Sorting out Relative Clauses[*]

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1. Introduction

Recent evidence from interpretation has led to progress in our understanding of the structure of restrictive relative clauses. The general pictures that has emerged from several studies is that relative clauses are ambiguous as originally proposed by Carlson (1977) and developed further in Bhatt (2002), Heim (1987) and Sauerland (1998, 2000, 2002). The ambiguity concerns the position in which the head NP of the relative clause is interpreted. In some cases, the head must be interpreted exclusively in a position internal to the relative clause. In others, it appears that the head must be interpreted external to the relative clause as well. In this paper, we present further evidence for the ambiguity and a complete semantics for the structures of restrictive relative clauses.

The two structures of restrictive relative clauses we argue for are called the raising and the matching structures by Bhatt (2002) and Sauerland (1998, 2000, 2002). In the raising structure, the head NP is interpreted only in the relative clause internal trace position. For the DP *the book John read*, the representation of the raising structure is given in (1a) and the LF-representation in (1b).
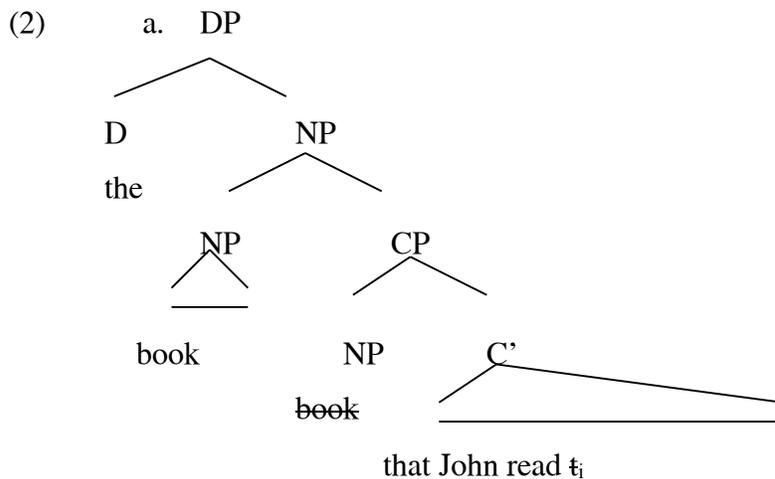
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(1)   a.   DP
         D   CP
        the
                NP   C'

              book$_i$ that John read t$_i$
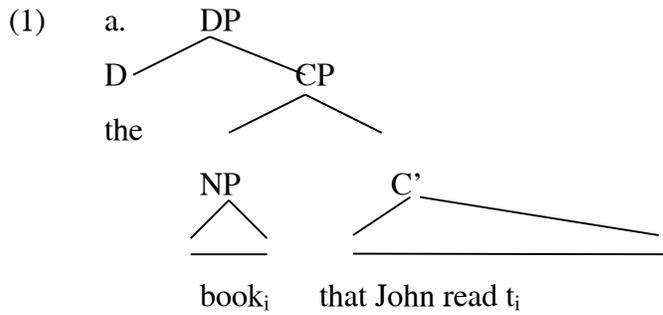
        b.   the λx. that John read the$_x$ book

For the interpretation of this structure, *the$_x$ book* can be interpreted as g(x) with a presupposition that g(x) is a book. The notation *the$_x$ book* may be understood as a shorthand for "the λy. (x=y and book(y))" (Fox 1999).

In the matching structure, the head NP is interpreted outside of the relative clause. Furthermore an elided NP is interpreted inside the relative clause that must be similar enough to the head NP for the purposes of ellipsis licensing (see Sauerland 2004). The matching structure is illustrated in (2a) with the LF-representation in (2b).

(2)   a.   DP
         D   NP
        the
                NP   CP

              book   NP   C'
                           ~~book~~
                                that John read t$_i$

        b.   the book λx. John read the$_x$ book

A third logical possibility that has been proposed is one in which externally headed structures are purely externally headed and have no elided copy of the NP inside the relative clause. However, Safir (1999) and Sauerland (1998) argue that such a structure must be unavailable for restrictive relative clauses, and that even in cases in which the head NP is present external to the relative clause, it is necessary to also interpret a copy internally.[1] Therefore, we will assume a matching analysis as the only externally headed structure.

As far as we know, two cases provide clear evidence for the raising analysis: the interpretation of idioms (Brame 1968, Schachter 1973) and the binding of variables (Schachter 1973, Vergnaud 1974). Bhatt (2002) discusses an ambiguity that arises with superlatives which he claims provide a new argument for the raising analysis. But, we show in section 3.1 that Bhatt's ambiguity is actually another example of the binding facts, in this case binding of world variables.

An example of how idiom interpretation requires the raising structure is (3). If the idiomatic reading of *headway* is available only if *headway* appears inside the complement of *make*, (3a) requires the raising analysis in (3b).

(3)   a.   John was satisfied by the amount of headway that Mary made.

          b.   John was satisfied by the λx Mary made the$_x$ amount of headway

An example where binding requires the raising structure is (4). Binding of the reflexive *himself* requires the matching analysis in (4b).

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[1] For reasons of space, we cannot present the two arguments in detail here against the purely head-external structure here. One argument stems from Safir's (1999:(66)) observation that certain material in the relative clause head always causes Strong Crossover/Condition C violations in the relative clause internal position. This argument is discussed in more detail in Bhatt (2002) and Sauerland (2002). A second argument arises from the observation of Sauerland (1998) that the content of the relative clause head affects ellipsis licensing in the relative clause. This argument is presented in Sauerland (2004).

(4)   a.   Mary liked the picture of himself that John sent.

       b.   Mary liked the λx John sent the$_x$ picture of himself$_x$

However, in examples like (5) where the binder in the relative clause is a quantifier, further assumptions about the interpretation of raising relative clauses must be made, because (5) does not entail that there is an x such that for every boy, x is a picture of that boy. We address this issue in section 3.

(5)   Mary liked the picture of himself that every boy sent.

One argument for the existence of the matching structure in addition to the raising structure comes from the distribution of Condition C effects in English (Sauerland 2002). Consider (6a) which in contrast to the wh-movement example (6b) allows coreference between *John* and *he.*

(6)   a. Which is the picture of John$_i$ that he$_i$ likes?

       b. *Which picture of John$_i$ does he$_i$ like?

While the raising structure (7a) would predict a Condition C effect for (6a), the absence of a Condition C effect is predicted by the matching structure (7b).

(7)   a.   the λx. he$_1$ likes the$_x$ picture of John$_1$

       b.   the picture of John$_1$ λx. he$_1$ likes the$_x$ picture of him$_1$

Sauerland (1998, 2000, 2002, 2004) and Bhatt (2002) give further arguments for the matching structure, but these will not play a role in the present paper.

