

---

# A Glue/ $\lambda$ -DRT Treatment of Resumptive Pronouns

MILTADIS KOKKONIDIS

Computational Linguistics Group, University of Oxford

miltiadis.kokkonidis@clg.ox.ac.uk

**ABSTRACT.** Anaphora and resumption, phenomena which intuitively seem to challenge resource sensitivity, have been argued to support its role in Glue. The resource deletion treatment of resumption in LFG Glue presented by Asudeh (2004) was designed to work together with the Glue resource duplication treatment of anaphora (Dalrymple et al., 1999). However, as ‘resumptive pronouns’ are mere pronouns, the choice of a treatment of anaphora that has long been found to be inadequate creates an issue. A modular treatment of pronouns using LFG, Glue, and  $\lambda$ -DRT (Kokkonidis, 2005) is the most promising alternative. A treatment of resumption for this treatment of pronouns is presented together with new insights about resource management, the new and the old treatment of resumption, and the intuitions behind them.

## 1 Introduction

It has been more than a decade since Dalrymple et al. (1993) presented Glue (Dalrymple, 2001; Kokkonidis, 2006), a compositional semantics framework for LFG (Kaplan and Bresnan, 1982; Dalrymple, 2001) based on linear logic (Girard, 1987), a resource-sensitive logic. Having a resource logic driving semantic composition suits the unordered nature of f-structure, while preserving the fundamental semantic principle (underlying also Montague-style compositionality) that the meaning of a phrase is formed by combining its semantic contributions using each of them once. A semantic version of the completeness and coherence principles (Dalrymple, 2001) is built into the formal system for meaning assembly.

Anaphora is a linguistic phenomenon that at first seems to provide counter-evidence for a hypothesis of linguistic resource-sensitivity: there is no limit to how many times an antecedent (a semantic resource) can be referred to (re-used). However, Dalrymple et al. (1999) argued that there is actually no conflict between the phenomenon of anaphora and the goal of a resource-sensitive semantic composition framework and gave a resource management analysis of pronouns in Glue. This analysis was interesting, but not without problems. As a result, a number of alternative analyses have appeared (Crouch and van Genabith, 1999; Dalrymple, 2001; van Genabith and Crouch, 1997; Kokkonidis, 2005).

Asudeh (2004) defines resumption as the existence of a surplus pronominal resource. This again creates a situation that at first seems to challenge the ability of a resource-sensitive approach to deal with the linguistic phenomenon at hand: if all semantic resources

must be used exactly once, what happens when surplus resources appear in the sentence being analysed? It turns out there is an answer to this question also. Moreover, Asudeh (2004) puts forward the proposition that his resource management analysis given in a resource-sensitive semantic composition framework owes much to the very fact that it is given in such a framework. Resource-sensitivity is thus once again argued to be a strength, not a weakness of Glue.

Kokkonidis (2005) provides an analysis of anaphora based on the classic DRT (Kamp, 1981; Kamp et al., 2005) anaphoric resolution mechanism. This analysis bypasses Glue and its resource sensitivity and is accompanied by argumentation that suggests that anaphoric resolution is not best addressed at the semantic composition layer. But as that analysis of anaphora avoids resource management while the analysis of resumption (and copy raising) of Asudeh (2004) owes much to it, the two would seem to be at odds with each other. This conflict leads to an unsatisfactory state of affairs. Ideally we would want to have the benefits of both analyses, but it is not immediately obvious how the two can be combined. Far from that, there seem to be statements in the work of Asudeh (2004) that indicate that something like that may not be possible at all. The present work shows it is.

While Kokkonidis (2005) argues that the Glue resource management approach creates more problems than it solves for anaphora and that anaphoric context management should be left to a dynamic semantic representation instead, not Glue, Asudeh (2004) attributes the success of his theory to it (p. 11):

The resource management theory is a unified theory of resumption that accounts for both resumptive pronouns and copy raising in resource logical terms, while maintaining key differences between the two phenomena that have blocked unified analyses.

While for Kokkonidis (2005) a pronoun has a Glue type like any other noun phrase, Asudeh (2004) claims that the fact that in the treatment of anaphora he uses (Dalrymple et al., 1999) pronouns have Glue types of a different form than any other semantic contribution is essential (p. 13):

Only pronouns can be used in resumption because they are the only things that have the correct form to be consumed by manager resources.

