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Than clauses as embedded questions *

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Abstract Quantifiers in comparative *than* clauses often appear to take scope at the matrix level, a phenomenon that has spawned a large recent literature. Here I reopen an old line of investigation that seeks illumination in the strikingly similar behavior of quantifiers in embedded questions. A novel observation in this connection is that English clausal comparatives support quantificational variability effects. I explore the possibility of treating *than* clauses as embedded questions, sketching two implementations, and weigh this type of analysis against recent approaches that invoke degree pluralities. I also discuss multiple-*wh* configurations in clausal comparatives.

Keywords: comparatives, quantifiers, questions, scope

1 Introduction

A major preoccupation of the recent literature on English comparatives has been the behavior of quantifiers in *than* clauses. The driving concern is the interpretation of examples like (1). As the paraphrases show, the *than*-clause-internal quantifier *every girl* appears to take syntactically exceptional matrix scope. This is of particular concern for theories that treat the *than* clause as a definite degree description derived via a maximality operator (von Stechow 1984; Rullmann 1995), since leaving the quantifier inside the *than* clause derives a description of the wrong degree (in this case, the height of the shortest girl).

(1) John is taller than every girl is.

a. 'for every girl g, John is taller than g is'

b. # 'John's height exceeds the maximal degree d such that every girl is d-tall'

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The problem is well known, including to the authors mentioned above, and attempts to solve it date at least to Larson 1988. Here I pursue a line of attack that was developed by Lerner & Pinkal (1991), Moltmann (1992), and Moltmann & Szabolcsi (1994) but that has been largely forgotten in the abundant literature of more recent years. These authors observe that the exceptional scopal behavior we see in clausal comparatives like (1) is also found with quantifiers in embedded questions. As I show here, the parallel runs even deeper: clausal comparatives also display quantificational variability effects, an observation that, to the best of my knowledge, is novel to the present paper.

I begin with a brief summary of the recent literature on the *than*-clause-internal quantifier problem. I then detail the parallels between clausal comparatives and embedded questions, before considering two candidate implementations of an embedded-question analysis of *than* clauses. I compare the predictions of this approach to those of the degree plurality approach recently developed by Beck (2014) and Dotlačil & Nouwen (2016). Finally, I consider multiple-*wh* configurations in *than* clauses.

2 The lay of the land

2.1 Encapsulation vs. entanglement

Accounts of *than*-clause-internal quantifiers fall into two broad classes, which I have elsewhere called ENCAPSULATION THEORIES and ENTANGLEMENT THEORIES (Fleisher 2016). Encapsulation theories derive the appropriate reading of (1) by having the *than* clause compositionally deliver the desired degree (the tallest girl's height) and plugging this degree into the matrix degree relation; representatives include Beck 2010 and Alrenga & Kennedy 2014. Entanglement theories derive the appropriate reading by having the degrees associated with the quantified-over individuals in the *than* clause (the girls' heights) distribute over the matrix degree relation; representatives include Schwarzschild & Wilkinson 2002, Heim 2006, and Dotlačil & Nouwen 2016. I briefly sketch a theory of each class here.

The encapsulation strategy is pithily summarized by Beck (2010: 27), who writes, "I want to come out of the calculation of the semantics of the *than* clause holding in my hand *the* degree we will be comparing things to" (emphasis original). Beck achieves this via the following process. First, she has *wh*-movement in the *than* clause deliver not a degree abstract but an interval abstract (after Schwarzschild & Wilkinson 2002 and Heim 2006): in the case of (1), this interval abstract gives us the set of scalar intervals that contain every girl's height. Next, she applies a maximal informativity operator to get the smallest such interval: the interval extending from the height of the shortest girl to the height of the tallest girl. Finally, she applies

another maximality operator to deliver the greatest degree in this interval: the tallest girl's height. In this way, Beck extracts the desired degree from the *than* clause compositionally even as the quantifier remains within the *than* clause at LF.

Where Beck's encapsulation strategy has the *than* clause denote a degree and serve as the argument of a matrix degree predicate, Heim's entanglement strategy has the *than* clause denote a degree quantifier and take scope. For (1), this degree quantifier characterizes the set of intervals that contain every girl's height (much as in Beck's approach, which moves in a different direction from this common starting point). When the *than* clause takes scope, it creates a degree abstract that serves as its argument: the set of degrees d such that John is taller than d. Composing the degree quantifier with its scope yields True iff every girl's height is contained in that set. Heim thus achieves via entanglement what Beck achieves via encapsulation: the sentence's truth conditions state that John is taller than (even) the tallest girl, all while the quantifier stays put within the *than* clause.

The contrast between Beck 2010, where the *than* clause denotes a degree, and Heim 2006, where it denotes a quantifier over degrees, reveals what I take to be the essence of the difference between encapsulation and entanglement. A number of authors offer variations, but all adopt one or the other of these basic strategies and produce theories that can be classified accordingly. I refer the interested reader to Fleisher 2016 for further discussion.

2.2 Encapsulation with DE differentials

Encapsulation and entanglement theories produce the same result for examples like (1). When we alter the entailingness of the matrix differential phrase, their predictions come apart. The crucial empirical paradigm is shown in (2) (Fleisher 2016).

(2) a. John is (more than six inches) taller than every girl is. MAX

b. John is exactly six inches taller than every girl is. MIN=MAX

c. John is less than six inches taller than every girl is. MIN-&-MAX

With an upward-entailing (UE) differential as in (2a), we get a MAX reading, so called because it requires that John be (more than six inches) taller than the tallest (MAX) girl. (We also get a MAX reading in (1), where we assume a silent existentially quantified—thus UE—differential.) With a non-monotone differential as in (2b), we get an inference that John is exactly six inches taller than both the tallest girl and the shortest girl, and thus that the girls are all equal in height; I call this a MIN=MAX reading. Finally, in (2c), the inference is that John is less than six inches taller than both the tallest girl and the shortest girl, and thus that the girls' heights span an

interval extending downward from John's height to the point six inches below his height (non-inclusive at both ends); I call this a MIN-&-MAX reading.

