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The structure and interpretation of non-restrictive relatives: Evidence from relative pronoun pied-piping

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1 Introduction

English is one of many languages in which relative clauses (RC) can be constructed using *wh*-words as *relative pronouns*. The relative pronoun originates lower in the clause and $\overline{\text{A}}$-moves to the edge of the RC. This movement can *pied-pipe* other material with it, resulting in *relative pronoun pied-piping* (RPPP):

(1) **Non-restrictive relative with relative pronoun pied-piping (RPPP):**
Mary, [$_{\text{RC}}$ [$_{\text{RPPP}}$ *whose* talk] I saw ___ at CLS], is clearly brilliant.

In this paper, we investigate the structure and interpretation of English *non-restrictive relative clauses*, also often called *appositive* relatives and sometimes *supplemental* relatives. We propose that in non-restrictive relatives, relative pronouns are interpreted in situ within the pied-piped constituent at LF, using Rooth-Hamblin alternative computation(Hamblin 1973, Rooth 1985, 1992, a.o). Evidence comes from the presence of *intervention effects* in RPPP; intervention effects (Beck 2006, Sauerland & Heck 2003, a.o.) can be used to diagnose regions of alternative computation (see Kotek & Erlewine to appear, Erlewine & Kotek 2014). The proposal here has the consequence that non-restrictive relatives are fundamentally *proposition-denoting* (Del Gobbo 2007) in contrast to restrictive relatives which are *property-denoting*.

Our proposal helps explain two differences between restrictive and non-restrictive RCs in English. First, non-restrictive relatives must use relative pronouns whereas restrictive relatives also have a *that*/$\emptyset$ complementizer option. The relative pronoun strategy must be used in non-restrictive relatives to arrive at the propositional denotation. Second, RPPP in non-restrictive relatives can be substantially larger than in restrictive relatives. This is due to the semantics of Rooth-Hamblin alternative computation, used to interpret relative pronouns in non-restrictive relatives, which is insensitive to syntactic barriers such as islands, although it is susceptible to intervention effects.

2 Setting the stage

In this section we discuss the desired semantics for relative clauses. We begin by looking at restrictive relative clauses in section 2.1, which motivates the idea that RCs are property-denoting. In section 2.2 we discuss the complications introduced by relative pronoun pied-piping and three different interpretational options of RPPP. Then in section 2.3 we discuss the interpretation of non-restrictive relatives.

2.1 Interpreting restrictive relative clauses

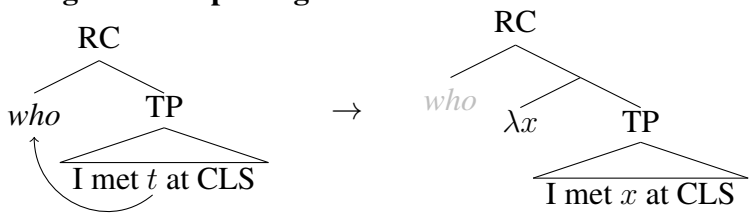
In approaching the semantics of relative clauses, it is instructive to first look at restrictive relative clauses, where their semantic contribution has been well-studied and is quite clear. Consider for example the relative clause in (2) below.

(2) **Restrictive relative clause with relative pronoun:**
Every phonologist [$_{\text{RC}}$ *who* I met ___ at CLS] gave a great talk.

Following Quine (1960), Partee (1973), and much subsequent work, the restrictor of *every* in (2) is interpreted as the set of individuals satisfying both *phonologist* and the predicate "λx . I met x at CLS." The relative clause acts to restrict the domain that the quantifier *every* quantifies over.

We arrive at the interpretation of the relative clause by interpreting the $\overline{\text{A}}$-movement of the relative pronoun (Chomsky 1977) as λ-abstraction.[1] Following the presentation in Heim & Kratzer (1998), the trace position of movement is interpreted as a variable, x, and a λ-binder below the target of movement abstracts over this argument (3).

(3) **Deriving and interpreting the relative clause:**



For the purposes of this illustration, assume that the relative pronoun itself does not contribute semantically, as in the discussion in Heim & Kratzer (1998, p. 186). This results in the desired denotation for the relative clause, $[\![\text{RC}]\!]$ = "λx . I met x at CLS." We can say that the semantics of the RC itself is *property-denoting*. As this is a restrictive relative, this property modifies the head noun *phonologist* intersectively, resulting in the desired restriction of the domain of quantification.