Asudeh uses a very simple analysis of pronouns. In the case of sophisticated analyses of pronouns (or indeed epithets or other noun phrases that can appear where resumptive pronouns can, assuming they are meant to be covered by the same analysis that covers resumptive pronouns) one would want their semantics incorporated into the meaning rather than deleted (p. 13):

Pronominal elements can be consumed by manager resources because it is precisely these elements whose removal is recoverable from elsewhere in the semantics.

Sections 2 and 3 outline the analyses of anaphora of Dalrymple et al. (1999) and Kokkonidis (2005) respectively. Section 4 presents a slightly improved version of the original treatment of resumption by Asudeh (2004). Section 5 shows that superficial differences between types can be deceiving, an essential insight useful throughout this paper. Section 6 presents an analysis of resumption which works in the LFG/Glue/ $\lambda$ -DRT setting of Kokkonidis (2005). Section 7 summarises the new technical results and insights obtained.

## 2 The Resource Duplication Analysis of Pronouns

The point of using linear, rather than, say, intuitionistic, types in Glue is that linear logic is resource sensitive. However, a discourse referent that is in the current context can be referenced any number of times. There may seem to be a problem with trying to treat anaphora within Glue. The antecedent-entity duplication treatment of anaphora of Dalrymple et al. (1999), the first ever analysis performing Glue resource management, addresses this issue, but this issue alone, which is why alternative treatments appeared (Crouch and van Genabith, 1999; Dalrymple, 2001; van Genabith and Crouch, 1997; Kokkonidis, 2005).

The idea behind it was simple: anaphoric resolution does not come down to free re-use of resources; it is the pronoun (overt or not) that actually triggers and manages this ‘re-use’. If the pronoun corresponds to label  $p$  and its antecedent to label  $a$  then its type will be  $e_a \multimap e_a \otimes e_p$ . The meaning of a pronoun is that of a duplicating function  $\lambda x.(x, x)$ . What this achieves is a controlled duplication of the antecedent in the Glue context. This analysis in particular and the general resource management idea behind it respectively are what Asudeh (2004) takes as the setting and the intuition for his treatment of resumption.

It is now possible to return to the question of how anaphora can be reconciled with resource sensitivity. In a sentence such as (1) it is not the case that the semantic contribution of ‘John’ can be used twice.<sup>1</sup> Glue’s resource sensitivity would not allow it. However, the semantic contribution of the pronoun has a complex meaning ( $\lambda x.(x, x)$ ). This clearly shows that the semantic representation language, in which the meanings of semantic contributions, larger units, and eventually the sentence are expressed, is not resource-sensitive. Meaning expressions themselves have no resource-sensitivity constraints, but the composition of meaning expressions into more complex ones does. Glue’s resource sensitivity does not affect at all the ability of expressing anaphoric binding within the chosen semantic representation.

$$\begin{array}{l}
 (1) \qquad \qquad \qquad \text{John likes himself.} \\
 \qquad \qquad \qquad \text{GLUE TYPING JUDGEMENT} \\
 \textit{john} : e_s, \textit{like} : (e_s \otimes e_o) \multimap t_f, \textit{himself} : e_s \multimap e_s \otimes e_o \vdash \textit{like}(\textit{himself} \textit{john}) : t_f \\
 \qquad \qquad \qquad \text{FOL SEMANTIC REPRESENTATION EXPRESSION} \\
 \qquad \qquad \qquad \text{LIKE (JOHN, JOHN)}
 \end{array}$$

$$\begin{array}{l}
 (2) \qquad \qquad \qquad \text{Everyone likes himself.} \\
 \qquad \qquad \qquad \text{GLUE TYPING JUDGEMENT} \\
 \textit{everyone} : \forall \alpha. (e_s \multimap t_\alpha) \multimap t_\alpha, \\
 \textit{like} : (e_s \otimes e_o) \multimap t_f, \vdash \textit{everyone} \lambda x. \textit{like}(\textit{himself} x) : t_f \\
 \textit{himself} : e_s \multimap e_s \otimes e_o \\
 \qquad \qquad \qquad \text{FOL SEMANTIC REPRESENTATION EXPRESSION} \\
 \qquad \qquad \qquad \forall x. \text{PERSON}(x) \Rightarrow \text{LIKE}(x, x)
 \end{array}$$

---

<sup>1</sup>Plausible as this may look for ‘John’ in (1), note that it is not for ‘everyone’ in (2).