What the paradigm in (2) reveals is that the MIN-&-MAX reading is the general case. The MAX reading is a special case of MIN-&-MAX found with UE differentials (if John is taller than the tallest girl, then he is also taller than the shortest girl), and MIN=MAX is a special case found with non-monotone differentials. Entanglement theories derive this straightforwardly: as long as the *than* clause takes the matrix differential in its scope, the girls' heights will be distributed over the requisite degree property. In (2c), for example, every girl's height will be in the set of heights d such that John is less than six inches taller than d. Encapsulation theories, by contrast, tend to crash here. Having discarded all but the tallest girl's height from the *than*-clause denotation, they have thrown away information that turns out to be needed for interpretation in the general case.

The difficulty stems from the fact that most recent theories of *than*-clause-internal quantifiers have been designed to capture examples like (1), where the MAX reading and the MIN-&-MAX reading happen to be equivalent. Entanglement theories get the desired reading by implementing a MIN-&-MAX strategy (even if their authors do not always explicitly recognize it as such), while encapsulation theories get it by implementing a MAX strategy.[1] In Fleisher 2016, I suggested that the MAX strategy is a deep and abiding characteristic of encapsulation theories, one that makes them incapable in principle of deriving the MIN-&-MAX reading in the general case. Zhang & Ling (2015) show that this conclusion is too hasty.

Zhang & Ling take the MIN-&-MAX reading as their starting point and succeed in implementing an encapsulation theory that derives the full paradigm in (2). For them, the *than* clause in (1)/(2) denotes the interval extending from the shortest girl's height to the tallest girl's height, abbreviated [shortest girl, tallest girl]. This is equivalent to what Beck derives after the operation of the first maximal informativity operator but before the operation of the second. Zhang & Ling then use interval subtraction to relate the *than*-clause interval, the matrix differential, and the interval containing the matrix subject's height. Their analysis is schematized in (3).

(3) $[\![$John is DIFF taller than every girl is$]\!]$
= 1 iff John's height $\in \iota D(D -$ [shortest girl, tallest girl] = DIFF$)$

With this much in place, Zhang & Ling assume straightforward denotations for the various matrix differentials in order to derive the full entailingness paradigm. I

1 Beck (2010) and Alrenga & Kennedy (2014) are aware of examples like (2b), with non-monotone differentials, and propose modifications for handling them. Neither theory successfully generalizes to cases with DE differentials. Beck (2010: 52) is the only author among those cited above who mentions the MIN-&-MAX reading found with DE differentials.

show the results in (4)–(6); for details on the interval subtraction operation and its use in these calculations, see Zhang & Ling 2015.

(4) John is taller than every girl is.

a. DIFF = $(0, +\infty)$

b. John's height $\in \iota D(D - [\text{shortest girl, tallest girl}] = (0, +\infty))$

c. D = (tallest girl, $+\infty$)

(5) John is exactly six inches taller than every girl is.

a. DIFF = [6 in., 6 in.]

b. John's height $\in \iota D(D - [\text{shortest girl, tallest girl}] = [6 \text{ in., } 6 \text{ in.}])$

c. D = [tallest girl + 6 in., shortest girl + 6 in.]

(6) John is less than six inches taller than every girl is.

a. DIFF = (0, 6 in.)

b. John's height $\in \iota D(D - [\text{shortest girl, tallest girl}] = (0, 6 \text{ in.}))$

c. D = (tallest girl, shortest girl + 6 in.)

For the example with a UE differential in (4), Zhang & Ling's truth conditions state that John's height is in the upper-unbounded interval whose (non-inclusive) lower bound is the tallest girl's height: a MAX reading (and a special case of MIN-&-MAX, as discussed above). With a non-monotone differential as in (5), John's height is in the interval whose lower bound is six inches above the tallest girl's height and whose upper bound is six inches above the shortest girl's height. Together with a requirement that an interval's upper bound be no lower than its lower bound, this gives us a trivial interval consisting of the degree six inches above the heights of both of those girls (and perforce of every other girl). We thus derive the inference that all the girls are equal in height: a MIN=MAX reading (once again a special case of MIN-&-MAX). With a DE differential as in (6), John's height is in the interval whose lower bound is the tallest girl's height and whose upper bound is six inches above the shortest girl's height (both non-inclusive). This ensures that the girls' heights span an interval extending no more than six inches below John's height: a MIN-&-MAX reading.

It bears emphasizing that the *than* clause functions as a term within the matrix clause in Zhang & Ling's theory, serving as an argument of the interval subtraction operator. The *than*-clause-internal quantifier contributes to the compositional derivation of the interval denoted by the *than* clause, but the *than* clause itself does not take the matrix clause within its scope (nor does any proper part of the *than* clause). Zhang & Ling thus succeed in developing an encapsulation theory that

derives the MIN-&-MAX reading as the general case, an important result and a first in the literature, to my knowledge.

With this result established, the ability to handle examples with DE differentials like (2c) is no longer a sufficient basis for preferring entanglement theories over encapsulation theories. We must turn to other diagnostics.

3 Entanglements old and new

While encapsulation theories and entanglement theories can both successfully derive the truth-conditional paradigm shown above in (2), they differ in how the readings in question are derived. As a result, the two classes of theories make different predictions about the availability of interpretive phenomena tied to scope. A number of diagnostics suggest that scope-taking (or something like it) is in fact at work, in line with the predictions of entanglement theories. Moreover, the interpretive phenomena we see in clausal comparatives find parallels in embedded questions (Lerner & Pinkal 1991; Moltmann 1992; Moltmann & Szabolcsi 1994), a domain where there are independent reasons to pursue entanglement-like strategies.

3.1 Scope inversion

To begin, consider scope inversion. A *than*-clause-internal quantifier can make a matrix-clause quantifier quantificationally dependent, as in (7).[2] A *than*-clause-internal universal can also license a "sentence-internal" reading of *different* in the matrix subject, as in (8), a reading that is available only in the scope of a distributive universal (for discussion, see Bumford 2015). This scopal behavior falls out naturally from entanglement theories, but not from encapsulation theories.