2.2 The problem of pied-piping

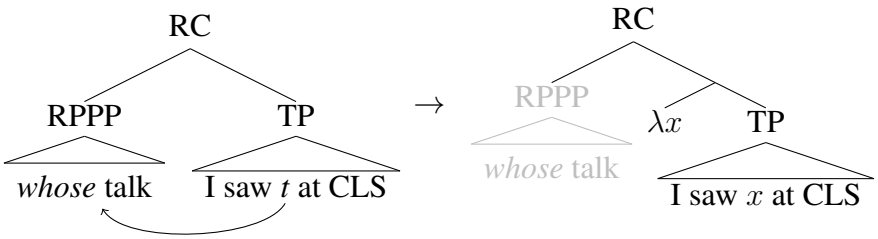
This procedure for interpreting the relative clause as a derived property is complicated by pied-piping. Consider the relative clause in (4) below.

(4) **Restrictive relative with relative pronoun pied-piping (RPPP):**
Every phonologist [$_{\text{RC}}$ [$_{\text{RPPP}}$ *whose* talk] I saw ___ at CLS] is clearly brilliant.

Following the discussion above, we want the relative clause in (4) to denote the property "λx . I saw x's talk at CLS." It's clear that the procedure from the previous section, illustrated in (3) above, is insufficient to derive this meaning. Interpreting the movement of the RPPP using λ-abstraction yields the derived predicate "λx . I saw x at CLS" (5). The semantic contribution of the pied-piped material is missing.

[1] Here we abstract away from the question of whether or not any of the nominal material outside of the relative clause, such as the head noun (here, *phonologist*), originated within the relative clause. See Sauerland (1998), Bhatt (2002), Hulsey & Sauerland (2006) and references therein for discussion.

(5) **A failed attempt at interpreting a relative clause with RPPP:**



There are at least three possible approaches to solving this problem. The first is to covertly move the relative pronoun out of the RPPP.[2] This approach is illustrated in (6). Covert movement is indicated by dashed arrows here.

(6) **Approach 1: covertly move the relative pronoun out of the RPPP**

a. LF: [$_{\text{RC}}$ *who* λy [[$_{\text{RPPP}}$ y's talk] λx . I saw x at CLS]]

b. $[\![\text{RC}]\!] = \lambda y$. $(\lambda x$. I saw x at CLS$)$ $(y$'s talk$)$
$= \lambda y$. I saw y's talk at CLS

We can interpret the covert movement step as another instance of λ-abstraction. The denotation of the RPPP constituent, "y's talk," becomes the argument for the predicate derived by the overt RPPP-movement step, and is bound above by λy. Again assuming that the relative pronoun (*who*, in gray) itself does not contribute interpretationally, we yield the desired denotation for the relative clause in (6b).

The second approach is to interpret the RPPP constituent, modulo the relative pronoun itself, down in the base position of movement, within the RC. That is, although the pied-piped material is pronounced high, in the LF representation it is interpreted low with λ-abstraction over just the relative pronoun's position.[3] The differing PF and LF representations under this view are illustrated in (7):

(7) **Approach 2: RPPP low at LF, abstract over just the relative pronoun**

a. PF: [$_{\text{RC}}$ [$_{\text{RPPP}}$ *whose* talk] I saw *t* at CLS]

b. LF: [$_{\text{RC}}$ *who* λx . I saw [$_{\text{RPPP}}$ x's talk] at CLS]

Looking at the LF representation, we see that the relative clause can be straightforwardly interpreted as the intended property "λx . I saw x's talk at CLS."

One argument against the idea that the relative pronoun is separated from the rest of the RPPP via movement comes from island diagnostics. Example (8b), based on the baseline in (8a), shows that the relative pronoun can be inside an island, inside RPPP. This evidence is immediately problematic for Approach 1, where the relative pronoun must move out of RPPP. It is also problematic for Approach 2,

[2]The same semantic effect can be derived by other approaches which relate the surface position of the relative pronoun within the RPPP and the edge of the RC. This could, for example, be the movement of the head noun (here, *phonologist*) from the position of *who* to its surface position, as in Kayne (1994).

[3]We can think of this discrepancy between the PF and LF representations as the result of covertly reconstructing much of the RPPP at LF or as an indication that the movement of the pied-piped material (somehow) only occurs at PF.

assuming that interpretation of RPPP in the base position, abstracting over just the relative pronoun position, requires a movement step.

(8) **The relative pronoun can be inside an island, inside RPPP:**
   a. This portrait, [$_{\text{RC}}$ [$_{\text{RPPP}}$ the background of *which*] is quite stunning], sold for a million dollars at auction.
   b. This portrait, [$_{\text{RC}}$ [$_{\text{RPPP}}$ the background [$_{\text{RC}}$ that was chosen for *which*]] is quite stunning], sold for a million dollars at auction.

The third approach is to interpret the relative pronoun in situ within the RPPP, using *Rooth-Hamblin alternative computation*, a different mode of semantic composition. Such an approach is briefly discussed but not ultimately adopted in Sternefeld (2001) and Sauerland & Heck (2003). We will introduce this approach by discussing its use in the interpretation of *wh*-in situ questions such as the Korean example in (9):

(9) **Korean *wh*-in situ:**
   Minsu-nun *nuku*-lûl po-ass-ni?
   Minsu-TOP who-ACC see-PAST-Q
   'Who did Minsu see?'