In section 2 of this paper, we present another argument for the matching analysis. We show that extraposed relative clauses only allow the matching structure. In section 3, we discuss the semantics of raising examples where the relative clause contains a variable that is bound only in a relative clause internal position. Section 4 concludes the paper.

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2. Extraposed Relative Clauses

2.1   Extraposition Blocks Raising

In the two cases mentioned above in which a raising analysis is necessary, it is not possible to extrapose the relative clause past a right-adjoined VP adverb (Hulsey 2001).

One such structure in which raising is forced is the idiom case in which an idiom is split between the head-NP and the relative clause VP (8). Under the assumption that an idiom must be interpreted as a constituent (Marantz 1984, Chomsky 1993), this requires the relative clause to be internally headed.

(8)   a.   Mary praised the headway that John made.
        b.   I was shocked by the advantage that she took of her mother.

These relative clauses cannot be extraposed past a temporal adverb (9). Here and below we assume that a temporal adverb marks the right edge of the VP.

(9)   a.   *Mary praised the headway last year that John made.
        b.   *I was shocked by the advantage yesterday that she took of her mother.

Both (9a) and (9b) are ungrammatical, though near-minimal pairs that do not contain idioms can be extraposed quite easily.

(10)   a.   Mary praised the pot roast yesterday that John made.
        b.   I was shocked by the garish dress yesterday that she took from her mother.

Unlike the idiom examples, the relative clauses in (10) do not force a raising analysis, and extraposition is allowed. Additionally, the ungrammaticality of (9) does not arise from the fact that there is extra lexical material intervening between the two halves of the

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idiom. The head noun can be separated from the VP-half of the idiom, as long as it is within the relative clause itself and does not indicate extraposition.

(11)   a.   Mary praised the headway that as of yesterday John had made.

           b.   I was shocked by the advantage that as of yesterday she had taken of her mother.

The ungrammaticality of (9) thus appears to come from an incompatibility of extraposition with idiomatically interpreted relative clauses.

Another case that forces a raising structure is one in which there is an anaphor in the relative clause head-NP bound by an NP inside the relative clause (12).

(12)   a.   I saw the picture of himself that John liked.

           b.   Mary discovered the book about himself that Bob wrote.

When we try to extrapose the relative clauses in (12) past the right edge of the VP, the resulting sentences are ungrammatical (13).

(13)   a.   *I saw the picture of himself$_i$ yesterday that John$_i$ liked.

           b.   *Mary discovered the book about himself$_i$ yesterday that Bob$_i$ wrote.

Related sentences that do not force a raising analysis permit extraposition here:

(14)   a.   I saw the picture of Clinton yesterday that John liked.

           b.   Mary discovered the book about Rome yesterday that Bob wrote.

In (14), nothing forces a raising structure for the relative clause, and extraposition is permitted. There is nothing wrong in principle with a reflexive in an NP that heads an extraposed relative clause, as long as the binder is not within the relative clause:

(15) a. I saw the picture of myself yesterday that John liked.

b. Mary discovered the book about herself that her father (secretly) wrote.

Examples (13)–(15) show that extraposition is also incompatible with the second case of forced raising: relative clauses in which an anaphor in the relative clause head is bound by an NP within the relative clause itself.

Bhatt (2002) discusses another environment that seems to require a raising analysis, namely the low readings of adjectival modifiers of the head-NP. (16) is ambiguous between a high and a low reading for the adjectival modifier *first*. The two readings are paraphrased in (17) and (18).

(16) I read the first book that John said that Tolstoy had written.

(17) *paraphrase of the high reading for (16)*

the first book about which John said that Tolstoy had written it.

(18) *paraphrase of the low reading for (16)*

the x s.t. John said that the first book that Tolstoy had written was x.

The low reading is incompatible with extraposition past right-adjoined *last week*, as (19) shows. Here we include the NPI *ever*, following Bhatt, since its licensing conditions force the low reading when placed within the *written* clause.

(19) *I read the first novel last week that John said that Tolstoy had (ever) written.

In contrast, the high reading permits extraposition. In this example, we have placed the NPI so as to force the high reading.

(20) I read the first novel last week that John (ever) said that Tolstoy had written.

Bhatt analyzes the high reading as being compatible with either a matching or a raising analysis. As we will see in section 2.2, at least in cases of extraposition, relative clauses with the high reading necessarily have a matching structure. We will show that extraposition is not simply incompatible with certain instances of the raising structure, but that it actually forces a matching structure.[2] In this section we have shown that of the three relative clause environments which are generally agreed to require a raising structure, none of them permit extraposition of the relative clause.

2.2   Why Extraposition Should Force an External Head

Fox and Nissenbaum's (2000) analysis of extraposition predicts that extraposition of a relative clause is only possible for one with a matching structure. Their analysis stems from some puzzling facts about extraposition: first, in extraposition of complements but not of adjuncts, the extraposed constituent can be shown to have undergone movement; secondly, in adjunct extraposition but not in complement extraposition, the source NP can be shown to have undergone (covert) movement. In their paper, they show that these facts can be accounted for by extending Lebeaux's (1988) (later modified by Chomsky (1993)) proposal about counter-cyclic merger of adjuncts.

The Lebeaux-Chomsky analysis accounts for the apparently puzzling fact that (22) appears to violate Condition C, while the seemingly similar (21) does not.

(21)   Which examinations near John$_i$ did he$_i$ peak at?
(22)   *Which pictures of John$_i$ does he$_i$ like?

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[2] Actually, the extraposition data is consistent with either of the two head-external   analyses, the matching one or the traditional purely externally headed one. However, following Safir (1999) and Sauerland (1998), we will assume that the purely externally headed structure is not available for restrictive relatives, leaving only the matching analysis when external heading is indicated.

In this account, the difference in grammaticality is tied to the fact that in (21) the R-expression is within an adjunct to the moved WH-phrase, while in (22) the R-expression is inside of a complement. Adjuncts are not subject to the Projection Principle, so [near John] can be merged directly to the higher position after WH-movement of [which examination] (23).

(23)   [Which examinations [near John$_i$]] did he$_i$ peak at <which examinations>?

Thus, (21) does not contain a configuration of [John] and [he] that violates Condition C, and the sentence is grammatical.

The late-merger analysis for (21) does not incorrectly predict that (22) should also be grammatical. In (22) the R-expression is within a complement to the NP of the WH-phrase. As a complement, [of John] is subject to the Projection Principle, which requires all thematic relations to be satisfied at all levels of the derivation. Since there is no copy of the complement in the base-generated position of [which picture], (24a) violates the Projection Principle. (24b), which does satisfy the Projection Principle, nevertheless violates Condition C, because [he] c-commands the lower instance of [John]. Accordingly, there is no licit way to derive the ungrammatical (22).