(7) Some boy or other is exactly six inches taller than every girl is.
OK: *every* > *some*

(8) A different boy is exactly six inches taller than every girl is.
OK: *every* > *different*

On an implementation like that of Heim 2006, the inverse-scope reading of (7) can be obtained by giving the *than* clause scope over the matrix subject, which in

2 It is important to choose an example in which the surface-scope and inverse-scope readings are truth-conditionally distinct; the non-monotone differential in (7) ensures this. Larson (1988) and Nouwen & Dotlačil (2017) argue against the availability of scope inversion in clausal comparatives, but their examples involve a silent UE differential, which neutralizes the scopal contrast. For example, in *Some boy is taller than every girl is*, if every girl g is such that some boy is taller than g is (an inverse-scope reading), then there is some boy who is taller than even the tallest girl; but these are just the truth conditions of the surface-scope reading.

turn scopes over the differential. The sentence comes out true iff for every girl g, g's height is in the set of degrees d such that there is some boy who is exactly six inches taller than d; and these are indeed the intuitively correct truth conditions. This is sketched in (9).

(9) a. LF: [wh_1 every girl is ~~t_1-tall~~]$_2$ [some boy]$_3$ [!6 in.]$_4$ [t_3 is t_4 taller than t_2]

b. True iff
$\lambda D.\forall x[\text{girl}(x) \rightarrow \text{height}(x) \in D]$ (λd.some boy is !6 in. taller than d)
iff $\forall x[\text{girl}(x) \rightarrow$ some boy is !6 in. taller than height$(x)]$

The inverse-scope reading found in examples like (7) has a number of notable characteristics. First, unlike in the cases with non-monotone differentials examined above, here there is no inference that the girls are all equal in height. This is problematic for encapsulation theories that derive the same-height inference via the compositional interaction of the differential with the *than* clause (or via a purpose-built *than*-clause-internal operator, as in Alrenga & Kennedy 2014). Second, the scalar interval extending from the shortest girl's height to the tallest girl's height—Zhang & Ling's denotation for the *than* clause—is not of much use to us here. The sentence's truth conditions require us to know each girl's height, not merely the tallest and shortest girls' heights. Third, the set of degrees that forms the nuclear scope of the *than* clause does not characterize an interval: for any two degrees d_1 and d_2 that verify the nuclear scope (i.e. the heights of two girls, each one of which is exactly six inches below the height of some boy or other), it does not follow that the degrees between d_1 and d_2 also verify the scope. This differs from what we find in examples like (2), where for any d_1 and d_2 to which John's height stands in the requisite relationship, it stands in the same relationship to all intervening degrees.[3]

All of the above characteristics are consistent with entanglement, whose defining feature is that the degrees associated with the *than*-clause-internal quantifier (here, the girls' heights) are distributed over a derived matrix degree predicate.

3.2 Parallels with embedded questions

The eye-opening behavior exhibited by these embedded quantifiers is not confined to clausal comparatives. We find a remarkably similar cluster of apparently exceptional scopal phenomena in embedded questions. The connection between clausal comparatives and embedded questions has been known at least since Lerner & Pinkal 1991, Moltmann 1992, and Moltmann & Szabolcsi 1994, though it has been largely ignored or forgotten in the comparatives literature since then. In this section I review

3 I thank Uli Sauerland (p.c.) for discussion of this point.

the parallels adduced a quarter century ago by these authors and add a new and (I believe) previously unknown one to the mix.

To begin, quantifiers in embedded questions support a matrix-scope-like interpretation much like the one in (1). The reading that launched a thousand ships in the comparatives literature is mirrored by the well-known pair-list reading of embedded questions. On this reading, (10a) says that for every girl *g*, John knows how tall *g* is. The parallel with clausal comparatives is noted in Lerner & Pinkal 1991, Moltmann 1992, and Moltmann & Szabolcsi 1994.

(10) a. John knows how tall every girl is.

b. John is taller than every girl is.

Embedded questions likewise permit scope inversion of the sort seen in (7) above (Moltmann & Szabolcsi 1994); the parallel with clausal comparatives is shown in (11). As Szabolcsi (1997) notes, binding data suggest that the reading in question indeed comes about via scope-taking of the entire embedded clause; this is shown in (12a). We find the same behavior in clausal comparatives like (12b).

(11) a. Some boy knows how tall every girl is.
OK: *every* > *some*

b. Some boy is less than six inches taller than every girl is.
OK: *every* > *some*

(12) a. [Some boy]$_1$ knows how tall every girl thinks he$_1$ is.
every > *some*

b. [Some boy]$_1$ is less than six inches taller than every girl thinks he$_1$ is.
every > *some*

Clausal comparatives and embedded questions likewise show a similar sensitivity to the choice of embedded quantifier. In particular, quantifiers headed by *no* fail to give rise to the wide-scope / pair-list reading seen with other quantifiers, as shown in (13).

(13) a. John knows how tall no girl is.
'no girl *g* is such that John knows how tall *g* is'

b. John is taller than no girl is.
'no girl *g* is such that John is taller than *g* is'

Finally, clausal comparatives behave like embedded questions in their ability to license quantificational variability (QV) effects. QV is well known in the literature

on embedded questions but is previously unreported in comparatives, to the best of my knowledge. Examples are shown in (14).[4]

(14) a. For the most part, John knows how tall every girl is.
'for most girls g, John knows how tall g is'

b. For the most part, John is less than six inches taller than every girl is.
'for most girls g, John is less than six inches taller than g is'

On the relevant reading of (14b), the girls' heights must simply be such that a majority of them fall within the six-inch span below John's height. No inference is licensed about John's relationship to the height of the tallest girl or the shortest girl. Here again, it seems that any satisfactory account must make use of the girls' heights as a domain of quantification or similar; the scalar interval occupied by all the girls' heights is of decidedly secondary importance here.

The parallels between clausal comparatives and embedded questions are thus even more extensive than Lerner & Pinkal (1991), Moltmann (1992), and Moltmann & Szabolcsi (1994) observed. In the remainder of the paper, I explore options for analyzing clausal comparatives that are inspired by work on the corresponding scopal phenomena in embedded questions.