Hamblin (1973) proposes a mechanism for interpreting *wh*-words in situ—that is, without overt or covert movement. This procedure is illustrated for (an English word order version of) example (9) in (10) below.[4] Here we follow Beck's (2006) presentation which uses Rooth's (1992) multidimensional semantics and notation: a set of *alternatives* for each node in the tree can be computed using the denotation function $[\![\cdot]\!]^f$ whereas ordinary semantic values are computed with $[\![\cdot]\!]^o$. Interrogative elements have only alternative-semantic values defined.

(10) **Interpreting (9a), presented as *wh*-in situ English:**
   a. [$_{\text{CP}}$ C$_Q$ [$_{\text{TP}}$ Minsu saw *who*]]
   b. $[\![\textit{who}]\!]^f = \{\text{John, Mary, Bill,...}\}$
   c. $[\![\text{TP}]\!]^f = \{\text{Minsu saw John, Minsu saw Mary, Minsu saw Bill,...}\}$

The *wh*-word introduces the set of corresponding possible short answers—in this case, animate individuals—as the alternative-semantic value of $[\![\textit{who}]\!]^f$. Each of these individual values composes pointwise with the verb *saw* and then with the subject *Minsu* to yield the alternatives in $[\![\text{TP}]\!]^f$. These alternatives correspond to possible answers to the question and are interpreted by C which contributes the question force.

We will refer to this mechanism as *Rooth-Hamblin alternative computation* after Rooth (1985) and Hamblin (1973) and we indicate regions where alternatives are computed using a squiggly arrow.

[4]We assume here that Korean in situ *wh*-words are indeed interpreted in situ at LF (Beck, 2006, a.o.). The facts for *wh*-in situ in English multiple *wh*-questions, however, are more complicated. See Pesetsky (2000), Beck (2006), Kotek (2015) for discussion.

This process of Rooth-Hamblin alternative computation can also be used to interpret interrogative *wh*-words inside pied-piped constituents (Cable 2007, Kotek & Erlewine to appear). Consider the structure in (11) below, based on an example sentence from Cable (2007).

(11) **Interpreting pied-piping using both movement and alternatives:**

a. $[_{\text{TP}}\ [_{\text{pied-piping}}$ A picture of *which* president$]$ λx . does Jim own $x]$?

alternative computation *movement*

b. $[\![\text{TP}]\!]^f = \left\{ \begin{array}{l} \text{Jim owns a picture of Roosevelt,} \\ \text{Jim owns a picture of Kennedy,} \\ \text{Jim owns a picture of Obama,...} \end{array} \right\}$

The introduction of alternatives at *which* leads to the pied-piped constituent having an alternative-semantic denotation of a set of pictures of different presidents. This composes with the rest of the question, which is a predicate derived by interpreting the movement chain as λ-abstraction. Composing pointwise, this results in the alternative-semantic denotation $[\![\text{TP}]\!]^f$ in (11b), corresponding to the desired set of possible answers. In this way, the interrogative *wh*-word can be interpreted in situ within the pied-piped constituent, with the movement step interpreted in the normal fashion.

This approach to interpreting *wh*-words using Rooth-Hamblin alternative computation has also been extended to non-interrogative (specifically, quantificational) uses of *wh*-words in work such as Kratzer & Shimoyama (2002). Returning now to the interpretation of relative clauses, the third approach to the problem of relative pronoun pied-piping would then be to use this same method of interpreting the relative pronoun in situ using alternative computation, within RPPP, and combining it with λ-abstraction for the overt movement of RPPP:

(12) **Approach 3: interpret using both movement and alternatives**

$[_{\text{RC}}\ [_{\text{RPPP}}$ *whose* talk$]$ λx . I saw x at CLS$]$

alt. computation *movement*

An immediate advantage of this approach is that it is compatible with the island data presented in (8). Rooth-Hamblin alternative computation, unlike movement, is not sensitive to syntactic islands (Rooth 1985).

In section 3, we will present a diagnostic which is able to detect regions of Rooth-Hamblin alternative computation. This diagnostic shows that Approach 3—with the relative pronoun interpreted in situ within the pied-piped constituent—is ultimately correct for non-restrictive relatives. This will, however, bring with it its own complication; specifically, there is not a straightforward way to use this in situ mode of composition to derive a property-denotation for the relative clause in (12). We will propose that the key to solving this puzzle is the unique semantics of non-restrictive relatives themselves, to which we now turn.