(24)   a.   *Which pictures of John$_i$ does he$_i$ like <which pictures>?
        b.   *Which pictures of John$_i$ does he$_i$ like <which pictures of John$_i$>?

The Lebeaux-Chomsky analysis thus accounts for the difference in grammaticality between (21) and (22) by showing that adjuncts can be merged counter-cyclically after WH-movement but that complements cannot be.

Fox and Nissenbaum (2000) extend the Lebeaux-Chomsky picture of counter-cyclic merger of adjuncts to cover the difference in behavior of extraposed complements and adjuncts. They suggest that adjuncts can be counter-cyclically adjoined not only after an overt movement like WH-movement, but also after a covert one like Quantifier Raising.

They argue that allowing post-QR merger of an adjunct can account for the divergent behavior of extraposed adjuncts and complements.

(25) is an example of adjunct extraposition and the Fox and Nissenbaum derivation for it. (25a) shows that the VP is constructed without the adjunct [by John] in the base position of [a painting]. [a painting] then undergoes rightward QR past the adverb [yesterday], which is assumed to mark the right edge of the VP (25b). Finally, [by John] is merged at the head of the QR chain to the higher, unpronounced instance of the NP (25c).

(25)   We saw a painting yesterday by John.
>   a.   We saw a painting yesterday.
>   b.   We saw [a painting] yesterday <a painting>
>   c.   We saw [a painting] yesterday [<a painting> by
>
>   John]

In contrast, an extraposed complement like (26) is derived by base-generation of the constituent [of John] within the VP as a complement to [painting] (26a). From there it undergoes rightward movement to its surface location (26b).

(26)   We saw a painting yesterday of John.
>   a.   We saw a painting of John yesterday.
>   b.   We saw a painting <of John> yesterday [of John].

Unlike an adjunct, a complement cannot be late-merged because of the requirements of the Projection Principle. Therefore, if it is extraposed, the configuration must arise from movement of the complement to the surface position. The source NP [a painting] is not required to undergo QR for this derivation. This account explains the facts of complement extraposition: the extraposed complement can be shown to have undergone movement, and there are no requirements on the source NP to undergo covert movement.

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Similarly, the facts for adjunct extraposition are accounted for by this analysis. An extraposed adjunct fails the tests for movement, as expected if it has not actually undergone movement but rather been late-merged in its surface position. Additionally, under this explanation we would expect the modified NP [a painting] to necessarily take scope at least as high as the extraposed adjunct since QR of [a painting] to that position is required to derive (25). This indeed turns out to be the case, as Fox and Nissenbaum show with various tests.

This analysis of extraposition also provides an explanation for the facts about relative clauses observed in section 2.1: it is not possible for a relative clause with a raising structure (27) to be extraposed from the NP with which it is associated.

(27)   DP   'Internally headed relative clause'
        D   CP
        the
                NP   C'

                book$_i$ that John read t$_i$
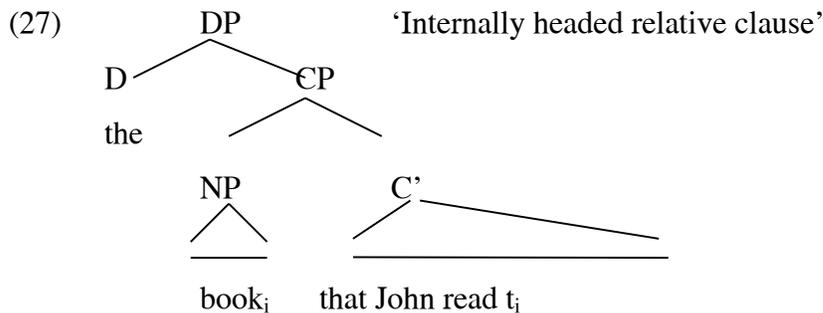
The relevant constituent to be extraposed, [that John read], cannot undergo Fox-Nissenbaum late-merger not only because it is not an adjunct, but also because the configuration of the CP in (27) does not allow it. [Book] is first merged *inside* the relative clause. By the time [book] is moved into the specifier of CP, leaving the target constituent [that John read], the entire CP has already been merged and thus could never be merged later than the NP.

It is likewise not possible for [that John read] to be merged in place and extraposed after the CP has been built, in the style of complement extraposition, since C' is not a constituent that can move on its own, leaving behind its specifier. Thus, if we adopt Fox and Nissenbaum's analysis of extraposition we have an account for why relative clauses such as (9), (13), and (19), which are forced for one reason or another have the raising

structure in (27), cannot be extraposed. Under this analysis, there is no way to derive such a structure.

Of course, under the late-merger analysis of extraposition, it is perfectly possible to extrapose a relative clause as long as no independent factor forces a raising structure. If a raising structure is not forced, the relative clause should be able to have a matching configuration (28), in which the relative clause CP is an adjunct to the NP [book].

(28)   DP   'Matching relative clause'
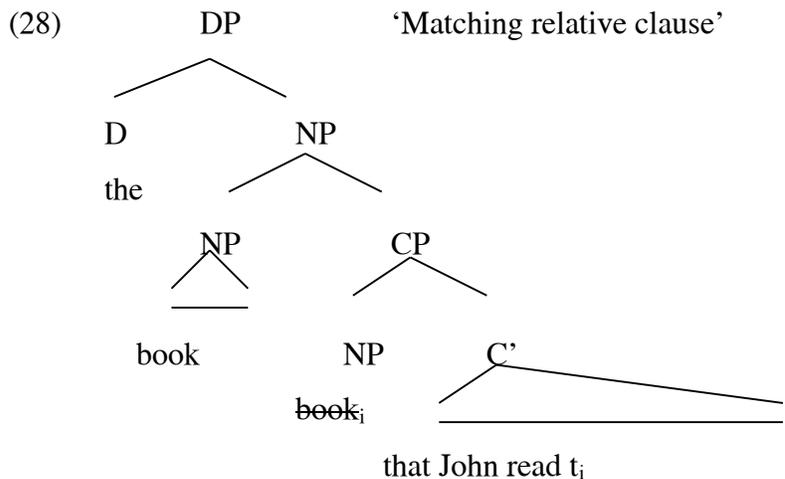
that John read t_i

In this case, extraposition happens as follows. [The book] in (29) is merged as a matrix object, from where it undergoes rightward QR past the adverb [last week]. The CP [$book_i$ that John read t_i] is then late-merged to the post-QR position, and the second [book] is obligatorily elided. This derivation is parallel to the one for the Prepositional Phrase in (25).

(29)   I bought the $book_j$ last week <the book>$_j$ [~~book~~$_i$ that John read t_i].

There is one relative clause environment that is generally agreed to force an externally headed structure for Binding Theoretic reasons, and this environment is indeed compatible with extraposition. (30) is an example of a relative clause in which there is an R-expression in the head-NP [John] that is co-referential with an NP [he] inside the relative clause.

