Anaphoric Properties of *which* and the Syntax of Appositive Relatives

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Abstract

I discuss the unusual anaphoric behavior of the relative pronoun *which* and argue that it poses problems for available theories of the syntax of appositive relative clauses. I then propose a modification of de Vries' (2006) coordination analysis of appositive relatives and show that, in combination with a new lexical semantics for *which*, we can derive the observed behavior. An extension of the coordination analysis to restrictive relatives is also briefly discussed. Overall, the facts discussed here are most naturally analyzed using a head-external analysis of appositive relatives and restrictive relatives alike.

1 Introduction

This essay discusses the anaphoric behavior of English *which*, focusing on appositive relative clauses (ARCs). *Which* in ARCs displays the following behaviors which are unexpected on the available theories of the syntax of ARCs:

(i) *Which* need not be closely syntactically connected with its antecedent, or even in the same sentence;
(ii) Items of virtually any syntactic category can antecede *which* in an ARC;
(iii) *Which* may, but need not, be followed by an NP;
(iv) When present, this NP is usually, but not always, identical to the NP contained in the DP antecedent, if any;
(v) *Which* cannot be pragmatically controlled as ordinary pronouns can, but must have an overt antecedent.

The first three of these properties are shared with other anaphors in English; the fourth is not obviously relevant (though I will suggest that this property is shared as well), and the fifth property is a distinctive property of *which* with important theoretical repercussions.

I suggest that we can account for these five properties of *which* by adopting de Vries' (2006) coordination analysis of ARCs, but paying closer attention to the internal syntax of relatives and the syntax and lexical semantics of *which*. On the analysis I propose, *which* is a quantifier whose restriction is often (but crucially, not always) deleted or a silent noun THING, which explains the fact that *which* is obligatorily discourse-anaphoric. The availability of the same silent noun as a restrictor for the quantifier is shown to explain property (ii) as well.

This proposal is somewhat complicated by the appearance of *which* in restrictive relatives (RRCs). In the final section I give a brief analysis of RRCs showing that the same theory of the internal syntax of relative clauses and the quantificational treatment of *which* allows for a similar treatment of RRCs once

independently motivated facts about anaphora and quantification are taken into account.

2 The Empirical Challenge: Anaphoric Properties of English ARCs

This section discusses the anaphoric properties of relative pronouns in English ARCs. Several of these properties, and their Italian counterparts, are discussed in more detail in Cinque (2006). Together, these phenomena demand an explanation, but existing theories do not provide one, as I will show in section 3.

2.1 Intra- and Inter-Sentential Non-Adjacency

English ARCs can occur in positions in which RRCs cannot, as the contrast between (1) and (2) shows:

(1)   Only the flower is used, which is not poisonous and is attached to the plant with a very fine stem.

<div align="right">(Huddleston and Pullum 2002: 1066)</div>

(2)   *Only the flower is used that/which is not poisonous and is attached to the plant with a very fine stem.

ARCs can even have an antecedent in a previous sentence, as in (3), a phenomenon for which there is no restrictive counterpart.

(3)   Mary: John is skipping class again.
        Sue: Which is why I'm on my way to the principal's office.

This use of ARCs is often called the *relatif de liaison*. I will employ this term descriptively in what follows.

2.2 Non-Nominal Antecedents

In English, RRCs can generally have only nominal antecedents. ARCs, on the other hand, can apparently have antecedents of virtually any category:

(4)   a. Jim is drunk all the time, which is probably how you'd like to be. (AP)
        b. Bill came late, which bothered Susan. (IP)
        c. Bill went into the tree, which is where I'd like to go too. (PP)
        d. Bill said that he would leave, which I said too. (CP)
        e. Bill came late, which Susan did too. (VP)

<div align="right">(Examples (a-c) from Jackendoff 1977: 175)</div>

RRCs cannot be anteceded by non-nominal categories – for instance by APs, as in (5) – even though there is no incoherence in what (5) is trying to express, as (6) shows.

(5)   *Jim is happy that you'd like to be.
(6)   Jim is the kind of happy that you'd like to be – He's drunk.

2.3. Internal NPs

It is possible, especially in archaic and formal English, for an ARC to have an internal NP in addition to the NP in its antecedent. The internal NP may or may not be identical to the NP in the antecedent (when there is one).

(7)   He rode twenty miles to see her picture of **a stranger, which stranger** politely insisted on his acceptance of it.

(Jespersen 1949: 126; cited in Cinque 2006)

(8)   Mark belongs to **the Knights of Columbus, which organization** has been condemned by the Jewish Defense League.

(McCawley 1981: 118)

In addition to formal styles in modern English, this construction is encountered frequently in older forms of English. For example, in (9-10), the internal NP refers to an event or action which is described in the previous sentence, but not referred to by any overt NP or DP.

(9)   Your highness, lately sending into France,
        Did claim some certain dukedoms, in the right
        Of your great predecessor, King Edward the Third.
        In answer of which claim, the prince our master
        Says that you savour too much of your youth …

(Shakespeare, *Henry V* Act 1, Scene 2)

The NP *claim* in (9) picks up the action described by the VP *did claim some certain dukedoms* in the previous sentence. The internal NP can be even more removed from its" antecedent" that this, as (10) shows:

(10)   *Lepidus*: To-morrow, Caesar,
        I shall be furnish'd to inform you rightly
        Both what by sea and land I can be able
        To front this present time.

        Octavius. **Till which encounter**,
        It is my business too. Farewell.

(Shakespeare, *Anthony & Cleopatra* Act 1, Scene 4)

In (10), the ARC-internal NP *encounter* does not pick up any explicit feature of the previous sentence, but describes an event which is a precondition for the event described in the previous sentence (i.e., in order for Lepidus to inform Octavius about military intelligence there must be an encounter between them).

Since examples (7-10) are not completely natural in modern English, it may be tempting to set them aside. However, given the many other similarities between formal and archaic English and our own, their existence suggests that it may be

fruitful to look for evidence of internal NPs in modern English ARCs as well. I will argue in the following that the facts considered here, taken together, suggest an analysis along these lines.

2.4. ARCs, Pronouns, and Demonstratives Compared

A number of authors (e.g., Jackendoff 1977, Emonds 1979, Sells 1986, Cinque 2006) have expressed the intuition that the relationship between an English ARC and its antecedent is one of "discourse anaphora". These authors are not always consistent, or even clear, in what they mean by this, but this intuition does seem to capture an important set of facts about English ARCs. In particular, the properties of English ARCs described in 2.1-2.4 are all shared by pronouns and demonstratives.

Pronouns obviously share the property of intra- and inter-sentential non-adjacency (property 2.1):

(11)   a. John wants us to visit him.
        b. John left. He seemed angry.

As for non-nominal antecedents (property 2.2), Jackendoff (1977: 175) notes that "relative pronouns in appositives can be anaphoric to the same constituents as ordinary demonstrative pronouns can". Compare (4) to (12):

(12)   a. Jim is drunk all the time – that is probably how you'd like to be. (AP)
        b. Bill came late. That bothered Susan. (IP)
        c. Bill went into the tree. That is where I'd like to go too. (PP)
        d. Bill said that we should leave. I said that too. (CP)
        e. Bill came late. Susan did that too. (VP)

Not only demonstrative pronouns, but also ordinary pronouns, can have antecedents of category PP, CP, IP, AP, and VP:

(13)   a. I know that you want to be happy so be it. (AP)[1]
        b. Bill came late. It really bothered Susan. (IP)
        c. Bill went into the tree, and it's where I'd like to go too. (PP)
        d. Bill said that we would win, and I said it myself, but we were wrong. (CP)
        e. Bill insulted Mary, and Susan did it too. (VP)

Finally, demonstrative pronouns can be followed by an NP in a way strongly reminiscent of the "internal head" phenomenon (property 2.3).