With reference to LFG, an advantage of this approach (and those of Crouch and van Genabith (1999) and Dalrymple (2001) which also place anaphoric resolution at the semantic composition level) over the one combining Glue with CDRT described by van Genabith and Crouch (1997) is that it can capture syntactic constraints on anaphora. This is done by a constraint on what can be the pronoun’s antecedent. However it has problems in treating intrasentential anaphora (Dalrymple et al., 1999; Dalrymple, 2001; Kokkonidis, 2005). As resumption is an intrasentential phenomenon, Asudeh (2004) whose concern was to best present his treatment of resumption did well to choose the simplest analysis of anaphora available at the time that enabled him to express antecedent constraints needed in his analysis even if that analysis has problems in dealing with intersentential anaphora and covering the spectrum of pronoun interpretation. But, as resumptive pronouns are ordinary pronouns, the analysis of pronouns used as the basis of an analysis of resumption must be one that covers anaphora as fully as possible. The state of the art is not very advanced, but the following analysis is possibly a good starting point for future work.

### 3 A Glue + $\lambda$ -DRT analysis of pronouns

Kokkonidis (2005) presented a modular analysis of pronominal anaphora using LFG, Glue and  $\lambda$ -DRT that deals with a number of issues more successfully and arguably more elegantly than preceding analyses.

If there is a pronoun and it makes up a noun phrase labelled  $p$ , then its type will be  $\forall\alpha.(e_p \multimap t_\alpha) \multimap t_\alpha$ . The dynamic semantics will take care of the anaphora. The meaning assigned to a pronoun<sup>2</sup> found at f-structure  $p$  will be:

$$\lambda P. \boxed{\begin{array}{l} x : e_{\hat{p}} \\ x = ? \end{array}} \sqcup P(x).$$

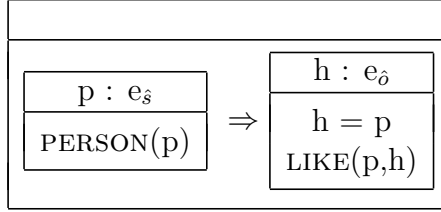
It will be up to DRT (augmented with a simple type system for discourse referents) to resolve  $?$  to an accessible discourse referent of a type compatible with the mandates of any syntactic constraints captured in terms of labels and the  $\wedge$  function mapping f-structures to anaphoric indices. Kokkonidis (2005) provides more details. Here is an example of a sentence and its anaphorically resolved DRS, whereby the  $?$  has been replaced by the only accessible discourse referent that obeys the constraint imposed by the syntactic properties of ‘himself’, namely that it is co-indexed with ‘everyone’:<sup>3</sup>

$$(3) \quad \begin{array}{l} \text{Everyone}_1 \text{ likes himself}_1. \\ \text{GLUE TYPING JUDGEMENT} \\ \text{everyone} : \forall\alpha.(e_s \multimap t_\alpha) \multimap t_\alpha, \\ \text{like} : (e_s \otimes e_o) \multimap t_f, \vdash \text{everyone } \lambda x. \text{himself } \lambda y. \text{like } x \ y : t_f \\ \text{himself} : \forall\beta.(e_o \multimap t_\beta) \multimap t_\beta \end{array}$$

<sup>2</sup>We will only be dealing with singular anaphora.

<sup>3</sup>This is expressed as  $\hat{o} = \hat{s}$ , which implies that  $e_{\hat{o}}$  is the same type as  $e_{\hat{s}}$ , as a result of which the type rules allow  $h = p$ .

DRT SEMANTIC REPRESENTATION EXPRESSION



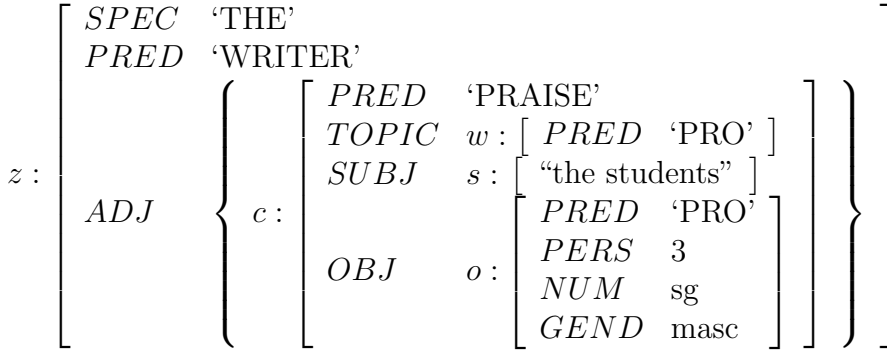
Note that the combination of LFG syntactic constraints and DRT semantic form constraints rules out the reading whereby ‘himself’ outscopes ‘everyone’. It also rejects the co-indexing of (4). There the constraint preventing co-indexation is one of accessibility. The idea of combining syntactic and semantic form constraints is an elegant and powerful one.

