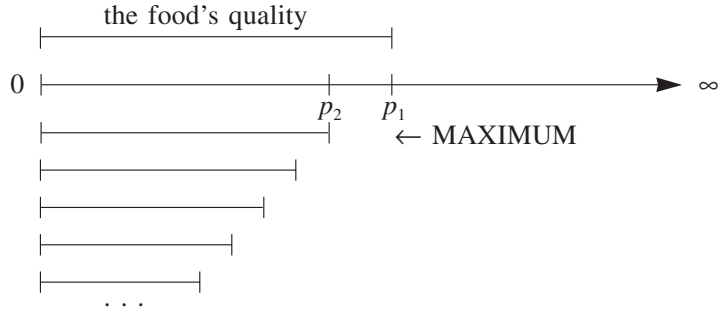


The representation in (54b) allows us to calculate the meaning of example (1b) as in (55). In a situation where the conversational background *h* is permissive, *The food is too good to throw away* is true if the quality of the food is better than the maximal *e** such that, if the food is *e**-good, we throw it away, given what is allowed.

(55) $[\![\textbf{too}(@)(\lambda w.\textbf{can}^{R}(w)(h)(\lambda w.\text{PRO}_1 \textbf{ is thrown away in } w))(\lambda e\lambda w.\textbf{the food}_1 \textbf{ is } e\textbf{-good in } w)]\!]^{g} = 1$
iff the maximal *e* such that food is *e*-good is greater than the maximal *e** such that, if the food is *e**-good, it can be thrown away given what is allowed.

These truth conditions predict the sentence to be true in the situation illustrated in (56). The actual quality of the food is compared to the maximal possible quality of the food, such that we still could throw it away given what is allowed.

(56)



The diagram also reveals that the standard of comparison is an upper bound of admissible values.

The interpretation of constructions with *too* in association with negative polar adjectives is represented in (57). Informally, (57a), *She was too young*

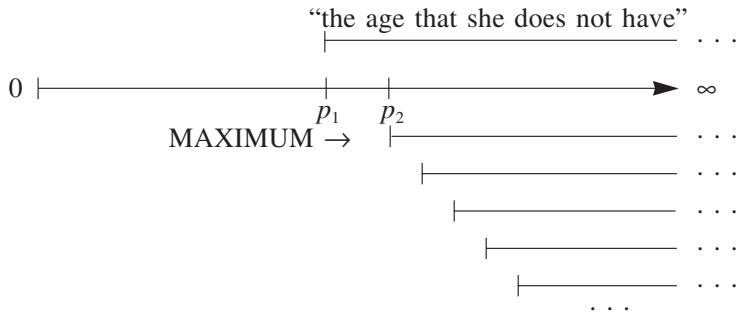
to date, is true in a world if the (negative) extent that satisfies the main clause in this world is greater than the maximal (negative) extent for which the corresponding conditional is true in this world. The derivation of this paraphrase is analogous to the previous procedure.

(57) a. She was too young to date.
b. "The maximal *e* such that she is *e*-young > the maximal *e** such that, if she is *e**-young, she could date."

In constructions with negative polar adjectives we compare negative extents that begin somewhere in the middle of the scale associated with the adjective and end nowhere. The extent of the age the subject does not have is said to exceed the maximal extent *e** of youth for which the relevant conditional 'If she is *e**-young she could date' is true.

The diagram in (58) is an illustration of a situation that makes (57a) true. The complement of the maximum of the age the subject does not have is the minimum of the age that she does have and in this respect a lower bound.

(58)



Again our analysis assumes the degree word *too* to be mobile at the level of LF.[18] That this is indeed the case may be illustrated with an example due to Heim (2000) that only has a wide scope reading. Heim has a situation in mind where the subject cannot take a certain job because he would not earn enough money to support his life-style.[19]

(59) Peter needs (to have) too much money to take this job.
"The maximal extent *e* such that Peter needs (to have) *e*-much money is greater than the maximal extent *e** such that Peter can take the job if he needs (to have) *e**-much money."