(14)   I served muffins$_i$, and Mary served scones$_j$. We bought [that food]$_{i+j}$ at Harrods.

Here demonstratives and pronouns seem to part ways: it is not possible for a pronoun in English to be followed by an overt NP.

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[1] http://answers.yahoo.com/question/index?qid=20080310121352AA2I9DQ

(15)   I served muffins$_i$, and Mary served scones$_j$. *We bought [it food]$_{i+j}$ at Harrods.

However, Postal (1966) and Elbourne (2005) have argued that pronouns are determiners, and that they do in fact have an NP complement, roughly as in (16):

(16)   I served muffins$_i$, and Mary served scones$_j$. We bought [it NP$_{\emptyset}$]$_{i+j}$ at Harrods.

According to these authors, the ungrammaticality of (15) is a morphological phenomenon, caused by the fact that the definite determiner must be spelled out as *the* when it has an overt complement. If this is correct, (15) is possible, but it must be realized as (17):

(17)   I served muffins$_i$, and Mary served scones$_j$. We bought [the food]$_{i+j}$ at Harrods.

In other words, if we adopt the Postal-Elbourne theory of pronouns, then pronouns too have something akin to the "internal head" phenomenon in English ARCs. Thus, each of the properties in 2.1-2.3 which distinguish ARCs and RRCs in English is shared by both demonstratives and ordinary pronouns in English.

2.5. Surface-Anaphoric Properties of ARCs
        Another point of contact between ARCs and the theory of anaphora in general is that ARCs share many of the characteristics of what Hankamer and Sag (1976) dub "surface anaphors", which require overt linguistic antecedents. Hankamer and Sag contrast these with "deep anaphors", which can be rendered felicitous by non-linguistic events or objects. (Note that I am using Hankamer and Sag's terminology descriptively, without assuming any particular theory of the contrast they note.) Hankamer and Sag illustrate these phenomena with the following examples:

(18)   [Hankamer attempts to stuff a nine-inch ball through a six-inch hoop]
        Sag: It's not clear that you'll be able to do it.

(19)   [Same context]
        Sag: # It's not clear that you'll be able to.

(20)   [Same context]
        Hankamer: I'm going to stuff this ball through this hoop.
        Sag: It's not clear that you'll be able to.

According to Hankamer and Sag, the contrast in (18-20) is explained by the fact that VP deletion is only possible in the presence of an overt linguistic antecedent, while *do it*-anaphora is possible also in the presence of a pragmatic (environmental) cue.
        Another phenomenon requiring an overt linguistic antecedent is stripping, "a rule that deletes everything in a clause under identity with corresponding parts of the

preceding clause, except for one constituent (and sometimes a clause-initial adverb or negative)”:

(21)   Hankamer: Listen, Ivan, he's playing the *William Tell Overture* on the recorder.
        Sag: Yeah, but not very well.

(22)   [Sag plays *William Tell Overture* on a recorder]
        Hankamer: #But not very well.

Like VP-deletion and stripping, *which*-ARCs are infelicitous when they do not have an overt antecedent. Recall the example of cross-sentential *which* above:

(23)   Mary: John is skipping class again.
        Sue: Which is why I'm on my way to the principal's office.

This dialogue is also fine with *that* or *and that*:

(24)   Mary: John is skipping class again.
        Sue: (And) that's why I'm on my way to the principal's office.

That is also possible when there is no overt linguistic antecedent, but *which* is completely impossible:

(25)   [Mary and Sue, between classes, watch John leave school and get in his car. Sue points at John and says:]
        Sue: *Which is why I'm on my way to the principal's office.

This is a major point of difference between ARCs vs. demonstratives and pronouns, which, as we saw in section 2.4, otherwise behave similarly in a number of ways. The fact that cross-sentential *which* can usually be paraphrased by *that* or *and that* is natural if, in Hankamer and Sag's (1976) descriptive terms, *that* is a deep anaphor and *which* is a surface anaphor. As Hankamer and Sag note, deep anaphors can be 'controlled' by either the linguistic or the pragmatic context, while surface anaphors require a linguistic antecedent. Thus, a surface anaphor can generally be replaced by a functionally similar deep anaphor, but the reverse is not true: just as *do it* cannot be omitted without a preceding linguistic context, as we saw above, (*and*) *that* cannot be replaced by *which* in the following example, where it lacks an overt linguistic antecedent:

(26)   [At the end of a performance]
        Announcer: (And) that's all, folks!

(27)   [At the end of a performance]
        Announcer: #Which is all, folks!

That is to say, the fact that cross-sentential *which* can usually be paraphrased by *(and) that* does not indicate that they are the same item, but only that the contexts in which *which* is possible are a subset of those in which *(and) that* is possible. *That,* when it does not modify an overt noun, is a deep anaphor, and *which* is a surface anaphor, however we cash out this distinction theoretically.

3   Appositive Relatives: Existing proposals

3.1. Right-Adjunction

Jackendoff (1977) takes English relative clauses to be right-adjuncts, with ARCs and RRCs as NP and N′ adjuncts, respectively. In modern incarnations of Jackendoff's theory this translates to DP- and NP-adjunction (e.g. Heim and Kratzer 1998). Jackendoff accounts for the anaphoric properties of ARCs by stipulating that the relative pronoun of an ARC is coreferential with the DP it modifies.

Jackendoff's proposal accounts for some properties of ARCs, including scope differences between ARCs and RRCs and the ordering restrictions illustrated in (28):

(28)   a. The man that came to dinner, who was drunk, fainted.
       b. *The man, who was drunk, that came to dinner fainted.

However, Jackendoff's proposal suffers from several weaknesses. First, it relies on pure stipulation to derive the obligatory coreference between a relative pronoun and its antecedent. Thus there is no explanatory account of why (29) is impossible:

(29)   *Bill$_i$ was talking to John$_k$, who$_i$ left for Kansas yesterday, about the election.

Furthermore, Jackendoff's theory makes crucial use of right-adjunction, which has come to be viewed as theoretically suspect. In particular, recent approaches such as Kayne (1994) and Baker (2002) have attempted to derive linear order from syntactic constituency, either in combination with ordering rules which can vary parametrically (Baker) or directly from c-command (Kayne's Linear Correspondence Axiom (LCA))). The fact that ARCs always follow their antecedent in English is simply stipulated by Jackendoff's theory.

Finally, Jackendoff's theory does not explain why ARCs can only be anaphoric to an overt antecedent, in contrast to ordinary pronouns.

3.2. The main clause hypothesis

A quite different approach to ARCs is pursued in various ways by Ross (1967), Emonds (1979), and Safir (1986). These theories propose, in various ways, that ARCs are underlyingly main clauses which are conjoined to the clause containing their antecedent at some later level (S-structure, LF′, etc.), much like parenthetical clauses. This proposal captures the fact that ARCs are in some sense semantically independent of the clause in which they are contained, and that they can often be paraphrased by a separate sentence with a pronoun. Compare (30) to (28a):

(30)   The man that came to dinner fainted. He was drunk.