(30)   the picture of John$_i$ [that he$_i$ likes]

Condition C is not violated in (30), which indicates that there cannot be a full copy of [John] inside the relative clause.[3] Therefore (30) must have an external head. Extraposition of this type of relative clause is allowed (31).

(31)   I saw the picture of John$_i$ yesterday that he$_i$ likes.

We have seen that known raising environments are not compatible with extraposition and that a known matching environment is. Therefore we propose that all extraposed relative clauses necessarily have matching structures, and that extraposition can be used as another test for the matching structure.

3. The Interpretation of Raising Relative Clauses

In the previous section we have seen a new argument for the claim that restrictive relative clauses allow both a raising and a matching structure. This raises the question of how the two structures are interpreted. For matching relative clauses, a semantic analysis is developed in Sauerland (2004); we focus here on raising relative clauses. Two points that we will argue for in particular are that raising relative clauses are not islands for quantifier raising and that there is semantic evidence for successive cyclic movement through a CP-adjoined position from raising relative clauses.

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[3]Recall that we assume that the relative clause internal head in a matching relative clause need not be lexically identical to the relative clause external head. Specifically, (30) does not violate Condition C if the relative clause internal head contains a pronoun instead of the proper name *John* (cf. Fiengo & May's 1994 discussion of *vehicle change*).

(i) I saw the picture of John$_i$ [[~~picture of him$_i$~~]$_j$ that he$_i$ likes t$_j$]

For the semantics of raising relative clauses, examples like (32) constitute the most interesting case. In (32), *himself* seems to be interpreted as a variable bound by the quantifier *everybody.*

(32)   The picture of himself that everybody sent in annoyed the teacher.

Interestingly, the raising structure in (33) does not straightforwardly derive the most salient interpretation of (32).[4]

(33)   [the $\lambda x.$ everybody $\lambda y.$ y send in the$_x$ picture of y] annoyed the teacher

In (33), the predicate created by λx is only defined for an individual that is, for everybody, a picture of that person. Therefore, (33) presupposes there to be a single picture that shows every student. However, the sentence (32) can also be true in a situation where each person sent in a picture that only shows a single person, namely himself. Therefore, structure (33) cannot be the only LF of (32).

We propose that (34) is also a possible LF-structure of (32). In (34), *everybody* has moved out of the relative clause to attach to the matrix clause.

(34)   everybody $\lambda y.$ [the $\lambda x.$ y send in the$_x$ picture of y] annoyed the teacher

The possibility of QR out of a relative clause to account for examples like (32) was first discussed by Doron (1982). Sharvit (1996, 1999), however, rejects the QR analysis because this hypothetical movement seems syntactically implausible to her, as relative

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[4] Recall from the introduction that we use "the$_x$ P" as a shorthand for "the λy (P(y) and x = y)".

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clauses are usually islands for movement.[5] Therefore Sharvit takes (32) to motivate a richer set of assumptions about the semantics which we address in more detail below.

In this section, we develop a new argument in favor of the QR analysis in (34). The argument has two steps. We first argue in section 3.1 that not only anaphors and pronouns, but also implicit world arguments in the relative clause head can be bound by a verb from a relative clause internal position, yielding particularly clear ambiguities with superlatives. Secondly, we compare in section 3.3 the interpretations available with binding by a verb with cases of binding by a quantificational DP, and show that the differences are exactly predicted from the assumption that verbs cannot QR to a position outside of the relative clause, while DPs can. Section 3.2 is not directly a part of this argument, but presents a complete analysis of low readings with superlatives, which is necessary for the understanding of section 3.3.

3.1 Intensional Readings of Relative Clause Heads

Consider the DP in (35).[6]

(35)   the longest book John believes Tolstoy wrote

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[5] In this paper, we set aside cases where the DP with the raising relative clause is the argument of a copula. It is well known that these have special properties (von Stechow 1990, Jacobson 1994, Sharvit 1999). For example, Sharvit notes the following difference: (32) presupposes that every student sent in a unique picture of himself. (i) with the copula, however, has a weaker presupposition since (i) can be acceptable if everybody sent in two pictures of himself.

(i)   The picture of himself everybody sent in is the self-portrait.

We therefore agree with Sharvit's conclusion that examples with a copula require a distinct analysis along the lines of specificational pseudo-clefts.

[6] Bhatt (1999: (20)) discusses the same example with *said* instead of *believes*. We changed the verb because we understand the lexical semantics of *believe* better.

The DP (35) can either refer to the longest book amongst those books which John believes that Tolstoy wrote or to the book such that John believes it is Tolstoy's longest. Bhatt (2002) calls these two readings the *High* and the *Low Reading* of the superlative *longest*.

We do not adopt Bhatt's analysis of (35), but develop our own for reasons discussed in (58) below. We claim that one factor in (35) is an ambiguity of binding analogous to example (36) where *himself* can either refer to John or to Bill.

(36)   John discovered a picture of himself Bill didn't want anyone to see.

We first outline our assumptions concerning the semantics of propositional attitudes. Cresswell (1990), Percus (2000) and others argue for the fully extensional treatment of propositional attitudes, which we adopt. They present evidence for the claim that LF-structures contain explicit variables of the type of possible worlds to account for the certain ambiguities sometimes labeled as *de re/de dicto* ambiguities (Quine 1956). Consider the example in (37)

(37)   John believes that the thousand-page book is interesting.

On one interpretation of (37), the DP *the thousand-page book* refers to an object that John believes be a thousand-page book, but that may actually be something else. On another interpretation, it refers to an object that actually is a thousand-page book, but that John may take to be something else. We assume that two different LF-representations give rise to these two interpretations. In (38-a), the world argument positions of noun and adjective are bound by the λ-operator introducing the complement of *believe*, which we assume has the interpretation in (39). (38-a) requires an interpretation where *the thousand page book* refers to something John believes to be a thousand-page book, but that may actually be something else. (38-b), on the other hand, the world arguments of *thousand page* and *book* are co-indexed with that of the matrix verb *believe.* Therefore,

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(38-b) requires that the DP *the thousand page book* refer to something that is actually a thousand-page book, but that John may believe to be something else.[7]

(38)   a. λw John believes(w) $\lambda w'$ that the [thousand-page(w') book(w')] is interesting(w')

              b. λw John believes(w) $\lambda w'$ that the [thousand-page(w) book(w)] is interesting(w')

(39) $[\![$believe$]\!]$(w)(P)(x) = 1 iff. $\forall w'$ (w' is compatible with the beliefs of x in w $\rightarrow$ P(w'))

Note that example (37) is predicted to allow the two further interpretations in (40-a) and (40-b) where the world argument variables of *thousand-page* and *book* are contra-indexed.

