# WHAT SYNTAX FEEDS SEMANTICS?

Workshop Proceedings

20th European Summer School in Logic Language and Information
ESSLLI 2008
Hamburg, 11-15 August 2008

Maribel Romero (ed.)

## Workshop Description

*Workshop Purpose*

The purpose of this workshop is to investigate on what kind of syntactic representation semantic interpretation applies. A dominant trend defends the existence of a covert level of representation, Logical Form (LF) in Generative Grammar/Minimalism, mediating between surface syntax and the semantic component. However, many of the original empirical reasons for LF have been challenged, and, for many phenomena commonly attributed to LF, alternative accounts exist that derive the semantics from the surface syntax. Other grammar formalisms -e.g. TAG, HPSG, LFG, CCG- use different syntactic inputs to arrive at the desired semantic interpretation. The workshop aims to provide a forum for researchers (including advanced PhD students) to present and discuss their work with colleagues working on the same or on different frameworks, in connection with the broad subject areas represented at ESSLLI.

*Workshop Topics*

The workshop is concerned with topics where the debate on the syntax-semantics mapping has been particularly active or can potentially lead to new results. Topics include, but are not limited to:

- scope and Noun Phrases (NPS): quantificational NPs, plurals, branching quantifier readings, etc.
- scope reconstruction
- connectivity effects (reflected in Binding Theory, NPI-licensing, opacity, etc.)
- scope in degree constructions (comparatives, superlatives, etc.)
- ellipsis (VP-ellipsis, gapping, NP-ellipsis, etc.)
- representation and binding of pronouns
- representation and binding of world/situation variables
- representation and binding of temporal variables

*Workshop Organizer*

- Maribel Romero, University of Konstanz

*Workshop Programme Committee*

- Chris Barker, New York University
- Rajesh Bhatt, University of Massachusetts at Amherst
- Miriam Butt, University of Konstanz
- Daniel Hardt, Copenhagen Business School and languagelens
- Pauline Jacobson, Brown University
- Laura Kallmeyer, University of Tübingen
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- Manfred Sailer, University of Göttingen
- Uli Sauerland, Zentrum für allgemeine Sprachwissenschaft (ZAS)
- Philippe Schlenker, Institut Jean-Nicod and New York University
- Yael Sharvit, University of Connecticut
- Mark Steedman, University of Edinburgh
- Satoshi Tomioka, University of Delaware

*Invited Speakers*

- Arnim von Stechow, University of Tübingen
- Aravind K. Joshi, University of Pennsylvania

*Workshop Speakers*

- Adrian Brasoveanu, Stanford University (Presentation cancelled)
- Markus Egg, Rijksuniversiteit Groningen
- Nicolas Guilliot, University of Toronto
- Ruth Kempson, Andrew Gargett, Eleni Gregoromichelaki, Chris Howes and Yo Sato, King's College London and/or Queen Mary University of London
- Qiong-Peng Luo, UiL OTS, Utrecht University and Center for Chinese Linguistics, Peking University
- Emar Maier, University of Amsterdam
- Carl Pollard, Ohio State University, Universitat Rovira i Virgili and LORIA
- Frank Richter and Manfred Sailer, University of Tübingen and University of Göttingen
- Hiroyuki Uchida, University College London

*URL*

http://ling.uni-konstanz.de/pages/home/romero/esslli/esslli08.html

## Programme

Monday, August 11

| | |
|---|---|
| 14:15 - 14:45 | Introductory remarks by Maribel Romero |
| 14:45 - 15:15 | Maier, Emar: *What syntax doesn't feed semantics: fake indexicals als indexicals.* |
| 15:15 - 15:45 | Kempson, Ruth, Andrew Gargett, Eleni Gregoromichelaki, Chris Howes and Yo Sato: *Dialogue-Grammar correspondence in Dynamic Syntax.* |

Tuesday, August 12

| | |
|---|---|
| 14:15 - 14:45 | Uchida, Hiroyuki: *Uniform structure of multiple scope readings.* |
| 14:45 - 15:15 | Guilliot, Nicolas: *To reconstruct or not to reconstruct: that is the question.* |
| 15:15 - 15:45 | Luo, Qiong-Peng: *Functional quantification in distributivity and events: a view from Chinese.* |

Wednesday, August 13

| | |
|---|---|
| 14:15 - 15:25 | INVITED TALK<br>Joshi, Aravind K.: TBA. |
| 15:25 - 15:45 | Workshop DISCUSSION led by Maribel Romero |

Thursday, August 14

| | |
|---|---|
| 14:15 - 14:45 | Pollard, Carl: *A parallel derivational architecture for the syntax-semantics interface.* |
| 14:45 - 15:15 | Richter, Frank and Manfred Sailer: *Simple trees with complex semantics: On epistemic modals and strong quantifiers.* |
| 15:15 - 15:45 | Egg, Markus: *Which syntax is required by semantics?* |

Friday, August 15

| | |
|---|---|
| 14:15 - 15:25 | INVITED TALK<br>von Stechow, Arnim: *Tense and modality as verbal quantifiers.* |
| 15:25 - 15:45 | Workshop DISCUSSION led by Maribel Romero |