4 Two implementations

In this section I consider what the analysis of clausal comparatives would look like if we treated *than* clauses as embedded questions. I sketch two implementations, both modeled on analyses of the scopal behavior of quantifiers in embedded questions.

To begin, I introduce an element that will be used in both implementations: a degree answerhood operator, $\textsc{ans}_d$, defined in (15). This operator takes a degree question and returns the degree found in its strongest true answer. I illustrate its use in a simple example in (16). I assume for concreteness that $\textsc{ans}_d$ is introduced by *than*, and that *wh*-movement within the *than* clause yields a constituent whose interpretation is equivalent to that of the corresponding degree question, as indicated in (16a).

(15) $\textsc{ans}_d(w)(Q) = \iota d[\textsc{abst}(Q)(d) = \textsc{maxinf}(w)(Q)]$, where:

a. $\textsc{abst}(Q)$ is Q's abstract (in the sense of George 2011)

b. $\textsc{maxinf}(w)(Q)$ is the strongest true answer to Q in w (cf. Beck & Rullmann 1999)

4 I focus on QV in embedded questions with quantifiers here. In quantifier-free examples, degree abstraction alone leaves the matrix adverbial without an appropriate domain to quantify over; witness the infelicity of #*For the most part, John knows how tall Mary is* and #*For the most part, John is taller than Mary is*. I discuss QV in multiple-*wh* configurations in section 5.2.

(16) Mary is taller than John is.

a. $[\![wh_1\ \mathrm{C}_{+\mathrm{Q}}\ [\text{John is } \cancel{t_1\text{-tall}}]]\!] = [\![\text{how tall is John?}]\!]$

b. $\textsc{abst}(\text{how tall is John?}) = \lambda d \lambda w.\text{tall}(w)(\text{John}, d)$

c. $\textsc{maxinf}(w)(\text{how tall is John?})$
$= \textsc{maxinf}(w)(\lambda p.\exists d[p = \lambda w'.\text{tall}(w')(\text{John}, d)])$
$= \lambda w'.\text{tall}(w')(\text{John}, d_{J,w})$ (where $d_{J,w}$ = John's max height in w)

d. $\textsc{ans}_d(w)(\text{how tall is John?})$
$= \iota d[\textsc{abst}(\text{how tall is John?})(d) = \textsc{maxinf}(w)(\text{how tall is John?})]$
$= \iota d[\lambda w.\text{tall}(w)(\text{John}, d) = \lambda w'.\text{tall}(w')(\text{John}, d_{J,w})]$
$= d_{J,w}$

e. True iff Mary's height in $w > \textsc{ans}_d(w)(\text{how tall is John?})$
True iff Mary's height in $w > d_{J,w}$

4.1 Quantification over subquestions

The first implementation takes the scopal behavior of *than*-clause-internal quantifiers to be an epiphenomenon of QV, following a proposal of Sharvit (2002) for quantifiers in embedded questions. On this theory, the *than*-clause denotation—a degree question, as sketched immediately above—is divided into subquestions that restrict a quantificational adverbial. Quantification over subquestions serves as a proxy for quantification over individuals, with the scopal effects detailed above as a result.

An example of this analysis in action is shown in (17). The LF is derived via raising of the *than* clause (or, more precisely, of the clausal complement of *than*) to a position where it serves as argument of DIV, an operator that divides it into logically independent subquestions (for details, see Sharvit 2002). A salient such division is shown in (17b). These subquestions restrict a matrix adverbial (the default universal **all** in this case), whose nuclear scope is the remainder of the matrix clause, including the *than*-clause trace.

(17) John is taller than every girl is.

a. LF: $\mathbf{all}_Q\ [Q \in \textsc{div}([\![wh_{\mathrm{i}} \text{ every girl is } \cancel{t_{\mathrm{i}}\text{-tall}}]\!])]\ [\text{John is taller than } \textsc{ans}_d(w)(Q)]$

b. $\textsc{div}([\![wh_{\mathrm{i}} \text{ every girl is } \cancel{t_{\mathrm{i}}\text{-tall}}]\!]) = \{\text{how tall is Ann?, how tall is Becca?}, \ldots\}$

c. For a subquestion Q_g associated with girl g, nuclear scope is verified:
iff John is taller than $\textsc{ans}_d(w)(Q_g)$
iff John is taller than g's maximal height in w

With a subquestion for each girl in the domain, universal quantification over subquestions serves as a proxy for universal quantification over girls, and we get

a MAX reading here as desired. As in other entanglement theories, the MIN-&-MAX reading falls out as the general case, provided the matrix differential remains within the nuclear scope. A matrix subject that remains within the nuclear scope will be quantificationally subordinate to the matrix adverbial, yielding an inverse-scope reading like the one seen above in (7). Finally, in keeping with the spirit and purpose of Sharvit's analysis, the approach offers a natural account of QV in clausal comparatives: in place of **all** in the LF above, substitute **most** as the translation of an adverbial like *for the most part* or *with few exceptions*. An example showing all of these features is sketched in (18).

(18) With few exceptions, some boy is exactly six inches taller than every girl is.

a. LF: $\textbf{most}_Q$ [$Q \in$ DIV($[\![wh_{\mathrm{i}}$ every girl is $\cancel{t_{\mathrm{i}}\text{-tall}}]\!]$)] [some boy is exactly six inches taller than $\mathrm{ANS}_d(w)(Q)$]

b. DIV($[\![wh_{\mathrm{i}}$ every girl is $\cancel{t_{\mathrm{i}}\text{-tall}}]\!]$) = {how tall is Ann?, how tall is Becca?, ...}

c. For a subquestion Q_g associated with girl g, nuclear scope is verified:
iff some boy is exactly six inches taller than $\mathrm{ANS}_d(w)(Q_g)$
iff some boy is exactly six inches taller than g's maximal height in w

With a subquestion for each girl, (18) correctly comes out true on the relevant reading iff for most girls g, there is some boy who is exactly six inches taller than g is.