(40)   a. λw John believes(w) $\lambda w'$ that the [thousand-page(w') book(w)] is interesting(w')

              b. λw John believes(w) $\lambda w'$ that the [thousand-page(w) book(w')] is interesting(w')

These interpretations are easier to perceive in (41) where the properties expressed by the two phrases are pragmatically unlikely to be true of one object simultaneously. Scenario 1 brings out the indexation pattern as in (40-a), while scenario 2 requires the indexation pattern (40-b). Interestingly, these two interpretation require a 'scare-quote' intonation for the phrase that takes w' as its argument. As far as our phonetically naïve intuitions allow us to discern, the 'scare quote' intonation pattern is characterized by a rise on the relevant phrase and intonation breaks surrounding it.

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[7] For reasons of clarity, the analysis of attitude verbs we adopt here is simplified in several regards and we refer to Percus & Sauerland (2003) for a recent more complete compositional analysis. The analysis we adopt here is, however, sufficiently precise and capable for the point we want to make in the following.

(41)   John believes the one thousand-page section of wall will keep him
         entertained.

Scenario 1: John is renting a new apartment. The previous occupant has painted the picture of bookshelf on the wall, but John mistakes the picture for a real bookshelf. In particular, he forms the belief that one thick volume in the painted shelf has one-thousand pages, and will keep him entertained.

Scenario 2: John is renting another new apartment. The previous occupant has left behind a bookshelf with one one thousand-page volume in it. John, however, perhaps because he suffered through scenario 1, believes that the bookshelf is a painted-on-the-wall fake. One of John's hobbies is cleaning and repainting walls, and he forms the belief that working on the section of wall that he takes the book to be will keep him entertained.

The ambiguity of world argument binding is clearly relevant to the high/ low ambiguity of the superlative examples like (35) above. On the high reading of (35) the actual lengths of certain books are compared, while on the low reading, the length as they are in John's belief worlds are compared.

We present a complete analysis of (35) making use of different positions for world argument binding in the following subsection. Note though that we do not assume that binding of world arguments from a position inside the relative clause is restricted to cases where a superlative occurs in the head. We therefore predict that an ambiguity concerning the binding of the world argument should arise whenever there is both a predicate in the relative clause head that has a world argument and a world variable binder taking scope over the relative clause internal trace position. We argue now that examples like (42) bear out this prediction.

(42)   The thousand page book John believes he bought turned out to be a DVD.

Example (42) is felicitous in a situation where John believes that he bought a 1000 page book, but what he bought is actually a DVD. We suggest that the subject of (42) allows the LF-representation in (43).

(43)   the λx John believes $\lambda w'$ he bought the$_x$ [thousand-page(w'), book(w')]

Bhatt (2002, p. 73) and Heycock (2003) point out two interesting apparent problems for the unification of the ambiguity of superlatives and the ambiguity of other relative clause heads. Bhatt points out that (44) (his (i), p. 73) requires a 'scare quote' interpretation for a reading of *wonderful* where its world argument bound within the relative clause, while the low reading of a superlative does not require this intonation.

(44)   the wonderful books that Siouxsie said that Lydia had written

Recall though that in (41) we observed that scare-quote intonation is always required when the world argument variables of two phrases inside NP are contra-indexed, even when reconstruction into a relative clause is not at issue. Furthermore, if we force an interpretation in the relative clause case where the noun *books* must also be interpreted in the scope of *say* the scare-quote intonation is not required any more.

(45)   The wonderful books that Siouxsie said that Lydia had written turned out to be
        just a bunch of one-page leaflets

Since the entire NP must be interpreted in the scope of the relative clause in the relevant superlative examples, it is not surprising that the scare quote interpretation is not available.

Heycock (2003) raises a second interesting issue. Namely, she points out that a low interpretation is possible in (46) even though no relative clause is present.

(46)   Siouxsie was always going on about the books that Lydia had written. But I've

read those wonderful books and they're completely rubbish. (Heycock 2003)

Note though superlatives, as well, allow a 'low' reading without a relative clause present as (47) shows:

(47)   Siouxsie was always going on about the new Tolstoy book she bought and that it's the longest by Tolstoy. But, I've read that longest book and it's a lot shorter than "War and Peace".

Therefore, Heycock's observation does not provide an argument against the unification of low readings of superlatives and other adjectives, but if anything seems to corroborate this unification. The phenomenon Heycock observes is reminiscent of modal subordination as discussed by Roberts (1989) and others, and we hope that future work on such examples will be able to spell out this intuition in more detail.

Overall, we have shown in this section that implicit world variable arguments of the head NP can be bound in a relative clause internal position, just like overt anaphors like *himself* in (32) can be.

3.2.   *Low Readings and Scope*

The previous section showed that world variable binding is one factor required for the low readings of superlatives. In this section, we present a complete account of low readings of superlatives. Bhatt claims that these facts show that superlatives can take scope inside of the relative clause. We, however, arrive at a different conclusion regarding scope in this section. Furthermore, we show that the low readings provide evidence for successive cyclic movement in the relative clause (Chomsky 1977).

Consider again (48) (repeated from (35)).

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(48)   the longest book John believes Tolstoy wrote

Consider first what the matching and raising analysis predict for (48). Since the adjective *longest* could be adjoined above or below the relative clause, the two matching representations shown in (49) are possible for (48).

(49)   a. $\lambda w \ldots$ the $-est(C)$ λd [long(d)(w), book(w), λx John believes(w)
                                $\lambda w'$ Tolstoy wrote the$_x$ long(d)(w) book(w)]
        b. $\lambda w \ldots$ the $-est(C)$ λd [long(d)(w), book(w), λx John believes(w)
                                $\lambda w'$ Tolstoy wrote book(w)]

We adopt the semantics of the superlative Sharvit & Stateva (2002) and Stateva (2002) argue for. The lexical entry of the superlative morpheme *–est* is in (50) (cf. Heim 1995, Sharvit & Stateva 2002, (11)). The first of its arguments is a contextually given comparison set. It then requires that its third argument have the property P to the different degree from all individuals in C. In case P is monotonous, P(x,d) entails P(x,d') for any d' smaller than d, and then (50) requires that x have property P to a higher degree than any other individual in C.

(50) $[\![-est]\!](C)(P)(x) = 1$ iff. $\exists d$ [$P(x,d) = 1$ & $\forall y \in C\backslash\{x\}$: $P(y, d) = 0$]

Here and in the following we assume that C is the set of all books. Structure (50-a) is undefined because the definite description corresponding to the trace in the relative clause is undefined for a book x if d refers to a length longer than x's length, and therefore the second argument of *est* in (49-a) only will be either true or undefined for any pair of a book and a length. (50-b), on the other hand, correctly predicts the high reading.[8]

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[8] Bhatt (2002:p. 68) claims that the matching analysis predicts another interpretation that is not actually attested. This is not the case for the matching analysis as we conceive of it following Sauerland (1998, 2000, 2002, 2004). The possibility of intermediate traces, which we discuss in the following, makes further

Next consider possible raising structures for (50). Two structures that come to mind are shown in (51). Because the degree variable d only occurs in the relative clause internal trace position, the superlative morpheme can be interpreted in at least the two positions shown in (51-a) and (51-b). We will show below that neither (51-a) nor (51-b) derive the low reading for (48), and offer reasons to believe that both are blocked.

