Evidence for Parallel Composition from Resumptive Pronouns

Ash Asudeh
ash_asudeh@carleton.ca
Carleton University

April 16, 2010
MIT

1 Introduction

- Modern theoretical linguistics in the broad generative tradition is based on three observations:
  1. Language is a mapping between form and meaning.
  2. Language must be learnable.
  3. Language is creative.
- The basic formal mechanism that has been developed on the syntactic side to explain these properties is *recursion*.
- The semantic correspondent of recursion is *compositionality*.
- **Principle of Compositionality**:
  The meaning of a linguistic expression is fully determined by the meanings of its parts and their arrangement.
- There are two approaches to compositionality and the syntax–semantics interface:
  1. **Parallel composition theories**: Syntax and semantics are built up in parallel.

     Other common terms for this family of theories are *rule-by-rule theories* and *categorial theories*.
  2. **Interpretive composition theories**: Semantics interprets the output of syntax.

     The most common exemplar of this kind of theory is Logical Form semantics.
- Modern theoretical semantics has grown out of the strongly model-theoretic tradition of Montague. Perhaps as a consequence, most semanticists view these two approaches as equivalent, except perhaps with respect to certain fine points of theory (e.g., Jacobson 1999, Barker and Jacobson 2007).

2 Main Question

- **Is there empirical evidence for the correct theory of composition?**
- **Anticipating the answer:** *Yes*
  Evidence from the typology, syntax and semantics of resumptive pronouns shows:
  1. A unification of puzzlingly heterogeneous kinds of resumption is possible if resumption is viewed as a problem of parallel semantic composition.
  2. *The parallel composition view of resumption can explain differences in the interpretation of resumptive pronouns and gaps, despite their syntactic equivalence in certain languages.*

3 Overview

1. *Introduction*
2. *Main Question*
3. *Overview*
4. Background
   (a) McCloskey's generalization
   (b) Two kinds of grammaticized resumption
   (c) Lexical Functional Grammar
   (d) Glue Semantics
   (e) Resource Management Theory of Resumption
5. Data
   (a) Irish
   (b) Vata
   (c) Swedish
6. Emergent Generalizations
7. Informal Analysis
8. Theoretical Consequences
9. Conclusion

4 Background

4.1 Two Kinds of Grammaticized Resumption

1. *Syntactically active resumptives* (SARs)
   Do not display gap-like properties
   Sample languages: Irish, Hebrew, varieties of Arabic, . . .

   (1) an ghirseach a-r ghoid na síogaí í (Irish; McCloskey 2002: 189)
   the girl COMP-PAST stole the fairies her
   'the girl that the fairies stole away'

2. *Syntactically inactive resumptives* (SIRs)
   Do display gap-like properties.
   Sample languages: Vata, Swedish

   (2) àlɔ́ ɔ̀ lɛ̄ sə̀ká lə̀ (Vata; Koopman 1982: 128)
   who he eat rice *wh*
   'Who is eating rice?'

	Syntactically Active RPs	Syntactically Inactive RPs
Grammatically Licensed	Yes	Yes
Island-Sensitive	No	Yes
Weak Crossover Violation	No	Yes
Reconstruction Licensed	No	Yes
ATB Extraction Licensed	No	Yes
Parasitic Gap Licensed	No	Yes
Non-Specific/*De Dicto* Interpretation	No	No
Pair-List Answers	No	No

Table 1: Some properties of SARs and SIRs

- Syntactic representation of SARs and SIRs (English used purely for exposition)

Target: [*Who did Jane see him?*]

RP is syntactically active

$$\begin{bmatrix} \text{PRED} & \text{'see}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{UDF} & \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PRONTYPE} & \text{Q} \end{bmatrix} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'Jane'} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PERSON} & 3 \\ \text{NUMBER} & \text{SG} \\ \text{GENDER} & \text{MASC} \end{bmatrix} \end{bmatrix}$$

RP is syntactically inactive

$$\begin{bmatrix} \text{PRED} & \text{'see}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{UDF} & \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PRONTYPE} & \text{Q} \\ \text{PERSON} & 3 \\ \text{NUMBER} & \text{SG} \\ \text{GENDER} & \text{MASC} \end{bmatrix} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'Jane'} \end{bmatrix} \\ \text{OBJ} & \end{bmatrix}$$

4.2 McCloskey's Generalization

- McCloskey (2006: 97):

> A fundamental question, which has not often been explicitly addressed, but which lies behind much of the discussion is why resumptive elements have the form that they do. That is, resumptive pronouns simply *are* (formally) pronouns. I know of no report of a language that uses a morphologically or lexically distinct series of pronouns in the resumptive function. If we take this observation to be revealing, there can be no syntactic feature which distinguishes resumptive pronouns from ordinary pronouns, and any appeal to such a feature must be construed as, at best, an indication of the limits of understanding. (emphasis in original)

- Two direct consequences of McCloskey's generalization are the following:

  1. There can be no underlying lexical/morphological/featural distinction specific to only resumptive pronouns in a language *L*. Any pronoun of *L* that occurs resumptively must also occur in other environments.
  2. There can be no process of syntactic insertion or semantic composition that is specific to only resumptive pronouns in a language *L*. Resumptives of *L* are inserted and composed just as non-resumptive pronouns of *L* are.

- This points to a division of theories of resumption into two kinds:

(3) **Ordinary Pronoun Theory (of Resumption)**:
No lexical/morphological/featural/syntactic difference between resumptive pronouns and referential or bound pronouns

(4) **Special Pronoun Theory (of Resumption)**:
Some lexical/morphological/featural/syntactic difference between resumptive pronouns and referential or bound pronouns

4.3 Lexical Functional Grammar

- LFG is a declarative, constraint-based linguistic theory (Kaplan and Bresnan 1982).
- The motivation behind LFG is to have a theory that contributes in three ways to our understanding of language:
  1. Theory, including language universals and typology
  2. Psycholinguistics, including language acquisition
  3. Computational linguistics, including automatic parsing and generation, machine translation, and language modelling (typically known as 'grammar engineering')

4.3.1 The Correspondence Architecture

- The grammatical architecture of LFG posits that different kinds of linguistic information are modelled by distinct data structures, all of which are present simultaneously.
- Structures are related by functions, called correspondence or projection functions., which map elements of one structure to elements of another.
- This architecture is a generalization of the architecture of Kaplan and Bresnan (1982) and is called the *Parallel Projection Architecture* or *Correspondence Architecture* (Kaplan 1987, 1989, Halvorsen and Kaplan 1988, Asudeh 2006, Asudeh and Toivonen 2009).
- Syntax: constituent structure (c-structure) and functional structure (f-structure).
- C-structure is represented by phrase structure trees:
  1. Word order
  2. Dominance
  3. Constituency
  4. Syntactic categories
- F-structure is represented by feature structures (also known as attribute value matrices):
  1. Grammatical functions, such as SUBJECT and OBJECT
  2. Case
  3. Agreement
  4. Tense and aspect
  5. Local dependencies (e.g., control and raising)
  6. Unbounded dependencies (e.g., question formation, relative clause formation)
- There are two principal methods for capturing the relations between structures:
  1. Description by analysis
  2. Codescription
- Description by analysis: one structure is analyzed to yield another structure (Halvorsen 1983)
- Codescription: a single description simultaneously describes various structures (Fenstad et al. 1987, Halvorsen and Kaplan 1988)

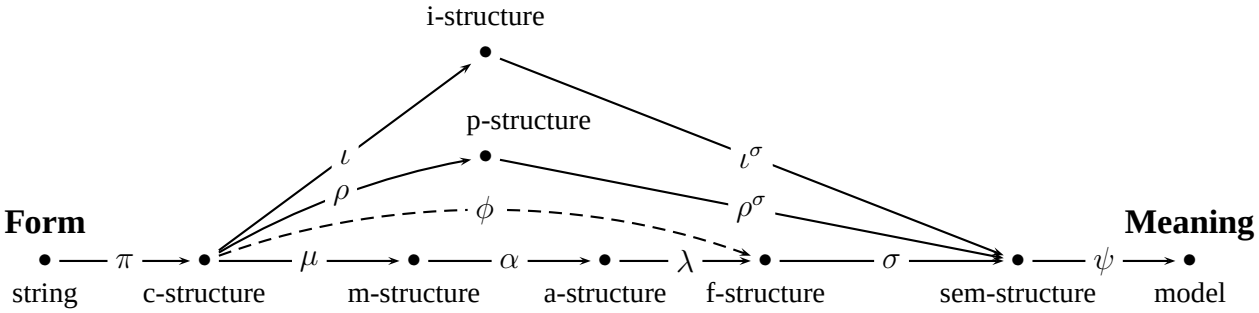


Figure 1: The Correspondence Architecture of Lexical Functional Grammar (Asudeh 2006)

4.3.2 Unbounded Dependencies

- There are versions of LFG that postulate traces/empty categories at the base of (at least some) unbounded dependencies (Bresnan 1995, 2001) and versions which eliminate traces entirely (Kaplan and Zaenen 1989, Dalrymple 2001).