This Sharvit-style approach thus captures a number of the phenomena adduced above in a straightforward way, by capitalizing on the parallels between clausal comparatives and embedded questions. Moreover, the subquestion approach's tight connection to QV suggests a natural link with cumulative readings of comparatives, a phenomenon first reported by Dotlačil & Nouwen (2016). QV and cumulative readings go together in embedded questions, where part–whole structures have been widely employed to handle them (Preuss 2001; Lahiri 2002; Beck & Sharvit 2002). It is therefore not surprising to discover that they appear to go together in clausal comparatives, as well. Space precludes fuller consideration of how to handle cumulative readings within the present approach.

One difficulty for the subquestion approach is the question of its extensibility to cases where the embedded-clause quantifier is not a distributive universal headed by *every*. Sharvit (2002: 281) proposes that non-monotone determiners raise to the position of the matrix adverbial, citing the unavailability of exceptional wide scope for such quantifiers when a quantificational adverbial is present; a corresponding case with a clausal comparative is shown in (19).

(19) # For the most part, some boy is less than six inches taller than exactly three girls are.

I leave it as an open question whether this approach affords a natural account of the full range of apparent wide scope phenomena for *than*-clause-internal quantifiers.

At a minimum, it requires us to countenance non-uniformity in the derivation of exceptional wide scope, with some determiners staying put within the *than* clause and others separating from their DP and raising to a matrix operator position.

4.2 Lifted questions

The second implementation of the embedded-question analysis of clausal comparatives that I explore here is one that treats them as lifted questions, following Szabolcsi's (1997) treatment of pair-list readings. Rather than having the *than* clause restrict a matrix adverbial as on the Sharvit 2002-style analysis above, here the *than* clause constitutes a layered quantifier that takes scope itself.

Szabolcsi's specific proposal, adapted to the case of a *than* clause, is sketched in (20). The degree question denotation of the *than* clause is lifted, and the *than*-clause subject is quantified into the lifted question via absorption (Chierchia 1993).

(20) $[\![wh_1 \text{ [every girl is } \cancel{t_1\text{-tall}}]]\!] = \lambda P.\forall x[\text{girl}(x) \rightarrow P(\text{how tall is } x?)]$

When the lifted question in (20) takes scope, we end up with an LF broadly similar to what we find in Heim 2006. In both approaches, the *than*-clause-internal quantifier takes widest scope within the embedded constituent; as a result, it ends up with scope at the position where the *than* clause itself takes scope. Our base case is sketched in (21).

(21) John is taller than every girl is.

a. LF: $[wh_1 \text{ [every girl is } \cancel{t_1\text{-tall}}]]_2$ [John is taller than t_2]

b. True iff
$\lambda P.\forall x[\text{girl}(x) \rightarrow P(\text{how tall is } x?)]\ (\lambda Q.\text{John is taller than } \textsc{ans}_d(w)(Q))$
iff $\forall x[\text{girl}(x) \rightarrow \text{John is taller than } \textsc{ans}_d(w)(\text{how tall is } x?)]$
iff $\forall x[\text{girl}(x) \rightarrow \text{John is taller than } x\text{'s maximal height}]$

With this entangling architecture, the lifted question approach derives the MIN-&-MAX reading as the general case, once again provided the differential scopes below the *than* clause. Inverse-scope readings like (7) fall out naturally as well; Szabolcsi (1997: 334) suggests that layered quantifiers (of which lifted questions are an example) inherit their scope inversion abilities from their internally wide-scoping individual quantifiers. To rule out wide scope for embedded quantifiers headed by *no*, Szabolcsi (1997: 329) offers a modification of the semantics in (20) according to which the layered quantifier is restricted not directly by the embedded quantifier but rather by a non-null witness set. For QV, Szabolcsi (1997: §4.2) suggests a dynamic treatment; another possibility for handling QV on this approach is via quantification over answers to the higher-order question formed via absorption,

following a suggestion of Lahiri (2002: §3.3). I leave further exploration of QV within this approach to another occasion.

While the Szabolcsi-inspired proposal sketched here has much in common with the theory of Heim 2006, they differ in at least one important way: for Heim, the *than* clause denotes a degree quantifier, while for us it denotes a question quantifier. This difference in semantic type has consequences for how we understand the scope-taking potential of the *than* clause. Degree quantifiers are known to be selectively sensitive to operators that intervene between them and their traces. In particular, it is widely agreed that an individual quantifier may not take scope between a degree quantifier and that degree quantifier's trace, while a modal may. This selective restriction is commonly known as the Heim–Kennedy Constraint; precise formulations differ.

A core explanandum for any quantificational approach to clausal comparatives, alluded to repeatedly in the discussion so far, is the fact that the *than* clause must always outscope the matrix differential (Beck 2010: 51ff.; Fleisher 2016: 18). The differential phrase is standardly treated as a degree quantifier, and thus sensitive to Heim–Kennedy intervention. If question quantifiers act as illicit Heim–Kennedy interveners and degree quantifiers do not, then we may have reason to prefer a lifted-question account of clausal comparatives to Heim's degree-quantifier implementation: the former but not the latter would successfully explain why the *than* clause always outscopes the differential. This may constitute a useful avenue for future research on the stubbornly mysterious Heim–Kennedy Constraint.

5 Further considerations

5.1 Embedded degree questions vs. degree pluralities

In this section I briefly consider how the embedded-question analysis of clausal comparatives explored here compares to analyses that take the *than* clause to denote a degree plurality (Beck 2014; Dotlačil & Nouwen 2016). Despite their architectural similarity, the degree plurality approach appears to be sensitive to a proportion-problem-like difficulty that does not affect the embedded-question approach.

Dotlačil & Nouwen's LF for clausal comparatives is similar in broad strokes to those found in other entanglement theories. The *than* clause raises as a whole, creating a predicate abstract out of the matrix clause. As in Heim 2006, this derived matrix predicate is a degree predicate (the *than* clause leaves behind a degree trace) that serves as the nuclear scope for a higher operator. But where Heim has the *than* clause denote a degree quantifier, Dotlačil & Nouwen propose that it denotes a degree plurality. The *than* clause and the matrix clause then compose via plural predication, with the *than* clause restricting the operator so introduced.

