Semantics & Pragmatics Volume 10, Article 15, 2017
https://doi.org/10.3765/sp.10.15

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Nouwen, Rick & Jakub Dotlačil. 2017. The scope of nominal quantifiers in comparative clauses. *Semantics and Pragmatics* 10(15). https://doi.org/10.3765/sp.10.15.

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EARLY ACCESS

The scope of nominal quantifiers in comparative clauses*

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Abstract We identify a new scope puzzle for quantifiers in comparative clauses. In particular, we argue that nominal quantifiers take scope at a higher level in the degree clause than previously assumed. On the assumption that quantifier scope is clause-bounded, this entails that there must be more structure in the clause than standardly assumed.

Keywords: comparatives, comparative clauses, scope, nominal quantifiers, modal quantifiers

1 Background

Clausal degree constructions can contain nominal or modal quantifiers, and when they do, they tend to yield readings that involve degrees corresponding to some minimum or maximum. The best-known example of this is the case of comparatives, where a universal modal in the *than*-clause yields comparison either to the maximally allowed degree, (1), or the minimally required one, (2).

(1) John drove faster than he should have. max

(2) John drove faster than he needed have. min

Similarly, nominal universal quantifiers in comparative clauses result in readings involving comparison to the degree that is maximal with respect to the quantifier's domain. For instance, for (3) John's speed is compared to the maximal speed among the speeds of his rivals.

(3) John drove faster than each of his rivals did. max

* The research leading to these results has received funding from the Netherlands Organisation for Scientific Research (NWO) VENI Grant 275.80.005 (Jakub Dotlačil) as well as from the European Research Council under the European Union's Seventh Framework Programme (FP/2007-2013) / ERC Grant Agreement no. 313502 (Rick Nouwen), which we hereby gratefully acknowledge. For discussion and comments, we would like to thank audiences at Amsterdam Colloquium 2015, Sinn und Bedeutung 2016 in Edinburgh and New Ideas in Semantics and Modeling 2016 in Paris. Finally, for numerous helpful comments, we would like to thank our S&P editor, Elizabeth Coppock, as well as two anonymous reviewers.

A huge body of literature addresses the compositional semantics of clausal comparatives and other clausal degree constructions containing quantifiers (von Stechow 1984, Larson 1988, Kennedy 1997, Beck & Rullmann 1999, Stateva 2000, Heim 2000, Schwarzschild & Wilkinson 2002, Heim 2006, Gajewski 2008, Schwarzschild 2008, van Rooij 2008, Beck 2012a, Krasikova 2008, Beck 2010, Matushansky 2011, Beck 2012b, 2014, Aloni & Roelofsen 2014, Alrenga & Kennedy 2014, Fleisher 2015, Dotlačil & Nouwen 2016). A common theme in a fair part of these articles is that degree semantics interacts with scope, and it is this relative scope that determines whether there is a maximum-related or minimum-related reading. A significant amount of work is devoted to distinguishing between (2), on one hand, and (1) and (3), on the other hand.

In this note, we focus on a distinction that was not discussed in detail so far, as far as we know. We study the contrast between (3), on one hand, and (1) and (2), on the other hand. What we find is that the interpretational effects of nominal quantifiers in degree constructions need to be accounted for differently from the effects of intensional operators. More specifically, we will argue that the maximum-related readings for (1) and (3) come about differently and, in particular, that the maximum-related reading for (3) comes about via scope that (in a sense that will become clear below) is extra-ordinarily high, yet still within the *than* clause.

In the next section, we provide two arguments that the reading of (3) comes about in a different way than (1) or (2). Section 3 will interpret this distinction as showing that nominal quantifiers take scope in a higher position than modals do. Section 4 sketches what extraordinary wide scope should look like.

2 New observations

Our *first argument* amounts to the observation that the maximum-related reading for nominal universal quantifiers does not uniformly arise in degree constructions. In degree questions, modal quantifiers do, but nominal quantifiers do not have minimum- or maximum-related readings. Assuming certain parallels between *than* clauses and degree questions (see Section 3), we interpret this as suggesting that the reading for (1) and (3) are only accidentally similar.

At first sight, there is a parallel between comparatives and degree questions. Just like there is a preference to interpret (2) as John driving faster than what was minimally necessary, (4) is preferentially interpreted as inquiring to what the minimum requirement is.

(4) How fast do I need to drive? min

For the case of *should*, as in (5), things are more complicated.

(5) How fast should I drive? min/?max

It seems that there is some variation in judgment here, and to some extent this variation extends to (4). For both (4) and (5) there seems to be an additional option of them not being interpreted as inquiring about a minimum or maximum at all, but instead about what the permitted *interval* is. This is predicted, for instance, on the interval approach to degree questions in (Abrusán & Spector 2011), which we will discuss in more detail below.