In this reading the comparison relation has wide scope with respect to the

[18] Corver (1990) predicts *too* to be immobile before S-structure (Spell-out).
[19] See footnote 17 for potential problems with this paraphrase.

modal in the main clause. If *too* were not mobile, it would not be possible to derive this reading.

3.4. *The Implicative and Non-implicative Use*

The implicative use and the non-implicative use of constructions with *too* and *enough* observed by Karttunen (1971) is in this account a reflection of the interpretation with respect to contexts with different characteristics. Let me demonstrate this for constructions with *enough*. While the sentence in (60b) implies preferably that John, in fact, left early, the sentence in (60a) seems not to imply the truth of the sentential complement in the actual world, at first sight. *John was clever enough to learn to read* does not necessarily mean that John indeed learnt to read.

(60) a. John was clever enough to learn to read. (non-implicative)
b. John was clever enough to leave early. (implicative)

In order to explain this difference, I propose to evaluate (60a), i.e., the non-implicative use, against a (partially) idealistic background. Suppose John is, in fact, a man from a poor neighborhood and didn't have the chance to learn to read. And suppose *ideally* that he had the money and the time to go to school instead of working every day of his childhood. In this context, the sentence means that the extent to which John is clever is greater than or equal to the minimal extent for which it is true that John could have learnt to read if he were as clever as he actually was and given an ideally conducive environment. Hence it does not follow that John can read in the actual world. It is only assumed that he could read in some ideal worlds.

(60b), the implicative use, on the other hand, I assume to be evaluated preferably with respect to a conversational background that is called by Kratzer a "totally realistic", or "fatalistic", background. A fatalistic background contains propositions that describe a world in full detail. *John was clever enough to leave early* means in such a context that the extent to which John is clever is greater than or equal to the minimal extent *e* for which it is true that he *can* leave early if he is *e*-clever, given all the facts. If it is compatible with the facts that John left early, and if the facts describe the actual world in full detail, then it is not possible that John didn't leave early in the actual world. In such a realistic context John has no choice, so to speak, but to do what he is prescribed to do by fate. Whatever John can do, he in fact does do. And this again means that it follows from the meaning of (60b) with respect to a realistic background that John in fact *did* leave early.

This means that it is determined by the characteristics of the context whether you commit yourself to the truth of the sentential complement or not. Analogous to simple modal sentences, the reality of the modalized sentence depends on the characteristics of the premises and the modal force of the modal expression.[20]

3.5. *Proper Inferring*

Kennedy (1999, p. 102) observed that the argument in (61) is valid, but not the argument in (62).

(61) Kim is too old to qualify for the children's fair

Sandy is older than Kim

Sandy is too old to qualify for the children's fair

(62) The bottle of milk is too old to drink

The bottle of wine is older than the bottle of milk

The bottle of wine is too old to drink

These facts are easily explained in terms of the theory proposed here.

In (61), Kim's and Sandy's actual age is compared to the maximal age a person has such that she still can go to the children's fair. The rules that play a role in the conversational background are the same for everybody. In other words, the standard of comparison in the argument in (61) does not differ for Sandy and Kim. And if Kim is older than the maximal extent *e* such that Kim can go to the children's fair if she is *e*-old and Sandy is older than Kim, then Sandy is too old, too.

In (62), on the other hand, the actual age of the milk is compared to the maximal age milk can have such that it is still drinkable. The actual age of the wine is compared to the maximal age wine of this variety can have such that it is still drinkable. But the maximal age of milk and the maximal age of wine differ. Milk may be kept longer if it is stored in the refrigerator or in the freezer. The maximal age of wine differs from grape to grape, it depends on the method of storage, and so on. A Fendant from the Valais in Switzerland, for example, should be stored at most ten years. But milk usually cannot be kept as long as wine. The causal laws that determine the drinkability of wine and milk are different. And this is the reason why the argument in (62) does not go through.