2.3 Interpreting non-restrictive relative clauses

In this section we discuss the semantics of non-restrictive relatives, which will be the focus of this paper. Although non-restrictive relatives are superficially similar to

their restrictive counterparts, there are a number of significant differences of note. The defining difference is of course that non-restrictive relatives do not have the function of restricting a domain of quantification; instead, they simply introduce additional information about the antecedent described.

The semantic contribution of non-restrictive RCs has traditionally been compared to that of an independent, possibly conjoined clause (Quine 1960, Ross 1967, Taglicht 1972, Thorne 1972, Emonds 1979, McCawley 1981, Demirdache 1991, de Vries 2006, a.o.) as in (13) below. More recently, Potts (2005, 2013) formally describes non-restrictive RCs—as well as other supplementals such as nominal appositives—as projective (always wide scope) and not-at-issue.

(13) **The semantic contribution of a non-restrictive relative, paraphrased:**
Mary, [$_{\text{RC}}$ *who* I met ___ at CLS], gave a great presentation.
$\approx$ Mary gave a great presentation. *(And) I met Mary at CLS.*

What is important here for our purposes is that the meaning introduced by the non-restrictive relative clause is a *proposition*, in this case *I met Mary at CLS*. We can intuitively break this proposition up into two parts: *Mary*, the referent being described, and the property "λx . I met x at CLS" which must be true of Mary.

Given the semantics independently necessary for restrictive relatives (§2.1), the null hypothesis would be to say that there is a uniform, *property-denoting* semantics for restrictive and non-restrictive RCs:

(14) **The null hypothesis: a uniform property-denoting semantics for RCs**
a. Core, shared meaning:
$[\![[_{\text{RC}}$ who I met at CLS$]\!]$ = λx . I met x at CLS *property*
b. Restrictive use:
$[\![$phonologist RC$]\!]$ = $[\![$phonologist$]\!] \cap [\![$RC$]\!]$
= λx . x is a phonologist and I met x at CLS
c. Non-restrictive use:
projects a not-at-issue proposition: $[\![$RC$]\!]$(*antecedent*$_{\text{RC}}$)
where *antecedent*$_{\text{RC}}$ is the referent described

The alternative would be that the entire proposition—in this case *I met Mary at CLS*—is built *directly*, without computing the property "λx . I met x at CLS" along the way. Clearly the null hypothesis is advantageous from the point of view of parsimony. In the following section we will build an argument that, in fact, the null hypothesis in (14) is incorrect and instead non-restrictive relatives are built directly and that they are inherently *proposition-denoting* (see also Del Gobbo 2007).

(15) **The alternative: non-restrictive RCs are proposition-denoting**
- Non-restrictive RCs denote an entire proposition and are computed directly without first computing the corresponding property.
- This proposition is then projected as a not-at-issue meaning.
- There is no core meaning shared between corresponding restrictive and non-restrictive RCs.

3 Evidence from intervention effects

In this section we investigate the structure and interpretation of RPPP in non-restrictive RCs. We argue that they are proposition-denoting based on the behavior of *intervention effects* in RPPP. Background on intervention effects will be introduced in section 3.1. The new data is presented in 3.2. In section 3.3 we discuss the implications of this data for the theoretical approaches reviewed in section 2.

3.1 Intervention effects

In section 2.2 above, we discussed three potential solutions to the problem of pied-piping, i.e. how to properly incorporate the semantics of the pied-piped material when interpreting a relative clause. One of these approaches involved interpreting the relative pronoun in situ using Rooth-Hamblin alternative computation, (12). Here we will introduce so-called *intervention effects* which we have shown in previous work (Kotek 2014, Kotek & Erlewine to appear, Erlewine & Kotek 2014) can be used as a diagnostic for regions of Rooth-Hamblin alternative computation.

Intervention effects have traditionally described a phenomenon where the addition of certain operators disrupts the interpretation of in situ *wh*-words (Beck 2006; see also Beck 1996, Kim 2002, a.o.). A classic example from Beck & Kim (1997) is reproduced in (16) below. Korean is generally *wh*-in situ, as shown in (9) above, but when the subject above the in situ *wh*-word is changed to the focus-sensitive expression 'only Minsu,' the question becomes ungrammatical (16a). This problem can be avoided by scrambling the *wh*-word over the intervener as in (16b).

(16) **Intervention effect in Korean *wh*-questions:** (Beck & Kim 1997)

a. * Minsu-**man** *nuku*-lûl po-ass-ni?
Minsu-only who-ACC see-PAST-Q
Intended: 'Who did only [Minsu]$_F$ see?'

b. ✓ *Nuku*-lûl Minsu-**man** ___ po-ass-ni?
who-ACC Minsu-only see-PAST-Q
'Who did only [Minsu]$_F$ see?'