What is crucial to us at this moment is independent of this variation in readings: While both (4) and (5) are compatible with a maximum- or a minimum-related reading, such a reading is unavailable for degree questions with nominal universal quantifiers, as in (6).

(6) How fast was each of the rivals driving? #max/#min

There are two readings available for (6). It has a pair-list reading, asking for each rival how fast this rival was driving, and it has what we will call a single-point reading, which presupposes that every rival drove at the same speed, and the question is asking what speed that was. Below we will suggest that this latter reading may be available for (4) and (5) too. For now, though, what is crucial is that (6) lacks end-point (max or min) readings, unlike degree questions with modals.

To strengthen our point, we conducted a small study on Mechanical Turk in which we asked participants to judge whether an answer providing a minimum or maximum was a 'good' answer to a given question, given a fixed scenario. The scenario throughout the experiment concerned three girls and three boys, each driving a car. Each of their speeds were given and both the minimum and maximum speed limit of the road they were on were given. We then asked them to judge question-answer pairs. An example stimulus is given in figure 1.

There were three target questions. Participants could choose one of two responses (*Yes, this is a good answer* vs. *No, this is not a good answer*).

(7) Questions:

a. How fast should the boys and girls drive? SHOULD
b. How fast do the boys and the girls need to drive? NEED
c. How fast is each boy/girl driving? EACH

Questions (7a) and (7b) were followed by either the minimum or the maximum speed limit as an answer, while (7c) was followed by either the speed of the slowest or the speed of the fastest boy, i.e., the parallel min/max reading if the nominal quantifier allowed it.

Minimum speed limit:	50mph
Maximum speed limit:	80mph

Anton:	40mph
Bob:	55mph
Carl:	75mph

Alison:	65mph
Brenda:	70mph
Cindy:	85mph

Given this scenario and the question below, please indicate whether you think the answer is suitable.

Question: **How fast is every girl driving?**
Answer: **85 mph**

Figure 1 An example stimulus

Each participant saw each combination of question and answer only once.[1] Aside from the 6 target stimuli, participants saw 20 fillers with a similar question-answer structure. 7 of the fillers presented a clearly good answer, 7 had an in-between status and 6 had a clearly bad answer. Only data from (self-identified) native English speakers were used even though this fact was not mentioned in instructions (so that people would have no incentive to falsely report their native language).

32 people participated in the study. One participant was removed since he/she accepted all bad fillers as presenting good answers and the speed of his/her responses (median: 836 ms) was much shorter than the median speed of the other participants (4863 ms), suggesting he/she did not engage in the experiment. The other participants responded to good and bad fillers in the expected way (median: 0 mistakes).

The results on target items are given in figure 2, where each number shows how many times the answer was accepted as a good answer out of a total number of 31 observations. They corroborate our empirical claim that degree questions with nominal quantifiers do not give rise to end-point related readings, while modal quantifiers do.[2] We think the data speak for themselves: we have respectively 31 and 21 observations of end-point readings for stimuli involving *need* and *should*, against

1 To be more precise, they never saw the exact same target question twice. Instead they saw different variations of the questions in (7). For instance, *How fast should you drive on this highway?* instead of (7a).

2 The table furthermore suggests that minima are generally better answers to degree questions with universal modals than maxima. It is well beyond the scope of this note to make sense of this. However, speculating somewhat, this tendency is perhaps not so surprising within the theory put forward in Abrusán & Spector (2011) (see below), since in that account the maximum (but not the minimum) reading needs to be derived from an interpretation that involves intervals rather than end-points of intervals Abrusán & Spector (2011: p. 136).

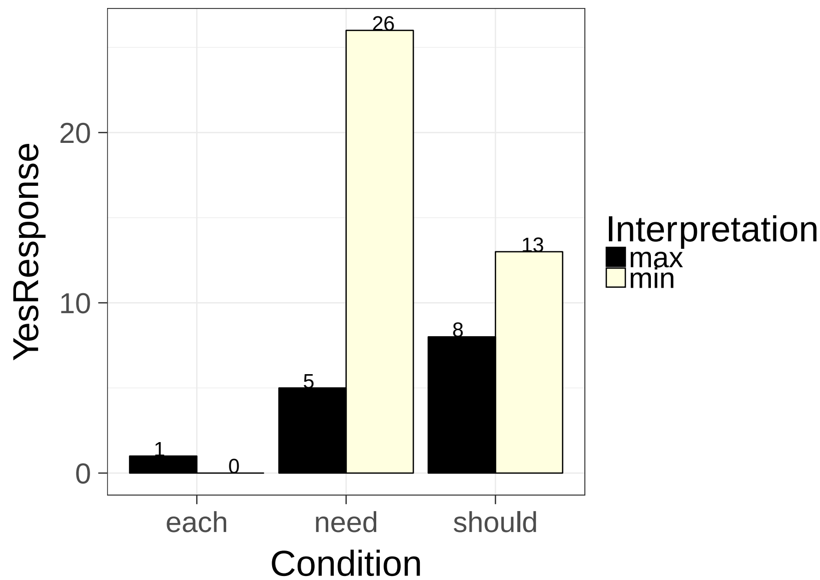

Figure 2 The number of times (out of 31) a minimum/maximum was judged to be a good answer to a degree questions in a small study