- (4) \*Nobody<sub>1</sub> came. He<sub>1</sub> laughed.

## 4 The deletion treatment of resumption

For our discussion of resumption we will be using the following example from Irish. In Irish there are two different versions of ‘a’, referred to as a*L* and a*N*, which behave differently with respect to resumption. Oversimplifying, one can say that a*N* licences resumptive pronouns while a*L* does not. Here we have an example involving a*N* and a resumptive pronoun (é).

- (5) an scríbeoir a molann na mic léinn é  
the writer a*N* praise the students him  
the writer who the students praise (him)



$$\Gamma = \begin{array}{l} the_z : \forall \alpha. (e_z \multimap t_z) \multimap (e_z \multimap t_\alpha) \multimap t_\alpha, \\ writer : e_z \multimap t_z, \\ rel : (e_w \multimap t_c) \multimap ((e_z \multimap t_z) \multimap (e_z \multimap t_z)), \\ the_s : \forall \beta. (e_s \multimap t_s) \multimap (e_s \multimap t_\beta) \multimap t_\beta, \\ students : e_s \multimap t_s, \\ praise : e_s \multimap e_o \multimap t_c, \\ him : e_w \multimap e_w \otimes e_o, \\ mngr : (e_w \multimap e_w \otimes e_o) \multimap (e_w \multimap e_o) \end{array}$$

Asudeh (2004) regards resumptive pronouns as ‘surplus resources’: a Glue derivation that would have been possible with a gap is no longer possible when an extraneous resumptive pronoun appears. In places where they are not meant to appear, this is exactly what he wants his analysis to predict. Indeed, he relies on Glue to complement syntax.<sup>4</sup> However, where resumptive pronouns are allowed, Glue derivations should be possible. If the treatment for, say, relative clauses is such that no resumptive pronouns are expected then when they appear, they indeed become extraneous for Glue. This is the setup Asudeh (2004) assumes. The solution he proposes is simple: as the surplus resource (the resumptive pronoun) prohibits a Glue derivation, its presence should be neutralised if and only if it is permitted according to the rules of the language. This task falls upon the resumption licenser. There are two flavours of deletion that I am aware of. In the one proposed by Asudeh (2004) it is the pronoun itself that is ‘deleted’, whereas in a variation of that (Mary Dalrymple, 2006, personal communication), it is its effect that is ‘deleted’ instead. Only Asudeh’s version will be considered here.

As a matter of fact what is called here a deletion treatment of resumption is not meant to be literally taken as involving deletion of anything either from the f-structure or from the Glue typing context. What happens instead is that a semantic contribution, a manager resource as Asudeh calls them, is added to the typing context, courtesy of the resumption licenser. The only role of this resource manager is to consume the resumptive pronoun and return nothing or something very similar to nothing. ‘Nothing’ in this context is  $() : 1$  as found in both linear and intuitionistic logic, but an alternative value, something very similar to ‘nothing’, the identity function  $(\lambda x.x)$  with glue type  $e_a \multimap e_a$  (where  $a$  is the label of the antecedent of the resumptive pronoun) is actually a better choice in terms of not introducing additional complexity in Glue and in the resulting terms. So with reference to example (5), Asudeh’s resource manager would be  $mng_r : (e_w \multimap e_w \otimes e_o) \multimap (e_w \multimap e_w)$ . Its semantics would be  $\lambda p.\lambda x.x$  where one can see that  $p$  i.e. the semantic expression corresponding to the resumptive pronoun is consumed and made no use of, which is why I call this a deletion treatment of resumption.