## Table of Contents

# Deictic and Sentence-Internal Readings of *Same / Different* as Anaphora: A Unified Compositional Account

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**Abstract**

The paper proposes the first unified account of deictic and sentence-internal readings of *same/different*. The analysis is executed in a stack-based dynamic system and it is fully compositional because the system is couched in classical type logic. The main proposal is that distributive quantification temporarily makes available two discourse referents within its nuclear scope, the values of which are required by sentence-internal uses of *same/different* to be identical/distinct – much as their deictic uses require the values of two discourse referents to be identical/distinct. The system is independently motivated by quantificational subordination, the availability of both dependent and independent readings for anaphora in the scope of *each* and, finally, dependent indefinites in various languages. Thus, *same* and *different* provide further support for the idea that natural language quantification is a composite notion, to be analyzed in terms of discourse reference to dependencies that is multiply constrained by the various components that make up a quantifier.

## 1 Deictic and Sentence-Internal Readings of *Same/Different*

The goal of this paper is to provide a unified account of deictic / sentence-external and sentence-internal readings of *same / different*, exemplified in (1)/(2) and (3) respectively. These readings have been known to exist at least since Carlson (1987), but no unified account has been proposed (see Barker (2007) and Matushansky (2007) for recent discussions) despite the fact that, in language after language, if a lexical item can have sentence-internal readings, then it can also have sentence-external readings.[1]

(1) **a.** Mary recited *The Raven.* **b.** Then, Linus recited a different poem.
(deictic/sentence-external: different from *The Raven*)

(2) **a.** Mary recited *The Raven.* **b.** Then, every boy recited a different poem.
(deictic/sentence-external: different from *The Raven*)

(3) Every boy recited a different poem.
(sentence-internal: for any two boys $a$ and $b$, $a$'s poem is different from $b$'s poem)

[*]I am grateful to Daniel Altshuler, Rajesh Bhatt, Uriel Cohen Priva, Cleo Condoravdi, Sam Cumming, Donka Farkas, Anubha Kothari, Sven Lauer, Marie-Catherine de Marneffe, Armin Mester, Rick Nouwen, Roumyana Pancheva, Asya Pereltsvaig, Jessica Rett, Ivan Sag, Oana Săvescu, Luis Vicente and two anonymous reviewers (*What syntax feeds semantics?*, ESSLLI 2008) for comments and/or discussion and/or judgments and to Maribel Romero (the organizer of *What syntax feeds semantics?*) for all her help. The usual disclaimers apply.

[1]See the preliminary survey in Brasoveanu (2008). The cross-linguistic generalization seems to be the following: (*i*) if a language has a lexical item that can have sentence-internal readings under morphologically singular and semantically distributive quantifiers like *every/each boy*, then that item can also have sentence-external readings (e.g., the English *different* or the German *anders*); (*ii*) a language can have a lexical item that allows only for sentence-external readings, e.g., the English *other/another* or the French *autre*; (*iii*) a language can have a lexical item that can be used with morphologically plural DPs like *the boys* that have a distributive interpretation, but not with morphologically singular and semantically distributive quantifiers; when used with such plural distributive DPs, the item can have sentence-internal readings, e.g., the German *verschieden*. See also Beck (2000) for more discussion of German and Laca & Tasmowski (2003) for more discussion of French.

The interpretation of *different* in (1b)/(2b) is sentence external in the sense that it is anaphoric to a discourse referent (dref) introduced in the previous sentence (1a)/(2a). In (1)/(2), *different* relates two drefs and requires their values, i.e., the actual entities, to be distinct.

The sentence-internal reading in (3) seems to relate values of only one dref, introduced by the narrow-scope indefinite *a poem*. These values, i.e., the recited poems, covary with the values of the dref introduced by the universal quantifier *every boy* – and *different* requires the poems to be distinct relative to distinct boys.

Carlson (1987) proposes the following generalization about the distribution of sentence-internal readings of *same/different* in English: such readings are licensed by morphologically singular and semantically distributive quantifiers like *every boy* in (3) above or by distributively interpreted plurals DPs like *the boys* in (4) below. Sentence-internal readings are not licensed by singulars or collectively interpreted plural DPs, as (5) and (6) below show.

(4) The boys recited different poems. (Carlson 1987)

(5) #Mary recited a different poem.

(6) #The boys gathered around different fires.[2]

In this paper, we focus on sentence-external readings and sentence-internal readings under morphologically singular and semantically distributive quantifiers like *every boy*, since these are the readings that are cross-linguistically realized by the same lexical item.

The main proposal is that distributive quantification temporarily makes available two drefs within its nuclear scope, the values of which are required by sentence-internal uses of *same* / *different* to be identical / distinct, much as their deictic uses require the values of two drefs to be identical / distinct. The analysis is formalized in a stack-based version of Plural Compositional DRT (PCDRT, Brasoveanu 2007).