just a single such observation for stimuli with *each*. For completeness, we present results of significance testing using logistic regression with answer as the dependent variable (*Yes, this is a good answer* vs. *No, this is not a good answer*) and quantifier as the independent variable (*each* vs. *need* vs. *should*). *Each* was the reference level. The intercept (*each*) was significantly below zero ($\beta = -4.111,\ z = -4.079,\ p < .001$), showing that participants were more likely to reject any end-point reading for *each* than to accept it. End-point readings for stimuli with the modals *need* and *should* were significantly more often accepted than with *each* ($\beta = 4.111,\ z = 3.955,\ p < .001$ and $\beta = 3.442,\ z = 3.300,\ p < .001$, respectively).

Our *second new observation* is that we can find a similar contrast between nominals and modals in comparatives, once we turn to differentials. First note that (8) and (9) have minimum / maximum-related readings.

(8) John is driving exactly 2mph faster than he should be driving.

(9) John is driving exactly 2mph faster than he needs to be driving.

In a scenario where the minimum speed is 40 and the maximum one is 70, (8) says that John is driving 72mph and (9) says he is driving 42mph. This is exactly as expected: comparatives with modals give rise to minimum / maximum-related readings and it is natural to expect that differential comparatives are no different. Yet, differentials with nominal quantifiers *are* different. For instance, (10) lacks a reading in which John is driving 2mph faster than his fastest rival (let alone faster than his slowest rival).

(10) John is driving exactly 2mph faster than each of his rivals is.

The only available reading is one in which all the rivals are driving at the same speed, namely 2mph slower than John.[3]

Note that although the modal cases are compatible with such readings, they certainly do not entail them:

(8)′ John is driving exactly 2mph faster than he should/needs to be driving.
$\not\Rightarrow$ For each permissible world *w*: John is driving exactly 2mph faster in @ than he is in *w*
= John is driving 2mph faster than the only speed he is allowed to drive at.

In sum, using the differential we can show that what looks like a regular maximum reading in bare comparatives with nominal universal quantifiers is really just an accident. Sticking in the differential argument clarifies that the nominal and the modal cases are essentially different.

Summing up, we have provided two empirical arguments that nominal quantifiers and modals operate differently in degree constructions: (i) there are no minimum / maximum-related readings in degree questions for universal DPs; (ii) there are no minimum / maximum-related readings in differential comparatives for universal DPs. We will now argue that the difference between nominal and modal quantifiers can be captured in the following generalization: *in degree constructions, nominal quantifiers must scope higher than modals have to (and higher than is normally assumed).*We

3 Beck (2010) provides a few examples in which differentials measure a gap from the maximal degree even with nominal quantifiers: *4 seconds* in (i) measures the gap between the winner of the race and the second fastest cyclist.

(i) WOW! Almost 4 seconds faster than everyone else, and a 9 second gap on Lance.

This would suggest that the max-reading is possible with DPs, after all.

However, the max-reading of this type is clearly different from end-point readings appearing with modals. First, while minimal or maximal readings are readily available with modals, max-readings with nominal quantifiers are hard to get (cf. also Table 2, which shows no or almost no acceptance of such a reading in case of EACH). Second, as Beck (2010) notes, one can also find cases in which differentials measure a gap from some other point than the minimal or maximal degree, for example, an average value. Both points strongly suggest that the max-reading of (i) is not an end-point reading appearing in degree constructions with modals. See Sect. 5 of Dotlačil & Nouwen (2016) for some more discussion on how these readings could be accounted for.

will furthermore show that wider than standard scope of nominal quantifiers may well be expected given contraints on movement. But the fact that quantifers scope high in degree constructons can already be appreciated here. Consider, for example, our observation that (10) expresses that all the rivals are driving at the same speed, 2 mph slower than John. This is straightforwardly expected if the nominal quantifier had wide scope, for a wide scope paraphrase gives exactly this reading:

(11) For each rival *x*: John is driving exactly 2mph faster than *x*.

3 Constraints on movement

One reason why we think that our observation for degree questions can provide hints as to what goes on in comparatives is because both structures involve operator movement, as illustrated by the island violations discussed in Bresnan (1975), cf the parallel between (12) and (13).

(12) *John is taller than he knows a boy who is.