This type of theory allows for the features which relative pronouns have in common with ordinary pronouns and demonstratives – in particular, non-nominal antecedents and (if the Postal/Elbourne theory of pronouns is adopted) internal heads. However, it does not offer a clear account of why the pronoun *he* in (30) surfaces as *who* when its clause is relativized, except as a stipulative rewrite rule. Also, like Jackendoff's (1977) theory, it fails to explain why relative pronouns require an overt linguistic antecedent, which is optional with ordinary pronouns. Furthermore, there is no obvious explanation of why ARCs are attached where they are. The *relatif de liaison* is relatively easy to explain – or rather, there is nothing to explain, since the following clause simply remains in its base position – but there is no explanation of why ARCs appear so often immediately following their antecedents. A possible response is that adjacency is necessary to enforce coreference, but this response simply reverses the direction of the problem: there is no explanation of the *relatif de liaison*, where the ARC is often separated by a considerable distance from its antecedent.

Finally, if ARCs are like parenthetical clauses then we might expect that ARCs can appear anywhere that parentheticals can, contrary to fact. An ARC cannot intervene between a RRC and its antecedent, but a parenthetical can:

(31)   a. *The man, who was drunk, that came to dinner fainted.
        b. The man, as you know, that came to dinner fainted.

3.3. The Head-Raising Theory

Elaborating a proposal by Vergnaud (1974), Kayne (1994) proposes an LCA-compatible alternative to the right-adjunction theory of RRCs, under which RRCs consist not of a D-NP-CP sequence as is normally assumed, but a D-CP sequence, where D selects CP, and the linear adjacency of D and NP is the product of movement of NP to Spec,CP.

(32) $[_{DP} D [_{CP} NP_i [_{C'} (C) [_{IP} ... t_i ...]]]]$

As for ARCs, Kayne (1994, p.111) proposes that "restrictives and nonrestrictives differ at LF but do not differ structurally in the overt syntax". He accounts for differences in determiner scope between ARCs and RRCs by suggesting that, in ARCs, the IP moves to Spec,DP at LF. The trigger for this movement is an unidentified feature that is realized phonologically in English as the intonational break marking off ARCs (Kayne 1994, p.112).

Kayne's proposal, supplemented with some refinements in Bianchi (1999, 2000), accounts for many phenomena involving RRCs and has been widely accepted. However, Kayne's proposal that RRCs and ARCs differ only at LF has been criticized for several reasons. First, the LF-raising proposal has been criticized as being essentially stipulative, even by those who accept the head-raising analysis of RRCs (cf. discussion in de Vries 2002, 2003, 2006). Second, Kayne himself (1998) has proposed eliminating covert movement, a position which is incompatible with his

earlier proposal on ARCs. Third, Kayne's proposal gets the prosodic facts wrong. As Bianchi (2002) notes, since IP is the constituent with the feature triggering covert movement, Kayne's analysis predicts that the intonational break in ARCs should be after the relative pronoun rather than before:

(33)   *All the painters who, used lead-based paint(,) got sick.

Furthermore, as Borsley (1997) points out, it is difficult to imagine how a head-raising analysis could explain the possibility of ARCs modifying CPs, VPs, IPs, PPs, and APs, as we saw in (4), section 2.2. For example, (34a) illustrates a head-raising analysis of an ARC "modifying" a DP, and (34c) is an attempted derivation along the same lines of an ARC "modifying" an IP:

(34)   a. John likes cookies$_i$, which t$_i$ I like t$_i$ too.
          b. I like cookies too.
          c. [John came late]$_i$, which t$_i$ I wasn't happy about t$_i$.
          d. *I wasn't happy about John came late.

The fact that (34d) is impossible suggests that the derivation of the ARC in (34c) is incorrect. The head-raising theory has similar problems with non-matching internal and external NPs and *relatives de liaison* (2.1).

Bianchi (2000), in a reply defending the head-raising analysis, suggests that the examples of non-nominal antecedents in (4), and the *relatives de liaison* in section 2.1, are not really relative clauses. However, she does not provide any alternative theory of what they are, or why they are so similar to relative clauses morphologically and in their internal syntax. The default assumption, it seems tome, is that the various types of ARCs are maximally similar. I will attempt to provide a theory in section 4 that gives a unified account of "ordinary" ARCs, ARCs with nonmatching NPs, and *relatives de liaison*.

I conclude that, even if the head-raising analysis is correct for RRCs, it does not provide a sufficient account of English ARCs.

3.4. Coordination

De Vries (2006), elaborating a proposal by Koster (2000), accepts the head-raising analysis for RRCs but argues that ARCs are similar to the nominal appositive constructions in (35):

(35)   a. My brother, Bill, left today.
          b. Jim, an utter fool, can't figure out how to use the computer.

De Vries notes that certain nominal appositives are matched by very similar constructions which have overt material between the phrases in apposition[2]:

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[2]It is admittedly unclear whether the constructions in (36) are best analyzed as being like (35), with two DPs in an appositive relationship, or like (i), which could be seen as a sort of correction.
          (i)   a. My brother, that is, Bill, …

(36)   a. the White House, (or) the house with the Oval Office
        b. Bill, (or) the best damn guitarist in town, …

De Vries suggests that (35) and (36) can be captured if we assume that there is, in addition to conjunction and disjunction, a third type of coordination, 'specifying' coordination, which requires that the second coordinate add information to the first (nonrestrictively). De Vries adopts Kayne's (1994) asymmetric structure for coordination, in which the head of the phrase is the coordination marker itself and the coordinates are its specifier and complement.

(37)   a. [CoP XP [Co' Co YP]]
        b. [CoP [DP the White House] [Co' or/ø [DP the house with the Oval Office]]]

The final piece of the puzzle is that, at least in English, it is possible to attach a restrictive relative to a pronoun and use the resulting DP as a nominal appositive, resulting in a 'false free relative':

(38)   Mary, (or) she who is our friend

(38) is stilted, but it is grammatical. De Vries suggests that the similarities between nominal appositives and ARCs noted above can be captured if we treat ARCs as being an appositive structure consisting of a DP and a false free relative whose head is a null pronoun:

(39)   [CoP DP [Co' Co [DP pro [DP *wh-* …]]

(40)   a. Mary, who is our friend
        b. [CoP [DP Mary] [Co' Co [DP pro$_k$ [CP who$_k$ [IP t$_k$ is our friend]]

De Vries shows that, if we assume the head-raising analysis for RRCs, this structure accounts for many of the differences between RRCs and ARCs.
        The coordination theory of ARCs appears quite promising in several respects. Like Jackendoff's (1977) theory, de Vries (2006) derives differences between ARCs and RRCs with respect to determiner scope by assuming that ARCs and RRCs are attached at DP and NP, respectively, and he manages to do this while remaining compatible with the LCA. In addition, the phenomenon of *relatif de liaison* can be unified with the broader phenomenon of cross-sentential coordination:

(41)   Mary: John is skipping class again.
        Sue: And I'm on my way to the principal's office.

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                b. The plumber, namely John, …
For instance, (ia) would be appropriate if the speaker were to realize that the uniqueness presupposition of *my brother* was not satisfied, and added *that is, Bill,* to make clear who was being referred to.

(42)   Mary: John is skipping class again.
       Sue: Which is why I'm on my way to the principal's office. (=(3))

The coordination analysis of ARCs makes it possible to ascribe the availability of cross-sentential and cross-speaker ARCs in (42) to whatever independent factors allow cross-sentential and cross-speaker conjunction in (41).

Furthermore, since the head of the second coordinate is a pronoun, we expect some connection between ARCs and anaphora in general. According to de Vries, the obligatory coreference between the relative pronoun and its antecedent is due to the semantics of the coordinating head: an ARC and its antecedent are underlyingly in a specifying coordination relationship, by virtue of which they are obligatorily coreferential.

