QUANTIFICATION IN *THAN*-CLAUSES

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This study proposes a solution to the problem of the non-homogeneous behaviour of quantifiers in comparative clauses. An interval-based approach is used for the implementation of the analysis. It is argued that the so called scope splitting modals, exemplified by *have to*, trigger the insertion of a covert exhaustivity operator of the kind proposed in Fox 2006 that is restricted by a set of alternatives ranked on a likelihood/effort scale. This explains the availability of more-than-min and more-than-max readings with *have to*. The present analysis also accounts for the fact that existential quantifiers, except for the polarity sensitive indefinites and possibility modals, are not interpreted under the comparative.

1. Introduction

Since Schwarzschild and Wilkinson 2002 sentences with quantifiers in comparative clauses have become the most serious test for any theory of comparison. Universal quantifiers contained within *than*-clauses usually appear to take scope over the comparative relation as demonstrated in (1). However, the 'clause-boundness' of QR along with other restrictions discussed in Schwarzschild and Wilkinson 2002 make an analysis that relies on scoping strategies virtually impossible.

(1) a. John is taller than every girl.
$\forall x$: $girl_{@}(x) \rightarrow Height_{@}(j) > Height_{@}(x)$
= John is taller than the tallest girl.

b. John is taller than I predicted.
$\forall w \in Acc_{@}$: $Height_{@}(j) > Height_{w}(j)$
= John is taller than my maximal prediction.

The facts turn out to be even more intricate. We find necessity modals that behave as if they didn't outscope the comparative. In (2) *have to*, in contrast to *should*, triggers the so called more-than-min reading that corresponds to the narrow scope of the modal. Crucially, the availability of readings depends on the choice of the quantifier and does not seem to be due to scope ambiguity.

(2) a. John is taller than he should be.
$\forall w \in Acc_{@}$: $Height_{@}(j) > Height_{w}(j)$
= John is taller than the maximally permitted height.
b. John is taller than he has to be.
$Height_{@}(j) > max(\{d: \forall w \in Acc_{@}: Height_{w}(j) \geq d\})$
= John is taller than the minimally required height.

The behaviour of existential quantifiers is no less puzzling. Possibility modals, like *be allowed* or *can*, result in the more-than-max interpretation, which can be represented by assigning narrow scope to the relevant modal with respect to the comparison, cf. (3). This option seems to be exploited by other existentials all of which appear in the form of polarity sensitive items, like *anyone*, cf. (4).

(3) John is taller than allowed.
$Height_{@}(j) > max(\{d: \exists w \in Acc_{@}: Height_{w}(j) \geq d\})$
= John is taller than the maximally permitted height.

(4) John is taller than any girl is.
$Height_{@}(j) > max(\{d: \exists x: girl_{@}(x) \ \& \ Height_{@}(x) \geq d\})$
= John is taller than the tallest girl.

We do not seem to be able to interpret indefinites, like *a girl* or *somebody*, under the comparative. They invariably get generic and wide-scope interpretations. Epistemic modals, like *might*, escape the scope of the comparative as well.

(5) It is warmer today than it might be tomorrow.
= $\exists w \in Acc_{@}$: $Temp_{@}(today) > Temp_{w}(tomorrow)$
= It is possible that it will be colder tomorrow than it is today.

(6) a. Lucky is bigger than a cat. (generic)
b. He did better than a student from his course. (wide scope)

Theories of the comparative should be able to account for the observed readings and explain why *than*-clauses license *any* and cannot host other existential quantifiers.

2. Interval based approach to the comparative and 'selection strategy'

Our starting point is Beck 2007's selection strategy, that relies on an interval-based interpretation of the comparative inspired by Schwarzschild and Wilkinson 2002 and Heim 2006. It amounts to the selection of the point of comparison from the interval denoted by the subordinate clause. So the comparison is ultimately between two points.

More specifically, Beck 2007's proposal is based on the adjectival meaning in (7a) due to Heim 2006 that enables us to treat *than*-clauses as generalised quantifiers over degrees, cf. (7b-d).