The more general project that the present investigation is a part of can be characterized as *decomposing quantification*: *same* / *different* provide further support for the idea that natural language quantification is a composite notion (see Brasoveanu (2007) and references therein), to be analyzed in terms of discourse reference to dependencies that is multiply constrained by the various components that make up a quantifier.

## 2 Sentence-External Readings as Cross-Sentential Anaphora

Deictic / sentence-external readings are just an instance of cross-sentential anaphora, of the same kind as the typical discourse in (7) below.

(7) **a.** A$^{u_0}$ man came in. **b.** He$_{u_0}$ sat down.

This discourse is straightforwardly analyzed in DRT (Kamp 1981) / FCS (Heim 1982) / DPL (Groenendijk & Stokhof 1991). The indefinite in sentence (7a) introduces a dref $u_0$, which is symbolized by the superscript on the indefinite article. This dref is then retrieved by the pronoun in (7b), which is symbolized by the subscript on the anaphoric pronoun. Discourse (7) as a whole is represented by the two Discourse Representation Structures (DRSs), a.k.a. (linearized) boxes, in (8) below. DRSs are pairs of the form [**new drefs** | **conditions**], the first member of which consists of the newly introduced drefs, while the second member consists of the conditions that the previously introduced drefs have to satisfy.

(8) $[u_0 \mid man\{u_0\}, come\_in\{u_0\}];\ [sit\_down\{u_0\}]$

[2] The sentence-internal reading is available if *the boys* denotes a set of groups of boys – and each group gathered around a different fire. Such group-level distributivity is basically the same as individual-level distributivity, modulo the fact that it licenses collective predicates like *gather*. This reading will not be discussed in the paper.

The first DRS in (8) is contributed by sentence (7a): we introduce a new dref $u_0$ and require its value to be a man that came in. The second DRS, contributed by sentence (7b), does not introduce any new drefs (the first member of the pair is empty, so we omit it) – it just further constrains the previously introduced dref $u_0$ to store an individual that sat down. The two DRSs are dynamically conjoined, symbolized by ";". Dynamic conjunction ensures that the anaphoric information contributed by the first DRS (i.e., the fact that $u_0$ stores a man that came in) is available to the second DRS.

The analysis of deictic / sentence-external readings follows the same general format.

(9) **a.** Mary$^{u_0}$ recited *The Raven*$^{u_1}$. **b.** Then, every$^{u_2}$ boy recited a$^{u_3}$ different$_{u_1,u_3}$ poem.

The proper name *The Raven* in (9a) introduces a new dref $u_1$ storing the poem *The Raven*. This dref is subsequently retrieved by the adjective *different* in (9b). *Different* constrains the value of the anaphorically retrieved dref $u_1$ in two ways. First, it requires $u_1$ to satisfy the conditions contributed by the nominal phrase following *different* – in this case, it requires $u_1$ to be a poem. To see this, replace the indefinite *a poem* in (9b) with the indefinite *a different passage of Scripture*: this yields an infelicitous discourse. This requirement is a presupposition, as shown by the standard S-tests for presupposition projection, e.g., the question *Did every boy recite a different passage of Scripture?* is also infelicitous in the context of sentence (9a). Secondly, *different* requires the value of the anaphorically retrieved dref $u_1$ to be distinct from the value of the dref contributed by the indefinite article that precedes *different* – in this case, $u_3$. This requirement is part of the asserted / at-issue content, as the S-tests also show. For example, consider the *different* under negation: *Mary recited* The Raven*, as she promised, but Linus didn't recite a different poem, despite what he promised* – we actually negate the requirement contributed by *different* that the poem Linus recited is distinct from *The Raven*.

The PCDRT representation that is compositionally assigned to discourse (9) is provided in (10) below. The **Appendix** provides all the formal details, including the meaning assigned to the adjective *different*. The $\mathbf{max}^{u_2}$ operator introduces the dref $u_2$ and requires it to store the (maximal) set of boys, i.e., the restrictor set of the quantifier *every*$^{u_2}$ *boy*. The **dist** operator is discussed in the next section.

(10) $[u_0, u_1 \mid u_0 = mary, u_1 = the\_raven, recite\{u_0, u_1\}]$; $\mathbf{max}^{u_2}([boy\{u_2\}])$;
$\mathbf{dist}_{u_2}([u_3 \mid \mathbf{singleton}\{u_3\}, \mathbf{disjoint}\{u_1, u_3\}, poem\{u_3\}, recite\{u_2, u_3\}])$

# 3 Sentence-Internal Readings as Quantifier-Internal Anaphora

The main proposal of the paper is that sentence-internal readings of *same* / *different* are parallel to the sentence-external ones in that they also involve anaphora and relate two drefs, requiring their values to be identical (for *same*) or distinct (for *different*). Distributive quantifiers like *every*$^{u_0}$ *boy* introduce a distributive operator $\mathbf{dist}_{u_0}$ relative to which the nuclear scope of the quantifier is evaluated, as shown in (11) below. The $\mathbf{dist}_{u_0}$ operator checks in a *distributive, pointwise* manner whether the restrictor set of the quantifier (stored in the dref $u_0$) satisfies the nuclear scope of the quantification.