- All else being equal, elimination of traces is more parsimonious: I assume the traceless variant.

- An unbounded dependency involves equations of one of the following two general forms:

  (5) $(\uparrow \textbf{Top}) = (\uparrow \textbf{Body} \quad \textbf{Base})$

  (6) $(\uparrow \textbf{Top})_\sigma = ((\uparrow \textbf{Base})_\sigma \text{ ANTECEDENT})$

- The top of the unbounded dependency is an unbounded dependency function, traditionally TOPIC or FOCUS (King 1995).

- I will instead assume a single function, UDF (UNBOUNDED DEPENDENCY FUNCTION).

- A UDF function must be properly integrated into the f-structure, in accordance with the Extended Coherence Condition (Zaenen 1980, Bresnan and Mchombo 1987, Asudeh and Toivonen 2009), which states that a UDF must either a) be functionally equal to or b) anaphorically bind another grammatical function.

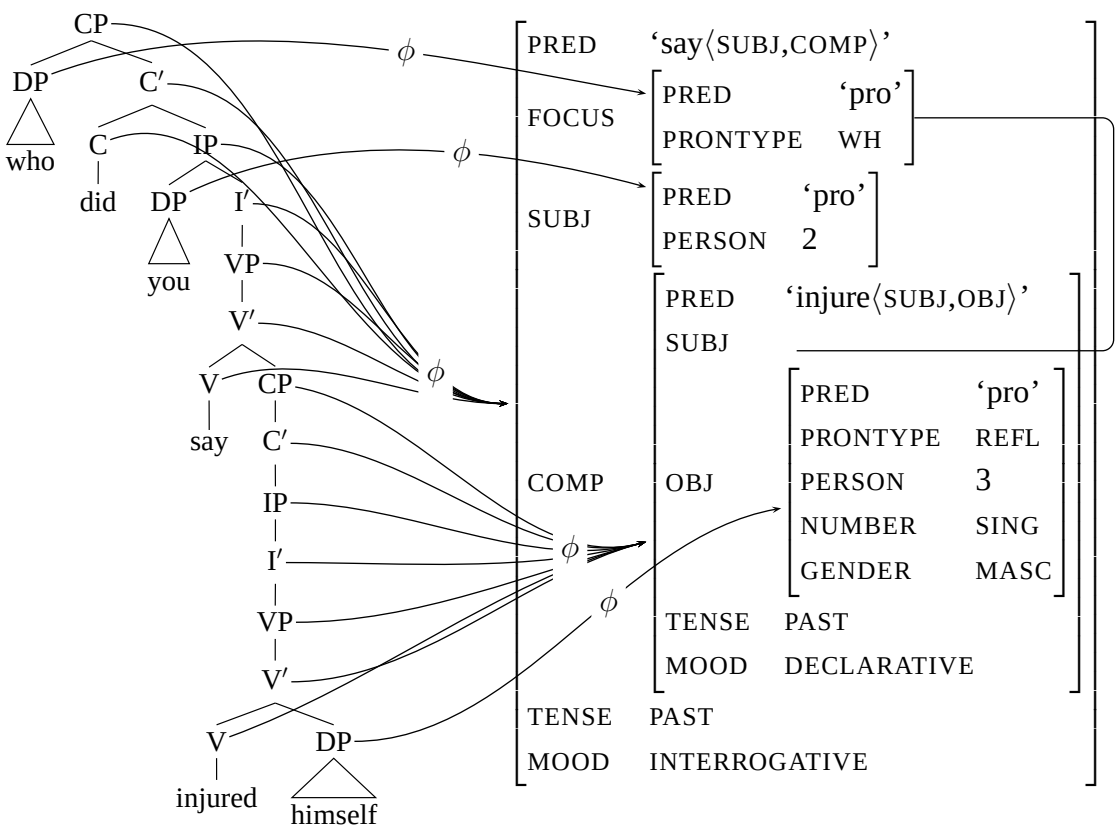
- Functional equality involves equations of the form (5). Anaphoric binding involves equations of the form (6). The type of equation in (6) involves the σ projection to sem(antic)-structure, since it is assumed that the ANTECEDENT feature for anaphoric binding is represented at sem-structure (Dalrymple 1993).

- The crucial difference between syntactically active resumptives and syntactically inactive resumptives is whether the relation between the binder and the resumptive is anaphoric binding — appropriate for SARs — or functional equality — appropriate for SIRs. I thus follow McCloskey's general suggestion that the two different kinds of grammaticized resumptives form different sorts of relations with their binders, but recast it in LFG-theoretic terms.

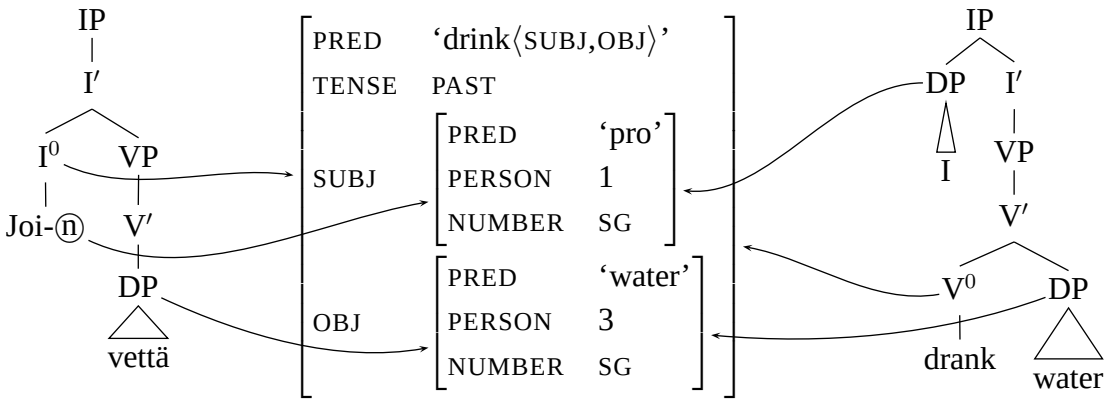
- This will allow the crux of the two kinds of resumption to be uniform and will allow McCloskey's generalization to be upheld.

4.3.3 Examples

(7)



(8)



4.4 Glue Semantics

- Glue Semantics (Dalrymple 1999, 2001, Asudeh 2004, Lev 2007, Kokkonidis 2008) is a theory of semantic composition and the syntax–semantics interface.
- Glue *meaning constructors* are obtained from lexical items instantiated in particular syntactic structures.

  (9) $\mathcal{M} : G$

  $\mathcal{M}$ is a term from some representation of meaning, a *meaning language*, and G is a term of the Glue logic that sticks meanings together, i.e. performs composition. The colon is an uninterpreted pairing symbol.
- Linear logic (Girard 1987) serves as the Glue logic (Dalrymple et al. 1993, 1999a,b).
- The meaning constructors are used as premises in a (linear logic) proof that consumes the lexical premises to produce a sentential meaning.
- A successful Glue proof for a sentence terminates in a meaning constructor of type t:

  (10) $\Gamma \vdash \mathcal{M} : G_t$
- Alternative derivations from the same set of premises $\rightarrow$ semantic ambiguity (e.g., scope)
- Linear logic is a *resource logic*: each premise in valid linear logic proof must be used exactly once.
- As discussed in detail by Dalrymple et al. (1999a), Glue Semantics is essentially a type-logical theory and is thus related to type-logical approaches to Categorial Grammar (Morrill 1994, Moortgat 1997, Carpenter 1997, Jäger 2005).
- The key difference between Glue and Categorial Grammar concerns grammatical architecture, particularly the conception of the syntax–semantics interface (Asudeh 2004, 2005, 2006). Glue Semantics posits a strict separation between syntax and semantics, such that there is a syntax that is separate from the syntax of semantic composition. Categorial Grmamar rejects the separation of syntax from semantic composition.
- I assume a small, rather weak fragment of linear logic, multiplicative intuitionistic linear logic (MILL; Asudeh 2004, 2005).
- Three proof rules of this fragment are of particular interest here: elimination for $\otimes$ (multiplicative conjunction) and introduction and elimination for linear implication $\multimap$.