(51)   a. λw … the –est(C) λd λx John believes(w) λw' Tolstoy wrote the$_x$

$$[\text{long(d)(w') \& book(w')}]$$

        b. λw … the λx John believes(w) λw' Tolstoy wrote

$$\text{the}_x \text{ –est(C)} \lambda d [\text{long(d)(w') \& book(w')}]$$

We propose that intermediate trace positions need to be represented in the LF-structure of the raising analysis of (48). The availability of such positions is expected given Frampton's (1991) and Fox's (1999) arguments for the LF-representation of intermediate trace positions in questions and Sauerland's (2001) independent argument from relative clauses. We assume that extraction in the relative clause must proceed in at least two steps as shown in (51) going through an intermediate position on the edge of the finite CP.

(52)   the [longest book] John believes t Tolstoy wrote t

               ^---------------------------| ^-----------------|

Movement to the intermediate position will create a λ-operator there and subsequent movement leaves a trace that will then serve as the argument of this λ-operator. The intermediate trace makes two new options available. Since it is in the scope of *believe*, the adjective *long* can be interpreted in this position while its world argument position is bound by the λ-operator on the complement of *believe.* To allow this possibility, we

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structures available for matching relative clauses, but as far as we can see these do not give rise to additional readings.

assume that syntactic adjectives like relative clauses can be adjoined late. Furthermore a third position where –est can be interpreted is the position between the λ-operator and the intermediate trace. Therefore all five structures in (52) need to be considered as possible LF-representations of the raising analysis.[9] Note that (53-a) and (53-b) are equivalent to (51-a) and (51-b) above, because in the intermediate position the predicate created by λx is applied immediately to the variable x. (53-c), (53-d), and (53-e), however, are not equivalent to either (51-a) or (51-b) as we show in detail below.[10]

(53)   a.   λw … the –est(C) λd λx John believes(w) λw' x λx Tolstoy wrote the$_x$
                         [long(d)(w') & book(w')]

         b.   λw … the λx John believes(w) λw' x λx Tolstoy wrote
                         the$_x$ –est(C) λd [long(d)(w') & book(w')]

         c.   λw … the λx John believes(w) λw' x –est(C) λd λx Tolstoy wrote
                         the$_x$ [long(d)(w') & book(w')]

         d.   λw … the –est(C) λd λx John believes(w) λw' x [long(d)(w')
                    & λx Tolstoy wrote the$_x$ book(w')]

         e.   λw … the λx John believes(w) λw' x –est(C) λd [long(d)(w')
                    & λx Tolstoy wrote the$_x$ book(w')]

First, look at (53-a) where the superlative morpheme is interpreted outside of the relative clause. Like in the matching representation (49-a) above, the second argument of –*est* in (53-a) is only defined for a pair (x,d) if the book x is actually d long, and then it is true. But, since it cannot be false for any pair (x,d), (53-a) necessarily results in a presupposition failure.

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[9] In (53), we only consider representations the world arguments of   *long* and *book* are bound within the complement of *believe*, which is a pre-requisite for the low reading. (i) is another raising representation, but it is predicted to have the high interpretation equivalent to the matching representation (49-b).

(i)   λw … the –est(C) λd [long(d)(w) & λx John believes(w) λw' Tolstoy wrote the$_x$ book(w)]

[10] Yael Sharvit (personal communication) first suggested to us to interpret the superlative morpheme   *est* outside of the relative clause.

Secondly consider representation (53-b). Assuming that C refers to the set of all books, the definite description in the trace position presupposes that x refer to the object that is the longest of all books in world w'. This is an absolute reading where x is the longest of all relevant books by any author. That is, the relative clause is defined for at most one individual x: John must believe x to be the longest book of any author. Furthermore, the relative clause would be true of x if John believes that Tolstoy wrote x. This interpretation does not seem to be available for (48), but requires an appositive relative clause with a scare quote intonation on the head as in (54).

(54)   the 'longest book', which John believes Tolstoy wrote,

We would like to suggest that representation (53-b) is ruled out by a pragmatic condition blocking a restrictive relative clause that expresses a function that is defined for only one individual.

Representation (53-c) is also predicted to be obligatorily a presupposition violation because, again, the second argument of –est is such that it is either true or undefined for any individual x and degree d.

Finally, for (53-d) and (53-e) it is helpful to consider the following situation: John is sure that *War and Peace* has 1000 pages, and that *Anna Karenina* is either 50 pages longer or 50 pages shorter that that, but he forgot which. Furthermore John believes that Tolstoy's other books are all shorter than 900 pages. In (55), we sketch the relevant two belief worlds of John to consider.

(55)   w1: *War and Peace* — 1000 pp.   w2: *War and Peace* — 1000 pp.
              Anna Karenina — 1050 pp.   *Anna Karenina* — 950 pp.

Following Heim (2001) and others, we assume that adjectives are monotonous and, specifically, that a 1000 page book is also n pages long for any n smaller than 1000. The

interpretation predicted for (53-d) then depends on the lexical semantics of *believe*: with the standard lexical entry for *believe* in (39), (53-d) is predicted to refer to *War and Peace* in the scenario (55) because *War and Peace* is 1000 pages long in both w_1 and w_2 while *Anna Karenina* is not. This, however, is not the right result: this account predicts that (56) should be true in scenario (55), in which there is no single book John believes to be Tolstoy's longest, if John is reading *War and Peace* right now. In fact though, (56) is odd and we would like to analyze it as a presupposition failure. [11]

(56)   #I am reading the longest book John believes Tolstoy wrote.

In contrast to (53-d), (53-e) correctly predicts a presupposition failure in scenario (55). The relative clause in (53-e) is defined only if there is one individual x such that, in both w_1 and w_2, it is the longest book Tolstoy wrote. This correctly predicts a presupposition failure for (56), and also predicts the low reading in case there is a unique book such that John is certain that it is the longest Tolstoy wrote.

At this point, it seems that (53-d) needs to be blocked somehow. However, there is independent reason to assume that (53-d) does not have the interpretation above: Heim (2000) observes that neg-raising verbs like *believe* do not seem allow comparative degree quantifiers to take scope above the neg-raising verb while binding a degree variable in the scope of the neg-raising verb. But in (53-c), *believe* separates d from the λ-operator binding it, violating Heim's descriptive generalization. We furthermore show now that Heim proposal to derive her generalization also carries over to (53-d): Heim suggests to add the uniformity presupposition in (57) to the semantics of *believe*. This presupposition derives the neg-raising property and, in the examples Heim considers, renders the interpretation where a comparative degree-quantifier takes scope above a neg-raising

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[11] Example (i) and other like it are acceptable, though, because the superlative occurs as the argument of a copula. This is not surprising, because arguments of the copula are well-known to allow specificational readings, as we mentioned in footnote 4 above (see also section 3.3).