(13) *How tall do you know a boy who is.

The ungrammaticality of (12) can be explained if we assume that comparative clauses involve a form of covert movement, parallel to the covert wh-movement in (13). Given that assumption, (12) is a straightforward case of an island violation, just like (13) is. Semantically, this covert movement is taken to leave behind a trace and introduce lambda abstraction at the top of the clause, as in (14) for *than John is tall*. (See, for instance, the overview in Beck 2011).

(14) [λd [John is d tall]]

If we take the standard interpretation of adjectives as relations between entities and degrees, as in (15), a structure like (14) will result in the set of degrees that range from 0 to John's height. We could then take the *than* clause to refer to the maximum degree in that set.

(15) $[\![\text{tall}]\!] = \lambda d.\lambda x.tall(x,d)$ where $tall(d,x) \Leftrightarrow \text{height}(x) \geq d$

(16) $[\![(14)]\!] = \lambda d.tall(j,d) = [0,\text{John's height}]$

(17) $[\![\text{than (14)}]\!] = max(\lambda d.tall(j,d)) = \text{John's height}$

Infamously, this strategy fails as soon as there is (for instance) a universal quantifier in the comparison clause:

(18) John is taller than every girl is.

The reason is that the lambda abstraction will collect degrees d such that every girl is tall to that degree, and as a consequence, any degree exceeding the shortest girl's height will be excluded from the set (see von Stechow 1984).

(19) $\lambda d.\forall x[girl(x) \rightarrow tall(x,d)]$ = [0,the height of the shortest girl]

A prominent response is to assume that degree constructions involve intervals (Schwarzschild & Wilkinson 2002) and that these intervals are formed by a covert shifting operator Π: point-to-interval (Heim 2006). Scope with respect to Π determines whether a minimum or a maximum reading is obtained (Heim 2006, Beck 2010).

Consider the example in (20), which follows Beck (2010). The A node is the structure as in (14). Π is defined as taking an interval I and an interval I' and saying that I contains the maximum of I'. The I' argument corresponds to the A node and the I argument is abstracted over. At node C, this results in the set of intervals I that contain the maximum degree of the interval denoted by A.

(20) $[_D$ select $[_C\ \lambda 2\ [_B\ [\ \Pi\ t_2\ ]\ [_A\ \lambda 1\ [$ John [is [t_1 tall]]]]]]]
- A the set of degrees to which John is tall = [0, John's height]
- B the maximum degree to which John is tall is contained in t_2
= John's height is contained in t_2
- C the set of intervals that contain John's height
- D John's height — Beck, 2010

So, rather than having the *than* clause denote the degrees up to and including John's height, the *than* clause now denotes the set of intervals that contain John's height. To get back to a single degree, we follow Beck (2010) in using a selection operator to shift back to a degree at the top of the structure.

(21) $[\![\text{select}]\!] = \lambda P_{\langle\langle d,t\rangle,t\rangle}.max(min(P))$

Here, *max* is the usual maximality operator; *min* collects all the degrees that are part of a minimal interval in a set: $min = \lambda P.\cup\lambda I.P(I) \wedge \neg\exists I'[P(I') \wedge I' \subset I]$.

As we explained above, the simple λ-abstraction account of *than* clauses generated minimum-related readings for clauses with universal quantifiers. Indeed, when we apply the Π operation to a node A containing a universal modal, the structure is simply going to return the set of intervals containing that minimum and, then, via the selection operator that minimum itself.

(22) $[_D$ select $[_C\ \lambda 2\ [_B\ [\ \Pi\ t_2\ ]\ [_A\ \lambda 1\ \Box$ John drive t_1 fast]]]]
- A the set of degrees such that John drives at least so fast in every permissible world = $[_{0,}$ the minimally required speed]

B the minimally required speed is contained in t_2
C the set of intervals that contain the minimum speed
D the minimally required speed

However, as soon as the modal is given wide scope over the Π operation, the interpretation changes into one selecting the maximum allowed speed.

(23) $[_D$ select $[_C\ \lambda 2\ [_B\ \Box\ [\ [\ \Pi\ t_2\ ]\ [_A\ \lambda 1$ John drive t_1 fast]]]]]
A [0, John's speed]
B it is required that John's speed is contained in t_2
C the set of intervals that contain John's speeds in every permissible world
D the maximally allowed speed

As such, the Π theory of *than* clauses gives us everything we need for modals, since via the relative scope of Π we can generate both minimum and maximum-related readings. (See Beck 2010 for a more finegrained picture of all the predictions.)

Abrusán & Spector (2011) extend this framework to degree questions. Parallel to the comparative examples above, Π allows them to derive the interpretation of questions that target the maximum allowed degree via a scope ordering $\Box > \Pi$ and questions about the minimally required degree via $\Pi > \Box$.