Application : Impl. Elim.

$$\frac{\begin{array}{cc}\vdots & \vdots \\ a : A & f : A \multimap B\end{array}}{f(a) : B} \multimap_{\mathcal{E}}$$

Abstraction : Impl. Intro.

$$\frac{\begin{array}{c}[x : A]^1 \\ \vdots \\ f : B\end{array}}{\lambda x.f : A \multimap B} \multimap_{\mathcal{I},1}$$

Pairwise substitution : Conj. Elim.

$$\frac{\begin{array}{cc} & [x : A]^1 \ [y : B]^2 \\ \vdots & \vdots \\ a : A \otimes B & f : C\end{array}}{let\ a\ be\ x \times y\ in\ f : C} \otimes_{\mathcal{E},1,2}$$

Figure 2: Linear logic proof rules with Curry-Howard correspondence

(11) Bo chortled.

(12)
$$\frac{bo : b \qquad chortle : b \multimap c}{chortle(bo) : c} \multimap_{\mathcal{E}}$$

- Anaphora in Glue Semantics are typically treated as functions on their antecedents (Dalrymple et al. 1999c, Dalrymple 2001). This is a kind of a variable-free treatment of anaphora, which has also been adopted in certain Categorial Grammar analyses (Jacobson 1999, Jäger 2005, among others), although the two variable-free traditions developed separately.
- A variable-free treatment of anaphora is quite natural in Glue, because the commutative linear logic allows anaphora to combine directly with their antecedents, in opposition to the kind of intervening operations that are necessary for variable-free anaphoric resolution in non-commutative Categorial Grammar.
- The meaning constructor for a pronominal has the following general form, where $\uparrow$ is the f-structure of the pronoun and $\uparrow_\sigma$ is its σ-projection in sem-structure:

(13) $\lambda z.z \times z : (\uparrow_\sigma \text{ANTECEDENT}) \multimap [(\uparrow_\sigma \text{ANTECEDENT}) \multimap \uparrow_\sigma]$

- The pronoun's type is therefore $\langle \sigma, \langle \sigma, \tau \rangle \rangle$, where σ is the type of the antecedent and τ is the type of the pronoun. I here assume that both σ and τ are type e (individuals).

(14) Bo fooled himself.

(15)
$$\dfrac{\dfrac{\dfrac{\textbf{Bo}\quad bo : b \qquad \textbf{himself}\quad \lambda z.z \times z : b \multimap (b \otimes p)}{bo \times bo : b \otimes p} \multimap_{\mathcal{E}} \qquad \dfrac{\dfrac{[x : b]^1 \qquad \textbf{fooled}\quad \lambda u \lambda v.fool(u,v) : b \multimap p \multimap f}{\lambda v.fool(x,v) : p \multimap f} \multimap_{\mathcal{E}} \qquad [y : p]^2}{fool(x,y) : f} \multimap_{\mathcal{E}}}{let\ bo \times bo\ be\ x \times y\ in\ fool(x,y) : f} \otimes_{\mathcal{E},1,2}}{fool(bo, bo) : f} \Rightarrow_{\beta}$$

- Glue does not assume that every semantic ambiguity corresponds to a syntactic ambiguity.

(16) Someone recommended every book.

(17) **Surface scope proof**
$$\dfrac{\textbf{someone}\quad \lambda S.some(person, S) : \forall X.(s \multimap X) \multimap X \qquad \dfrac{\dfrac{\dfrac{[z : s]^1 \qquad \textbf{recommended}\quad \lambda x \lambda y.recommend(x,y) : s \multimap b \multimap r}{\lambda y.recommend(z,y) : b \multimap r} \multimap_{\mathcal{E}} \qquad \textbf{every}\quad \lambda R \lambda S.every(R,S) : (v \multimap r) \multimap \forall Y.(b \multimap Y) \multimap Y \qquad \textbf{book}\quad book : v \multimap r}{\lambda S.every(book, S) : \forall Y.(b \multimap Y) \multimap Y} \multimap_{\mathcal{E}}}{every(book, \lambda y.recommend(z,y)) : r} \forall_{\mathcal{E}}, [r/Y]}{\lambda z.every(book, \lambda y.recommend(z,y)) : s \multimap r} \multimap_{\mathcal{I},1}}{some(person, \lambda z.every(book, \lambda y.recommend(z,y))) : r} \forall_{\mathcal{E}}, [r/X]$$

(18) **Inverse scope proof**
$$\dfrac{\dfrac{\textbf{someone}\quad \lambda S.some(person, S) : \forall X.(s \multimap X) \multimap X \qquad \dfrac{\dfrac{[z : b]^1 \qquad \textbf{recommended}\quad \lambda y \lambda x.recommend(x,y) : b \multimap s \multimap r}{\lambda x.recommend(x,z) : s \multimap r} \multimap_{\mathcal{E}}}{some(person, \lambda x.recommend(x,z)) : r} \forall_{\mathcal{E}}, [r/X]}{\lambda z.some(person, \lambda x.recommend(x,z)) : b \multimap r} \multimap_{\mathcal{I},1} \qquad \dfrac{\textbf{every}\quad \lambda R \lambda S.every(R,S) : (v \multimap r) \multimap \forall Y.(b \multimap Y) \multimap Y \qquad \textbf{book}\quad book : v \multimap r}{\lambda S.every(book, S) : \forall Y.(b \multimap Y) \multimap Y} \multimap_{\mathcal{E}}}{every(book, \lambda z.some(person, \lambda x.recommend(x,z))) : r} \forall_{\mathcal{E}}, [r/Y]$$

4.5 The Resource Management Theory of Resumption

- The Resource Management Theory of Resumption (RMTR) is based on the following two claims, one of which we have already discussed.

  1. **The Resource Sensitivity Hypothesis (RSH)**:
     Natural language is resource-sensitive.
  2. **McCloskey's Generalization**:
     Resumptive pronouns are ordinary pronouns.

- RSH stems from the resource-logical perspective on semantic composition in Glue Semantics (Dalrymple 1999, 2001), which uses the resource logic linear logic (Girard 1987) to assemble meanings.

- RSH is equivalent to the claim of Linguistic Resource Sensitivity, which is in turn derived from Logical Resource Sensitivity:

  (19) **Logical Resource Sensitivity**:
  In a resource logic, premises in proofs cannot be freely *reused* or *discarded*.

  (20) **Linguistic Resource Sensitivity**:
  Natural language is resource-sensitive: elements of combination in grammars cannot be freely *reused* or *discarded*.

- The upshot of RSH is that compositional semantics is constrained by resource accounting, such that component meanings cannot go unused or be reused.

- For example, in the following sentence, the adverb *slowly* contributes a single lexical meaning resource which cannot be used twice to derive the unavailable meaning that the plummeting was also slow.

  (21) John slowly rolled over the edge and plummeted to the ground.

- RSH fulfills a similar role to Full Interpretation, but is a consequence of the logic of composition, not a separate principle (Asudeh 2004: 97–99).

- Returning to RMTR, the logic behind the theory is as follows. If a resumptive pronoun is an ordinary pronoun, then it constitutes a surplus resource. If Resource Sensitivity is to be maintained, then there must be an additional consumer of the pronominal resource present.

- The resource surplus constituted by a resumptive pronoun can be demonstrated by an example from English, which does not have grammatically licensed resumptives in majority dialects (Chao and Sells 1983, Sells 1984):

  (22) *Every clown who Mary tickled <u>him</u> laughed.