(11) Every$^{u_0}$ boy $\mathbf{dist}_{u_0}$(recited a$^{u_1}$ different$^{+2}_{u_0,u_1}$ poem).

This pointwise, distributive update proceeds as shown in (12) below. First, the quantifier *every boy*$^{u_0}$ introduces a new dref $u_0$ that stores the restrictor set of the quantifier, i.e., the set of boys. Then, we temporarily introduce two new drefs, each storing one and only one boy in the restrictor set $u_0$; the two boys stored by the two drefs must be distinct. Then, we predicate the nuclear scope of the quantification of each temporary dref and simultaneously make all the necessary updates ('simultaneously' means something like 'simultaneous recursion' here). In particular, we associate each of the two boys with their corresponding $u_1$-poems.

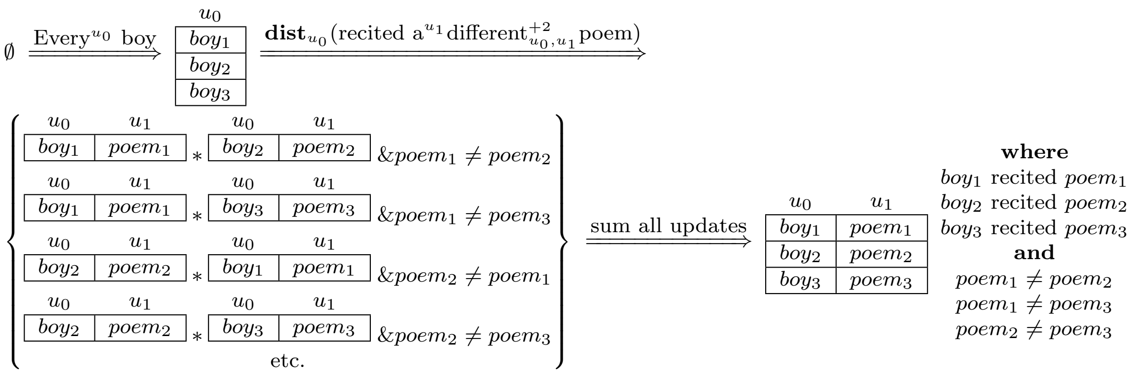
The sentence-internal *different*$^{+2}_{u_0,u_1}$ is anaphoric to the restrictor dref $u_0$ and is interpreted *in situ*, i.e., within the indefinite $a^{u_1}$ ... *poem*. *Different*$^{+2}_{u_0,u_1}$ tests that the two $u_0$-boys that we are currently considering are distinct and, also, that their corresponding $u_1$-poems are distinct (*same* would check that the two $u_0$-boys are distinct and that their $u_1$-poems are identical).

The superscript +2 on *different* is the one that tells us where to look for the boys and their corresponding poems: the two boys are stored by the drefs $u_0$ and $u_{0+2}$ (i.e., $u_2$); their corresponding poems are stored by the drefs $u_1$ and $u_{1+2}$ (i.e., $u_3$). This is a consequence of the fact that the $*$ operator in (12) below concatenates 'boy-poem' sequences, for example:

$$\begin{array}{|c|c|}\multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} \\ \hline boy_1 & poem_1 \\ \hline \end{array} \; * \; \begin{array}{|c|c|}\multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} \\ \hline boy_2 & poem_2 \\ \hline \end{array} \; = \; \begin{array}{|c|c|c|c|}\multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} & \multicolumn{1}{c}{u_2} & \multicolumn{1}{c}{u_3} \\ \hline boy_1 & poem_1 & boy_2 & poem_2 \\ \hline \end{array}$$

The superscript on sentence-internal *different* is not arbitrary: it reflects how many drefs have been introduced prior to the occurrence of sentence-internal *different*. In our case, the superscript is +2 because we have previously introduced the two drefs $u_0$ and $u_1$. Thus, the superscript is basically the length of the sequence of individuals relative to which *different* is interpreted.[3] However, a more systematic theory of anaphora 'indexation' in stack-based PCDRT is a project I leave for future research (as Bittner (2007) argues, such a theory can and should be provided in stack-based dynamic systems).

The final step depicted in (12) is to repeat the above procedure for any two distinct boys stored in $u_0$, i.e., any two individuals in the restrictor set – and, then, to sum together all the updates thus obtained.

(12) 


The procedural flavor of the above informal description is largely just an expository device. The actual definition of the **dist** operator (provided in the **Appendix**) directly encodes the non-procedural, guiding intuition that sentence-internal readings of *same* / *different* provide a window into the internal structure of distributive quantification: distributivity does not merely involve selecting one individual at a time from the restrictor set and checking that the nuclear scope holds of this individual, but distributivity involves selecting *pairs* of distinct individuals and *simultaneously* evaluating the nuclear scope relative to each individual.

This is why *same* / *different* are licensed only in the nuclear scope of distributive quantifiers or distributively interpreted pluralities (as Carlson (1987) observes): the very process of distributively evaluating the nuclear scope temporarily constructs the same kind of contexts that license anaphoric, sentence-external readings. Thus, in a nutshell, the analysis is just this: sentence-internal readings are quantifier-internal / distributivity-internal anaphora.