(24) How fast should I be driving? max = $\Box > \Pi$

(25) How fast do I need to drive? min = $\Pi > \Box$

At this point we can go back to our first argument: neither of the available scope orderings yields the correct interpretation for (26):

(26) How fast did each of the rivals drive? #max/#min

We claim this is to be expected on a strict interpretation of the so-called Heim-Kennedy constraint (HKC), which is usually stated as follows:

(27) *Nominal quantifiers cannot intervene between degree operators and their trace.*

Or schematically,

(28) *[$\mathrm{DegOp}_i \ldots \mathrm{Q}_{\mathrm{nom}} \ldots t_i$] Heim 2000

Here, the term degree operators is to be understood as degree *quantifiers*, i.e. operators of type $\langle\langle d,t\rangle,t\rangle$. Support for this constraint comes from (29) and (30). While the latter is ambiguous between a surface scope reading (the paper has to be exactly

15pp long) and an inverse scope reading (the minimum requirement for the paper's length is exactly 15pp), the former example only has a surface scope reading (Heim 2000). (See also Hackl 2000).

(29) (John is 4' tall.) Every girl is exactly 1" taller than that.

(30) (This draft is 10pp.)
The paper is required to be exactly 5 pages longer than that.

The same data could also be accounted for by a stricter version of the Heim-Kennedy constraint, one where it is not intervention between an operator and a trace that matters but rather intervention between a lambda abstractor over a degree or a degree interval and its bound variable:[4,5]

(31) *[λX ... Q_{nom} ... X] — strict HKC
where X is of type d or $\langle d,t \rangle$

We propose here to adopt this stricter version, since it would immediately account for why (26) lacks a reading about a minimum or a maximum. In (32) and (33), we give the two logical forms for these readings:

(32) *[$\lambda 2$ [[Π t_2]$_1$ [$\lambda \mathbf{1}$ [[**each rival**]$_3$ [t_3 drove $\mathbf{t_1}$ fast]]]]] — min

In (32), *each rival* intervenes between $\lambda 1$ and t_1. As such, this is excluded by the original Heim-Kennedy constraint as well as our stricter version, and so both versions block minimum-related readings. The LF for the maximum reading, (33), is ruled out by our stricter version only: *each rival* intervenes between $\lambda 2$ and t_2.

(33) *[$\lambda \mathbf{2}$ [[**each rival**]$_3$ [[Π $\mathbf{t_2}$]$_1$ [$\lambda 1$ [t_3 drove t_1 fast]]]]] — max

Apparently, the pair-list reading and the single-speed reading are escape hatches to the scoping dilemma posed here. At least for the pair-list reading this makes sense, since it is generally assumed that such readings involve scope that is higher than everything else in the clause (e.g. Krifka 2001). For instance, the pair-list reading of *How fast was each rival driving?* would roughly have the structure in (34). No violation of the Heim-Kennedy constraint occurs here, neither in its original guise, nor in the stricter version we propose.

(34) [[**each rival**]$_3$ [Question-Op [$\lambda \mathbf{2}$ [[Π $\mathbf{t_2}$]$_1$ [$\lambda 1$ [t_3 drove t_1 fast]]]]]]

4 This is how Bhatt & Pancheva (2004) present the constraint, but we do not know whether they had a departure from, say, Heim's 2000 conception in mind.

5 Note that the distinction between type d and $\langle d,t \rangle$ we make here becomes unnecessary once intervals are treated as degree pluralities, as in Beck (2014) and Dotlačil & Nouwen (2016).

Note that if we adopt the strict HKC, there is *no* position in the clause that the nominal quantifier could go to. As a result, we not only predict that degree questions with nominal *universal* quantifiers will never have minimum / maximum-related readings, we, in fact, predict that minimum / maximum-related readings never occur with *any* nominal quantifier in a degree question. This prediction is borne out. For instance:

(35) How fast were most of John's rivals driving? #min/#max

Since *most* doesn't allow pair-list readings, (35) only has a single-speed reading.

Let us take stock. We have seen that while plain, non-differential comparatives suggest that nominal and modal universal quantifiers affect the interpretation of the degree construction in the same way, the data for degree questions is quite different. However, these observations are expected if we take the Heim-Kennedy constraint and turn it into a prohibition of nominals intervening between a lambda abstraction over degrees. It follows that the readings for (36) and (37) should come about differently.

(36) John drove faster than each of his rivals did max

(37) John drove faster than he should have max

Despite the appearance that these sentence are semantically similar, since they both involve comparison to a maximum, their respective readings are derived via quite different logical forms: (36) comes about via (38) and (37) via (39).