(7) a. $[\![\text{tall}]\!] = \lambda w.\lambda D.\lambda x.\ \text{Height}_w(x) \in D$
b. John is taller than he should be.
c. [λD should [John D tall]]
d. $\lambda D.\ \forall w \in Acc_@: \text{Height}_w(\text{John}) \in D$
= the set of intervals that include John's height in each accessible world

It is assumed that the set designated by the *than*-clause is passed to a *min* operator that returns the set of the smallest interval(s) contained in it. Then the selection step follows: the set obtained from the application of *min* is operated on by the specially defined *max* operator that gives the maximum of the interval from this set that either extends highest or lowest on the relevant scale. We demonstrate the derivation of the more-than-max reading of (8) in (9).

Among the advantages of the selection analysis is the fact that the observed readings are not obtained by assigning different scope to quantifiers and that the comparative is treated as a simple '>' relation between two degrees.

(8) a. John is taller than I predicted.
b. -------------w3-----w2---------w1-------------J----->

J	John's height in the actual world
w1-w3	John's heights in prediction worlds

(9) a. $\min(\lambda D.\ \forall w \in Acc_@: \text{Height}_w(\text{John}) \in D)$
$= \{[\text{Height}_{w1}(\text{John}), \text{Height}_{w3}(\text{John})]\}$
b. $\max(\{[\text{Height}_{w1}(\text{John}), \text{Height}_{w3}(\text{John})]\}) = \text{Height}_{w3}(\text{John})$
c. $[\![\text{er}]\!](\max(\min(\text{than-clause})))(\max(\min(\text{matrix-clause})))$
$= \text{Height}_@(\text{John}) > \text{Height}_{w3}(\text{John})$

We build on Beck 2007's analysis and suggest that the 'selection of the point' step can be reduced to picking the maximum of the smallest *than*-clause interval. In effect, there is no selection going on: the item of comparison is always the maximal degree of the unique minimal interval. This is achieved by an exhaustification step in the derivations involving certain quantifiers, which affects the interval expressed by the *than*-clause. In the following sections we will sketch the analyses of the relevant *than*-clauses.

3. Universal quantifiers

This section aims to account for the contrast in (2). The availability of the more-than-min reading, cf. (2b), depends on the choice of modal. In general, universal modals seem to fall into two classes. *Should*-like modals always result in the more-than-max reading, whereas *have-to*-like modals, termed scope-splitters in Schwarzschild 2004, allow comparison with the minimum as well as with the maximum of the span corresponding to the accessible worlds[1]. See Krasikova 2007 for discussion of the data.

Obviously, the proposal sketched at the end of the previous section can be immediately applied to the analysis of *should*-like modals. For the analysis of (2a) consider a situation in which John's goal is to become a pilot and pilots are required to be between 1.70m and 1.80m. Applied to this situation, the comparative clause of (2a), viz. (7d) would denote a set of intervals including [1.70; 1.80], provided that the accessible worlds are the ones in which John's goal is fulfilled. Picking the minimal interval form this set and passing it to the comparative operator defined in (10) gives us the desired comparison with the maximally permitted height, i.e. with 1.80m.

(10) a. $[\![er]\!] = \lambda I.\lambda I'.\ max(I') > max(I)$
b. $[\![er]\!](min(than\text{-}clause))(min(matrix\text{-}clause))$
c. $[\![min]\!] = \lambda D_{(dt)t}.\ \iota D' \in D: [\forall D'' \in D: D' \subset D'']$

For (2b) we assume that we can insert a covert exhaustifier (*exh*), like *only*, freely at the LF, see (11). This insertion is motivated if it strengthens the ordinary meaning according to the pragmatic program defended in Fox 2006. Importantly, *exh* is restricted by the likelihood ordering that is associated with *have to*, see (12a-b). The likelihood scale only becomes prominent with *have-to*-like modals which explains the absence of the strengthening effect with the other class of modals. The meaning of (11) is given in (13).

(11) $[\lambda D\ [exh_{C, >R}\ have\ to_{>R}] \sim C\ [Peter\ D_F\ tall]]$

(12) a. $[\![exh_{C, >R}]\!] = \lambda w.\ \lambda M.\ \lambda q.\ M(w)(q)\ \&\ \forall p \in C: p >_R q: \neg M(w)(p)$
b. $\forall p,q: p >_R q$ iff p is less likely than q (or iff p is more difficult than q)
c. $C = \{\lambda w.Height_w(Peter) \in D: D \in D_{dt}\}$

(13) $\lambda D.\ \forall w \in Acc_@: Height_w(Peter) \in D\ \&$
$\forall p \in C: p >_R [\lambda w.Height_w(Peter) \in D] \rightarrow \neg \forall w \in Acc_@: p(w)$
= the set of intervals s.t. it is required that Peter's height falls into them and everything less likely / more difficult is not required.