The compositionally obtained PCDRT representation for the sentence-internal reading of *different* exemplified in (11) above is provided in (13) below. All the formal details can be found in the **Appendix**, including a meaning for sentence-internal *different* that includes as its main component the meaning for sentence-external *different* discussed in the previous section.

[3] More precisely, the length of the initial sub-sequence up to and including the dref that is introduced by the indefinite DP that *different* is a part of.

Thus, we formally capture the cross-linguistic generalization that, if a language has a lexical item that can have sentence-internal readings under morphologically singular and semantically distributive quantifiers, then this item can also have sentence-external readings.

(13) $\mathbf{max}^{u_0}([boy\{u_0\}]);$
$\mathbf{dist}_{u_0}([u_1 \,|\, \mathbf{singleton}\{u_1\}, \mathbf{disjoint}\{u_{1+2}, u_1\}, poem\{u_1\}, recite\{u_0, u_1\}])$

# 4 Stacks, Plural Info States and Pair-based Distributivity

This section discusses the formalization of the three main features of the analysis and provides independent empirical motivation for them. These features are: (*i*) interpreting expressions relative to *sets* of variable assignments and not single assignments (the assignments are the rows storing boys and poems in (12) above; **dist** operators distribute over such sets of assignments); (*ii*) making multiple drefs simultaneously available by *concatenating* variable assignments (this is what happens when we 'simultaneously' consider multiple boys and their corresponding poems in the scope **dist** operators); (*iii*) finally, the fact that we distribute over *pairs* of individuals instead of single individuals.

These three features of the analysis are independently motivated by: (*i*) quantificational subordination, the PCDRT analysis of which also relies on sets of assignments (see Brasoveanu 2007); (*ii*) the availability of both dependent and independent anaphora in the scope of distributors like *each*, which Nouwen (2007) accounts for by means of variable assignment concatenation; (*iii*) the interpretation of dependent indefinites in languages like Hungarian and Romanian, discussed in Farkas (1997, 2007).

I will propose a novel analysis of dependent indefinites that crucially relies on the availability of two individuals in the scope of distributive quantifiers. This analysis will effectively equate dependent indefinites and 'possibly different' indefinites in English that always take narrow scope relative to a distributive quantifier, e.g. *Every boy recited a possibly different poem.* In the process, we will be able to define a notion of covariation that is the semantic counterpart of the syntactic notion of narrow scope.

## 4.1 Stacks

We work with stacks / sequences of individuals instead of total or partial variable assignments, following Bittner (2001, 2007), Nouwen (2003, 2007) and references therein, in particular Vermeulen (1993) and Dekker (1994). The main motivation for using stacks is that, when we introduce new drefs, we never override old drefs and, therefore, never lose previously introduced anaphoric information: we always add information to a stack and we do this in an orderly manner, based on the particular position in the stack that the update targets. One important consequence of this fact for our analysis is that we can easily define the notion of stack concatenation that is a crucial component of the **dist** operators we need.

We indicate the empty positions in a stack $i$ by storing the dummy individual # there. The dummy individual # makes any lexical relation false, i.e., # is the universal falsifier.[4]

| $0$ | $1$ | $\dots$ | $n-1$ | $n$ | $n+1$ | $\dots$ |
|---|---|---|---|---|---|---|
| $\alpha_0$ | $\alpha_1$ | $\dots$ | $\alpha_{n-1}$ | $\#$ | $\#$ | $\dots$ |

The length of a stack $i$, abbreviated $\mathbf{lng}(i)$, is provided by the 'leftmost' position in which the stack stores an individual different from the universal falsifier # – to which we need to add 1, because the first position in the stack is the 0-th position. An example of a stack of length 4 (that is, $\mathbf{lng}(i) = 4$) is provided in (15) below; the cells storing the universal falsifier # are

[4] We ensure that any lexical relation $R$ of arity $n$, i.e. of type $e^n t$, where $e^0 t := t$ and $e^{m+1} t := e(e^m t)$, yields falsity whenever # is one of its arguments by letting $R \subseteq (D_e^{\mathfrak{M}} \setminus \{\#\})^n$.

simply omitted. The positions in a stack can be indicated by either natural numbers or – as we will do from now on – drefs that have natural numbers as indices. Indices on drefs are essential: they indicate the stack position where the value of the dref is stored.

(14) **Abbreviation – stack length**[5]

$$\mathbf{lng}(i) := \begin{cases} 1 + \iota n.\ (i)_n \neq \# \wedge \forall n' > n((i)_{n'} = \#) & \text{if } \exists n((i)_n \neq \# \wedge \forall n' > n((i)_{n'} = \#)) \\ 0 & \text{if } \forall n((i)_n = \#) \\ \# & \text{otherwise} \end{cases}$$

(15)

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| $\alpha$ | $\beta$ | $\gamma$ | $\delta$ |

or, equivalently:

| $u_0$ | $u_1$ | $u_2$ | $u_3$ |
|---|---|---|---|
| $\alpha$ | $\beta$ | $\gamma$ | $\delta$ |

## 4.2 Plural Information States

Just as in Dynamic Plural Logic (van den Berg 1996), information states $I, J, \ldots$ are modeled as *sets* of stacks $i_1, i_2, i_3, \ldots, j_1, j_2, j_3, \ldots$. Such *plural* info states can be represented as matrices with stacks (sequences) as rows, as shown below.