(38) [each rival]$_3$ $>>$ [$\lambda 2$ [[[Π t_2]$_1$ [$\lambda 1$ [t_3 drove t_1 fast]]]]] max

(39) [$\lambda 2$ [$\Box$ [[Π t_2]$_1$ [$\lambda 1$ [John drove t_1 fast]]]]] max

We already understand why (39) gives rise to the maximum reading, but it is also quite easy to see why (38) would do the same. The following interpretation, where the quantifier has the widest scope possible yields a more-than-maximum reading.

(40) $\forall x[\text{rival}(x) \rightarrow$ John is faster than $x]$

As we explained above, once we add a differential argument to the comparative we can actually observe that the logical forms for comparatives with nominal quantifiers are quite different from those with modal quantifiers.[6]

6 An anonymous reviewer questions whether our claim can truly hold of all nominal quantifiers, and whether it not just holds of a restricted subset. In particular, they have in mind *any* and *no* as exceptions to our claim. Consider (i) and (ii):

(i) John drove faster than any of his rivals.

4 What the scope of nominal quantifiers should look like

If nominal quantifiers take extra-wide scope, where do they go? The structure we have now looks like this:

(41) $[_{\text{D}:d}$ select $[_{\text{C}:\langle\langle d,t\rangle,t\rangle}$ $\lambda \ldots \Pi \ldots [\ \ldots t$ ADJ]]]

Raised quantifiers can only adjoin to t-nodes, but there is none available. This may suggest the quantifier needs to scope out of the degree clause (cf. von Stechow 1984) and adjoin to the matrix clause. But this is undesirable for well-known reasons, witness the following examples based on Larson (1988: pp. 4-5).

(42) Who is Felix taller than is?

(43) Some student is smarter than every professor is.
$\neq$ For every professor x, there exists a student y: y is smarter than x.

The example in (42) shows that *than* clauses prohibit wh-extraction. (In contrast, the phrasal comparative version of (42), *Who is Felix taller than?*, is fine.) Assuming a parallel between wh-movement and QR, the latter should be not be possible out of the *than* clause either. A more semantic argument comes from (43). If quantifiers in comparative clauses can attach at the matrix level, then they should be able to scope higher than the subject, and so one would expect inverse scope readings along the lines of [[every professor] [[some student] is smarter than t is]]. But the resulting reading is not available.

We have now reached a tricky dilemma: If QR out of the comparative clause is not available and our current model of what that clause looks like leaves no position

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(ii) *John drove faster than none of this rivals did.

The reviewer assumes that *any* is an NPI in (i) and needs to have low scope in order to be licensed. However, as Aloni & Roelofsen (2014) argue, *any* here is the free choice item *any*, which makes it less clear that we are dealing with an obligatorily narrow scope quantifier. Independent of this is the fact that in differentials, *any*, just like *every*, does not show end point-related readings, only single point-related readings. '*John is exactly 5mph faster than any of his rivals*' means the same as '*John is exactly 5mph faster than each of his rivals*'. This once more suggests that a low scope position for nominal quantifiers is unavailable.

For (ii), the puzzle is why, if quantifiers take wide scope, (ii) is ungrammatical. Usually, (ii) is generally explained as follows: the than clause here at some point involves the maximum degree such none of John's rivals drove that fast. Such a maximum simply does not exist, hence the unacceptability. It is true that such an explanation is unavailable once we assume that nominal quantifiers take wide scope. However, on our proposal, the unacceptability follows straightforwardly. This is because even if the quantifier takes scope on a higher level, we still need to collect those degrees d such that none of the rivals drove d-fast. There is simply no way of doing that that will result in something intelligible.

open for a quantifier to move to, then we are truly out of options. As it stands, we would predict that nominal quantifiers in comparative clauses are simply infelicitous.

As we see it, the only way out of this dilemma is to assume that there must be a previously unacknowledged layer in the *than* clause. This layer should have two properties: (i) it should introduce a propositional node that can be targeted by QR; and (ii) it should be vacuous for cases where the *than* clause does not contain a nominal quantifier. Schematically, we want a structure like (44) which for non-nominal cases simply passes the value at node *D* up to the top node, and where there is some node α which is propositional in nature.

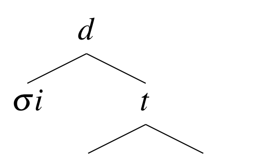
(44) $[\ \ldots [\alpha \ldots [_D \text{ select } \lambda \ \ldots \Pi \ldots t \text{ ADJ}]\ ]\ ]$

As we will show now, there is a way to achieve this while at the same time making all the right predictions for comparatives with nominal quantifiers.