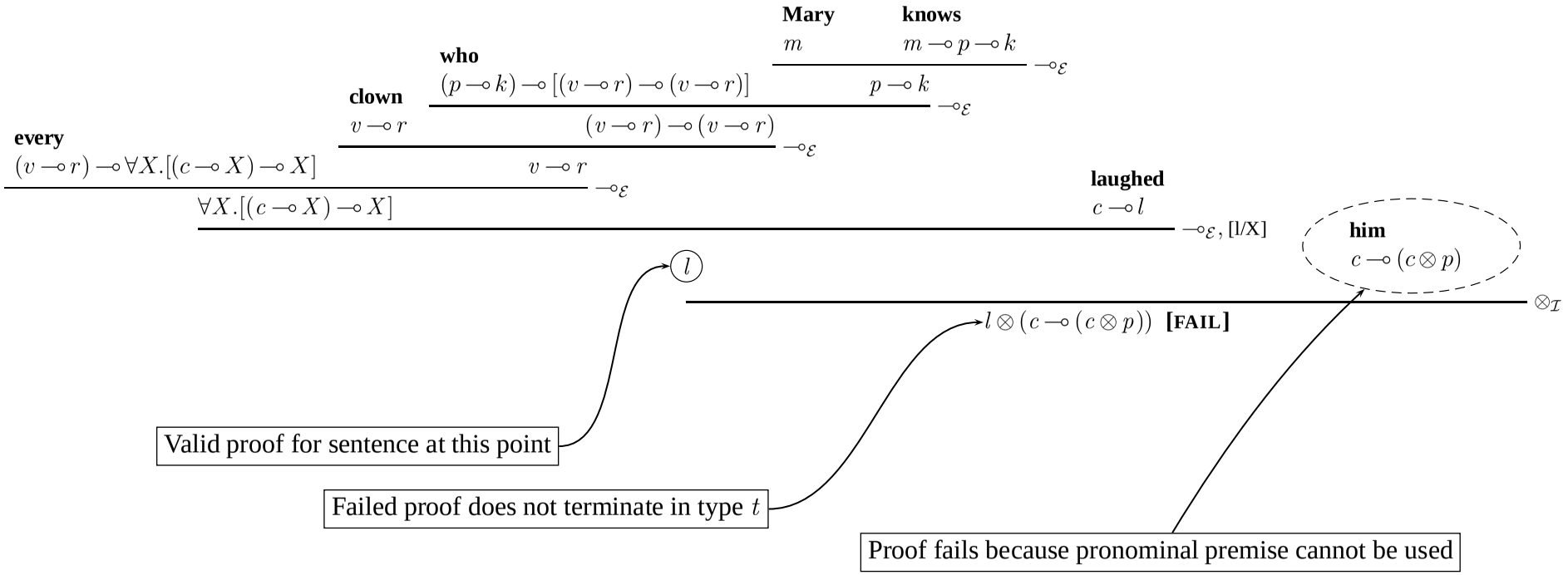


Figure 3: Proof failure due to a surplus resumptive pronoun resource

- What about resumptives in languages in which RPs are properly grammatically licensed?
  - If a resumptive pronoun is surplus to the basic compositional requirements of its sentence, but the sentence is nonetheless grammatical, then RSH entails that there must be a consumer of the resumptive pronoun's resource.
  - The resumptive consumer is a further resource that consumes a pronominal resource. These resources are called *manager resources*, because they manage an otherwise unconsumable pronominal resource.
  - *A resumptive pronoun language has such manager resources in the portion of its lexical inventory or grammar that concerns unbounded dependencies.*
  - *A language which does not license resumptive pronouns in unbounded dependencies lacks manager resources in its grammar.*
- Manager resources have the following general compositional schema, where P is some pronoun that the lexical contributor of the manager resource can access and A is the antecedent or binder of P:

(23) $(A \multimap A \otimes P) \multimap (A \multimap A)$

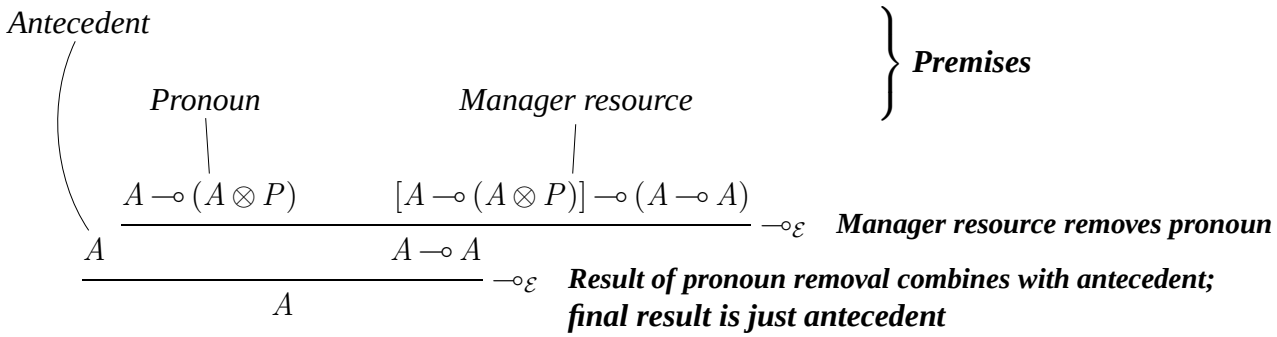


Figure 4: A manager resource in action (binder of lower type)

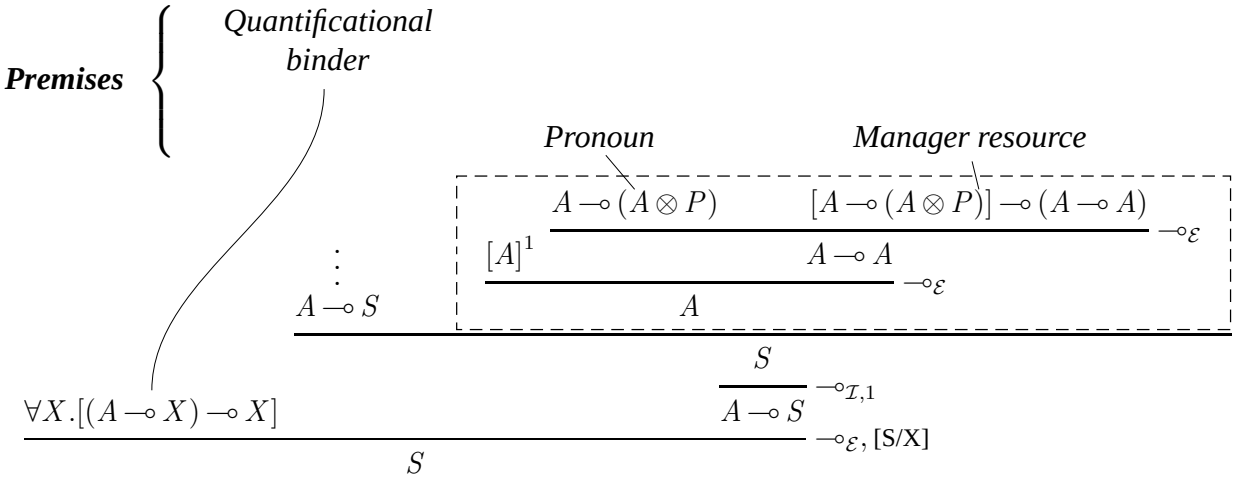


Figure 5: A manager resource in action (quantificational binder)

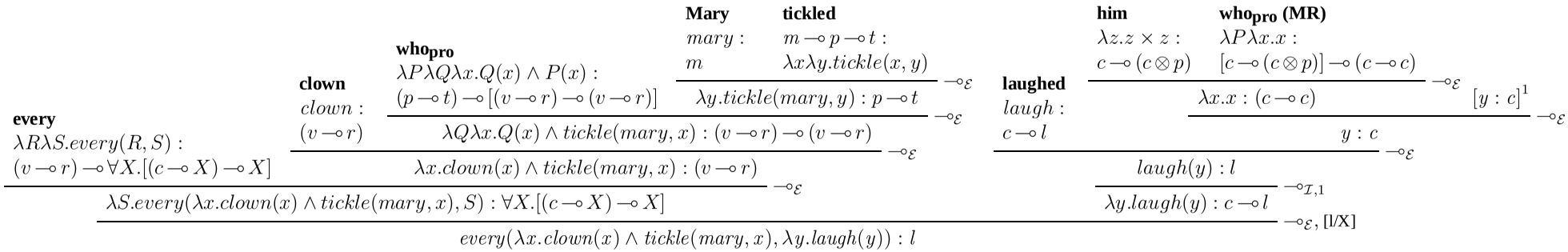


Figure 6: Proof for expository resumptive example *Every clown who$_{pro}$ Mary tickled him laughed.*

5 Data

5.1 Irish

- The simplest generalization about resumptive pronouns in Irish is that they occur in any syntactic position in any unbounded dependency, except where blocked by independent constraints.
- The key independent constraint is the Highest Subject Restriction

(24) **Highest Subject Restriction**

a. * an fear a raibh sé breoite (McCloskey 1990: 210, (29a))
the man COMP be.PAST he ill
'the man that (he) was ill'

b. * na daoine a rabhadar breoite (McCloskey 1990: 210, (29b))
the people COMP be.PAST.3PL ill
'the people that (they) were ill'

c. cúpla muirear a bhféadfaí a rá go rabhadar bocht
a.few families COMP one.could say.INF COMP be.PAST.3PL poor
'a few families that one could say (they) were poor'
(McCloskey 1990: 210, (30b))

- Other than this restriction, Irish resumptives occur in a wide variety of unbounded dependency constructions:

(25) **Restrictive relative clauses**

a. an ghirseach a-r ghoid na síogaí í
the girl COMP-PAST stole the fairies her
'the girl that the fairies stole away'
(McCloskey 2002: 189, (9b))

b. an fear a dtabharann tú an tairgead dó
the man COMP give you the money to.him
'the man to whom you give the money'
(McCloskey 1979: 6, (3))

(26) **Nonrestrictive relative clauses**

Tháinig an saighdiúir eile, nach bhfaca mé roimhe é, aníos chugainn.
came the soldier other NEG.COMP saw I before him, up to.us
'The other soldier, whom I hadn't seen before, came up to us.'
(McCloskey 1990: 238, (97a))

(27) **Questions**

a. Céacu ceann a bhfuil dúil agat ann?
which one COMP is liking at.you in.it
'Which one do you like?'
(McCloskey 2002: 189, (10b))

b. d'inis siad cén turas a raibh siad air
told they what journey COMP be.PAST they on.3SG.MASC
'they told what journey they were on (it)'
(McCloskey 1990: 238, (98a))

(28) **Clefts**

Is tú a bhfuil an deallramh maith ort.
COP.PRES you COMP is the appearance good on.2SG
'It is you that looks well.'
(McCloskey 1990: 239, (99a))

(29) **Reduced Clefts**

Teach beag seascair a-r mhair muid ann.
house little snug COMP-PAST lived we in.it
'It was a snug little house that we lived in.'
(McCloskey 2002: 189, (11b))

(30) **Comparatives**

Do fuair sé leaba chó math agus a-r lui sé riamh uirthi.
get PAST he bed as good as COMP lie.PAST he ever on.3SG.FEM
'He got a bed as good as he ever lay on (it).'
(McCloskey 1990: 239, (100b))

- Gaps in Irish are island-sensitive.

(31) **Complex NP Islands**

a. * an fear aL phóg mé an bhean aL phós
the man COMP kissed I the woman COMP married
'the man who I kissed the woman who married'
(McCloskey 1979: 30, (78))

b. * Cén fear aL phóg tú an bhean aL phós?
which man COMP kissed you the woman COMP married
'Which man did you kiss the woman who married?'
(McCloskey 1979: 30, (80))

(32) ***Wh*-Islands**

a. * fear nachN bhfuil fhios agam cén cineál mná aL phósfadh
a man COMP.NEG I know what sort of a woman COMP would marry
'a man who I don't know what woman would marry'
(McCloskey 1979: 32, (87))

b. * Cén sagart nachN bhfuil fhios agat caidé aL dúirt?
which priest COMP.NEG you know what COMP said
'Which priest don't you know what said?'
(McCloskey 1979: 32, (88))

c. * Cén sagart aL d'fhiafraigh Seán diot arL bhuail tú?
which priest COMP asked John of you QUEST
'Which priest did John ask you if you hit?'
(McCloskey 1979: 32, (89))

- Irish resumptives are not island-sensitive.

(33) **Complex NP Island**
Sin teanga aN mbeadh meas agam ar duine ar bith aL tá ábalta i a labhairt
that a.language COMP would be respect at me on person any COMP is able it to speak
'That's a language that I would respect anyone who could speak it.'
(McCloskey 1979: 34, (95))

(34) ***Wh*-Island**
Sin fear nachN bhfuil fhios agam cén cineál mná aL phósfadh é
that a man COMP.NEG I know what sort of a woman COMP would marry him
'That's a man who I don't know what kind of woman would marry him.'
(McCloskey 1979: 33, (91))

- Gaps in Irish are subject to weak crossover effects:

(35) a. * fear a d'fhág a bhean __ (McCloskey 1990: 237, (95a–b))
man COMP left his wife
'a man that his wife left'

b. * an fear so a mhairbh a bhean féin __
this man COMP killed his own wife
'this man that his own wife killed'

- Resumptive pronouns in Irish are not subject to weak crossover effects:

(36) a. fear ar fhág a bhean é (McCloskey 1990: 236–7, (94a–b))
man COMP left his wife him
'a man that his wife left'

b. an fear so ar mhairbh a bhean féin é
this man COMP killed his own wife him
'this man that his own wife killed'

5.2 Vata

- Vata (Niger-Congo; Ivory Coast) requires the foot of an unbounded dependency to be a resumptive pronoun if it is a subject and a gap otherwise (Koopman 1982, Koopman and Sportiche 1982).

(37) **Highest subject**
àlɔ́ ɔ̀ / * __ lɛ̄ sȧ́ká lȧ́ (Koopman 1982: 128, (1a))
who heR / * __ eat rice WH
'Who is eating rice?'

(38) **Embedded subject**
àlɔ́ ǹ gūgū nā ɔ̀ / * __ yì lȧ́ (Koopman 1982: 128, (4a))
who you think that heR / * __ arrive WH
'Who do you think arrived?'

(39) **Highest object**
yī kòfi lɛ̇ __ / * mí lȧ́ (Koopman 1982: 128, (1b))
what Kofi eat __ / * it WH
'What is Kofi eating?'

(40) **Embedded object**
àlɔ́ ǹ gūgū nā wȧ́ yɛ̀ˋ __ / * mɔ̀ yé lȧ́ (Koopman 1982: 128, (4b))
who you think that they see __ / him PART WH
'Who do you think they saw?'

- Gaps and resumptive pronouns in Vata are both subject to weak crossover.

(41) * àlɔ́$_i$ ɔ̀$_i$ nɔ́ gùgù nā ɔ̀$_i$ mlì lȧ́ (Koopman and Sportiche 1982: 10a)
who$_i$ his$_i$ mother think that he$_i$ left WH
'Who did his mother think left?'

(42) * àlɔ́$_i$ ǹ yrȧ́ ɔ̀$_i$ nɔ́ nā ɔ̀$_i$ mlì lȧ́ (Koopman and Sportiche 1982: 10b)
who$_i$ you tell his$_i$ mother that he$_i$ left WH
'Who did you tell his mother left?'

- Vata resumptive pronouns are island sensitive. A resumptive cannot be extracted from a *wh*-island.

(43) * àIÓ ǹ nɪ̀ [zɛ̄ mɛ̄mɛ̀ˋ gbʊ́ Ò dɪ̀ˋ -ɓʊ́ *t* mɛ́] yì lȧ́
who you NEG-A reason it-it for he-R cut REL it know WH
'Who don't you know why he cut it?'
(Koopman and Sportiche 1986: 161, (19a))

(44) * àIÓ ǹ nylȧ́ nynɪ̀ nā Ò dɪ́ mɛ́ lȧ́
who you wonder NA he-R cut it WH
'Who do you wonder whether he cut it?'
(Koopman and Sportiche 1986: 161, (19b))

5.3 Swedish

- In *Rikssvenska* — the Swedish spoken in Sweden as opposed to on mainland Finland or the Åland Islands — resumptive pronouns are obligatory following overt material in the left periphery of CP (Engdahl 1982).

(45) **Left-peripheral *Wh*-phrase**
[Vilket ord]$_i$ visste ingen [$_{CP}$ [hur många *M*]$_j$ [$_{C'}$ det$_i$ stavas med _$_j$]]?
which word knew nobody how many *M*s it is.spelled with _
'Which word did nobody know how many *M*s (it) is spelled with?'
(Engdahl 1985: 8, ∼(11))

(46) **Complementizer**

a. [Vilket ord]$_i$ visste ingen [$_{CP}$ [$_{C'}$ om det$_i$ stavas med ett *M*]]?
which word knew nobody if it is.spelled with an *M*
'Which word did nobody know if (it) is spelled with an *M*?'
(Engdahl 1985: 8, ∼(11))

b. [Vilken elev]$_i$ trodde ingen att han$_i$ skulle fuska?
which student thought no one that he would cheat
'Which student did no one think that (he) would cheat?'
(Engdahl 1982: 166, ∼(65c))

- Swedish resumptive pronouns allow Across the Board Extraction.

(47) Där borta går en man som jag ofta träffar _ men inte minns vad han heter.
There goes a man that I often meet _ but not remember what he is called
'There goes a man that I often meet but don't remember what he is called.'
(Zaenen et al. 1981: 681, (9))

- Swedish resumptive pronouns license parasitic gaps.

(48) Det var den fången$_i$ som läkarna inte kunde avgöra om han$_i$ verkligen var sjuk utan att tala med *p*$_i$ personligen.
it was that prisoner that the.doctors not could decide if he really was ill without to talk with _ in person
'(This is the prisoner that the doctors couldn't detemine if he really was ill without talking to in person.)'
(Engdahl 1985: 7, (8))

- Turning to interpretation . . .