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[20] The same reasoning may apply to constructions with *too* in the implicative and non-implicative use.

4. CONSTRUCTIONS WITH *SO . . . THAT*

For constructions with *so . . . that*, i.e., genuine result clause constructions, I want to propose an analysis analogous to the one given for *enough*, Like *enough*, *so* is assumed to introduce a comparison relation between two extents, where the first extent is the extent that makes the extent predicate expressed by the main clause true and the second extent is the minimal number of a set of extents determined by the relevant hidden conditional. The definition of resultative *so* may be stated as in (63).

(63) $[\![\textbf{so}]\!] = [\![\textbf{enough}]\!]$

In other words, *so* and *enough* are assumed to be equivalent. Constructions with *so . . . that* I propose to be implicitly modalized, however, by a modal with universal force, if they are not explicitly modalized.

With these assumptions, I predict constructions with *so . . . that* and *enough* to be equivalent only if both are (explicitly or implicitly) modalized by the same modal expressions and if they are evaluated with respect to the same conversational background.

That this prediction is confirmed is exemplified by the following pair of sentences. In an epistemic context, the constructions in (64) are equivalent.

(64) a. The jet flies fast enough to beat the speed record.
b. The jet flies so fast that it *can* beat the speed record.
"The *e* such that the jet flies *e*-fast ≥ the minimal *e** such that, if the jet flies *e**-fast, it can beat the speed record, given what we know."

Whereas (64a) is assumed to be modalized *implicitly* by a modal expression denoting *can*, the construction with *so . . . that* in (64b) is modalized *explicitly* by the modal *can*. The two sentences have equivalent Logical Forms.

Sentences like (65a,b) are not equivalent. In constructions like (65a) the standard of comparison is determined by the minimal extent *e** such that the indicative conditional 'If the lion is *e**-tame, the lionkeeper can enter its cage' is true. In constructions like (65b), on the other hand, the standard is different. It is determined by the conditional 'If the lion was *e**-tame, the lionkeeper *could* enter its cage'.[21] The standards of comparison are, therefore, a minimal pair with respect to the modal expressions *could* and *can*.

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[21] Here I assume that *could* is not counterfactual. It just expresses possibility in the past.

(65) a. The lion was tame enough for the lionkeeper to enter its cage.
"The e such that the lion is e-tame ≥ the minimal e* such that, if the lion is e*-tame, the lionkeeper can enter its cage."

b. The lion was so tame that the lionkeeper could enter its cage.
"The e such that the lion was e-tame ≥ the minimal e* such that, if the lion was e*-tame, the lionkeeper *could* enter its cage."

It seems obvious that these conditions on the standard of comparison do not define the same extent on the scale associated with *tame*, at first sight. The standard of comparison of (65a) intuitively seems to be lower than the standard of comparison of (65b). While (65b) appears to imply that the lion was very tame, (65a) does not. I assume here that these differences are purely a matter of context. (65a) preferably seems to be evaluated against an epistemic background with buletic elements, and (65b) against a totally realistic background. Therefore, it is possible for (65b) to be uttered in a situation where the lionkeeper, in fact, entered the cage; in such a situation the lion has to be tamer indeed than in a situation in which the lionkeeper merely intends to enter the cage, as in (65a).

In (66), neither construction is explicitly modalized.

(66) a. The apartment has such a beautiful view that we rented it.
"The (max.) e such that the apartment has a e-beautiful view ≥ the minimal e* such that, if the apartment has a e*-beautiful view, we *have* to rent it."

b. The apartment has a view beautiful enough for us to rent it.
"The (max.) e such that the apartment has a e-beautiful view ≥ the minimal e* such that, if the apartment has a e*-beautiful view, we *can* rent it."

For (66a) I propose that a modal expression like *have to*, as defined in (67), may be added.

Whereas *can* is defined in terms of compatibility between an amended conversational background and the proposition expressed by the main clause, *have to* is defined in terms of entailment, in analogy to *must*.