5 A double shift: From *d* to *t* and back

Let's assume that we have a theory that derives the following: (i) a *than* clause denotes a degree; (ii) for non-quantificational clauses, this is the maximum degree to which someone has the property denoted by the adjective (for instance John's height for *than John is tall*); (iii) for some modals it returns the minimally required degree (e.g. *than John need to drive fast*); (iv) for other modals it returns the maximally allowed one (e.g. *than John is required to drive fast*). An example of a theory like this would be the one we have been following above, essentially the proposal of Beck (2010), as illustrated in (41). We will assume that this theory derives these interpretations for a node we will call *D*. We now introduce two operations. One will shift this *d* to *t* and the second operator shifts the resulting *t* back to *d*.

(45)



It is desirable that the combination of these operators is in principle vacuous, so that the correct results of the theory that delivers the degree in node *D* are passed on to the top node. We do this as follows: we assume that $\exists i$ takes a degree and states that there is a value assigned to variable *i* that is identical to this degree:

(46) $[\![\exists i]\!] = \lambda d.i = d$

The sigma operator should look up the values assigned to variables in such propositions. Such an operation is definable in a dynamic framework: DRT's Σ operator Kamp & Reyle (1993), for instance, does something quite similar. In fact, this whole procedure can *only* work if we understand type t not as truth-values, but rather as context change potentials. It is naturally impossible to retreive the value of a variable from the truth-value of a proposition, but it is possible to retreive such values from, say, the relation between assignment functions that the proposition expresses in a dynamic framework like Dynamic Predicate Logic (Groenendijk & Stokhof 1991). Conceptually, then, what σi does when applied to a proposition p is collect all the values that get assigned to i at some point in a successful update with p. This makes most sense in a dynamic *plural* predicate logic (van den Berg 1996, Nouwen 2003, Brasoveanu 2006, Nouwen et al. 2016), since in such formalisms this sum is exactly what ends up being assigned to i when an update with p takes place.

(47) $[\![\sigma v]\!] = \lambda p.c[p](v)$

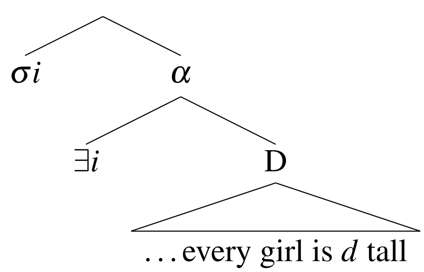
where $c[p]$ is the update of context c with p
where for any context c: $c(v) = \sqcup\{f(v) \mid \text{for } f \text{ an assignment function in } c\}$
where $\sqcup X$ is the infimum of the closure under sum formation of X (i.e. it turns a set into the corresponding plural individual).

As we said before, the combination of σi and $\exists i$ is vacuous. For instance $\sigma i(\exists i(x)) = x$, for any x. However, there is now a t-node that can be targeted by QR and, naturally, as soon as a quantifier intervenes between σ and $\exists$, the vacuity disappears. Take (48):

(48) John is taller than every girl is.

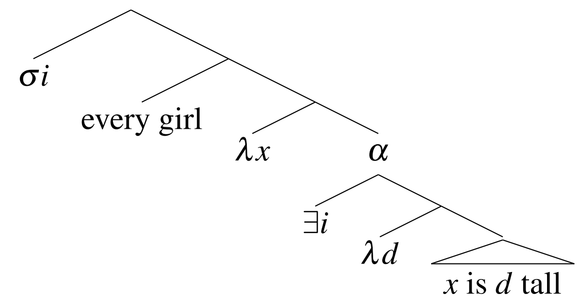
Following (45), we start with the structure in (49). Note that α is of type t:

(49)



The quantifier *every girl* needs to escape the prohibited Heim-Kennedy configuration, i.e. it needs to escape from *D*. There is just a single node where this is possible, labelled α. We get the structure in (50), which returns the interpretation in (51).

(50)



(51) $\sigma i.\forall x[girl(x) \rightarrow \exists i[\text{height}(x) = i]]$.

In a plural dynamic framework, scope interaction between quantifiers yield dependencies between the corresponding variable assignments. Let us assume there are three girls of 150cm, 170cm and 180cm, respectively. In such a context, the scope of the σ operator in (51) is a proposition that in a context will yield a set of assignment functions such that each function in that set assigns a girl to x and the height of that girl to i. The sigma term collects all the values assigned to i in that output context into a single plurality: $150 \sqcup 170 \sqcup 180$.

The upshot is that when quantifiers take scope between σ and $\exists$, the *than* clause denotes a potentially plural degree. For our example, (48), that would mean that the following comparison is checked:

(52) John's height$>$ $150 \sqcup 170 \sqcup 180$

But what is the interpretation of (52)? How does one compare one's height to the *plurality* of heights? We have nothing new to say here, we simply follow Beck 2014 and Dotlačil & Nouwen 2016 that provide a semantics for cases like (52).