On this theory, the relative pronoun itself does not have any special status. However, de Vries' theory encounters several empirical problems. First, the "surface-anaphoric" properties of ARCs (2.6) cannot be explained simply by the lexical semantics of the coordinating head *Co*. The reason is that *which* is not an ordinary pronoun: as we have seen, it cannot pick up its reference from any salient object, but requires a specifically *linguistic* antecedent.

(43)   [Mary and Sue, between classes, watch John leave school and get in his car. Sue points at John and says:]

       Sue: That/*Which is why I'm on my way to the principal's office.

(44)   [At the end of a performance]

       Announcer: That/*which is all, folks!

On de Vries' theory an ARC is simply the second member of a coordination, and it should be able to occur outside of a coordination context, as the two members of a conjunction generally can. So, if *which* is just a pronoun, we should expect (ceteris paribus) that it can occur where other pronouns can. But while *that* in these examples can easily pick up its reference pragmatically, *which* cannot: it needs a discourse antecedent.

De Vries' explanation for the surface-anaphoric properties of *which* in other cases rested on the semantics of the coordinating head *Co;* thus he predicts that if *Co* is not present then the reference of the ARC should be as free as that of ordinary pronouns. But this explanation of the obligatory coreference of a relative pronoun and its antecedent in run-of-the-mill ARCs cannot extend to these examples. *Which* must be special in someway, in addition to the fact that it often occurs in such coordination structures.

The coordination theory, like the others we have examined, also stumbles on the phenomenon of non-nominal antecedents (2.2). For instance, an ARC can modify a VP as in (4b), to which de Vries' theory would presumably assign the representation in (45a).However, a VP and a DP cannot be coordinated using *and* or *or*:

(45)   a. Bill [CoP [VP came late]i, *Co* [DP pro [CP whichi Susan did ti too.]]].
         b. *John saw [[DP Mary] and [VP building the wall]].
         c. * John saw [[DP Mary] or [VP building the wall]].

Finally, the existence of internal heads, while not a problem for de Vries per se, needs explaining within his theory. Since he does not give a detailed theory of how the anaphoric connection between an antecedent and the *which*-phrase, it is not clear how, as in example (8), *the Knights of Columbus* and *which organization* are connected.

        To sum up, this section has discussed four influential analyses of ARCs, each of which has various difficulties in accounting for the phenomena described in section 2. In the following section I will outline an account of ARCs which combines elements of several of these theories. This allows us to explain the "surface-anaphoric" properties of relative pronouns while retaining the insights of de Vries' coordination theory.

4   ARCs, Coordination, and NP-deletion

Of the four theories discussed in section 3, the closest to the analysis that I suggest is de Vries' (2006) coordination analysis. Although it has problems, I will suggest that the difficulties lie not in the notion that ARCs are coordinated with their antecedents, but in the details of the implementation. Specifically, I argue contra de Vries that *which* is actually a special type of quantifier. This explains the similarities between *which*-phrases and surface-anaphors, and the further issue of why internal heads are possible only when they are at least partly coextensive – but not necessarily identical! –with the initial conjunct. Furthermore, I claim that "internal heads" are not special, but that ARCs always have internal heads: that is, the quantifier *which* takes two arguments of type $<e,t>$, but the first is often either deleted or silent. Finally, I suggest an analysis of non-nominal antecedents in light of the prior discussion.

4.1. Surface anaphora and the lexical semantics of which
        ARCs differ from both pronouns and definite descriptions in that they must have a linguistic antecedent. A pronoun or a definite description can refer to a previously mentioned object or to any sufficiently salient object to which unique reference is possible. Heim (1982) calls this the 'familiarity condition'. As Heim also shows, *a* displays the further peculiarity of being obligatorily associated with a new discourse referent (the 'novelty condition'), as (46) shows:

(46)   [A man]i walked into the room. #Then [a man]i went out of the room.

This difference between *the* and *a* can be treated in one of the many varieties of dynamic semantics following Heim (1982) and Kamp (1982) which treat quantification as involving manipulation of variable assignments and/or sets of discourse referents. For example, Heim explains the oddness of (46) by stipulating that *a NP* must modify the existing variable assignment to introduce a new variable. In contrast, *the NP* must refer to a familiar object, whether its familiarity is due to

explicit mention or to pragmatic salience. This is meant to explain why (47) is acceptable:

(47) [A man]ᵢ walked into the room. Then [the man]ᵢ went out of the room.

I will suggest that the "surface-anaphoric" properties of *which* can be explained by treating it as, in some sense, the converse of *a*: as a lexical semantic property, *which NP* is unable to introduce a new discourse referent, but must pick up an existing discourse referent. Because of the complexity of the semantic frameworks involved, my presentation here must be relatively informal; but a requirement of this type can be implemented in a semantic theory that allows items to explicitly manipulate variable assignments, e.g. Muskens' (1996) Compositional Discourse Representation Theory (CDRT). The crucial point of the theory for our purposes is that it treats sentence meanings as functions from a set of variable assignments to another set of variable assignments. The sentence functions as a "test" on incoming variable assignments, so that the denotation of a sentence is typically a condition which incoming variable assignments must meet in order to "pass through". A discourse is viewed as a process of eliminating assignments as being representative of the actual world, roughly as described in Stalnaker (1978) and Heim (1982).

The surface-anaphoric properties of *which* are accounted for if *which* quantifies over the variable assignments which may satisfy its arguments. I cannot state the precise formulation of this lexical entry in CDRT without an excessive detour, but the conditions that *which* places on objects which may satisfy its arguments is very roughly this:

(48) [|*which*|] = λPλQλx . P(x) & Q(x) & x is in the set of incoming discourse referents

There are various problems with this informal version: in particular, "discourse referent" is not a primitive notion in CDRT, but must be defined in terms of properties of sets of variable assignments. Nevertheless, the intuitive notion should be sufficient for present purposes. See footnote 3 for some technical details, including a refinement necessary for the treatment of quantified RRCs in section 5.[3]

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[3]Axiom 1 of CDRT (Muskens 1996, p.156) states that every object can occur in every position in some sequence of variables (states, in Muskens' terminology). As a result the initial set of variable assignments is very large (but most assignments are discarded once a sentence is uttered). We can reconstruct the notion of "discourse referent" in CDRT by ignoring any position in a sequence that displays the full range of variation: that is, if the set of assignments relevant to the discourse is such that a position *n* is filled by every object in some assignment, it follows that the discourse has not made use of that position to narrow down the set of assignments in any way (since, if it had, some variable assignments would have been eliminated, and there would be some object which did not occur in some position in some assignment).

We can thus state the condition in (48) more precisely. Take *i,j* to be variables ranging over assignments/states and *u* to be a variable ranging over individuals. $i(u_n)$ picks out the *n*th member of the assignment *i*, and $i[u_n]j$ means that *i* and *j* differ at most in the value of u_n.

(i)   [|*which*|] = λPλQλx . P(x) & Q(x) & ∀i∀n[x = i(u_n) iff ∃y(¬∃j(i[u_n]j & j(u_n) = y))]

An alternative approach to the problem of ensuring that *which* has a linguistic antecedent is to follow the suggestion of Lewis (1972) that among the several context parameters is a "discourse" parameter, which resolves the interpretation of phrases such as "the aforementioned man". On this approach we might treat "Max, who is my brother" as something like "Max, and the aforementioned Max is my brother". I will not choose this route for two reasons: first, the precise nature of the discourse parameter is unclear; and second, I suspect that it would not work for quantified RRCs.