(67) $[\![\textbf{have to}^R]\!] = f : D_{\langle s, \langle h, \langle p, \langle p, t\rangle\rangle\rangle}$
For any world $w \in W$, conversational background $h \in D_h$, and propositions $p, q \in D_p$:
$f(w)(h)(q)(p) = 1$ iff $\bigcap(h(w) \cup \{p\}) \subseteq q$.

Evidence for the correctness of this assumption is, again, that we do not change the meaning of (66a) when we add a modal expression to the

subordinated clause. (66a) and (68) may be equivalent if the modal is interpreted purely epistemically.

(68) The apartment has such a beautiful view that we had to rent it.

Whereas it follows under these assumptions from (66a) that we, in fact, rented the apartment, this does not follow from (66b), since the modal associated with the *enough*-construction has existential force only.

It is well known that constructions with modals as well as verbs of saying and verbs of propositional attitudes in the main clause of a result clause construction generally show ambiguities as in (69).

First, (69) is supposed to have a reading where the fact that Bertha is going to get the job is a result of her having claimed she has influential friends. This is a *de re* reading. And second, it is assumed to have a *de dicto* reading where Bertha says that she is going to get the job because she has influential friends.

(69) Bertha said that she has such influential friends that she is going to get the job. (ambiguous; Rouveret 1978)
   a. Bertha said the extent *e* such that she has *e*-influential friends ≥ the minimal extent *e** such that she necessarily gets the job if she has *e**-influential friends." (wide scope of *said*)
   b. The extent *e* such that Bertha said she has *e*-influential friends ≥ the minimal extent *e** such that she necessarily gets the job if she says that she has *e**-influential friends." (narrow scope of *said*)

In order to derive the first reading I think it is necessary to assume that in a first step the DP *such influential friends* dominating *such* moves out of the scope of the verb of saying. This movement is an instance of quantifier raising. The content of the DP is pied-piped. In a second step, the degree phrase is adjoined to the dominating CP and the pied-piped material is reconstructed in the scope of the prepositional attitude. The result of this procedure is the LF in (70a). This formula denotes a comparison between an extent *e* that satisfies that Bertha said she had *e*-influential friends and the minimal extent *e** such that it is true that Bertha is necessarily going to get the job if she says she has *e**-influential friends. If we interpret the construction with respect to a circumstantial background that is made up of causal laws and facts, we can indeed derive the fact that Bertha is going to get the job. This first reading is a wide scope reading. The narrow scope reading, represented formally in (70b), I propose to derive by short movement of the DP containing *such* and syntactic reconstruction of the pied-piped material. In this reading (69) is true if Bertha said

that the extent *e* such that she has *e*-influential friends is greater than or equal to the minimal extent *e** such that, if she has *e**-influential friends, she necessarily is going to get the job.

(70) a. $[_{CP}\ [_{DegP}$ such $[_{CP}$ that she is going to get the job$]]_i\ [_{IP}$ Bertha said $[_{CP}$ that $[_{IP}$ she has t_i influential friends$]]]]$

b. $[_{IP}$ Bertha said $[_{CP}$ that $[_{CP}\ [_{DegP}$ such $[_{CP}$ that she is going to get the job$]]_i$ [CP she has t_i influential friends$]]]]$

Interestingly, the movement is restricted by the usual island constraints for LF-movement. Long *so*-movement seems not to be possible in non-bridge contexts. (71) has only the *de dicto* reading.[22]

(71) Bertha whispered that she has such influential friends that she is going to get the job (unambiguous)

This argument shows that LF-movement of *such* patterns with *wh*-LF-movement and quantifier movement.[23]

5. Duality Relations

Constructions with *so*/*enough* and *too*, respectively, are considered to be duals of each other. In construction with a positive polar adjective, for example, *enough*/*so* is equivalent to the negation of a construction with *too* if the polarity of the adjective is reversed. This relation between *too* and *enough*/*so*, however, is not duality in the proper sense of the word, since it is not based on the concepts of outer negation and inner negation, but instead on (outer) negation and polarity reversal of the adjective (Löbner 1990).