But the fact that there is a surplus contribution for a resumptive pronoun in the typing context is not the only way that that pronoun manifests itself in a way that affects the Glue derivation. Asudeh’s resource manager will combine with that resource giving an identity function that affects neither the derivation nor the semantics. As far as resource accounting goes it will be as if that surplus resource never existed. But the presence of the resumptive pronoun is also evident in the f-structure where it fills a position that would have otherwise been linked to another part of the f-structure. In the resumption-less version of (5) the object  $o$  of the inner clause  $c$  is the topic  $w$  i.e.  $o = w$ . In (5) where we have a resumptive pronoun in  $o$ , the f-structures for  $o$  and  $w$  are distinct. Because of this difference in the f-structure, the effect of the resumptive pronoun is manifest in the Glue typing context in a way that Asudeh’s resource manager does not do anything

---

<sup>4</sup>This is a role Glue can play to some extent in addition to its normal role of composing meanings. The work of Fry (1999) with Glue in negative polarity licensing also uses Glue for similar purposes.

about. It does consume the contribution of the resumptive pronoun, but its presence is still evident in the Glue type of the relative clause. If we consider the first six elements (that is ignoring the resumptive pronoun and its corresponding resource manager) of the typing context for (5) we see that  $rel$  expects an argument of type  $e_w \multimap t_c$  but  $e_w$  is mentioned nowhere else among those six elements. Asudeh’s solution is to introduce a relabeler resource  $relab : (e_o \multimap t_c) \multimap (e_w \multimap t_c)$  with semantics  $\lambda P.P$ . A simpler version of that is  $relab : e_o \multimap e_w$  with semantics  $\lambda x.x$ .

Simplifying Asudeh’s treatment one step further, one can simply provide instead of a contribution that deletes the resumptive pronoun and another that performs relabelling a single resource manager that does both. This has the exact same semantics as Asudeh’s but its Glue type is a bit different:  $(e_w \multimap e_w \otimes e_o) \multimap (e_w \multimap e_o)$ . This is what was used in the typing context for (5). It has the form (resumptive pronoun)  $\multimap$  (relabeler). This is preferable to the proposal of Asudeh (2004) of having a combination of a resource manager ((resumptive pronoun)  $\multimap$  (identity function)) and a relabeler, both because there is no need to introduce an identity function in the process of ‘deleting’ the resumptive pronoun and because one instead of two semantic contributions are made by the resumption licenser.

Asudeh (2004) notes that in order to account for what are called mixed chains in Irish aN may need to only contribute a relabeler rather than both that and a resource manager. This is expressed naturally also in our view: either aN consumes a resumptive pronoun and does relabelling ( $mngr : (e_w \multimap e_w \otimes e_o) \multimap (e_w \multimap e_o)$ ) or it only does relabelling ( $relab : e_o \multimap e_w$ ).

## 5 The issue of form

Pronouns in the antecedent-entity duplication approach of Dalrymple et al. (1999) have Glue types of a different form than any other semantic contribution. According to Asudeh (2004) this difference in form prohibits, at the Glue layer, anything other than a pronoun being licensed by resumption licensers. Such a difference in form between pronouns and other phrases does not exist when Glue is combined with  $\lambda$ -DRT (Kokkonidis, 2005). A Glue treatment of  $\lambda$ -DRT resumptive pronouns must ideally offer all the benefits of the treatment proposed by Asudeh (2004) for antecedent-entity duplicating pronouns. An *a priori* criticism that emerges for any Glue treatment of  $\lambda$ -DRT resumptive pronouns is that, as pronouns will have types similar in form to those of other noun phrases, a resource manager will not be able to distinguish a resumptive pronoun from, say, a proper name: if we take any grammatical sentence with a resumptive pronoun and replace that pronoun with a proper name, their types will be the same and Glue will not be able to tell the difference and reject that sentence. This is certainly true. But that would also have been the case with the original analysis of Asudeh (2004). Despite appearances, antecedent entity duplicating pronouns are *not* “the only things that have the correct form in the resource logic to be consumed by manager resources” in Asudeh’s analysis either.

To understand why Glue can not make this distinction, we should note that both a quantifier  $\forall \alpha.(e_x \multimap t_\alpha) \multimap t_\alpha$  and a pronoun  $e_a \multimap e_a \otimes e_x$  (in the antecedent entity

duplication analysis of Dalrymple et al. (1999)) are indirect (and somewhat constrained) ways of offering  $e_x$ . If we have an entity  $e_a$  corresponding, say, to a proper name, it is possible to derive an expression with a quantifier type (good old type raising):

$$alonso : e_x \vdash \lambda P. P \ alonso : \forall \alpha. (e_x \multimap t_\alpha) \multimap t_\alpha.$$

Similarly it is possible to obtain an expression with a pronoun type:

$$alonso : e_x \vdash \lambda x. (x, alonso) : e_a \multimap e_a \otimes e_x.$$

The power of Glue makes superficial differences in the form of types irrelevant. If it is only pronouns that we want resumption licensers to allow, this can be specified by means of a syntactic form constraint.