- Swedish resumptive pronouns do not support non-specific/*de dicto* readings.

(49) Kalle letar efter en bok som han inte vet hur den slutar.
Kalle looks for a book that he not knows how it ends
'Kalle is looking for a book that he does not know how (it) ends.'

- In contrast, a gap does support a non-specific reading.

(50) Kalle kommer att hitta boken som han letar efter __.
Kalle comes to find book.DEF that he looks for __
'Kalle will find the book that he is looking for.'

- *Ålandssvenska* (the dialect of Swedish spoken on the Åland Islands, Finland): allows gaps in post-*wh*-phrase subject positions and the minimal pair to (49) with a gap allows both non-specific and specific readings.

(51) Kalle letar efter en bok som han inte vet hur __ slutar.
Kalle looks for a book that he not knows how __ ends
'(Kalle is looking for a book that he does not know how ends.)'

- Swedish resumptive pronouns do not support pair-list answers to functional questions.

(52) Vilken elev undrar varje lärare om han fuskar?
Which student wonders every teacher if he cheats
'Which student does every teacher wonder if (he) cheats?'

a. Pelle
b. Hans mest begåvada elev
His most gifted student
c. *Andersson, Alfons; Boberg, Benny; Cornelius, Conny

- In contrast, a gap does support a pair-list answer.

(53) Vilken elev tror varje lärare __ fuskar?
Which student tror every teacher __ cheats
'Which student does every teacher think cheats?'

a. Pelle
b. Hans mest begåvade elev
His most gifted student
c. Andersson, Alfons; Boberg, Benny; Cornelius, Conny

- A post-complementizer gap in *Ålandsvenska* allows all three answers:

(54) Vilken elev undrar varje lärare om __ fuskar?
Which student wonders every teacher if __ cheats
'Which student does every teacher wonder if (he) cheats?'

a. Pelle
b. Hans mest begåvade elev
His most gifted student
c. Andersson, Alfons; Boberg, Benny; Cornelius, Conny

6 Emergent Generalizations

- There are languages in which resumptive pronouns *do not* pattern like gaps; e.g., Irish.
  - Syntactically Active Resumptive Pronouns
- There are languages in which resumptive pronouns *do* pattern like gaps; e.g., Vata, Swedish.
  - Syntactically Inactive Resumptive Pronouns
- *Even when RPs pattern syntactically like gaps they are* not *interpreted semantically like gaps.*

7 Informal Analysis

- Grammaticized resumptive pronouns of *both kinds* (SARs and SIRs) are licensed by lexically contributed manager resources.
- The resumptive contributes an ordinary pronominal meaning, which the manager resource consumes, thus removing the problem of saturation which the pronoun would otherwise cause.
- Syntactically inactive resumptive pronouns require an additional, *syntactic* mechanism to remove the pronoun from syntax.
- In LFG-theoretic terms, this mechanism is *restriction* (Kaplan and Wedekind 1993), which allows removal of specified features from f-structures.

(55) $(\uparrow \text{UDF})\backslash\text{PRED} = (\uparrow \text{GF}^{*}\ \text{SUBJ})\backslash\text{PRED}$

- *Irish, Vata and Swedish all equally have manager resources in their lexicons, which allows them to deal with the problem of semantic composition constituted by resumptive pronouns, but Vata and Swedish have an additional mechanism that inactivates the pronoun in the syntax.*

Target: [*Who did Jane see <u>him</u>?*]

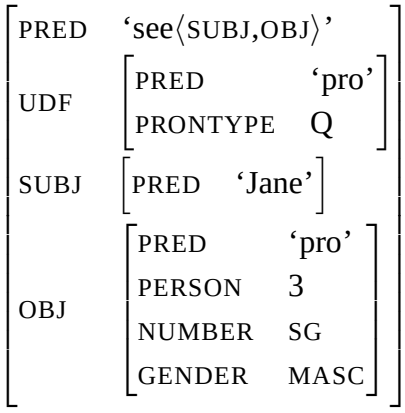
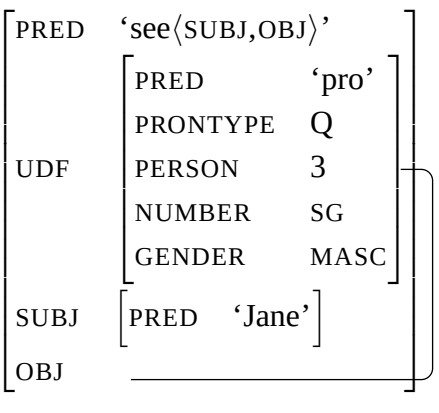
	RP is syntactically active	RP is syntactically inactive
Syntax		
Semantics	Resumptive licensed by MR	Resumptive licensed by MR

Table 2: Syntax and semantics of SARs and SIRs

8 Theoretical Consequences

- Two approaches to compositionality and the syntax–semantics interface:
  1. **Parallel composition theories**: Syntax and semantics are built up in parallel.
  2. **Interpretive composition theories**: Semantics interprets the output of syntax.
- The unification of resumption achieved by RMTR depends on the parallel composition view. On the alternative view, in the case of syntactically inactive resumptives, there is no real pronoun in the part of syntax that feeds meaning (f-structure) and there is therefore no pronominal resource for a manager resource to consume.
  - *RMTR gives theoretical support for the parallel composition view, because that view supports a unification of otherwise heterogeneous resumptive phenomena.*
- Perhaps even more interestingly, the empirical evidence that resumptives are not interpreted like gaps points in the same direction.
  - The syntax of syntactically inactive resumptives is explained if they are treated as absent from the part of syntax that models unbounded dependencies (f-structure).
  - If SIRs are syntactically like gaps and composition is interpretive, then resumptives should be interpreted like gaps, contrary to fact.
  - If composition is parallel to syntactic construction, then a resumptive pronoun contributes syntactic and semantic information simultaneously. Operations on the syntax do not necessarily affect operations on the semantics, so the pronoun can have the syntax of a gap, *yet retain pronominal semantics.*

9 Conclusion

- A unified theory of resumption (RMTR) is possible based on semantic composition.
- Resumptive pronouns are ordinary pronouns in RMTR (McCloskey's generalization).
- The theory supports parallel composition theories over interpretive composition theories of the syntax–semantics interface.
- This dovetails with empirical evidence that resumptives that behave syntactically like gaps nevertheless do not behave semantically like gaps. This fact would be puzzling on an interpretive approach to composition in which resumptives are ordinary pronouns.

		Syntax		Semantics	
	Morpholexical	C-structure	F-structure	Interface/Composition	Type
SARs	Ordinary Pronoun	Present	Present (Active)	Removed Compositionally	Ordinary Pronoun
SIRs	Ordinary Pronoun	Present	Absent (Inactive)	Removed Compositionally	Ordinary Pronoun

Table 3: Summary: properties of grammaticized resumptive pronouns

References

Asudeh, Ash. 2004. Resumption as Resource Management. Ph.D. thesis, Stanford University.

—. 2005. Relational Nouns, Pronouns, and Resumption. *Linguistics and Philosophy* 28: 375–446.

—. 2006. Direct Compositionality and the Architecture of LFG. In Miriam Butt, Mary Dalrymple, and Tracy Holloway King, eds., *Intelligent Linguistic Architectures: Variations on Themes by Ronald M. Kaplan*, 363–387. Stanford, CA: CSLI Publications.

Asudeh, Ash, and Ida Toivonen. 2009. Lexical-Functional Grammar. In Bernd Heine and Heiko Narrog, eds., *The Oxford Handbook of Linguistic Analysis*, 425–458. Oxford: Oxford University Press.

Barker, Chris, and Pauline Jacobson, eds. 2007. *Direct Compositionality*. Oxford: Oxford University Press.

Bresnan, Joan. 1995. Linear Order, Syntactic Rank, and Empty Categories: On Weak Crossover. In Dalrymple et al. 1995, 241–274.

—. 2001. *Lexical-Functional Syntax*. Oxford: Blackwell.

Bresnan, Joan, and Sam A. Mchombo. 1987. Topic, Pronoun, and Agreement in Chicheŵa. *Language* 63(4): 741–782.

Carpenter, Bob. 1997. *Type-Logical Semantics*. Cambridge, MA: MIT Press.

Chao, Wynn, and Peter Sells. 1983. On the Interpretation of Resumptive Pronouns. In Peter Sells and Charles Jones, eds., *The Proceedings of NELS 13*, 47–61. Amherst, MA: GLSA.