<table>
<tr><th>Info State $I$</th><th>$u_0$</th><th>$u_1$</th><th>$u_2$</th><th>...</th></tr>
<tr><td>$i_1$</td><td>$\alpha_1$ (i.e., $u_0 i_1$)</td><td>$\beta_1$ (i.e., $u_1 i_1$)</td><td>$\gamma_1$ (i.e., $u_2 i_1$)</td><td>...</td></tr>
<tr><td>$i_2$</td><td>$\alpha_2$ (i.e., $u_0 i_2$)</td><td>$\beta_2$ (i.e., $u_1 i_2$)</td><td>$\gamma_2$ (i.e., $u_2 i_2$)</td><td>...</td></tr>
<tr><td>$i_3$</td><td>$\alpha_3$ (i.e., $u_0 i_3$)</td><td>$\beta_3$ (i.e., $u_1 i_3$)</td><td>$\gamma_3$ (i.e., $u_2 i_3$)</td><td>...</td></tr>
<tr><td>...</td><td>...</td><td>...</td><td>...</td><td>...</td></tr>
<tr><td colspan="2">Quantifier domains (sets) are stored columnwise: $\{\alpha_1, \alpha_2, \ldots\}$, $\{\beta_1, \beta_2, \ldots\}$ etc.</td><td colspan="3">Quantifier dependencies (relations) are stored rowwise: $\{\langle\alpha_1, \beta_1\rangle, \langle\alpha_2, \beta_2\rangle, \ldots\}$, $\{\langle\alpha_1, \beta_1, \gamma_1\rangle, \langle\alpha_2, \beta_2, \gamma_2\rangle, \ldots\}$ etc.</td></tr>
</table>

Plural info states enable us to encode discourse reference to both quantifier domains, i.e. *values*, and quantificational dependencies, i.e. *structure*. The values are the sets of objects that are stored in the columns of the matrix, e.g., the dref $u_0$ stores a set of individuals $\{\alpha_1, \alpha_2, \alpha_3, \ldots\}$ relative to a plural info state because $u_0$ is assigned an individual by each stack/row. The structure is encoded in the rows of the matrix: for each stack/row $i_1, i_2$ etc. in the info state, the individual assigned to the dref $u_0$ (for example) by that stack is structurally correlated with the individual assigned to the dref $u_1$ (and/or $u_2$, and/or $u_3$ etc.) by the same stack.

From now on, we will use simpler representations for plural info states – we will only indicate the drefs and the stored individuals (omitting the universal falsifier), as exemplified below.

| $u_0$ | $u_1$ | $u_2$ | ... |
|---|---|---|---|
| $\alpha_1$ | $\beta_1$ | $\gamma_1$ | ... |
| $\alpha_2$ | $\beta_2$ | $\gamma_2$ | ... |
| $\alpha_3$ | $\beta_3$ | $\gamma_3$ | ... |
| ... | ... | ... | ... |

## 4.3 Concatenating Stacks and Plural Info States

The stack and plural info state concatenation operations are defined in (19) and (20) below.

(16) **Projection functions over stacks**: $(i)_n$ is the individual stored at position $n$ (a.k.a. $u_n$) in stack $i$.

[5] The "otherwise" case covers stacks of infinite length, for example, the stack storing the universal falsifier # at all odd-number positions $1, 3, 5, \ldots$ and individuals different from # at the other positions.

(17) **Stack update**: $i[n]j$ (a.k.a. $i[u_n]j$) $:= \forall m < n((j)_m = (i)_m) \wedge \forall m > n((j)_m = (i)_{m-1})$
($j$ is the stack obtained by shifting all the $i$-individuals at positions greater than or equal to $n$ by one position and introducing a new random individual at position $n$)[6]

(18) **Concatenating stacks and individuals** (based on Bittner 2007, Nouwen 2007):
$i * x \ := \ \iota j.\ i[\mathbf{lng}(i)]j \wedge (j)_{\mathbf{lng}(i)} = x$
($i * x$ is the stack obtained by appending the individual $x$ at the end of stack $i$)

(19) **Concatenating stacks** (based on Nouwen 2007): $i * j \ := \ (i * (j)_0) * ... * (j)_{\mathbf{lng}(j)-1}$
($i * j$ is obtained by appending the first individual in stack $j$, namely $(j)_0$, at the end of stack $i$, then appending the second individual in $j$ at the end of the resulting stack etc.)