## 6 A Glue/ $\lambda$ -DRT treatment of resumption

The two new kinds of semantic contributions Asudeh (2004) introduced, namely resource managers and relabelers, were fairly simple and corresponded well to his intuition. The problem with simple solutions is that they are best appreciated when presented after confused complex alternatives. The Glue/ $\lambda$ -DRT treatment of resumption is also trivial, but a number of less trivial alternatives were rejected before it emerged. What is also interesting is how similar it is to a treatment of resumption in the setting of Dalrymple et al. (1999) not considered previously.

- (6) an scríobneoir a molann na mic léinn é  
the writer aN praise thee students him  
the writer who the students praise (him)

$$z : \left[ \begin{array}{l} SPEC \text{ 'THE'} \\ PRED \text{ 'WRITER'} \\ \\ \\ ADJ \left\{ \begin{array}{l} c : \left[ \begin{array}{l} PRED \text{ 'PRAISE'} \\ TOPIC \ w : \left[ \begin{array}{l} PRED \text{ 'PRO'} \\ SUBJ \ s : \left[ \begin{array}{l} \text{"the students"} \end{array} \right] \\ PRED \text{ 'PRO'} \\ PERS \ 3 \\ NUM \ sg \\ GEND \ masc \end{array} \right] \end{array} \right] \end{array} \right\} \\ OBJ \ o : \left[ \begin{array}{l} PRED \text{ 'PRO'} \\ PERS \ 3 \\ NUM \ sg \\ GEND \ masc \end{array} \right] \end{array} \right] \end{array} \right]$$

$$\Gamma = \begin{array}{l} the_z : \forall \alpha. (e_z \multimap t_z) \multimap (e_z \multimap t_\alpha) \multimap t_\alpha, \\ writer : e_z \multimap t_z, \\ rel : (e_w \multimap t_c) \multimap ((e_z \multimap t_z) \multimap (e_z \multimap t_z)), \\ the_s : \forall \beta. (e_s \multimap t_s) \multimap (e_s \multimap t_\beta) \multimap t_\beta, \\ students : e_s \multimap t_s, \\ praise : e_s \multimap e_o \multimap t_c, \\ him : \forall \gamma. (e_o \multimap t_\gamma) \multimap t_\gamma, \\ mngr : ??? \end{array}$$

Let us recap. In example (6) we have a common noun (“scríbhneoir”, Glue:  $writer : e_z \multimap t_z$ ), which corresponds to  $R$ , a function from entities to DRSs that is to be modified by the relative clause. We also have a complete inner clause (“molann na mic léinn é”, Glue:  $the_s students \lambda s.him (praise s)$  or  $him \lambda h.the_s students \lambda s.praise s h$ ). That inner clause corresponding to English “the students praise him” is complete. It can be given two Glue readings both of which correspond to the same DRS  $C$ . Note that in this view the resumptive pronoun is not a surplus resource; its contribution namely a new discourse referent, let us call it  $\chi$ , and a condition  $\chi = ?$  have been incorporated into  $C$ . Note also that in this view the presence of a resumptive pronoun does not necessitate any mention of relabelling. Finally, the meaning of  $R$  modified by the relative clause is simply  $\lambda x.(R x) \sqcup C$  where  $?$  is somehow instantiated to whatever  $x$  is.

We know that  $x$  will be the discourse referent introduced by the meaning of  $the_z$ . Let us call it  $\zeta : e_z$ . Using the coindexation constraints of Kokkonidis (2005) and knowing that  $\hat{w} = \hat{z}$ , all that needs to be added is a constraint  $\hat{o} = \hat{w}$ . Even without a discourse referent for the relativiser, the transitivity provided by this setup for syntactic constraints on anaphora, guarantees that  $\hat{o} = \hat{z}$  which means that in  $\chi = ?$ ,  $?$  can only be  $\zeta$  (or a discourse referent equal to  $\zeta$ ). This takes care of one issue. The other is actually merging those two DRSs.