A key semantic difference between Dotlačil & Nouwen's theory and the embedded-

question analyses sketched above thus concerns the domain of quantification. While both approaches fall within the entanglement family, Dotlačil & Nouwen's involves quantification over degrees, while the embedded-question theory involves either quantification over subquestions (in the Sharvit-style variant) or quantification over individuals (in the Szabolcsi-style variant). A natural question then is whether there are any domain-of-quantification-related phenomena that might help us sift and winnow among these analyses.

QV in clausal comparatives may provide a useful test case. Consider the sentence in (22b) evaluated in the scenario described in (22a).

(22) a. Scenario: There are 10 girls. Seven of these girls are equal to each other in height; the remaining three are of different heights. John's height is greater than the height of the seven same-heighted girls; the height difference between John and those girls is less than six inches. The remaining girls are variously either taller than John or at least six inches shorter than him.

b. For the most part, John is less than six inches taller than every girl is.

On the relevant QV reading—'for most girls *g*, John is less than six inches taller than *g* is'—sentence (22b) comes out true in the scenario described in (22a): John's height is less than six inches greater than the heights of seven of the 10 girls. The intuitive truth conditions involve quantification over girls. In order to get the right result here, then, we need to quantify over individuals or a suitable proxy for individuals. The lifted-question variant of the embedded-question approach involves quantification over individuals (though we still owe an account of how QV works), while the subquestion approach involves quantification over subquestions (and is expressly designed to handle QV, after Sharvit). As long as there is one subquestion for each individual quantified over, as there is with quantifiers headed by *every*, quantification over subquestions serves as a successful proxy for quantification over individuals.

There is reason to question whether quantification over degrees can be a similarly effective proxy. On Dotlačil & Nouwen's approach, the degree plurality denoted by the *than* clause in (22) consists of four atomic degrees: the height of the seven same-heighted girls and the heights of the three remaining differently heighted girls. While we presently lack a worked-out account of QV within this approach, what is clear from (22) is that a degree-plurality-denoting *than* clause will not be a suitable restriction for the adverbial. It is not the case in (22) that, for most atomic degrees *d* found within the *than*-clause degree plurality, John is less than six inches taller than *d*; he bears this relationship to only one of the four atomic degrees that form the domain of quantification here. If the *than*-clause degree plurality were the restriction of *for the most part*, we would predict (22b) to come out false in scenario (22a), contrary to fact.

In other words, a theory that uses degrees as the top-level domain of quantification for clausal comparatives risks a proportion problem revealed by QV examples like (22). Note that while Heim's (2006) theory also involves quantification over degrees—the *than* clause denotes a degree quantifier and the matrix clause denotes a derived degree predicate—in her theory the *than* clause smuggles an individual quantifier to the widest scope position in the sentence; the semantic operations on degrees are all quantificationally subordinate to this individual quantifier.[5] While there remains much work to do on QV within the various approaches to clausal comparatives, examples like (22) show that the intuitive truth conditions involve quantification over individuals. A given analysis will profit or perish according to whether its chosen domain of quantification successfully mirrors this intuition.

5.2 Multiple *wh*

Pair-list readings of embedded questions are found not just with embedded quantificational subjects, but also with multiple-*wh* questions. An analysis that treats *than* clauses as embedded questions must reckon with multiple-*wh* configurations. Though the data at first appear discouraging, I will suggest that this is in fact another area where the parallels between *than* clauses and embedded questions are both striking and consistent with expectations.

The embedded multiple-*wh* question in (23a) supports a pair-list reading, according to which John knows a list of student–book pairs such that the student read the book.[6] By contrast, the clausal comparative in (23b) supports no comparable reading; it appears uninterpretable as anything other than an echo question, and certainly lacks the MIN-&-MAX reading that has elsewhere been the counterpart of the pair-list reading of embedded questions.

(23) a. John knows which student read which book.

b. # John is taller than which student is.

The proponent of the embedded-question approach to clausal comparatives owes an account of the contrast here. All *than* clauses have a *wh*-degree operator; why doesn't the inclusion of an additional *wh*-phrase, like *which student* in (23b), yield something akin to the multiple-*wh* embedded question in (23a)?

To begin, let us sharpen the comparison. The *than* clause in (23b) is syntactically parallel not to the multiple-*wh* question in (23a) but to the one in (24), which is far more awkward. (I return to its interpretation below.) Could the superiority

5 A similar arrangement obtains in the lifted-question analysis sketched in section 4.2, with questions in place of degrees.

6 There are additional requirements that the reading must satisfy, some of which I discuss below. For fuller discussion and references, I refer the interested reader to Dayal 2016: §4.

violation found in (23b) and (24)—with the *wh*-degree operator moving across the *wh*-subject to SpecCP—explain their (relative) unacceptability? No: the story cannot be so simple. Superiority violations are known to be acceptable with D-linked *wh*-phrases (Pesetsky 1987; Kotek 2014), as in (25). And even when we control for superiority, the multiple-*wh than* clause in (26) remains unacceptable, in contrast to its embedded-question counterpart.[7]

(24) ? John knows how tall which girl is.

(25) John knows which book which student read.

(26) a. John knows how many tickets Rita wrote on which day.

b. # John wrote more tickets than Rita did/wrote on which day.

I suggest that we can understand the data above by taking a closer look at the semantics of multiple-*wh* constructions. I adopt the family-of-questions approach to multiple-*wh* interpretation for present purposes (Hagstrom 1998; Kotek 2014), as it affords a particularly straightforward way of modeling the issues at hand, though I believe that what I have to say could be recast in other frameworks.

On the family-of-questions approach, a multiple-*wh* question denotes a set of questions (i.e. a set of sets of propositions, on an underlying Hamblin/Karttunen semantics for questions). The questions in the set are questions formed with the lower *wh*-phrase; the set contains one such question per element in the domain of the higher *wh*-phrase. The superiority-obeying multiple-*wh* question in (23a) thus denotes the set {which book did John read?, which book did Mary read?, . . . }, where John and Mary are students. Its counterpart in the superiority-violating (25), where the *wh*-phrases occur in the opposite order, is the set {which student read *Aspects*?, which student read *SPE*?, . . . }, where *Aspects* and *SPE* are books. (For discussion and a formal implementation, see Kotek 2014.)