Thus I take (48), with the clarifications in footnote 3, to give the basic meaning of "which". Note that this is not intended as a final theory; CDRT is complex and no doubt problematic, and I use it simply because it is capable of expressing the requirement that *which* cannot be used without an overt discourse antecedent, in contrast to ordinary pronouns. Another semantic theory would do just as well if it is capable of expressing this requirement.

4.2. NP-Deletion and "Internal Heads"

The lexical entry for *which* in (48) requires that *which* take two arguments of type *<e,t>*. However, in most cases, only one argument is visible: the relative CP. I suggest that, in most cases, the first argument – an NP – is deleted under identity with some previous NP. NP-deletion in quantifier phrases is common, as (49) shows:

(49)   a. Sue only bought two books, but Mary bought **at least three**.
        b. Most movies bore Mary, but she does like **some.**
        c. Most MIT students build robots, and **all** watch *Star Trek*.

(Elbourne 2005: 45)

My suggestion is that a sentence such as (50a) contains a similarly deleted NP:

(50)   a. I saw John's book, which you were looking for.
        b. I saw John's book, which ~~book~~ you were looking for.

If this is correct, then the problem of "internal heads" evaporates. Examples such as (7-10) are unusual only in that the internal NP is not deleted, whether because of the formal style (7); because the two are not identical, and so syntactic deletion is not licensed (8); or because there is no overt NP in the antecedent (9-10).

We may wish to pursue a different strategy with regard to the relative words *who, where* etc., though. I will deal exclusively with *who* here, since the fact that *where, how, why*, etc. behave as PPs introduces extraneous difficulties. We could treat

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In words, (i) says that the incoming set of variable assignments must be such that not every object occurs in every position, and for every assignment *i*, x is the *n*th member of *i* iff there is some object y that does not occur as the *n*th member of any assignment. This ensures that the discourse has placed some requirements on what sort of objects can occupy the *n*th position of a sequence, i.e. that position *n* is being "used" already. Note that it would not have been sufficient to stipulate that the *same* object occupy x's position (as the "discourse referent" notion may seem to suggest), since this would not allow for quantified cases discussed below.

who as a morphological variant of *which* appearing when the following NP is [+animate]. On this analysis, (52) has the analysis in (53).

(52)   The painters, who used lead-based paint, got sick.

(53)   The painters, who ~~painters~~ used lead-based paint, got sick.

It also seems possible, however, that *who* is bimorphemic and spells out *which PERSON(S)*, as suggested in Jackendoff (1977: 174):

(54)   The painters, which PERSONS used lead-based paint, got sick.

I will adopt Jackendoff's suggestion, although nothing vital hinges on it.

        With this in mind, we can relate the proposed denotation for *which* to the syntactic structure of the relative CP. The quantifier phrase headed by *which* moves to the specifier position of the relative CP. *Which* takes the "internal NP" as its first argument, and the remainder of the CP as its second argument; it follows that relative CPs have the syntactic structure in (55).

(55)   [$_{CP}$ [$_{QP}$ which PERSONS]$_k$ λ$_k$ C$_ø$ [$_{IP}$ t$_k$ used lead-based paint]]

Which takes as its first argument *PERSONS,* i.e. [λx . **person**(x)]. Its second argument is the sister of the QP with the variable *k* abstracted, i.e. [λx . **used**(**lead-based paint**)(x)]. The quantifier returns the set of individuals who are persons, used lead-based paint, and have been mentioned previously in discourse, in accordance with (i) in fn. 3. Note that, at the level of CP, the relative clause denotes an object of type <*e,t*>. Of course this cannot be coordinated with a DP of type *e*; the following section addresses this problem.

4.3. Coordination and Pronouns

        Suppose that ARCs which appear immediately adjacent to their antecedent DP are indeed appositives along the lines of de Vries' (2006) theory, which was described in section 3.4. De Vries' proposal was given in (40) and is repeated as (56). Crucially, de Vries argued that ARCs are DPs with *false free relatives* in apposition, i.e. that they have a silent pronoun heading the second coordinate:

(56)   a. Mary, (she) who is our friend
        b. [$_{CoP}$ [$_{DP}$ Mary] [$_{Co'}$ Co [$_{DP}$ pro$_k$ [$_{CP}$ who$_k$ C$_ø$ [$_{IP}$ t$_k$ is our friend]]]]]

Now, there is some reason to think that pronouns are definite determiners (Postal 1966; Elbourne 2005). If we adopt this approach – and I will, since, in addition to Elbourne's many arguments in favor of the hypothesis, it makes the right predictions here – the silent pronoun in (56b) can be treated instead as a silent determiner.

(57)   [$_{CoP}$ [$_{DP}$ Mary] [$_{Co'}$ Co

[DP THE [CP [which PERSON]$_k$ λ_k C$_\emptyset$ [IP t$_k$ is our friend]]]]]

Semantically, the determiner heading the second coordinate resolves the problem noted at the end of the last section because it converts a property (type $<e,t>$) into an individual (type e). Since *Mary* is of type e, this makes it possible for *Mary* and *who is our friend* to be coordinated by *Co*.[4] Note that *THE* is sometimes overt in ARCs in archaic and formal English.[5]

Incorporating Jackendoff's proposal that *who* is bimorphemic, we arrive at the representation in (58):

(58)   [CoP [DP Mary] [Co' Co
            [DP THE [CP [DP which PERSON]$_k$ λ_k C$_\emptyset$ [IP t$_k$ is our friend]]]]

Similarly, the updated version of de Vries' proposal given here yields a representation of(51), with non-matching internal and external heads, with the desired properties.

(59)   a. the Knights of Columbus, which organization has been condemned by the Jewish Defense League
        b. [CoP [DP the Knights of Columbus]]] Co
            [DP THE [CP [DP which organization]$_k$ λ_k C$_\emptyset$ [IP t$_k$ has been …]

(59a) is problematic for both Kayne's and de Vries' original theories. However, by modifying de Vries' coordination analysis of ARCs with the treatment of *which* as a quantifier taking two arguments as suggested above, the current theory explains the possibility of non-matching internal and external heads – indeed, predicts that this phenomenon should exist.

The remaining ingredient is an explicit denotation for *Co*. More or less following Potts (2005), I suggest that *Co* is a function taking two arguments of type e and returning the second intact, on the condition that the two arguments are equivalent:

(60)   [|*Co*|] = $\lambda x \lambda y [x=y: y]$

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[4]See de Vries (2006) for syntactic arguments that a pronoun is present here. The reader may also, if she wishes, think of THE here as Partee's (1986) iota typeshifter, invoked to repair what would otherwise be a type-mismatch.

[5] Frequently in Shakespeare, for example in *Henry IV* (Act 5 Scene 1):

(i)   The better part of valour is discretion; in **the which better part** I have saved my life.

Neil Myler also points me to an instance of *the which* in an ARC in Lewis Carroll's poem "The Hunting of the Snark":

(ii)   We have sailed many weeks, we have sailed many days,
        (Seven days to the week I allow),
        But a Snark, **on the which** we might lovingly gaze,
        We have never beheld till now!

We can see that this denotation for the *Co* head, in combination with the syntax and semantics I gave above for relative CPs, yields the correct result: (59a) will turn out to be felicitous only if the Knights of Columbus is an organization and has been condemned by the Jewish Defense League and has been previously mentioned. The latter condition, of course, is trivially satisfied, since the Knights of Columbus just has been mentioned. If (59a) is felicitous, then by (60) it denotes the Knights of Columbus.[6]

4.4. Non-Adjacency

    Within a coordination theory of ARCs, the explanation for the fact that ARCs can be separated from their antecedents, sometimes by considerable distances (property 2.1),is naturally explained as a general fact about coordination. Koster (2000), in particular, discusses the similarities between coordinate extraposition and extraposition of ARCs at length. As I noted in section 3.4 above, cross-sentential *which* is no more (or less) of a mystery than sentence-initial conjunctions like *and, but,* and *or* on such a theory:

(61)   Mary: John is skipping class again.
        Sue: Which is why I'm on my way to the principal's office. (=(48))

(62)   Mary: John is skipping class again.
        Sue: And I'm on my way to the principal's office. (=(49))

(63)   Jim: We should go to a movie.
        Sue: Or maybe to a play.