The idea is that comparison relations, e.g., $>$, only apply to atoms. This would generate a sort mismatch in case of (52), but such a mismatch is very common in the semantics of plurals. Distributive predicates often occur with plural arguments and when they do they are interpreted by quantifying distributively over the atoms in the plurality. We can think of the predicate λx.John's height $> x$ as a distributive predicate. Using the standard mechanisms from the semantics of plurals, in particular, the quantification over the atoms in the plurality, we can interpret (52) as:

(53) $\forall d[d$ is an atomic part of $150 \sqcup 170 \sqcup 180 \rightarrow$ John's height $> d]$

This is the desired more-than-maximum reading. Applying the same idea to differential comparatives, say for *John is exactly 2" taller than each girl is* we get (54) and (55) (for more details, see Dotlačil & Nouwen 2016).

(54) John's height - height-of-girl1$\sqcup$height-of-girl2$\sqcup$height-of-girl3 = 2"

(55) $\forall d[d$ is an atomic part of height-of-girl1$\sqcup$height-of-girl2$\sqcup$height-of-girl3 $\rightarrow$ John's height$-d$=2"]

This can only be true if all the girls have the same height, that is, if the top node of the structure returns an atom rather than a non-atomic degree. This is entirely as desired: as we observed above, differential comparatives with nominal quantifiers yield point readings.

6 Critical assessment

Since von Stechow (1984), it has been common to think of *than* clauses as degree points. This intuition was overturned in Schwarzschild & Wilkinson (2002), who make the following observation (p. 10): "In deciding whether [someone] is taller than everybody else is, we don't look for a point corresponding to everyone else, but rather we scan the scale to check everyone's height. This simple observation is missed by degree analyses." We have argued in this note that the intuition of Schwarzschild & Wilkinson (2002) is correct, but only for some comparative clauses – those that include nominal quantifiers. When modal quantifiers are used, the intuition that a *than* clause provides a degree point is justified. A way to account for the data is to say that degree clauses will have to contain an extra layer and the extra layer must be used by nominal quantifiers (but not by modals) as a scope position at a higher level than previously acknowledged.

While we strongly believe that the data calls for a revision of the semantics of the comparative along the lines we sketched above, we at the same time have some concern about the particular implementation of wide scope semantics for nominals. First of all, the account outlined in the previous section relies on the modelling of anaphoric dependencies in dynamic semantic frameworks, which is odd given that we are dealing with an essentially non-anaphoric phenomenon here. The second problem we see is much more serious. If the operations making up the layer we propose occur in comparative clauses, then why do we not see them in action anywhere else (e.g. in relative clauses)?

This second point, however, has an important twist, for the question why the mechanisms involved are not at play in other constructions will apply not just to the solution we sketched here, but to any solution that will solve our dilemma. In that sense, the data we uncovered in this note suggest that degree abstraction may diverge in important respects from other forms of abstraction.

In one particular sense, this special status of degree abstraction should not come as a surprise.[7] As has been convincingly argued in Beck et al. (2004, 2009), degree abstraction is simply unavailable in languages like Japanese and Chinese. Indicative

7 Thanks to an anonymous reviewer for pointing us into this direction.

of this, such languages lack degree questions, subcomparatives and scope interactions between comparatives and intensional operators, even though such languages do have measure phrases and differential comparatives. The point then is that even though any language has abstraction, languages that can express degrees do not necessarily have degree abstraction. This indicates that, somehow, degree abstraction is a separate part of grammar, that is to a significant extent independent of other abstraction phenomena.

We will end this note with a speculation regarding the interaction of modals and nominal quantifiers. Schwarzschild & Wilkinson (2002) argue against an account that assigns wide scope to nominal quantifiers on the basis that they can be responsible for *de dicto* readings in the comparative clause. For instance, (56) most naturally has a reading in which Bill has no predictions for specific rivals in mind.

(56) John was faster than Bill predicted most rivals to be.

If we are right, *most rivals* should take scope at a very high position in the *than* clause of (56). But how then can it yield a de dicto reading? The only option would be that *predict* takes even wider scope. This means that it should in principle be possible for not just nominal quantifiers to scope in the extended part of the *than* clause, but also intensional ones. None of the data we presented above excludes this option, since we have only shown that nominal quantifiers do not yield the readings compatible with the lower position; we have not shown that modals exclude the readings that occur in the very high part of the clause. And, indeed, the differential version of (56) gives rise to a point interpretation, and not to a minimum / maximum-related reading.

(57) John was exactly 2mph faster than Bill predicted most rivals to be.

We are not sure how insightful this is, however, since predictions are quite naturally related to a single point way anyway. It is not clear, for instance, what a maximum-related reading of (58) would be.

(58) How fast did Bill predict John to drive?

It is hard, though, to construct examples parallel to (56) and (57) that contain, say, the deontic modals we discussed above. For that reason we leave investigating such examples for further research.

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