According to the semantics proposed above, the sentence *Bertha is rich enough to own a car* may be paraphrased as in (72a). Assuming that the sentential negative *not* has a standard meaning of negation and is interpreted with wide scope, the informal truth conditions for the negative sentence *Bertha is not too poor to own a car* may be paraphrased as in (72b). Both sentences are equivalent.

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[22] See Liberman (1974) for discussion.

[23] I will not commit myself to an answer as to whether the difference between bridge verb contexts and non-bridge verb contexts is a difference in the lexical meaning of the verbs (Müller 1993) or instead a structural difference between the complements of bridge verbs and non-bridge verbs (Kayne 1984).

(72) a. Bertha is rich enough to own a car.
"The e such that Bertha is e-rich ≥ the minimal e^* such that, if Bertha is e^*-rich, she can own a car."

b. Bertha is not too poor to own a car.
"It is not the case that the e such that Bertha is e-poor > the maximal e^* such that, if Bertha is e^*-poor, she can own a car."

In order to derive the equivalence of these sentences, I follow again von Stechow (1984b). He introduces a second kind of negation for extents in order to express polarity reversal, as in (73). Polarity reversal in this view is, in fact, some sort of complementation.

(73) *"Negation" of extents*
a. $-\langle_A 0, n\rangle \coloneqq \langle_{\overline{A}} n, \infty\rangle$ (neg. of positive extents)
b. $-\langle_{\overline{A}} n, \infty\rangle \coloneqq \langle_A 0, n\rangle$ (neg. of negative extents)
where n is a real number.

The negation of a positive extent is equal to the negative extent on the scale identified by an adjective, and the negation of a negative extent is equal to a positive extent on the same scale. A positive polar adjective A and a negative polar adjective $\overline{A}$ are antonyms if the condition in (74) is satisfied.

(74) $\iota e\overline{A}(x, -e) = \iota eA(x, e)$

Whenever an object is related by a negative polar adjective to a negative extent, it is related to the negation of the corresponding positive extent. And simultaneously, it is related by the positive antonym to this positive extent.

Now consider again our examples. Assume that the extent $\langle 0, n\rangle$ stands for Bertha's wealth in the actual world and assume that $\langle 0, m\rangle$ is the minimal extent e such that Bertha can own a car if she is e-rich, given some relevant contextual information. Then (72a) is true if n is greater than m. In order to derive the equivalence of (72a) with (72b) we can apply the definition in (73a), as done in going from (75b) to (75c) below. Positive extents are complements of negative extents. By contraposition we can derive that the relevant negative extents stand in the 'smaller than'-relation; this is the step from (75c) to (75d). (75e) is the result of a pure algebraic operation. The negative extent $\langle_{poor} n, \infty\rangle$ is just Bertha's poverty, and the extent from m to infinity is the maximal extent e^* such that, if Bertha is e^*-poor, she can own a car, given the same context. And this is precisely the denotation of (72b).

(75) Suppose $\forall w$, h: ιe.rich(w)(Bertha, e) = $\langle_{rich} 0, n\rangle$ and $MIN(\lambda e.\text{can}^{R}(w)(h)$(Bertha is e–rich, she owns a car)) = $\langle_{rich}\ 0, m\rangle$. Then
a. $[\![(72a)]\!] = 1$ iff
b. $\langle_{rich}\ 0, n\rangle \geq \langle_{rich}\ 0, m\rangle$ iff (by definition (73a))
c. $-\langle_{poor}\ n, \infty\rangle \geq -\langle_{poor}\ m, \infty\rangle$ iff (by contraposition)
d. $\langle_{poor}\ n, \infty\rangle \leq \langle_{poor}\ m, \infty\rangle$ iff
e. $\neg(\langle_{poor}\ n, \infty\rangle > \langle_{poor}\ m, \infty\rangle$ iff (by (74))
f. $\neg(\iota e.$poor(Bertha, e) > $MAX(\lambda e.\text{can}^{R}(w)(h)$(B is e–poor, she owns a car))) iff
g. $[\![(72b)]\!] = 1$