In examples where one of the *wh*-phrases is a degree phrase, the syntactic relationship between the multiple *wh*-phrases determines the type of the questions in the resulting set. This is important for us, since on the semantics sketched in section 4, the ANS_d operator must compose with a degree question. In order for a multiple-*wh than* clause to deliver a set of degree questions, however, the *wh*-degree phrase must be the lower of the two *wh*-phrases. This, in turn, conflicts with the core syntax of comparative *than* clauses, which always involve movement of a *wh*-degree operator to SpecCP. For multiple-*wh than* clauses, then, the syntax of the comparative seems bound to derive a structure whose denotation—a set of individual questions, one per degree[8]—is useless for further semantic composition.

7 I thank Polly Jacobson (p.c.) for discussion of this point and for providing the examples in (26).

8 It is widely observed that a family of questions must contain a question for each element of the

Is it ever possible for a structure where a *wh*-degree phrase is highest to denote a set of degree questions? Yes: there are at least two such cases, and in both of them the resulting clausal comparatives are fully acceptable. The first case is the one we have been examining all along: *than* clauses with quantificational subjects. Replacing the crossed-over *wh*-phrase in a multiple-*wh* question with a quantifier flips the domain and range of the resulting listed pairs (Nicolae 2013; Dayal 2016); on a family of questions approach, it inverts the hierarchical organization of the resulting family of questions. This is sketched in (27).

(27) a. ⟦which book which student read⟧ = {which student read *Aspects*?, which student read *SPE*?, . . . }

b. ⟦which book every student read⟧ = {which book did John read?, which book did Mary read?, . . . }

A *than* clause in which the *wh*-degree operator crosses over a quantificational subject will thus yield a set of degree questions, as required. (Space precludes an account of how precisely to integrate this family-of-questions view with the candidate analyses sketched in section 4; suffice it to say for now that there are natural affinities among them.)

The second case is one in which a multiple-*wh than* clause occurs in a sentence that also contains a matrix *wh*-phrase. In such a configuration, we get a family of questions pairing the matrix *wh*-phrase with the lower of the two embedded *wh*-phrases; Dayal (2002) calls this a "*wh* triangle". The resulting question denotation is a set of matrix-level questions; the higher embedded *wh*-phrase stays put, semantically speaking, in the embedded clause. As a result, it determines the type of the embedded question, yielding a degree question in the case of a *than* clause, as required for interpretability. Embedded-question and clausal-comparative examples are shown in (28), with their family-of-questions denotations.

(28) a. ⟦Which boy knows how tall which girl is?⟧ = {which boy knows how tall Ann is?, which boy knows how tall Becca is?, . . . }

b. ⟦Which boy is exactly six inches taller than which girl is?⟧ = {which boy is exactly six inches taller than Ann is?, which boy is exactly six inches taller than Becca is?, . . . }

Additional clausal-comparative examples are shown in (29) and (30): the former is a *wh*-triangle counterpart to Jacobson's superiority-obeying example in (26)

higher *wh*-phrase's domain; this requirement is often called domain exhaustivity or domain cover (Dayal 1996, 2016). Since degree scales are dense (Fox & Hackl 2006), a family of questions keyed to degrees can satisfy domain exhaustivity only if the *wh*-degree phrase is D-linked, with a highly restricted domain of contextually salient degrees. The awkwardness of (24) may be related to the difficulty of getting a D-linked reading for *how tall*.

(take care to read *on which day* within the embedded clause), the latter perhaps a more natural-sounding example drawn from life.[9] In all of these cases, the inclusion of a matrix *wh*-phrase renders the multiple-*wh than* clause acceptable. Like their quantifier-containing counterparts shown above and like ordinary embedded multiple-*wh* questions, such multiple-*wh* clausal comparatives support QV, as in (31).

(29) Which Beatle wrote more tickets than Rita did on which day?

(30) Which present-day movie star is now older than which *Cocoon* cast member was in 1985?

(31) a. For the most part, John knows which student read which book.

b. For the most part, John knows which present-day movie star is now older than which *Cocoon* cast member was in 1985.

The multiple-*wh* data are thus consistent with the embedded-question approach to *than* clauses, despite initial impressions to the contrary. Clausal comparatives might provide a new source of evidence for research on the syntax and semantics of multiple-*wh* questions.

6 Summary

The semantic parallels between *than* clauses and embedded questions are striking and thoroughgoing. The QV and multiple-*wh* data adduced here add to the store of similarities brought to light by Lerner & Pinkal (1991), Moltmann (1992), and Moltmann & Szabolcsi (1994), and suggest that the comparatives literature may profit from a return to the line of investigation they initiated. Attending to this wider range of scopal behavior also tells in favor of the entanglement approach to clausal comparatives, despite the possibility of deriving MIN-&-MAX readings via encapsulation (Zhang & Ling 2015).

The present paper leaves a large number of loose ends. While I have sketched some approaches that I take to be promising, none yet successfully incorporates the scope, QV, cumulativity, and multiple-*wh* phenomena found in clausal comparatives into a single coherent analysis. I hope that my observations here will help point us toward such a theory.

9 Example (30) is inspired by a tweet (https://twitter.com/timcarvell/status/1020163883678552064) conveying the information that "Tom Cruise is five years older in *Mission: Impossible: Fallout* than Wilford Brimley was in *Cocoon*". As noted in a reply (https://twitter.com/qpheevr/status/1020489919528079360), (30) is best read such that *is now older than* means 'has just now become older than'; this makes the degree relation non-monotone, helping to ensure that the present-day movie stars vary with the *Cocoon* cast members. Keep in mind that we are interested here in the pair-list reading, which is available despite requiring a somewhat more fanciful context than the straightforward single-pair (e.g. Brimley–Cruise) reading.

References

Alrenga, Peter & Christopher Kennedy. 2014. *No more* shall we part: Quantifiers in English comparatives. *Natural Language Semantics* 22. 1–53. doi:10.1007/s11050-013-9099-4.

Beck, Sigrid. 2010. Quantifiers in *than*-clauses. *Semantics and Pragmatics* 3. 1:1–1:72. doi:10.3765/sp.3.1.