(20) **Concatenating plural info states** (Nouwen 2007): $I * J \ := \ \{i * j : i \in I \wedge j \in J\}$

For example, we concatenate two stacks of length 2 to obtain a stack of length 4 – or two plural info states of length 2 to obtain a plural info state of length 4:

$$\begin{array}{|c|c|} \multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} \\ \hline boy_1 & poem_1 \\ \hline \end{array} \ * \ \begin{array}{|c|c|} \multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} \\ \hline boy_2 & poem_2 \\ \hline \end{array} \ = \ \begin{array}{|c|c|c|c|} \multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} & \multicolumn{1}{c}{u_2} & \multicolumn{1}{c}{u_3} \\ \hline boy_1 & poem_1 & boy_2 & poem_2 \\ \hline \end{array}$$

$$\begin{array}{|c|c|} \multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} \\ \hline boy_2 & poem_2 \\ \hline \end{array} \ * \ \begin{array}{|c|c|} \multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} \\ \hline boy_1 & poem_1 \\ \hline boy_2 & poem_2 \\ \hline boy_3 & poem_3 \\ \hline \end{array} \ = \ \begin{array}{|c|c|c|c|} \multicolumn{1}{c}{u_0} & \multicolumn{1}{c}{u_1} & \multicolumn{1}{c}{u_2} & \multicolumn{1}{c}{u_3} \\ \hline boy_2 & poem_2 & boy_1 & poem_1 \\ \hline boy_2 & poem_2 & boy_2 & poem_2 \\ \hline boy_2 & poem_2 & boy_3 & poem_3 \\ \hline \end{array}$$

## 4.4 Independent Motivation for Plural Info States and Stacks

Both plural info states and stacks are independently motivated. We will discuss them in turn.

Brasoveanu (2007) argues that we need a semantics based on plural info states to account for quantificational subordination (among other things). Consider the example of quantificational subordination in (21) below (from Karttunen 1976). One of the interpretations of discourse (21) is that Harvey courts a different woman at every convention and, at each convention, the woman courted by Harvey at that convention comes with him to the banquet of the convention. The singular pronoun $she_{u_0}$ and the adverb $always_{u_1}$ in sentence (21b) elaborate on the quantificational dependency between conventions and women introduced in sentence (21a).

(21) **a.** Harvey courts $a^{u_0}$ woman at $every^{u_1}$ convention. **b.** $She_{u_0}$ $always_{u_1}$ comes to the banquet with him. [**c.** $The_{u_0}$ woman is $usually_{u_1}$ also very pretty.]

Plural info states enable us to give a semantics for sentence (21a) that, as a result of the very process of interpreting sentence (21a): (*i*) introduces two quantifier domains (the conventions and the women) and a quantificational dependency between them (the 'being courted by Harvey' relation), (*ii*) stores the quantifier domains and quantificational dependency in a plural info state and, finally, (*iii*) passes on this info state to sentence (21b), which further elaborates on it.

Thus, we need plural info states not only for the quantifier-internal dynamics that licenses the sentence-internal readings of *same* / *different*, but also for the quantifier-external dynamics involved in quantificational subordination.

The example of cross-sentential anaphora to quantifier domains in (22) below (based on an example in Nouwen 2007) provides similarly independent motivation for the use of stacks and stack-concatenation operations. In sentence (22b), we can refer back to the narrow-scope indefinite $a^{u_1}$ *poem*: (*i*) with the singular pronoun $it_{u_1}$, in which case (22b) says that each boy recited the poem he chose – that is, we elaborate on the quantificational dependency between boys and poems introduced in sentence (22a), or (*ii*) with the plural pronoun $them_{u_1}$, in which case (22b) says that each boy recited all the poems under consideration.

[6] A stricter version is possible whereby you can update a position in a stack only if all the 'previous' positions have already been updated, i.e., none of them stores the universal falsifier #: $i[u_n]j \ := \ \forall m < n((j)_m = (i)_m \wedge (i)_m \neq \#) \wedge \forall m > n((j)_m = (i)_{m-1})$.

(22) **a.** Every$^{u_0}$ boy chose a$^{u_1}$ poem. **b.** Then, they$_{u_0}$ each$_{u_0}$ recited it$_{u_1}$ / them$_{u_1}$.

Thus, in the scope of the distributor each$_{u_0}$ in sentence (22b), we need to have access to both the dependency between boys and poems and the entire set of poems introduced in sentence (22a). Nouwen (2007) proposes to give a semantics for *each*$_{u_0}$ in terms of stack concatenation to account for the availability of both distributive / dependent and collective / independent anaphora in its scope. The update contributed by sentence (22a), schematically represented in (24) below, relates an input and an output plural info state. The input state is the singleton set containing the empty stack – this is the initial info state that stores no anaphoric information. The output state is a set of stacks that stores all the boys in its first column and their corresponding poems in the second column (the boy-poem dependency is stored stack-wise).