6. Previous Proposals

Constructions with extent clauses have not received too much attention in the semantic literature so far. Guéron and May (1984) and others classify *so* in result clause constructions as a causal (compound) subordinator, but they do not mention the semantic interrelation between *so*/*enough* and *too*. In my account the causal meaning component of result clause constructions is a contextual effect. It always occurs if the *so*-construction is evaluated with respect to a conversational background that includes causal laws and factual information.

Von Stechow (1984a) analyses constructions with *too* as so-called comparative counterfactuals. For the sentence *The package was too heavy to lift* he proposes the Logical Form in (76a) (slightly simplified) and the paraphrase in (76b), respectively.

(76) The package was too heavy to lift.
a. **would**(@)(λw.**could**(w)(λw*.**one lifts the package in** w*), λw**.max(λd.**the package is** d-**heavy in** w**) < max(λd*.**the package is** d*-**heavy in** @))
b. "If one could lift the package, it would be less heavy than it actually is."

This analysis is problematic for the so-called non-implicative use of *too*-constructions (see section 3.4 for discussion of Karttunen's terminology). In its non-implicative use, a construction with *too* does not imply the negation of the proposition expressed by the infinitival complement.

The non-implicative use of *too* is exemplified by the example in (77). If we utter the sentence *John is too stupid to be a regent*, we are not committed to the falsity of the proposition expressed by the infinitival

complement. This is shown by the fact that this sentence may be continued by an utterance like *Nevertheless he was elected.*

The Stechow analysis is problematic for these non-implicative constructions, because it predicts the sentence in (77) to be trivially false in a situation in which John actually is a regent, contrary to the facts.

(77) John is too stupid to be a regent. Nevertheless he was elected.
   a. **would**(@)(λw.**J is a regent in** w, λw*.max(λd.**J is** d-**stupid in** w*) < max(λd*.**J is** d*-**stupid in** @))
   b. "If John were a regent, he would be less stupid than he actually is."

If John is a regent, the counterfactual conditional "If John were a regent, he would be less stupid than he actually is," given in (77b), has a true antecedent. And, counterfactuals with true antecedents can only be true if their consequent is true in the actual world, according to Lewis. If the consequent is false, the counterfactual is false, too.

(78) Truth conditions for *would* (Lewis, 1973)
$[\![\textbf{would}]\!] = f : D_{\langle s, \langle\langle s, t\rangle, \langle\langle s, t\rangle, t\rangle\rangle\rangle}$
For any world $w \in W$ and propositions $p, q \in D_p$:
$f(@)(p, q) = 1$ iff
$\exists w[p(w) = 1 \;\&\; q(w) = 1 \;\&\; \forall w^*[p\ (w^*) = 1 \;\&\; q(w^*) = 0 \Rightarrow w^* >_{@} w]]$

In our case the consequent of the construction is trivially false. The truth conditions of the consequent in (79) cannot be met in the actual world, because they are contradictory.

(79) $[\![$λw*.max(λd.**John is** d-**stupid in** w*) < max(λd*.**John is** d*-**stupid in** @)$]\!]_g(@) = 1$ iff
The maximal degree *d* so that John is *d*-stupid in the actual world is smaller than the maximal degree *d** so that John is *d**-stupid in the actual world.

Constructions with true antecedents are predicted to be trivially false under the assumption of a Lewis-style analysis for counterfactuals, contrary to Karttunen's observation.

In our account the sentence in (77) may be paraphrased as in (80). The main idea is to evaluate the conditional of the standard of comparison with respect to some ideal conversational background where only smart politicians are subject to elections.

(80) "The (max.) extent *e* such that John is *e*-stupid ≥ the maximal *e** such that John can be a regent if he is *e**-stupid, given some ideal of the political landscape."