Here we say that 'only Minsu' is an *intervener*; interveners are bolded here. The intervention effect in example (16a) and its amelioration via scrambling in (16b) motivate the idea that *intervention effects only affect regions of alternative computation, not movement* (Beck 2006, Beck & Kim 2006). Informally, interveners interrupt the projection of alternatives (squiggly arrow) before they reach the interpreting operator—in this case, interrogative C.[5]

(17) **Intervention affects alternatives, not movement:**

a. * [$_{CP}$ C ... **intervener** ... *wh*] (16a)

b. ✓ [$_{CP}$ C ... *wh* **intervener** ... *t*] (16b)

[5]For reasons of space, here we will concentrate on the distribution of intervention effects and be less concerned with the mechanism that causes intervention. See Beck (2006) for one prominent view. Crucially all interveners used for our evidence in section 3.2 are items which have been previously shown to cause intervention in interrogative *wh*-constructions.

Sauerland & Heck (2003), Cable (2007), and Kotek & Erlewine (to appear) show that intervention effects also occur inside pied-piped constituents triggered by interrogative *wh*-movement.

(18) **Intervention effect in English pied-piping:** (based on Cable 2007, p. 262)
- a. ✓ [$_{\text{pied-piping}}$ A picture of *which* president] does Jim own ___?
- b. * [$_{\text{pied-piping}}$ **No** pictures of *which* president] does Jim own ___?
- c. * [$_{\text{pied-piping}}$ **Few** pictures of *which* president] does Jim own ___?
- d. * [$_{\text{pied-piping}}$ **Only** PICTURES of *which* president] does Jim own ___?

If an intervener is placed between the *wh*-word and the edge of the pied-piping constituent, it results in ungrammaticality. This is explained by the view, introduced briefly above (11), that interrogative *wh*-words are interpreted in situ within pied-piping constituents, using Rooth-Hamblin alternative computation. The following schema illustrates this configuration:

(19) **The pied-piping intervention schema:**

*[$_{\text{pied-piping}}$ ... **intervener** ... *wh*] λx . ... x ...

alt. computation *movement*

We know that it is specifically this region within the pied-piping that is sensitive to intervention because different choices of pied-piping size can lead to structures where the intervener is stranded below. Such questions are grammatical, (20). This reflects the fact that intervention effects affect Rooth-Hamblin alternative computation, here used to interpret the pied-piping constituent, but not structures that are derived through movement chains and interpreted through λ-abstraction.

(20) **Intervention avoided with smaller pied-piping:** (Cable 2007)
- a. ✓ [$_{\text{pied-piping}}$ Of *which* president] does Jim own **no** pictures ___?
- b. ✓ [$_{\text{pied-piping}}$ *Which* president] does Jim own **no** pictures of ___?

3.2 Intervention effects in RPPP

We now turn to an investigation of RPPP in non-restrictive RCs. The minimal pair in (21) shows that the region between the relative pronoun and the edge of RPPP is indeed susceptible to intervention effects.

(21) **Intervention effect in RPPP:**
I want to try this recipe,
- a. ✓ [$_{\text{RC}}$ [$_{\text{RPPP}}$ the ingredients for *which*] I (already) have ___ at home].
- b. * [$_{\text{RC}}$ [$_{\text{RPPP}}$ **no** ingredient(s) for *which*] I have ___ at home].
- c. ?? [$_{\text{RC}}$ [$_{\text{RPPP}}$ **very few** ingredients for *which*] I have ___ at home].
- d. ?? [$_{\text{RC}}$ [$_{\text{RPPP}}$ **only** [one]$_{\text{F}}$ ingredient for *which*] I have ___ at home].

This pattern parallels the behavior of material pied-piped with interrogative *wh*-words, reviewed above. The interveners in (21) are known pied-piping interveners, observed in (18) above and discussed in Kotek & Erlewine (to appear) and Erlewine & Kotek (2014).

It's important to note that this effect is not simply due to the use of any quantificational expression inside the RPPP. Other, non-intervening quantifiers do not have this effect:

(22) **Non-intervening quantifiers in RPPP:** (cf 21)
I want to try this recipe,
a. ✓ [$_{RC}$ [$_{RPPP}$ an ingredient for *which*] I'm missing ___].
b. ✓ [$_{RC}$ [$_{RPPP}$ three ingredients for *which*] I (already) have ___ at home].
c. ✓ [$_{RC}$ [$_{RPPP}$ many ingredients for *which*] I (already) have ___ at home].

It is also not the case that the ungrammatical examples in (21) express particularly strange meanings. Take example (21b) above. If a smaller constituent is chosen for fronting, so that the intervener is not included within the RPPP, no intervention occurs:

(23) **Intervention avoided with smaller RPPP:**
I want to try this recipe,
a. * [$_{RC}$ [$_{RPPP}$ **no** ingredients for *which*] I have ___ at home]. (=21b)
b. ✓ [$_{RC}$ [$_{RPPP}$ for *which*] I have **no** ingredients ___ at home].
c. ✓ [$_{RC}$ [$_{RP}$ *which*] I have **no** ingredients for ___ at home].