(i)   The longest book John believes Tolstoy wrote is either War and Peace or Anna Karenina.

verb equivalent to one where the degree-quantifier scopes immediately below the neg-raising verb.

(57) $[\![\text{believe}]\!](w)(P)(x)$ is defined only if $\forall w' \in \text{Dox}(x,w): P(w') = 1$ or

$\forall w' \in \text{Dox}(x,w): P(w') = 0$

(where $\text{Dox}(x,w)$ be the set of all worlds compatible with what x believes in w)

The uniformity presupposition predicts that *John believes* Anna Karenina *is d-long* is undefined for $g(d) > 950$ and $g(d) \leq 1050$. With (57) then, (53-d) is correctly predicted to be a presupposition failure in scenario (55). Hence, the uniformity presupposition also predicts that the representations (53-d) and (53-e) are equivalent to each other.

The preceding discussion has shown that the low reading of (48) is correctly predicted by both (53-d) and (53-e). This raises the question whether both (53-d) and (53-e) are available. We have seen that with neg-lowering verbs like *believe*, the two yield equivalent interpretations and therefore do not allow us to answer this question. Heycock (2003) claims that low readings are restricted to neg-lowering verbs, which would follow if only representations like (53-d) are available. However, at present we do not know of a mechanism that would rule out (53-e). Furthermore, low readings are available with *say*, which is not a neg-lowering verb (see Heycock (2003) for discussion).

Finally, compare our proposal to Bhatt's. The structure we propose in (53-e) bears a superficial similarity to Bhatt's (2002) proposal in (58) (adapted from Sharvit, in progress) since he also assigns –*est* scope above the embedded clause.[12]

(58) $\lambda w \ldots$ the λx John believes(w) $\lambda w'$ –est(C) $\sim$(C) λd Tolstoy wrote

the $[x]_F$ [long(d)(w') & book(w')]

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[12] We assumes the definition of $\sim$ in (i), where $[\![\text{XP}]\!]_f$ be the set of focus alternatives of XP. Rooth (1992) proposes for the interpretation of $\sim$ essentially (i) plus an extra contrast condition, which we do not adopt.

(i) $[\![\sim\!\text{C XP}]\!]^g$ is defined only if $g(C) \subseteq [\![\text{XP}]\!]_f$

Where defined, $[\![\sim\!\text{C XP}]\!]^g = [\![\text{XP}]\!]^g$

Notice, though, Bhatt does not assume the intermediate trace position with the λ-operator below it that we assume, and therefore there is no direct relationship between *est* and the trace variable x. Bhatt assumes that a relationship between *est* and x is via association with focus. He assumes Heim's (1995) version of the superlative morpheme in (59), which only has an implicit restrictor C, the value of which can be determined by focus (see also Szabolcsi 1986).

(59) $[\![est]\!](C)(P) = 1$ iff $\forall Q \in C\backslash\{P\}$: $\max_d P(d) > \max_d Q(d)$

The restrictor C must denote a set of properties of degrees, which, as shown in (58), is constrained by focus. Specifically, the ~-operator in (58) presupposes that C only contain properties of the form in (60):

(60) $[\![\lambda d.$ Tolstoy wrote the$_X$ d-long book$]\!]$ with X in the domain of individuals

While this proposal correctly predicts the low reading for (48), we agree with Sharvit's (in progress) criticism that Bhatt's proposal leaves open the question why focus must be placed as it is in (58). In particular, Sharvit shows that Bhatt's analysis generates unattested interpretations unless it is stipulated that only the variable inside the trace in the scope of –est is focused. This criticism does not apply to our proposal.

3.3   *Relative Clauses are not Scope Islands*

In the previous two sections, we have considered in detail some cases where world variables are bound from a position inside of the relative clause. Since it is well known that individual variables (pronoun and reflexives) allow such binding, it is not surprising that it is possible for world variables as well. In fact, though, we already observed some facts that show that binding of world and individual variables behave differently when bound from a position inside the relative clause. In this section, we review the relevant

facts and propose an explanation for them. Our explanation claims that the certain binders of individual variables, DPs headed by *each* or *every*, can undergo quantifier raising to a position outside of the relative clause, while the binders of world variables, verbs, are not allowed to undergo such movement.

Recall the discussion of (61-a) (repeated from (32)) above. Specifically, we showed that representation (61-b) presupposes the existence of a single picture that shows everybody, which does not correspond to the most salient interpretation of (61-a).

(61)   a.   The picture of himself that everybody sent in annoyed the teacher.

         b.   [the λx. everybody λy. y sent in the$_x$ picture of y] annoyed the teacher

We want to compare two proposals to explain the lack of a presupposition violation in (61-a). Our proposal is that the quantificational DP *everybody* can syntactically move to a position outside of the relative clause and take scope there as shown in (62).

(62)   everybody λy. [the λx. y sent in the$_x$ picture of y] annoyed the teacher

The other proposal we consider is that of Sharvit (1999). Sharvit proposes that the relative clause can contain a functional trace. Adjusting the notation slightly, her proposal amounts to the representation in (63).

(63)   [the λf. everybody λy. y sent in the$_{f(y)}$ picture of y] annoyed the teacher

In (63), f is of the type $<e,e>$ of Skolem functions. We furthermore introduce the meaning of the definite in (64-a) specific to predicates of functions, and the convention in (64-b) for evaluating an individual predicate applied to a function.[13]

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(64)   a. $[\![\text{the}]\!](P^{<<e,e>,t>}) = f$, where f is the unique function such that

        i.   domain(f) = min {domain(g) | g ∈ domain(P)}

        ii.   P(f) = 1

    b. $P^{<e,t>}(f^{<e,e>}) = 1$ iff. $\forall x \in$ domain(f): P(f(x)) = 1

In example (63), the suitable f would be the function that is defined for all people that *everybody* quantifies over, and maps each x from this domain to the y such that y is the picture of x that x sent in. From (64-b), it follows then that (63) is true iff for every y for which f is defined, f(y) annoyed the teacher.