This ideal, however, is not met in the actual world, and therefore it is possible that stupid John is a regent in the real world. This reasoning shows that it does not follow from the truth conditions of *too* and some conversational background that John *is* a regent. But it is compatible with the truth conditions for John to be a regent.

Bierwisch (1987) is the only analysis that offers truth conditions for *too* and *enough* that at least address the duality relation between these operators. I will quickly discuss his truth conditions for *enough* and show that they are not adequate.

In Bierwisch's opinion, constructions with *enough* in association with positive polar adjectives are comparisons between two degrees: first, the actual degree an object has and, second, a critical lower bound on the relevant scale. In order to capture this intuition, Bierwisch proposes a semantics for *enough* that allows a sentence such as (81a), *John was intelligent enough to leave early*, to be paraphrased as in (81b).

(81) a. John was intelligent enough to leave early.
b. "The degree of John's intelligence is higher or equally high than a certain critical degree *k*."
Possible assignments for *k* are all degrees *k** that make the material implication 'If John leaves early, his degree of intelligence is higher than *k**' true.

And this again is problematic. This can be most dramatically illustrated by sentences with necessarily true complements. A sentence such as (82a) is predicted to be true by Bierwisch's account, contrary to the facts.

(82) a.# Bertha is old enough to be self-identical.
b. "The degree of Bertha's age is higher or equally high as a critical degree *k*."
Possible assignments for *k* are all degrees *k** that make the material conditional 'If Bertha is self-identical, her degree of age is higher than *k**' true.

Let me quickly show why: The material conditional that defines the possible assignments *k** and *k* is true if either it is not the case that Bertha is self-identical or if Bertha is older than *k**. Since Bertha *is* self-identical, only degrees that are smaller than Bertha's actual age qualify as assignments for *k*. Hence, it is trivially true that all possible assignments for *k* are smaller than Bertha's actual age.

Constructions with trivially true antecedents are predicted to be true in the Bierwisch-style semantics, contrary to the facts.

Most recently, Heim (2000) proposed a semantics for *too*. Her proposal is very similar to my proposal in that it captures the semantics of these constructions as comparisons between two values, where the standard of comparison is a modalized construction (as in my account). However, in her account the modalization is not the result of a syntactic process, but is built into the semantics of the degree operator. This account has the advantage of being very elegant and simple. But Heim disregards the semantic contribution of the sentential complement. Further elaboration of her account and its evaluation will need to be left to the future.

7. Conclusions

Let me sum up my findings on *enough*, *too*, and *so*. In order to interpret constructions with these expressions I rely on two assumptions: (a) the constructions have a modalized sentential complement, and (b) the modal is interpreted as a four-place relation, as if it were in the consequent of a genuine conditional. If the sentential complement is not explicitly modalized, I assume that it is implicitly modalized. One may think of this modalization as the result of a syntactic process. In constructions with *so* the modals have universal force, whereas in constructions with *too* and *enough* they have existential force. Since the interpretation of the modal expression is highly context dependent, the interpretation of constructions with *enough*, *too*, and *so* is highly context dependent, too.

Besides the modal meaning component, I propose that all these constructions have a comparative meaning component. Whereas constructions with *so* and *enough* express a 'greater than or equal'-relation, construction with *too* express a 'greater than'-relation. In this respect the former pattern with genuine equatives and the latter with genuine comparatives. The items compared are assumed to be extents in the sense of von Stechow (1984b). The standard of comparison is always the minimal or maximal element of a set of extents that satisfy a relevant conditional triggered by the implicit modal.

Constructions with *so* in the result clause differ from constructions with *enough* in that the modal that implicitly modifies the sentential complement has universal force rather than existential force. Therefore, constructions with *so* and *enough* are only equivalent if they are modalized by the same modal expressions (and if they are evaluated with respect to the same conversational background).

These truth conditions also allow us to derive the duality relations

between *so* and *enough*, on the one hand, and *too*, on the other, and they predict the so-called implicative and non-implicative uses of these constructions.

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