This parallels the contrast observed in interrogative pied-piping between (18) and (20) above. Intervention effects occur in RPPP whenever an intervener occurs above the relative pronoun, inside its pied-piping.

The susceptibility of RPPP to intervention effects shows that relative pronouns are interpreted in situ within the RPPP using Rooth-Hamblin alternative computation, similarly to pied-piping in *wh*-questions. This is compatible only with Approach 3 to the problem of pied-piping presented in section 2.2 above, (12). This effect would not be explained if the relative pronoun is moved out of RPPP (Approach 1) as movement is not sensitive to intervention. It is also not explained if the rest of RPPP is interpreted low, in the base position of movement (Approach 2), as the sensitivity to the size of movement (23) would be unexplained.

Note that we present this evidence here solely for non-restrictive relatives. This is, at least in part, due to a methodological issue: non-restrictive relative clauses allow for larger RPPP than restrictive relatives (Emonds 1976, Emonds 1979, Jackendoff 1977, Nanni & Stillings 1978, a.o.) and this extra structure in the RPPP is necessary to construct the intervention test cases as in (21) above.

(24) **Restrictive relatives disallow larger RPPP:** (exx Cable, 2010)
a. This book, [$_{RC}$ [$_{RPPP}$ the reviews of *which*] were awful], is really quite nice.
b. * No book [$_{RC}$ [$_{RPPP}$ the reviews of *which*] are awful] is really quite nice.

3.3 The problem of pied-piping again

Let us now consider how Approach 3 could yield the desired semantics for non-restrictive relative clauses. Consider the LF representation of the relative clause in Approach 3, repeated here:

(25) **One attempt at interpreting RC using Approach 3:**

a. $[_{\text{RC}}\ [_{\text{RPPP}}\ \textit{whose}\ \text{talk}]\ [_{\alpha}\ \lambda x\ .\ \text{I saw}\ x\ \text{at CLS}]]$ (=12)

alt. computation *movement*

b. $[\![\alpha]\!]^{o} = \lambda x\ .\ \text{I saw}\ x\ \text{at CLS}$ type $\langle e, t\rangle$

c. $[\![\textit{who}]\!]^{f} = \{\text{John, Mary, Bill,...}\}$ set with elements of type e

d. $[\![\text{RPPP}]\!]^{f} = \{\text{talk A, talk B, talk C,...}\}$ set with elements of type e

e. $[\![\text{RC}]\!]^{f} = \left\{ \begin{array}{l} \text{I saw talk A at CLS,} \\ \text{I saw talk B at CLS,} \\ \text{I saw talk C at CLS,...} \end{array} \right\}$ set of propositions

Consider the interpretation of this structure. Like in the interpretation of *wh*-questions using alternative computation, we take the *wh* relative pronoun to have the set of animate individuals as its alternative-semantic value. This composes with the rest of the pied-piping, yielding a set of talks as the alternative-semantic denotation of RPPP. Without loss of generality, we refer to the members of this set as {talk A, talk B, talk C,...} (25d). Composing these values pointwise with α, we yield the alternative-semantic denotation for the entire RC in (25e), a set of propostions.[6]

Recall the null hypothesis in (14) above: non-restrictive relative clauses, like their restrictive counterparts, are *property-denoting*. In the case of (25), the property we want to derive is a function that takes an individual, corresponding to the relative pronoun *who*, and returns the corresponding propositions in $[\![\text{RC}]\!]^{f}$ (25e).

This desired property thus requires a mapping from *speakers* to *talks*. However, this information cannot be reverse-engineered from the set of propositions in $[\![\text{RC}]\!]^{f}$. Intuitively, the propositions in (25e) lack the information on *whose* talks are being discussed. For example, the propositions in $[\![\text{RC}]\!]^{f}$ are compatible with John having given talk A, Mary having given talk B, and Bill having given talk C, but they are also compatible with Mary having given talk A, John having given talk B, and Bill having given talk C. We are hence unable to derive the correct property denotation required by the null hypothesis (14).

Rooth (1992) notes that this construction of a "decoding function" is in general not possible (see in particular footnote 15). This "decoding" problem has been observed by previous authors who have considered Approach 3 (Sternefeld 2001, Sauerland & Heck 2003), leading them to ultimately not pursue this approach to the interpretation of RPPP.

We now seem to be at an impasse. On the one hand, evidence from intervention effects suggests the relative pronoun inside RPPP is interpreted via Rooth-Hamblin alternative computation, and disrupting this process leads to uninterpretability of the non-restrictive relative. On the other hand, we are unable to use the result of Rooth-Hamblin alternative computation to construct a property denotation for the relative clause, as required by the null hypothesis in (14), that non-restrictive relatives include a property-denoting core shared with corresponding restrictive relatives.