This is the job of the meaning of  $rel : (e_w \multimap t_c) \multimap ((e_z \multimap t_z) \multimap (e_z \multimap t_z))$  with semantics  $\lambda F.\lambda R.\lambda x.(F x) \sqcup (R x)$ . But  $C : t_c$  is complete as it is, it does not depend on  $x$  in the sense a function from entities to DRSs would normally depend on its argument although it does in a different way as its metavariable  $?$  will be equal to whatever  $x$  is thanks to the  $\hat{w} = \hat{z}$  constraint. If we want to avoid changing  $mngr$ , what we can do is introduce

$$mngr : t_c \multimap e_w \multimap t_c$$

with semantics  $\lambda C.\lambda x.C$ . Notice that what we would normally want, to ensure that  $C$  depends on  $x$  is not done through function application here, but through anaphoric resolution within the DRS  $C$ . As  $x$  is not used in the semantics, the new analysis given resembles a resource deletion analysis.

Let us provide such an analysis also. We will take something as being a surplus resource. But instead of claiming that this is the entity of the resumptive pronoun, the way we have described things it is the entity the relativiser offers to fill the gap no longer there in the relative clause that is a surplus resource now. This explanation, to repeat the point once again, comes with no need to refer to a concept of relabelling. The manager resource needs to have a type that consumes  $e_w$  and return nothing or, for practical reasons, something close to nothing i.e. an identity function. One fairly attractive possibility is

$$mngr : e_w \multimap t_c \multimap t_c$$

If we regard this and the previous version of the manager resource as functions of two arguments, the only difference is the order of the arguments. The corresponding semantics for this version is  $\lambda x \lambda C.C$ . Another possibility, with identical (modulo types) semantics i.e.  $\lambda x \lambda y.y$ , is

$$mngr : e_w \multimap e_o \multimap e_o$$

This is interesting for another reason. The effect deletion treatment of resumption (Mary Dalrymple, 2006, personal communication) in the setting with the pronouns of Dalrymple et al. (1999) for this example would give a resource manager

$$mng_r : (e_w \otimes e_o) \multimap e_w.$$

If we were to apply the same idea of combining that with the relabeler as we did for the proposal of Asudeh (2004), we would get

$$mng_r : (e_w \otimes e_o) \multimap e_o.$$

The curried version of that is

$$mng_r : e_w \multimap e_o \multimap e_o.$$

The pronouns were different, the idea was to delete rather than use the pronoun meaning, what was considered as a ‘surplus resource’ was the  $e_o$  added by the resumptive pronoun rather than the  $e_w$  supplied by the relative clause construction, yet the result is the same! This brings us back to the question of form: pronouns in both approaches are there to offer an entity, of type  $e_o$  in the given example. It should not come as a surprise that resource managers designed for one kind of pronoun will work with the other.

What really changes when  $\lambda$ -DRT pronouns are used is the anaphoric coindexing constraint for the benefit of label-sensitive DRT anaphoric resolution (Kokkonidis, 2005) that replaces a similar constraint expressed in terms of an ANTECEDENT feature used with the antecedent-entity duplication treatment of anaphora (Asudeh, 2004). This difference becomes more interesting when mixed chains in Irish are investigated, but space limitations prohibit such a venture here.

## 7 Conclusions

The aim of this work was to provide a Glue treatment of resumption that would work with  $\lambda$ -DRT pronouns, but would retain all advantages of the one Asudeh (2004) gave for antecedent-entity duplicating pronouns (Dalrymple et al., 1999). This seemed to be a challenge; some apparent obstacles seemed easy to overcome, some not.

Before contemplating a treatment of resumption for the LFG/Glue/ $\lambda$ -DRT setting, it seemed that it would be impossible for any such treatment to have a certain property Asudeh’s treatment had hitherto been assumed to have. However, further investigation showed Asudeh’s system did not have the property that a pronoun is the only kind of Glue semantic contribution a resource manager may consume as its argument either. The only difference is that this is obvious from the start in the new setting, but obscured by the superficial difference in form between the types typically associated with pronouns as opposed to those typically associated with other noun phrases in the original setting. That pronouns are a syntactic concept means that that if it is only them that we want resumption licensers to allow, syntax should have been where we would normally first try to place such a constraint anyway. That Glue can not help here is not really an issue.