Dalrymple, Mary. 1993. *The Syntax of Anaphoric Binding*. Stanford, CA: CSLI Publications.

Dalrymple, Mary, ed. 1999. *Semantics and Syntax in Lexical Functional Grammar: The Resource Logic Approach*. Cambridge, MA: MIT Press.

Dalrymple, Mary. 2001. *Lexical Functional Grammar*. San Diego, CA: Academic Press.

Dalrymple, Mary, Vaneet Gupta, John Lamping, and Vijay Saraswat. 1999a. Relating Resource-Based Semantics to Categorial Semantics. In Dalrymple 1999, 261–280.

Dalrymple, Mary, Ronald M. Kaplan, John T. Maxwell III, and Annie Zaenen, eds. 1995. *Formal Issues in Lexical-Functional Grammar*. Stanford, CA: CSLI Publications.

Dalrymple, Mary, John Lamping, Fernando Pereira, and Vijay Saraswat. 1999b. Overview and Introduction. In Dalrymple 1999, 1–38.

—. 1999c. Quantification, Anaphora, and Intensionality. In Dalrymple 1999, 39–89.

Dalrymple, Mary, John Lamping, and Vijay Saraswat. 1993. LFG Semantics via Constraints. In *Proceedings of the Sixth Meeting of the European ACL*, 97–105. European Chapter of the Association for Computational Linguistics, University of Utrecht.

Engdahl, Elisabet. 1982. Restriction on Unbounded Dependencies in Swedish. In Elisabet Engdahl and Eva Ejerhed, eds., *Readings on Unbounded Dependencies in Scandinavian Languages*, 151–174. Stockholm: Almquist and Wiksell International.

—. 1985. Parasitic Gaps, Resumptive Pronouns, and Subject Extractions. *Linguistics* 23: 3–44.

Fenstad, Jens Erik, Per-Kristian Halvorsen, and Tore Langhold amd Johan van Benthem. 1987. *Situations, Language and Logic*. Dordrecht: D. Reidel.

Girard, Jean-Yves. 1987. Linear Logic. *Theoretical Computer Science* 50: 1–102.

Halvorsen, Per-Kristian. 1983. Semantics for Lexical-Functional Grammar. *Linguistic Inquiry* 14(4): 567–615.

Halvorsen, Per-Kristian, and Ronald M. Kaplan. 1988. Projections and Semantic Description in Lexical-Functional Grammar. In *Proceedings of the International Conference on Fifth Generation Computer Systems*, 1116–1122. Institute for New Generation Systems, Tokyo. Reprinted in Dalrymple et al. (1995: 279–292).

Jacobson, Pauline. 1999. Towards a Variable-Free Semantics. *Linguistics and Philosophy* 22: 117–184.

Jäger, Gerhard. 2005. *Anaphora and Type Logical Grammar*. Dordrecht: Springer.

Kaplan, Ronald M. 1987. Three Seductions of Computational Psycholinguistics. In Peter Whitelock, Mary McGee Wood, Harold L. Somers, Rod Johnson, and Paul Bennett, eds., *Linguistic Theory and Computer Applications*, 149–181. London: Academic Press. Reprinted in Dalrymple et al. (1995: 339–367).

—. 1989. The Formal Architecture of Lexical-Functional Grammar. In Chu-Ren Huang and Keh-Jiann Chen, eds., *Proceedings of ROCLING II*, 3–18. Reprinted in Dalrymple et al. (1995: 7–27).

Kaplan, Ronald M., and Joan Bresnan. 1982. Lexical-Functional Grammar: A Formal System for Grammatical Representation. In Joan Bresnan, ed., *The Mental Representation of Grammatical Relations*, 173–281. Cambridge, MA: MIT Press. Reprinted in Dalrymple et al. (1995: 29–135).

Kaplan, Ronald M., and Jürgen Wedekind. 1993. Restriction and Correspondence-Based Translation. In *Proceedings of the 6th Meeting of the EACL*. European Chapter of the Association of Computational Linguistics, University of Utrecht.

Kaplan, Ronald M., and Annie Zaenen. 1989. Long-Distance Dependencies, Constituent Structure, and Functional Uncertainty. In Mark Baltin and Anthony Kroch, eds., *Alternative Conceptions of Phrase Structure*, 17–42. Chicago, IL: University of Chicago Press. Reprinted in Dalrymple et al. (1995: 137–165).

King, Tracy Holloway. 1995. *Configuring Topic and Focus in Russian*. Stanford, CA: CSLI Publications.

Kokkonidis, Miltiadis. 2008. First-Order Glue. *Journal of Logic, Language and Information* 17(1): 43–68.

Koopman, Hilda. 1982. Control from COMP and Comparative Syntax. *Linguistic Review* 2(4): 365–391. Reprinted in Koopman (2000: 126–150).

—. 2000. *The Syntax of Specifiers and Heads*. London: Routledge.

Koopman, Hilda, and Dominique Sportiche. 1982. Variables and the Bijection Principle. *Linguistic Review* 2(2): 139–160. Reprinted in Koopman (2000: 19–39).

—. 1986. A Note on Long Extraction in Vata and the ECP. *Natural Language and Linguistic Theory* 4(3): 357–374. Reprinted in Koopman (2000: 151–166).

Lev, Iddo. 2007. Packed Computation of Exact Meaning Representations. Ph.D. thesis, Stanford University.

McCloskey, James. 1979. *Transformational Syntax and Model Theoretic Semantics: A Case-Study in Modern Irish*. Dordrecht: Reidel.

—. 1990. Resumptive Pronouns, $\overline{\text{A}}$-Binding and Levels of Representation in Irish. In Randall Hendrick, ed., *Syntax of the Modern Celtic languages*, vol. 23 of *Syntax and Semantics*, 199–248. San Diego, CA: Academic Press.

—. 2002. Resumption, Successive Cyclicity, and the Locality of Operations. In Samuel David Epstein and T. Daniel Seeley, eds., *Derivation and Explanation in the Minimalist Program*, 184–226. Oxford: Blackwell.

—. 2006. Resumption. In Martin Everaert and Henk van Riemsdijk, eds., *The Blackwell Companion to Syntax*, 94–117. Oxford: Blackwell.

Montague, Richard. 1970. English as a Formal Language. In Bruno Visentini et al., eds., *Linguaggi nella Societá e nella Tecnica*, 189–224. Milan: Edizioni di Communità. Reprinted in Montague (1974: 188–221).

—. 1973. The Proper Treatment of Quantification in Ordinary English. In Jaakko Hintikka, Julian Moravcsik, and Patrick Suppes, eds., *Approaches to Language*, 221–242. Dordrecht: Reidel. Reprinted in Montague (1974: 247–270).

—. 1974. *Formal Philosophy: Selected Papers of Richard Montague*. New Haven, CT: Yale University Press. Edited and with an introduction by Richmond H. Thomason.

Moortgat, Michael. 1997. Categorial Type Logics. In Johan van Benthem and Alice ter Meulen, eds., *Handbook of Logic and Language*, 93–177. Cambridge, MA: MIT Press. Co-published with Elsevier Science B.V., Amsterdam.

Morrill, Glyn. 1994. *Type Logical Grammar*. Dordrecht: Kluwer.

Sells, Peter. 1984. Syntax and Semantics of Resumptive Pronouns. Ph.D. thesis, University of Massachusetts, Amherst.

Zaenen, Annie. 1980. Extraction Rules in Icelandic. Ph.D. thesis, Harvard University. Reprinted as Zaenen (1985).

—. 1985. *Extraction Rules in Icelandic*. New York, NY: Garland.

Zaenen, Annie, Elisabet Engdahl, and Joan Maling. 1981. Resumptive Pronouns can be Syntactically Bound. *Linguistic Inquiry* 12: 679–682.