[6]For convenience, extensional types are presented here. These propositions can be thought of as intensionalized truth conditions, rather than as truth values.

4 Proposal

We propose to resolve this problem by rejecting the null hypothesis (14). Instead, non-restrictive relative clauses are computed directly as a proposition, rather than first computing the corresponding property.

Following the derivation illustrated in (25), however, there is still a question of identifying the appropriate proposition among those generated in $[\![\text{RC}]\!]^f$. We propose that this is done by radically contextually restricting the alternative-semantic denotation of the relative pronoun *who* to the singleton set denoting the antecedent described by the RC, (26).

(26) **Relative pronoun *who*:**

a. $[\![\mathit{who}_{\text{RP}}]\!]^o$ undefined

b. $\boxed{[\![\mathit{who}_{\text{RP}}]\!]^f = \{\mathit{antecedent}_{\text{RC}}\}}$

(27) **Regular *who*:** (Beck, 2006, a.o.)

a. $[\![\mathit{who}]\!]^o$ undefined

b. $[\![\mathit{who}]\!]^f = \{x \mid x \in D_e \text{ animate}\}$

We adopt from Sells (1985), Demirdache (1991), and Del Gobbo (2007) the idea that $\mathit{antecedent}_{\text{RC}}$ is an E-type anaphor, similar to cross-sentential anaphora. This contrasts with the denotation proposed for *wh*-words in interrogative and quantificational constructions in (27), where the alternative-semantic value of *wh* ranges over the entire set of possible corresponding short answers.

Consider now the interpretation of the non-restrictive relative in example (1) under this approach, in a context where Mary's talk was talk B:

(28) **Proposed structure and interpretation:**
"Mary, whose talk I saw at CLS, is clearly brilliant." (=1)

a. $\mathit{antecedent}_{\text{RC}}$ = Mary

b. [$_{\text{RC}}$ [$_{\text{RPPP}}$ *whose* talk] [$_{\alpha}$ λx . I saw x at CLS]]
alt. computation *movement*

c. $[\![\alpha]\!]^o = \lambda x$. I saw x at CLS — type $\langle e, t\rangle$

d. $[\![\mathit{who}_{\text{RC}}]\!]^f = \{\mathit{antecedent}_{\text{RP}}\} = \{\text{Mary}\}$ — set with element of type e

e. $[\![\text{RPPP}]\!]^f = \{\text{talk B (= Mary's talk)}\}$ — set with element of type e

f. $[\![\text{RC}]\!]^f = \{\text{I saw talk B (= Mary's talk) at CLS}\}$ — set with a single prop.

Although the resulting alternative-semantic denotation $[\![\text{RC}]\!]^f$ is still a set of propositions, it is always a *singleton set*. As a result, there is no problem identifying the proposition corresponding to the antecedent *Mary*. All that remains is to introduce this one element of $[\![\text{RC}]\!]^f$ into the discourse as a not-at-issue projective meaning. Notice that there is no step in this computation where we compute the property "λx . I saw x's talk at CLS."

Note that, because we contextually restrict $[\![\mathit{wh}]\!]^f$ to be a singleton set in (26), this proposal is very similar to the effect of enforcing coindexation between the relative pronoun and the antecedent. This alternative is illustrated in (29).

(29) **An alternative with coindexation in place of alternative computation:**
Mary$_i$, [[*who*$_i$'s brother] I met at CLS], is clearly brilliant.

The crucial difference is that, under our proposal here, we are computing the RPPP using Rooth-Hamblin alternatives—albeit the projection of a single alternative—which makes it susceptible to intervention effects. Intervention effects are unexpected under the binding approach in (29).

Because alternative computation is normally used to compute non-singleton sets of alternatives, we might wonder whether there are cases where there are, in essence, multiple antecedents, with the meaning of the non-restrictive relative ranging over this set of individuals. This does not occur. Consider the test case in (30) below, which contrasts a restrictive and non-restrictive relative:

(30) **Restrictive RC vs non-restrictive RC with plural head:**

a. Every mother [$_{\text{RC}}$ [$_{\text{RPPP}}$ *whose* son] is in the army] is concerned.
⇒ Each (relevant) mother has her own son. *restrictive*

b. Mary and Sue, [$_{\text{RC}}$ [$_{\text{RPPP}}$ *whose* son] is in the army], are concerned.
⇒ Mary and Sue have a son together. *non-restrictive*

In the restrictive case in (30a), the relative clause property is tested against each individual mother to restrict the domain of quantification. In contrast, in the non-restrictive case in (30b), the antecedent *Mary and Sue* are necessarily described together. Non-restrictive RCs do not "distribute" over antecedent individuals. There is always one (possibly plural) antecedent which is described.