It is possible to argue, even convincingly perhaps, that there is no conflict between the aversion of Kokkonidis (2005) to resource management in the antecedent-entity duplication treatment of anaphora and a treatment of resumption along the lines of Asudeh’s original resource management (deletion) treatment because the later manages (deletes) resumptive pronouns whatever they may be. Something we have not seen is that trying to consume a  $\lambda$ -DRT pronoun will only work sometimes, that is in some Glue readings. What we have seen though is that resource managers designed for the LFG/Glue/ $\lambda$ -DRT setting can be independently motivated in the antecedent-entity duplication setting and vice versa. This is a much stronger response to the question of what problems there will be when trying a resource management approach for resumption in a setting where anaphora does not involve resource management at the Glue level: there is no issue and no difference whatsoever. The new treatment is, as far as the resource managers go, identical to a treatment deleting the entity resource contributed by a pronoun. Even Asudeh’s original ‘pronoun consuming’ resource managers can be transferred without modification to the new setting. It is Glue’s flexibility that makes exact form irrelevant in most cases and the fact that pronouns in both settings offer an entity resource that is the reason of this similarity. Also the fact that one can choose not to take the approach that the pronoun is surplus and still get the same results is due to the fact than in the presence of resumption there are two equal entities competing for one place so which one is chosen is irrelevant. Different intuitions lead to the same result.

Finally, given their similarity an expectation that the new analysis that did not try to delete the resumptive pronoun but use its meaning would have an advantage over the ‘pronoun deletion’ approach of Asudeh (2004) when the pronoun is replaced by something that does carry more meaning, such as an epithet, is now easily seen not to be true. An independent clue could have been that his resource managers only involve entities, not statements about those entities, in effect deleting one. The whole meaning expression of a pronoun may not be recoverable from elsewhere but this entity, being equal to another, is.

The goal of obtaining a Glue analysis for  $\lambda$ -DRT pronouns was achieved not only thanks to the Glue analyses the paper concentrated on, but also thanks to the simple and elegant way of syntactically restricting DRT anaphoric resolution of Kokkonidis (2005). It is thanks to that that only correct DRT readings are obtained after anaphoric resolution. In retrospect it is this part of the analysis that is most important rather than the trivial Glue resource managers. With respect to Glue, the insight developed by investigating the topic from a different perspective was the main benefit, more important than the new simpler resource managers surprisingly applicable in both the old and the new settings. The original goal was achieved, albeit in an unexpected manner. We set out to sail to the end of the world only to come back where we came from; but we now know that it is round.

## Acknowledgements

I wish to thank Mary Dalrymple and Ash Asudeh for a number of interesting discussions that have greatly influenced this paper and the two anonymous reviewers for their comments and suggestions.

---

## Bibliography

- Asudeh, A. (2004). *Resumption as resource management*. Ph.D. dissertation, Stanford University.
- Crouch, R. and J. van Genabith (1999). Context change, underspecification, and the structure of glue language derivations'. See Dalrymple (1999).
- Dalrymple, M. (Ed.) (1999). *Semantics and Syntax in Lexical Functional Grammar: The Resource Logic Approach*. MIT Press.
- Dalrymple, M. (2001). *Lexical Functional Grammar*. Number 42 in Syntax and Semantics Series. Academic Press.
- Dalrymple, M., J. Lamping, F. C. Pereira, and V. Saraswat (1999). Quantification, anaphora, and intensionality. See Dalrymple (1999).
- Dalrymple, M., J. Lamping, and V. Saraswat (1993). LFG semantics via constraints. In *Proceedings of the Sixth Meeting of the European ACL*, University of Utrecht, pp. 97–105. European Chapter of the Association for Computational Linguistics.
- Fry, J. (1999). Proof nets and negative polarity licensing. See Dalrymple (1999).
- Girard, J.-Y. (1987). Linear logic. *Theoretical Computer Science* 50, 1–102.
- Kamp, H. (1981). A theory of truth and representation. *Formal Methods in the Study of Language*.
- Kamp, H., J. van Genabith, and U. Reyle (2005). Discourse representation theory. Draft of chapter in the forthcoming Gabbay, D. and Guenther, F. (eds.) *Handbook of Philosophical Logic*, Vol.2, Springer.
- Kaplan, R. M. and J. Bresnan (1982). Lexical functional grammar: A formal system for grammatical representation. In J. Bresnan (Ed.), *The Mental Representation of Grammar Relations*, pp. 173–281. MIT Press.
- Kokkonidis, M. (2005). Why glue your donkey to an f-structure when you can constrain and bind it instead? In M. Butt and T. H. King (Eds.), *Proceedings of the LFG05 Conference*. CSLI Publications.
- Kokkonidis, M. (2006). First-order Glue. *Journal of Logic, Language and Information*. To appear.
- van Genabith, J. and R. Crouch (1997). How to glue a donkey to an f-structure or porting a dynamic meaning representation language into LFG's linear logic based glue language semantics. In *Proceedings of the International Workshop for Computational Semantics*, Tilburg, pp. 52–65.