I will not give a detailed typology, but refer the reader to Koster (2000) for extensive discussion and evidence that ARCs, *and*, and *or* behave similarly with respect to extraposition of this type in both Dutch and English.

4.5. Non-nominal antecedents

    The fact that ARCs can modify non-nominal antecedents can also be explained on the present theory as a subcase of a larger problem, this time in the theory of anaphora and semantic types. As noted above, not just relative pronouns, but also ordinary pronouns and demonstratives, can resume non-nominal antecedents (64). To this we can add indefinite pronouns like *something* (65), as well as *cosa* 'thing' in Italian (66):

(64)   a. I know that you want to be happy, so be it. (=(13a))
        b. Bill came late. It really bothered Susan. (=(13b))
        c. Bill said he hated me. Did you say that too?

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[6]Potts (2005) argues that the condition that $x=y$ not a presupposition, but a conventional implicature. I think this is correct, but it does not matter for our purposes.

(65)   a. Bill came late, something which really bothered Susan.
         b. You want to be happy, something you never will be.

(66)   Carlo lavora troppa poco. Cosa   che verrà   certamente notate.
         Carlo works too   little. Thing that will be certainly   noticed
         "Carlo works too little, which will certainly be noticed." (Cinque 2006)

Potts (2002) discusses the syntactic behavior of ARCs modifying IPs in English, showing that they behave like individuals in various ways. For example, as Szabolcsi and Zwarts (1993) have noted, individual-denoting expressions can often escape islands that expressions of other types cannot (67a-b). Potts shows that expressions that denote propositions can typically escape these islands as well (67c):

(67)   a. John hates avocados, which I had been wondering whether he liked.
         b. *John comes from Atlanta, where I had been wondering whether he was born.
         c. John called the bartender a fool, which I had been wondering whether Bill knew.

In addition, proposition-denoting expressions can be equated with individual-denoting expressions in English:

(68)   The problem is that John won't come.

If *is* in (68) is an equative which requires that its arguments be of the same semantic type, as Heycock and Kroch (1999) argue in detail, (68) should be illicit on the assumption that *the problem* is of type *e* and *that John won't come* is of type *t*.
        Potts suggests that the facts in (67-68) are explained if *that John won't come* in (68) is a nominalized proposition, as in the theory of Chierchia (1984, 1998). A nominalized proposition is an individual, and so we expect it to behave as an individual with respect to equatives and selective islands, as it does in (67-68). Chierchia's theory also contains a type-shifting function that nominalizes properties. This is useful to us because ARCs picking up VPs and APs can also escape selective islands:

(69)   a. John called the bartender a fool, which I had been wondering whether he would.
         b. John was happy, which I had been wondering whether he would be.

If the nominalizing type-shifter is available in coordination contexts, under the present theory an ARC should be able to modify anything which can be nominalized. This seems to be correct if we compare (69) to (70), where a DP and a CP are coordinated.

(70)   a. John's departure, and that the food had all run out, really upset Mary.
         b. Did you say that you were leaving, or something else?

Since CPs and DPs can be coordinated using *and* and *or* as shown in (70), Potts' approach to non-nominal antecedents seems plausible within the coordination theory of ARCs. It remains to be seen whether it can be extended to all cases on non-nominal antecedents. For instance, VPs pass the island-sensitivity test (69) but fail the coordination test (71):

(71)   *John saw [[$_{DP}$ Mary] and [$_{VP}$ call the bartender a fool]].

This problem merits further investigation. Nevertheless, this approach seems promising.

A significant drawback of the current analysis, it may seem, is that accounting for ARCs with non-nominal antecedents forces us to include not only objects of type *e*, but anything that can be nominalized, in the variable assignment (or whatever other method of conversational scorekeeping we adopt). This seems to be necessary if, as I have argued, *which* always has an NP-complement. But the resulting representation is strange:

(72)   John was late, [[which ~~John was late~~]$_i$ I resent t$_i$].

Since *which* requires that its antecedent be an existing discourse referent, in order for (72) to be acceptable, the nominalized proposition itself must somehow be present in the variable assignment. Worse, we have to allow, not just that the nominalized proposition can be of semantic type *e*, but that it can actually function syntactically as an NP, and thus fulfill the selectional requirements of the index.

As an alternative, however, we can make use again of silent nouns. Elbourne (2005) argues on unrelated grounds that there is a silent noun *THING*, which refers to the entire domain of objects $\mathbf{D}_e$ and appears in contexts in which a NP deletion appears to be licensed pragmatically. Imagine I see your dog get very excited as you pull out a bag of Iams dog food. I could reasonably say:

(73)   Mine prefers Puppy Chow.

As Elbourne notes, (73) would be bizarre in a context in which it is not obvious that a dog is under discussion. He proposes to explain the felicity of (73) in certain contexts, not as the result of a strange operation in which environmental cues (the presence of a dog) affect the syntactic structure directly, but as a general consequence of semantic domain restriction, so that (73) is analyzed as (74):

(74)   My THING prefers Puppy Chow.

If this approach is successful, we can account for the felicity of (72) along the same lines by positing that the complement of *which* in (72) is not *John was late*, but simply *THING*, where [|*THING*|] = λ*x* . *x* ∈ $\mathbf{D}_e$.

(75)   John was late, [[which THING]$_i$ I resent t$_i$].

Empirical support for this alternative comes from German. In German, unlike English, there is an overt morphological difference between the equivalent of *which* with interrogatives and ARCs with internal NPs (as in *which man*) and the equivalent of *which* picking up non-nominal antecedents (as in *John left early, which upset me*). Notably, the latter is identical to the question word *what*:

(76)   a.   Was   hast du   gemacht?
                What have you done
                "What did you do?"

        b.   Mein Haus,   welch-es /*was   sehr alt ist, ist noch schön.
                My house-NEUT which-NEUT/*what very old is   is still nice
                "My house, which is very old, is still nice."

        c.   Hans war verspätet, was/*welch-es   mir   ärgerte.
                Hans was late   what/*which-NEUT me-DAT upset
                "Hans was late, which upset me."

I suggested earlier that the difference between *which* and *who* in English is that *which* has an NP complement that is either overt or deleted, while *who* is the spellout of *which PERSON*. It seems likely that the difference between *welch-* and *was* in German is that the former has an optionally deleted NP-complement (*Haus* in (76b)), while the latter is19the spellout of *which THING*. This is supported by the fact that *welches* in (76b) displays neuter agreement, as if with the neuter noun *Haus*; this is explained if there is in fact a deleted *Haus* after *welches*.

The fact that *welches* is impossible in (76c), and only *was* is possible, suggests that the relative DP *was* in (76c) is not *welch- Hans war verspätet* with a deleted copy of the earlier IP, but rather spells out *welch- THING*. I suggest that English is like German in this respect, except that *which* and *which THING* happen to be homophonous in English. If this line of reasoning is successful, we are relieved of the burden of allowing objects of any syntactic category to appear in the assignment; all we need is to allow that THING denotes [λx . $x \in \mathbf{D}_e$], and that nominalized propositions, properties, etc. are of type *e*.