The idea that the antecedent is identified by an E-type anaphor is motivated by Demirdache (1991) by showing that cross-sentential anaphora can pick out the correct referent for the antecedent of parallel non-restrictive relatives. This works in simple cases such as (31a) as well as in cases where the referent described is not an individual (31b–c) (based on Demirdache, 1991, pp. 114–116).

(31) **Non-restrictive RCs and parallel cross-sentential anaphora:**[7]

a. i. I saw Mary, [$_{\text{RC}}$ *who* was late].
ii. I saw Mary$_i$. She$_{i/*j}$ was late.

b. i. We [read *Tom Sawyer*], [$_{\text{RC}}$ *which* we had never done _ as children]. (Thompson 1971)
ii. We [read *Tom Sawyer*]$_i$. We had never done it/that$_{i,*j}$ as children.

c. i. I go there [whenever I have time], [$_{\text{RC}}$ *which* isn't actually very often]. (Sells 1985)
ii. I go there [whenever I have time]$_i$. It/that$_{i/*j}$ isn't actually very often.

Note that the ability to describe a non-individual antecedent is unique to non-restrictive relatives, pointing to a fundamental difference between the derivations of restrictive and non-restrictive relatives.

Furthermore, it is long known that non-restrictive relatives cannot be used with certain quantificational antecedents (Thorne 1972, Karttunen 1976, McCawley 1988, Potts 2002, a.o.). The availability of cross-sentential anaphora to refer to this antecedent patterns with the availability of non-restrictive relatives:

[7]These examples are modified minimally from Demirdache (1991) and the original sources she draws upon to make them sound maximally natural to our ears. In addition, for examples (b) and (c) Demirdache gives only the anaphor *it*, but the anaphor *that* is also good for us, if not better.

(32) **Limits on antecedents of non-restrictives and cross-sentential anaphora:**

a. Indefinites: (Emonds 1979, p. 236)

i. {✓One, ✓some, *each, *no} student at this conference, [$_{\text{RC}}$ *who* I talked to ___ on the phone], is happy.

ii. [{✓One, ✓some, *each, *no} student at this conference]$_i$ is happy. I talked to him/her$_i$ on the phone.

b. Non-specific indefinite under negation: (Demirdache 1991, p. 134)

i. * I didn't see a donkey, [$_{\text{RC}}$ *who/which* eats too much].

ii. * I didn't see a donkey$_i$. It$_i$ eats too much.

In addition, Demirdache (1991) notes that this approach provides a natural solution to split-antecedent relative clauses (Perlmutter & Ross, 1970), exemplified in (33a). The non-restrictive relative *who were quite similar* in (33a) describes the sum of the man and woman introduced discontinuously. Split-antecedent relative clauses have been notoriously difficult to model for common approaches to relative clause formation.[8] Example (33b) shows that cross-sentential anaphora can indeed be used to identify the correct antecedent for the relative clause in (33a).

(33) **Split-antecedent RC and parallel cross-sentential anaphor:**

a. A man$_i$ entered the room and a woman$_j$ went out, [$_{\text{RC}}$ *who*$_{i\oplus j}$ were quite similar]. (Perlmutter & Ross 1970)

b. A man$_i$ entered the room and a woman$_j$ went out. They$_{i\oplus j}$ were quite similar. (Demirdache 1991, p. 116)

5 Conclusion

In this paper we argued that restrictive and non-restrictive relative clauses have a fundamentally different semantic interpretation: while restrictive relatives are *property-denoting*, non-restrictive relatives are *proposition-denoting* (see also Del Gobbo 2007). The evidence motivating this claim came from a consideration of relative pronoun pied-piping, concentrating specifically on the behavior of intervention effects inside RPPP. Intervention effects have been shown in previous work to diagnose regions of Rooth-Hamblin alternative computation. We show that RPPP, like pied-piping in *wh*-questions, is sensitive to intervention effects.

We propose that non-restrictive relatives are interpreted through a combination of movement of a relative pronoun—with pied-piping—and alternative computation inside pied-piping. To derive the non-intersective meaning of the RC, we propose that the relative pronoun projects a singleton alternative set, corresponding to the RC's antecedent. This allows us to directly derive the proposition denoted by the RC, without first computing the corresponding property.

This proposal helps explain two differences between restrictive and non-restrictive relatives in English. First, the fact that relative pronouns must be used in order to arrive at the propositional denotation of a non-restrictive RC explains why non-restrictive relatives can only be constructed using relative pronouns, whereas restrictive relatives also have a *that*/$\emptyset$ complementizer option. Second, the semantics

[8] See McKinney-Bock (2013) for a recent review of approaches.

of Rooth-Hamblin alternative computation, used to interpret relative pronouns in non-restrictive relatives, is insensitive to syntactic barriers such as islands. This explains why RPPP in these RCs can be substantially larger than in restrictive RCs.

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