Beck, Sigrid. 2014. Plural predication and quantified 'than'-clauses. In Luka Crnič & Uli Sauerland (eds.), *The Art and Craft of Semantics: A Festschrift for Irene Heim*, 91–115. Cambridge, Mass.: MIT Working Papers in Linguistics. http://semanticsarchive.net/Archive/jZiNmM4N/.

Beck, Sigrid & Hotze Rullmann. 1999. A flexible approach to exhaustivity in questions. *Natural Language Semantics* 7. 249–298. doi:10.1023/A:1008373224343.

Beck, Sigrid & Yael Sharvit. 2002. Pluralities of questions. *Journal of Semantics* 19. 105–157. doi:10.1093/jos/19.2.105.

Bumford, Dylan. 2015. Incremental quantification and the dynamics of pair-list phenomena. *Semantics and Pragmatics* 8. 9:1–9:70. doi:10.3765/sp.8.9.

Chierchia, Gennaro. 1993. Questions with quantifiers. *Natural Language Semantics* 1. 181–234. doi:10.1007/BF00372562.

Dayal, Veneeta. 1996. *Locality in WH Quantification: Questions and Relative Clauses in Hindi*. Dordrecht: Kluwer. doi:10.1007/978-94-011-4808-5.

Dayal, Veneeta. 2002. Single-pair versus multiple-pair answers: *Wh*-in-situ and scope. *Linguistic Inquiry* 33. 512–520. doi:10.1162/ling.2002.33.3.512.

Dayal, Veneeta. 2016. *Questions*. Oxford: Oxford University Press. doi:10.1093/acprof:oso/9780199281268.001.0001.

Dotlačil, Jakub & Rick Nouwen. 2016. The comparative and degree pluralities. *Natural Language Semantics* 24. 45–78. doi:10.1007/s11050-015-9119-7.

Fleisher, Nicholas. 2016. Comparing theories of quantifiers in *than* clauses: Lessons from downward-entailing differentials. *Semantics and Pragmatics* 9. 4:1–4:23. doi:10.3765/sp.9.4.

Fox, Danny & Martin Hackl. 2006. The universal density of measurement. *Linguistics and Philosophy* 29. 537–586. doi:10.1007/s10988-006-9004-4.

George, B. R. 2011. *Question embedding and the semantics of answers*. Los Angeles, Calif.: UCLA Ph.D. dissertation. https://semanticsarchive.net/Archive/DZiMDlmZ/.

Hagstrom, Paul. 1998. *Decomposing questions*. Cambridge, Mass.: MIT Ph.D. dissertation. https://dspace.mit.edu/handle/1721.1/9649.

Heim, Irene. 2006. Remarks on comparative clauses as generalized quantifiers. Ms., MIT. https://semanticsarchive.net/Archive/mJiMDBlN/.

Kotek, Hadas. 2014. *Composing questions*. Cambridge, Mass.: MIT Ph.D. disserta-

tion. https://dspace.mit.edu/handle/1721.1/93840.

Lahiri, Utpal. 2002. *Questions and Answers in Embedded Contexts*. Oxford: Oxford University Press.

Larson, Richard K. 1988. Scope and comparatives. *Linguistics and Philosophy* 11. 1–26. doi:10.1007/BF00635755.

Lerner, Jean-Yves & Manfred Pinkal. 1991. Comparatives and nested quantification. In P.J.E. Dekker & M.J.B. Stokhof (eds.), *Eighth Amsterdam Colloquium*, 329–347. Amsterdam: ILLC.

Moltmann, Friederike. 1992. *Coordination and comparatives*. Cambridge, Mass.: MIT Ph.D. dissertation. https://dspace.mit.edu/handle/1721.1/12896.

Moltmann, Friederike & Anna Szabolcsi. 1994. Scope interactions with pair-list readings. In *North East Linguistic Society (NELS) 24*, Amherst: GLSA.

Nicolae, Andreea Cristina. 2013. *Any questions? Polarity as a window into the structure of questions*. Cambridge, Mass.: Harvard University Ph.D. dissertation. https://dash.harvard.edu/handle/1/11129203.

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

Pesetsky, David. 1987. *Wh*-in-situ: Movement and unselective binding. In Eric J. Reuland & Alice G. B. ter Meulen (eds.), *The Representation of (In)definiteness*, 98–129. Cambridge, Mass.: MIT Press.

Preuss, Susanne Marie-Luise. 2001. *Issues in the semantics of questions with quantifiers*. New Brunswick, N.J.: Rutgers University Ph.D. dissertation. https://ling.rutgers.edu/images/dissertations/preuss.pdf.

Rullmann, Hotze. 1995. *Maximality in the semantics of WH-constructions*. Amherst, Mass.: University of Massachusetts Ph.D. dissertation. https://scholarworks.umass.edu/dissertations/AAI9524743/.

Schwarzschild, Roger & Karina Wilkinson. 2002. Quantifiers in comparatives: A semantics of degree based on intervals. *Natural Language Semantics* 10. 1–41. doi:10.1023/A:1015545424775.

Sharvit, Yael. 2002. Embedded quantifiers in *which*- and *whether*-questions. In Brendan Jackson (ed.), *Semantics and Linguistic Theory (SALT) 12*, 266–285. Ithaca: Cornell University. doi:10.3765/salt.v12i0.2863.

von Stechow, Arnim. 1984. Comparing semantic theories of comparison. *Journal of Semantics* 3. 1–77. doi:10.1093/jos/3.1-2.1.

Szabolcsi, Anna. 1997. Quantifiers in pair-list readings. In Anna Szabolcsi (ed.), *Ways of Scope Taking*, 311–347. Dordrecht: Kluwer. doi:10.1007/978-94-011-5814-5.

Zhang, Linmin & Jia Ling. 2015. Comparatives revisited: Downward-entailing differentials do not threaten encapsulation theories. In Thomas Brochhagen, Floris Roelofsen & Nadine Theiler (eds.), *20th Amsterdam Colloquium*,

478–487. Amsterdam: ILLC. http://semanticsarchive.net/Archive/mVkOTk2N/AC2015-proceedings.pdf.

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