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[1] We may identify a scope splitter if embed it under only and get a sufficiency modal interpretation. See von Fintel and Iatridou 2005 for a descriptive overview of such modals and the semantics of the SMC.

Under the assumptions that $>_R$ is defined on propositions with non-overlapping intervals and that it corresponds to the ordering on the height scale, (13) amounts to the set of intervals that include the minimal compliance interval: in the pilot scenario these are the intervals that start with 1.70m. Combining this result with the matrix clause we get the extension for (2b) that corresponds to the more-than-min reading:

(14) $[\![er]\!]([1.70; 1.70])(\min(\lambda D.\text{Height}_{@}(\text{Peter}) \in D)) = 1$, iff $\text{Height}_{@}(\text{Peter}) > 1.70$

The minimal compliance interval is determined by what is considered the most likely or the least difficult amount of the relevant property. Therefore the resulting reading depends on the direction of the likelihood scale and ultimately on the context of utterance, which is a welcome prediction.

4. Existential quantifiers

Applying *min* defined in (10c) to a *than*-clause containing an existential quantifier results in the undefinedness: the uniqueness condition is violated, i.e. the set in (15) may contain more than one minimal interval.

(15) $\lambda D.\ \exists x: \text{Height}_{@}(x) \in D$

We believe that this explains why existential quantifiers escape *than*-clauses in general. However, polarity sensitive items, like *any*, can occur there resulting in a universal interpretation. We argue that the free choice implicature associated with items like *any* can change the meaning of the subordinate clause so that the application of *min* becomes possible. In (17) the free choice effect of (16) is derived as a result of a parse with two covert *exh* operators defined in (18), following Fox 2006.

(16) a. Peter is taller than John or Bill.

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|-------------1.70--------1.75-------P--------->
               J           B
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(17) a. $\lambda w.\ \lambda D.\ \text{exh}A'(\text{exh}A(\lambda w.\exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in D))$

b. $A = \{\lambda w.\exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in D \mid D \in D_{dt}\}$

c. $A' = \{\text{exh}(A)(p): p \in A\}$
$= \{\lambda w.\ \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.70; 1.75];$
$\lambda w.\ \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.70; 1.70]\ \&$
$\neg\exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.75; 1.75];$
$\lambda w.\ \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.75; 1.75]\ \&$
$\neg\exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.70; 1.70] \ldots\}$

d. $\lambda w.\ \lambda D.\ \forall x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in D$

(18) $[\![\text{exh}]\!]^w(A_{(st)t})(p_{st}) = \lambda w.\ p(w)\ \&\ \forall q \in \text{I-E}(p,A){:}\neg q(w)$, where $\text{I-E}(p,A) =$

$\cap\{A' \subseteq A |\ A'$ is a maximal set in A, s.t.,$\{\neg p{:}\ p \in A'\} \cup \{p\}$ is consistent$\}$

The first layer of exhaustification is trivial. It retains the alternatives that contain either Bill's height or John's height or both. The second *exh* restricted by A′ defined in (17c) excludes all alternatives except for the one with the biggest interval [1.70; 1.75]. This strengthens the original meaning to produce the universal interpretation in (17d) or the more-than-max reading. This procedure is parallel to Fox's derivation of the free choice effect in disjunctions under possibility modals.

We assume that a similar effect is responsible for the more-than-max interpretation of comparatives with *be allowed* and other non-epistemic possibility modals that cannot escape the comparative clause.

5. Conclusion

We presented an analysis for comparative sentences with quantifiers in *than*-clauses that solves a number of long standing problems in this area of semantics. It is based on the standardly assumed meanings of the comparative operator and the adjective. The analysis explains the diversity of readings available with universal modals without relying on a problematic scoping strategy, as well as the more-than-max reading of certain existential quantifiers that can be interpreted under the comparative.

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