A Formal Analysis

A.1 Irish

(56) an ghirseach a-r ghoid na síogaí <u>í</u> (McCloskey 2002: 189, (9b))
the girl COMP-PAST stole the fairies her
'the girl that the fairies stole away'

(57) *í*, D $(\uparrow \text{PERSON}) = 3$
$(\uparrow \text{NUMBER}) = \text{SG}$
$(\uparrow \text{GENDER}) = \text{FEM}$
$@\text{PRONOUN}$

(58) $@\text{PRONOUN} = (\uparrow \text{PRED}) = \text{'pro'}$
$(\uparrow_\sigma \text{ANTECEDENT}) \multimap [(\uparrow_\sigma \text{ANTECEDENT}) \otimes \uparrow_\sigma]$

(59) an fear a dtabharann tú an tairgead <u>dó</u> (McCloskey 1979: 6, (3))
the man COMP give you the money to.him
'the man to whom you give the money'

(60) *dó*, P $(\uparrow \text{PRED}) = \text{'to}\langle\text{OBJ}\rangle\text{'}$
$(\uparrow \text{OBJ PRED}) = \text{'pro'}$
$(\uparrow \text{OBJ PERSON}) = 3$
$(\uparrow \text{OBJ NUMBER}) = \text{SG}$
$(\uparrow \text{OBJ GENDER}) = \text{MASC}$

(61) $[_{\text{CP}}\ aL \ldots [_{\text{CP}}\ aL \ldots [_{\text{CP}}\ aL \ldots \_\_ \ldots]]]$

a. an t-ainm a hinnseadh dúinn a bhi __ ar an áit (McCloskey 2002: 190, (13a))
the name *aL* was-told to-us *aL* was __ on the place
'the name that we were told was on the place'

(62) $[_{\text{CP}}\ aN \ldots [_{\text{CP}}\ go \ldots [_{\text{CP}}\ go \ldots\ Rpro\ \ldots]]]$

a. fir ar shíl Aturnae an Stáit go rabh <u>siad</u> díleas do'n Rí
men *aN* thought Attorney the State *go* were they loyal to-the King
'men that the Attorney General thought were loyal to the King'
(McCloskey 2002: 190, (16))

(63) $[_{\text{CP}}\ aN \ldots [_{\text{NP}}\ \text{N}\ [_{\text{CP}}\ aL \ldots \_\_ \ldots]]]$ **Pattern 1**

a. rud a raibh coinne agam a choimhlíonfadh __ an aimsir
thing *aN* was expectation at-me *aL* fulfill.COND __ the time
'something that I expected time would confirm'
(McCloskey 2002: 196, ∼(28))

(64) $[_{\text{CP}}$ *aL* …$[_{\text{CP}}$ *aN* … *Rpro* …]] **Pattern 2**

a. Cé is dóigh leat a bhfuil an t-airgead aige?
who *aL*.COP.PRES likely with-you *aN* is the money at-him
'Who do you think has the money?'
(McCloskey 2002: 198, (35))

(65) $[_{\text{CP}}$ *aN* …$[_{\text{CP}}$ *aN* … *Rpro* …]] **Pattern 3**

a. na cuasáin thiorma ar shíl sé a mbeadh contúirt ar bith uirthi tuitim
the holes dry *aN* thought he *aN* would-be danger any on-her fall.[−FIN]
síos ionnta
down into-them
'the dry holes that he thought there might be any danger of her falling down into them'
(McCloskey 2002: 199, (44))

	Role Relative to Position			
	Not bottom	**Bottom**	**Method**	**Cyclic?**
aL	Passing	Grounding	Functional equality	Yes
aN	Passing	Grounding	Anaphoric binding	No

Table 4: The role of the Irish complementizers *aL* and *aN* in unbounded dependencies

(66) a. $[_{\text{CP}}$ *aL* … pass … $[_{\text{CP}}$ *aL* … ground … — …]]] Core *aL* multi-clause pattern

b. $[_{\text{CP}}$ *aN* … pass … $[_{\text{CP}}$ *aL* … ground … — …]]] Pattern 1

c. $[_{\text{CP}}$ *aL* … pass … $[_{\text{CP}}$ *aN* … ground … *Rpro* …]]] Pattern 2

d. $[_{\text{CP}}$ *aN* … pass … $[_{\text{CP}}$ *aN* … ground … *Rpro* …]]] Pattern 3

(67) *aL*, C …
$(\uparrow \text{UDF}) = (\uparrow \text{CF}^{*} \text{GF})$
$(\rightarrow \text{UDF}) = (\uparrow \text{UDF})$

(68) *aN*, C …
$(\uparrow \text{UDF})_{\sigma} = ((\uparrow \text{GF}^{*} \{ \text{CF} \mid [\text{GF} - \text{UDF}] \})_{\sigma} \text{ANTECEDENT})$
@MR(→)

(69) $\text{CF} \equiv \{ \text{XCOMP} \mid \text{COMP} \}$

(70) $\text{@MR}(f) = \lambda P \lambda y.y : [(\uparrow \text{UDF})_{\sigma} \multimap ((\uparrow \text{UDF})_{\sigma} \otimes f_{\sigma})] \multimap ((\uparrow \text{UDF})_{\sigma} \multimap (\uparrow \text{UDF})_{\sigma})$

(71) *go*, C …
$\neg(\uparrow \text{UDF})$

A.2 Vata

(72) ɔ (↑ PERSON) = 3
(↑ NUMBER) = SG
(↑ GENDER) = MASC
@PRONOUN
@DEFAULT-TONE
@WH-TONE

(73) @PRONOUN = (↑ PRED) = 'pro'
$(\uparrow_\sigma$ ANTECEDENT) $\multimap$ [$(\uparrow_\sigma$ ANTECEDENT) $\otimes \uparrow_\sigma$]

(74) @DEFAULT-TONE = { ($\uparrow_\rho$ TONE) | ($\uparrow_\rho$ TONE = MID-HIGH) }

(75) @WH-TONE = { ¬[(SUBJ ↑) ∧ ($\uparrow_\sigma$ ANTECEDENT TYPE) = WH-OPERATOR] |
($\uparrow_\rho$ TONE) = LOW }

(76) àlɔ́$_i$ ɔ̀ gūgū nā ɔ̀$_j$ / * ɔ̀$_i$ / ɔ̀$_i$ ní yà là
who$_i$ heR$_i$ think that he-ɔ̀$_j$ / * he-ɔ̀$_i$ / he-ɔ̀$_i$ NEG healthy WH
'Who thinks he is sick?'
(Koopman and Sportiche 1982: (15a))

(77) àlɔ́$_i$ ɔ̀$_i$ yrà ɔ̀$_i$ nɔ́ nā ɔ̀$_i$ mlì là (Koopman and Sportiche 1982: (16))
who$_i$ heR tell his$_i$ mother that he$_i$ left WH
'Who told his mother that he left?'

(78) (↑ UDF)\PRED =
(↑ CF* { [GF − SUBJ] | SUBJ\PRED })
(→ PRED) = (↑ UDF PRED) (↑ UDF)$_\sigma$ = ($\rightarrow_\sigma$ ANTECEDENT)
@MR(→)

(79) àlɔ́ ɔ̀ mlì là (Koopman and Sportiche 1982: 14a)
who heR left *wh*
'Who left?'

(80)
$$\begin{bmatrix} \text{PRED} & \text{'leave}\langle\text{SUBJ}\rangle\text{'} \\ \text{UDF} & \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PRONTYPE} & \text{Q} \\ \text{PERSON} & 3 \\ \text{NUMBER} & \text{SG} \\ \text{GENDER} & \text{MASC} \end{bmatrix} \\ \text{SUBJ} & \square \end{bmatrix}$$

Restriction

- F-structures are sets of attribute-value pairs (attribute-value matrices).
- The restriction of some f-structure f by an attribute a, designated $f\backslash a$, is the f-structure that results from deleting the attribute a and its value v from f-structure f (Kaplan and Wedekind 1993: 198): the pair $\langle a, v\rangle$ is removed from the set of pairs that constitutes the f-structure in question.

  (81) **Restriction** (Kaplan and Wedekind 1993: 198)
  If f is an f-structure and a is an attribute:
  $f\backslash a = f|_{\text{Dom}(f)\text{-}\{a\}} = \{\ \langle s, v\rangle \in f \mid s \neq a\ \}$

- The restriction of an f-structure is itself an f-structure, so the operation can be iterated, but the outcome is not order-sensitive; restriction is associative and commutative in its attribute argument: $[f\backslash a]\backslash b = [f\backslash b]\backslash a = f\backslash\{a\ b\}$ (Kaplan and Wedekind 1993: 198).
- Restriction is defined in terms of set complementation: restriction of an f-structure by an attribute that the f-structure does not contain vacuously succeeds.

  (82) a. $f = \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{CASE} & \text{NOM} \end{bmatrix}$

  b. $f\backslash\text{PRED} = \begin{bmatrix} \text{CASE} & \text{NOM} \end{bmatrix}$

- $f\backslash a$ subsumes f ($f\backslash a \sqsubseteq f$)
- As an operation on f-structures, restriction can be combined with usual function-application as follows (Kaplan and Wedekind 1993: 198):

  (83) If f and g are f-structures, then $f\backslash a = g\backslash a$ is true if and only if f and g have all attributes and values in common other than a; they may or may not have values for a and those values may or may not be identical.