4.6. Interim Summary

        Section 4 began with a discussion of NP-deletion and the lexical semantics of *which*. I argued that the difference between pronouns and relatives with respect to deep/surface anaphora should be recast as a distinction between items which can, as a lexical semantic property, introduce a new discourse referent, and those which cannot. In combination with a modified version of de Vries' (2006) coordination theory of ARCs, the difficulties discussed in section 2 are explained.

        The theory of appositive relatives that I have proposed is closest in spirit to the coordination analysis of de Vries (2006), but it has points in common with each of the other theories examined in section two. Like Jackendoff (1977), it is compatible with explaining differences in determiner scope between ARCs and RRCs in terms of level of attachment (a property which we have not discussed in detail for reasons of space).

Like the head-raising analysis of Kayne (1994), I think that there is an important sense in which the noun which appears immediately following the definite determiner exists within the relative clause; the difference is that, on my analysis, this noun does not form a chain with the "head" noun. This difference is crucial in explaining the possibility of having both internal and external "heads", which may or may not be identical. On my theory, all ARCs have this property, and cases in which there is no overt internal head are either the effect of an optional NP-deletion process or the presence of a silent NP.

Finally, the proposal in this section derives the fact that *which NP* can only be used with an overt linguistic antecedent, in contrast with ordinary pronouns.

5   Restrictive Relatives

ARCs are a large enough topic for one paper, and for this reason I have said little about restrictive relatives. But ARCs and RRCs cannot be treated completely independently: given their shared syntactic and morphological characteristics, a theory of one is bound to make predictions about the other. This section is a very brief discussion of one claim I have made that may seem troubling in light of restrictive relatives: the claim that *which NP* is obligatorily discourse-anaphoric, and the specific implementation I suggested. The motivation for this move was that de Vries' theory could not explain why *which*-clauses always have an overt antecedent; at best, he could account for coreference in cases in which the *which*-clause occurs as the second member of a specifying coordination. Of course, *which* also occurs in RRCs, for which de Vries accepts Kayne's (1994) head-raising theory. It is not immediately obvious how my theory can account for RRCs, and this section is devoted to an outline of a theory which treats *which* as a quantificational element in ARCs and RRCs alike. (Note that I deal here only with RRCs with *which/who* etc., not those with *that*.)

The claim that *which* requires a linguistic antecedent seems to be at odds with some basic facts about RRCs. For instance, unlike ARCs, RRCs can be used to refer to objects that have not occurred in previous discourse, as in (77). Even more strikingly, they can be quantified (78):

(77)   [Out of the blue]
        The man who we saw at the party didn't look well.

(78)   Every boy who came late left early.

Both (77) and (78) may seem unexpected according to the lexical entry for *which* that I gave earlier. Indeed, if we had stayed with the idea that *which NP* must refer to an already mentioned *person or object*, the theory would fail for RRCs. But, I will show, the specific implementation of the notion of 'discourse referent' given in section 4 explains the data in (77) and (78) once we take account of some general facts about anaphora and quantification.

We ended section 4.2 with a small problem (resolved soon after): a relative CP denotes an object of type $<e,t>$, but the specifying coordination head *Co* required an

object of type *e*. As it happens, RRCs are often taken to link two objects of type *<e,t>* (e.g., by Heim & Kratzer 1998; Rebuschi 2005). I suggest that ARCs and RRCs with *which, who,* etc. are identical up to the level of CP: in other words, the internal morphological and syntactic similarities of ARCs and RRCs are explained by the fact that they are largely identical. The differences, then, stem from the way they are connected to the larger structure.

There are three main differences between ARCs and RRCs if we wish to pursue this line of reasoning. First, RRCs are connected to their "antecedents" by a different coordinating head: call it CoR. CoR takes two arguments of type *<e,t>*, such as NPs or relative CPs. It is semantically simple and, as Rebuschi (2005) emphasizes, similar to conjunction in type *<e,t>*:[7]

(79) $[|CoR|] = \lambda P \lambda Q \lambda x \, . \, P(x) \, \& \, Q(x)$

Abstracting away from issues about the status of *which*, this denotation for CoR predicts that *boy CoR who left* returns the set of individuals who are boys and who left, and *the boy who left* returns the unique member of this set, if there is one. This is essentially the proposal of Rebuschi (2005).

The second major difference between ARCs and RRCs on such an approach is that the silent pronoun/determiner which de Vries claimed was present in ARCs (cf. section 4.3) is not present in RRCs. As a result an RRC denotes an object of type *<e,t>* and is syntactically a CP, unlike ARCs, which are syntactically DPs and of type *e*. The third difference, which is really derived from the other two, is that RRCs are coordinated with an NP, while ARCs are usually coordinated with a DP. Notably, on this proposal the differences between ARCs and RRCs boil down to differences in the presence or composition of two silent elements which are external to the relative CP, and in a syntactic difference that is normally string-vacuous. This may explain why ARCs and RRCs are so similar in their internal syntax and morphology: often, the only overt difference between them is prosodic, which may reflect the syntactic difference in level of attachment (cf. Wagner 2007).

The resulting structure is given in (80):

(80)   a. The book which I read
         b. [DP the [CoRP [NP book] [CoR′ CoR [CP [QP which book]i [C′ Cø [IP I read ti]]]]]]

(80) may seem problematic in light of the requirement that *which book* pick out an existing discourse referent, since the sentence is perfectly acceptable even out of the blue. But an important finding of Heim (1982) was that discourse referents are added in real-time as a sentence progresses, rather than being added in one fell swoop at the

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[7]This of course leads us to ask why English does not use an overt *and* in RRCs, a question that Rebuschi (2005) does not answer. One route would be to look for languages that do use overt *and* in RRCs, but I am not aware of any such language. A more promising line of explanation may be that the function in (79) does not give the correct denotation for *and*: Heycock and Zamparelli (2005) have argued that English *and* does not denote the function that I have assigned to *CoR*, but the more complex operation 'set product'. They argue that this is necessary to explain the fact that *this man and woman* does not mean (only) "this hermaphrodite".