Now, compare (61-a) with (65) (repeated from (56)). (65), as was observed above, actually causes a presupposition violation unless there is a book of which John believes that it is Tolstoy's longest. In particular, (65) is odd in the situation sketched in (55).[14]

(65)   #I am reading the longest book John believes Tolstoy wrote. (in scenario (55))

As we already discussed, representation (66) (repeated from (53-e)) correctly predicts the presupposition of (65).[15]

(66)   λw I am reading(w) the λx John believes(w) λw' x –est(C)

             λd [long(d)(w') & λx Tolstoy wrote the$_x$ book(w')]

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[13] Sharvit (1999) discusses further restrictions on the set of functions available. We don't fully understand Sharvit's assumptions concerning the interpretation of functions as arguments of predicates, but believe that the proposal in (74) is close enough to what she has in mind for our purposes.

[14] Bhatt (2002: p.66) discusses a similar scenario and also observes a presupposition violation. The example he considers unfortunately bears plural morphology on the relative clause head, and therefore, we would expect Bhatt's example to be a presupposition violation simply because inappropriate number morphology is present.

We have seen, however, that we need to assume either long QR or functional traces to avoid a presupposition violation in (61-a). Would the application of QR or of functional traces in (65) incorrectly predict that no presupposition violation should arise?

Consider first QR. The QR required is very radical: In representation (67), the quantifier over worlds λP *John believes (w)(P)* takes scope outside of the relative clause. This representation would no longer predict a presupposition violation for (65) because the presupposition of the definite is now that in world w' there be a unique individual that John believes to be Tolstoy's longest book.

(67) λw [λP John believe(w)(P)] $\lambda w'$ I am reading(w) the λx w' $\lambda w'$ x $-$est(C)
              $\lambda d \lambda x$ Tolstoy wrote the$_x$ [long(d)(w') & book(w')]

Therefore, it is a good thing that (67) is syntactically very implausible. If we assume that only DPs can undergo QR, it predicts (67) to be unavailable. The different syntactic properties of verbal and nominal quantifiers explain in this way that (65) results in a presupposition violation, while (61-a) is acceptable.

Now consider functional traces. In this case, we need to consider representation in (68) where f is a function from worlds to individuals.

(68) λw I am reading(w) the λf John believes(w) $\lambda w'$ f(w') $-$est(C)
              $\lambda d \lambda x$ Tolstoy wrote the$_x$ [long(d)(w') & book(w')]

In (68), no presupposition violation arises because f(w') can select the longest book Tolstoy wrote in all of John's belief worlds. (65) is predicted to be true in case I am reading every book that in at least one of John's belief worlds is the longest book Tolstoy wrote. In scenario (56), (68) would be true if I am reading both *War and Peace* and *Anna Karenina*. Since (65) does not have this interpretation, however, (68) must be blocked. But, while it was natural to block (66) on the QR-analysis, it is difficult to see why (68) should be blocked if functional readings are available in other cases. Of course, we could

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stipulate that Skolem functions of type <s,e> (from worlds to individuals) are impossible, while those of type <e,e> are possible. However, we know of no independent argument for this stipulation, while the fact that only DP-quantifiers can undergo QR is empirically supported by differences in scopal behavior between DPs and quantificational verbs. In this way, (65) provides an argument for the QR-analysis and against the functional analysis of (61-a).

That the relevant difference between (61) and (65) is the type of the bound variable receives further support when we look at world variable binding in examples not involving superlatives. Consider (69) in the following scenario (cf. (41)): John is renting a new apartment with the picture of a bookshelf painted on the wall. John believes it was a real bookshelf and that there is one book on the shelf. However, he is not certain which book it is: He thinks it could be Tolstoy's *War and Peace*, Dostoyevsky's *Crime and Punishment*, or Goncharov's *Oblomow*. I happen to be reading all three books right now.

(69)   #I'm reading the book John believes is in the apartment.

The presupposition violation in (69) can receive the same explanation as (65) and, for the functional analysis (69), is problematic in the same way as (65) is.

Note that initially it seems that QR into the matrix clause should create new options for variable binding. Consider, in particular, the matching structure again. It may seem that QR to a position outside of the relative clause in (69) should make the matching analysis shown in (69) possible, which would then predict that extraposition should be possible contrary to what we showed in section 2.

(69)   everybody λy [the[picture of y] [$\lambda x.$ y $\lambda y.$ y sent in the$_x$ picture of y]] annoyed
           the teacher

Note, however, that (69) violates the weak crossover condition, and is therefore expected to be ruled out. Consider furthermore examples like (70) that initially seem to involve

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binding of *his* by the QR-ed quantifier *everybody* challenging our weak crossover account of (69).

(70)   The picture of himself everybody sent in annoyed his mother.

But in (70), *his* can be analyzed as the E-type pronoun *the person on x*, where *x* is bound by the DP the picture of himself, similar to proposals for apparent binding in inverse linking constructions (Reinhart 1987, Büring 2004). Note that, for the matching structure (70), on the other hand, an E-type analysis of *himself* is not possible, because *himself* is contained in the *picture*-NP, and binding by the *picture*-NP of a position inside of itself is would violate the prohibition against i-within-i reference (Chomsky 1981).
We conclude, therefore, that at least raising relative clauses are not islands for quantifier raising of distributive universal DPs.

4. Conclusion

We have argued that English restrictive relative clauses are in many cases ambiguous between two different LF-structures: the raising and the matching structures. We have provided a detailed account of the interpretation of the raising structure in section 3, while a proposal for the semantics of the matching structure is made in Sauerland (2004). In particular, we argued in Section 3 that raising relatives are transparent for quantifier raising. This paper completes an account of English restrictive relative clauses, the other parts of which are the discussion of Condition C in (Sauerland 2002) and that of matching relative clauses in (Sauerland 2004).

We have discussed a number of factor that disambiguate the matching and raising ambiguity in one way or the other. On the one hand, three factors reliably force the raising structure: One factor is if there is a variable or anaphor in the relative clause head that is bound by a phrase within the relative clause. Secondly, low readings of adjectival modifiers, as we discussed in section 3, are another case of binding into the relative

clause head, but in addition require the adjective to be interpreted in an intermediate position in the relative clause. The third factor is when the relative clause head is part of an idiom, the other parts of which only occur inside of the relative clause. On the other hand, several factors force the matching analysis. We argued in section 2 that extraposition is expected to require the matching analysis if extraposition must be late adjunction of the relative clause as argued by Fox and Nissenbaum (2000). Further evidence for the matching analysis comes from the Condition C facts mentioned in (6) (Sauerland 2002), ellipsis licensing as discussed in (Sauerland 2004), and the cases with pied-piping in the relative clause Bhatt (2002) discusses.

The major prediction of this picture is that any example is ungrammatical that contains an element that requires the matching analysis, but also contains an element that requires the raising analysis. In section 2, we have demonstrated that this prediction is borne out in the interaction of extraposition with binding into the relative clause head, idiom-parts as the relative clause head, and low readings of adjectival modifiers. Sauerland (2002) demonstrates the same prediction using Condition C instead of extraposition to force the matching analysis. In sum, the matching and raising ambiguity is well supported for relative clauses.

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