end. Heim showed that this assumption is necessary to explain quantified donkey sentences like (81):
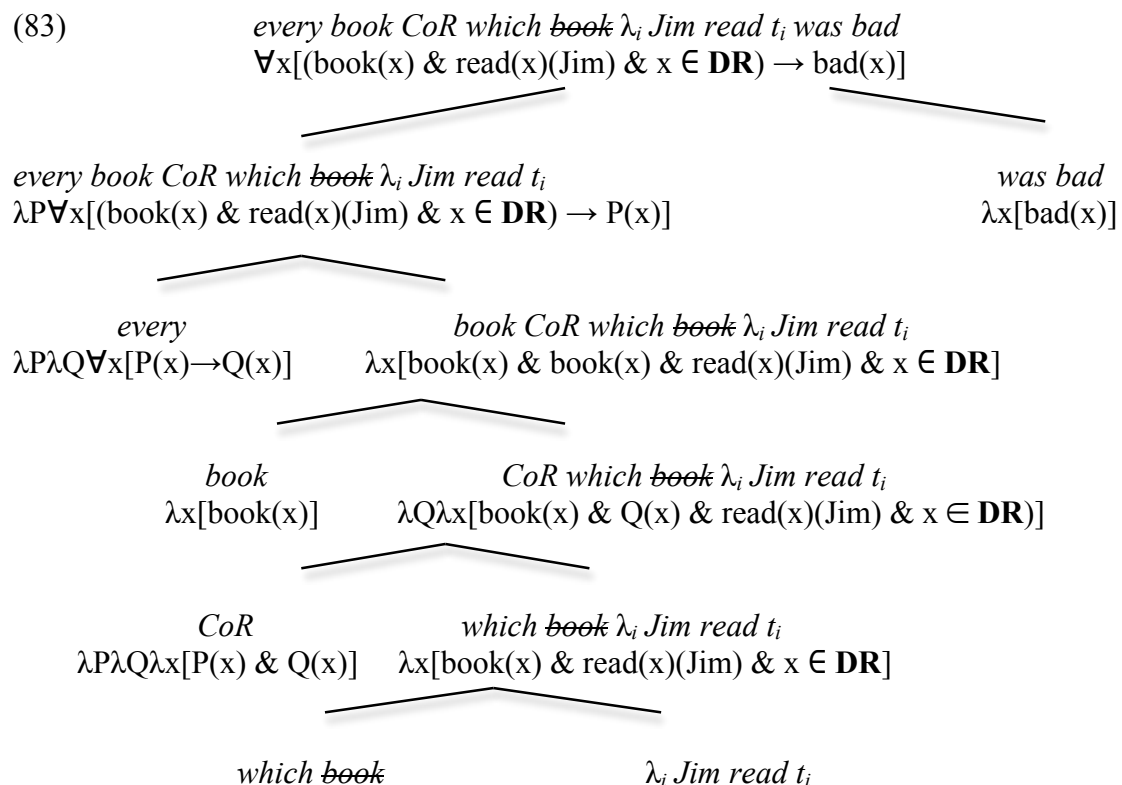
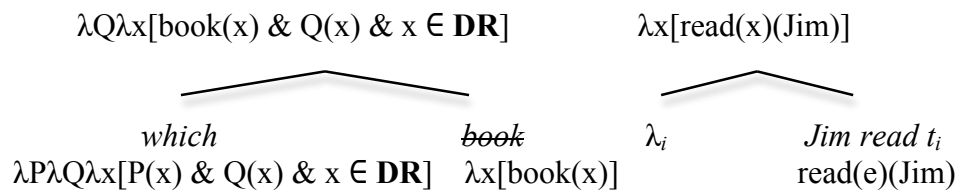(81)   Every boy with a pretzel ate it.

In (81) *a pretzel* introduces a discourse referent, which is immediately picked up by *it*. If discourse referents were added only after a sentence's meaning has been fully computed, (81) would be unacceptable. By the same token, *book* in (80) introduces a discourse referent (or, more technically, *book* is associated with some u_n and all assignments whose nth member is not a book are discarded immediately, without waiting for the end of the sentence). As a result, the requirement that *which book* have an overt antecedent is fulfilled (cf. note 3).

      Quantified relative clauses function similarly. I give the proposed syntactic structure of quantified RRCs in (82) and a semantic derivation in (83). **DR** represents the set of discourse referents as defined in fn. 3, i.e. $\{x \mid \forall i \forall n[x = i(u_n)$ iff $\exists y(\neg\exists j(i[u_n]j$ & $j(u_n) = y))]\}$. The derivation does not represent the dynamic, real-time computation of **DR** discussed in the previous paragraph. I also leave out quantifier raising of the subject QP, which plays no significant role in the semantic derivation in this example, and the internal syntax of the embedded IP in the RRC.

(82)   a. Every book which Jim read was bad.
        b. [QP every [CoRP [NP book] [CoR′ CoR
                  [Co′ [QP which book]i [C' Cø [IP Jim read ti]]]]]]]

(83)   *every book CoR which ~~book~~ λ_i Jim read t_i was bad*
        $\forall x[(book(x)$ & $read(x)(Jim)$ & $x \in$ **DR**$) \rightarrow bad(x)]$

every book CoR which ~~book~~ λ_i Jim read t_i   *was bad*
$\lambda P \forall x[(book(x)$ & $read(x)(Jim)$ & $x \in$ **DR**$) \rightarrow P(x)]$ $\lambda x[bad(x)]$

   every   *book CoR which ~~book~~ λ_i Jim read t_i*
$\lambda P \lambda Q \forall x[P(x) \rightarrow Q(x)]$ $\lambda x[book(x)$ & $book(x)$ & $read(x)(Jim)$ & $x \in$ **DR**$]$

   book   *CoR which ~~book~~ λ_i Jim read t_i*
$\lambda x[book(x)]$ $\lambda Q \lambda x[book(x)$ & $Q(x)$ & $read(x)(Jim)$ & $x \in$ **DR**$)]$

   CoR   *which ~~book~~ λ_i Jim read t_i*
$\lambda P \lambda Q \lambda x[P(x)$ & $Q(x)]$ $\lambda x[book(x)$ & $read(x)(Jim)$ & $x \in$ **DR**$]$

   which ~~book~~   *λ_i Jim read t_i*

$$\lambda Q\lambda x[\text{book}(x) \;\&\; Q(x) \;\&\; x \in \textbf{DR}] \qquad\qquad \lambda x[\text{read}(x)(\text{Jim})]$$

which   ~~*book*~~ λ_i *Jim read t_i*
$\lambda P\lambda Q\lambda x[P(x) \;\&\; Q(x) \;\&\; x \in \textbf{DR}]$ $\lambda x[\text{book}(x)]$ $\text{read}(e)(\text{Jim})$

As (83) shows, this approach is able to capture the truth-conditions of sentences with quantified RRCs. The most important problem which (83) does not address is the existence of reconstruction effects in RRCs, which has been perhaps the primary motivation for the head-raising analysis (cf. Kayne 1994; de Vries 2006). The viability of the approach to RRCs sketched here will rely on the availability of an approach to reconstruction effects which does not rely on syntactic movement exclusively. See Boef (2011) for a number of arguments suggesting that the head-raising theory overgenerates reconstruction effects in Dutch and English RRCs, and that a semantic analysis is needed on independent grounds. If this approach is correct, then the syntax and semantics of RRCs sketched here may be viable as well.

6   Summary and Conclusion

Appositive relative clauses share several properties of pronouns and demonstratives but behave differently in certain ways. In section two we saw three properties of ARCs and the relative pronouns that they contain that are shared by ordinary pronouns and demonstratives: having both internal and external heads and non-adjacency; and a property that distinguishes relatives from pronouns, the requirement that the relative DP have an overt linguistic antecedent.

In section three I surveyed four theories of ARCs, arguing that each of these encounters problems with the data in section two. Section four proposed that *which* should be treated as a quantifier rather than a pronoun, and that the discourse-anaphoric properties of ARCs are the result of its lexical semantics. This claim was supported by comparison with the treatment of *the* and *a* in dynamic semantics, which have related restrictions on their anaphoric possibilities. I suggested that the "internal head" phenomenon should be turned on its head: instead of asking why some ARCs have internal NPs, we should ask why not all do. Deletion is favored in informal contexts, but there is still an internal NP when *which* appears apparently alone.

I argued that, if we adopt the coordination analysis of ARCs, the phenomenon of intersentential *which* may be reducible to the availability of intersentential coordination; and suggested an account of non-nominal antecedents based on independently motivated proposals by Chierchia (1984, 1998) and Potts (2002). Finally, in section 5 I briefly discussed RRCs with *which*, showing that the fact that discourse referents are introduced in real time allows us to extend the treatment of *which* in ARCs to RRCs as well.

Overall, the data surveyed here support a head-external coordination analysis of ARCs and possibly RRCs as well; they also highlight the importance of looking at relative clause syntax and semantics in tandem, since, as we have seen, the semantic facts constrain the space of available syntactic analyses considerably.

7 References

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