(23) $i_{\#} := \iota i.\ \mathbf{lng}(i) = 0$ (the empty stack)

(24) $\{i_{\#}\} \xRightarrow{\text{Every}^{u_0}\text{ boy chose a}^{u_1}\text{ poem}}$

| $u_0$ | $u_1$ | |
|---|---|---|
| *boy*$_1$ | *poem*$_1$ | *boy*$_1$ chose *poem*$_1$ |
| *boy*$_2$ | *poem*$_2$ | *boy*$_2$ chose *poem*$_2$ |
| *boy*$_3$ | *poem*$_3$ | *boy*$_3$ chose *poem*$_3$ |

The update contributed by sentence (22b) and, in particular, by the distributor *each*$_{u_0}$, further updates this output info state as shown in (25) below. First, we temporarily introduce each boy, one at a time, and his corresponding poem and concatenate this stack with the entire input stack. Then, we check that the update in the scope of *each*$_{u_0}$ holds relative to the resulting stacks of length 4, which can license both distributive / dependent anaphora (i.e., the singular pronoun) and collective / independent anaphora (i.e., the plural pronoun).

(25)

| $u_0$ | $u_1$ |
|---|---|
| *boy*$_1$ | *poem*$_1$ |
| *boy*$_2$ | *poem*$_2$ |
| *boy*$_3$ | *poem*$_3$ |

$\xRightarrow{\text{They}_{u_0}\text{ each}_{u_0}\text{ (recited it}_{u_1}\text{/them}^{+2}_{u_1}\text{)}}$

$\left\{\right.$

| $u_0$ | $u_1$ | $u_2$ | $u_3$ |
|---|---|---|---|
| *boy*$_1$ | *poem*$_1$ | *boy*$_1$ | *poem*$_1$ |
| *boy*$_1$ | *poem*$_1$ | *boy*$_2$ | *poem*$_2$ |
| *boy*$_1$ | *poem*$_1$ | *boy*$_3$ | *poem*$_3$ |

| $u_0$ | $u_1$ | $u_2$ | $u_3$ |
|---|---|---|---|
| *boy*$_2$ | *poem*$_2$ | *boy*$_1$ | *poem*$_1$ |
| *boy*$_2$ | *poem*$_2$ | *boy*$_2$ | *poem*$_2$ |
| *boy*$_2$ | *poem*$_2$ | *boy*$_3$ | *poem*$_3$ |

| $u_0$ | $u_1$ | $u_2$ | $u_3$ |
|---|---|---|---|
| *boy*$_3$ | *poem*$_3$ | *boy*$_1$ | *poem*$_1$ |
| *boy*$_3$ | *poem*$_3$ | *boy*$_2$ | *poem*$_2$ |
| *boy*$_3$ | *poem*$_3$ | *boy*$_3$ | *poem*$_3$ |

$\left.\right\}$

The plural pronoun *them*$^{+2}_{u_1}$ is marked as independent / collective by its superscript +2; this superscript indicates that the pronoun retrieves not the single $u_1$ poem currently under consideration, but all the poems, which are stored two positions to the right of $u_1$, i.e., by dref $u_{1+2} = u_3$. Just as in the case of sentence-internal *different*, the superscript on independent pronouns is not arbitrary: it depends on how many drefs have been previously introduced. In our case, the superscript is +2 because we introduced the two drefs $u_0$ and $u_1$ prior to the occurrence of the independent pronoun *them*.

The cross-sentential availability of multiple drefs in (22) is made possible by the fact that the distributor *each* temporarily introduces new drefs by (*i*) selecting a subset of stacks from a particular plural info state and (*ii*) concatenating this subset of stacks with another set of stacks. We use the same stack-concatenation technique to define the quantifier-internal distributive operator that we need to give a unified account of sentence-internal and sentence-external readings of *same* / *different*. Moreover, the stack-based PCDRT system defined in the **Appendix** goes beyond Nouwen (2007) and actually provides a *compositional* interpretation procedure that derives the intuitively correct meaning for discourse (22).

However, the stack-based PCDRT definition of **dist** operators – except for the fact that it makes use of Nouwen-style concatenation – builds on the notion of distributivity in van den Berg (1996) and Brasoveanu (2007) rather than on the one defined by Nouwen (2007) to capture the meaning of *each*. The difference is that the full input state is never available in the scope of **dist** operators. This is motivated by the fact that we cannot have collective / independent anaphora of the kind exemplified in (22) above in the scope of distributive quantifiers. This is shown by the fact that the sentence *Every lawyer hired a secretary they liked* cannot be interpreted as: each of the lawyers hired a secretary they all liked – at least, not in a discourse-initial position where there is no contextually-salient set of lawyers that the plural pronoun *they* could refer to.

## 4.5 Independent Motivation for Pair-based Distributivity: Dependent Indefinites, *Possibly Different* and the Nature of Covariation

The availability of two drefs in the scope of distributive quantification is independently motivated by the interpretation of dependent indefinites. Such indefinites were first discussed in Farkas (1997), where it was noted that the indefinite determiner and cardinal numerals in Hungarian may reduplicate, in which case the DP must be interpreted as covarying with an individual or event/situation variable bound by a quantifier within the same clause. Farkas (2007) shows that the same effect is obtained in Romanian by having the item *cîte* precede an indefinite or numeral, as exemplified in (26) below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (26) | *Fiecare*$^{u_0}$ | *băiat* | *a* | *recitat* | *cîte*$^{+2}_{u_1}$ | *un*$^{u_1}$ | *poem.* |
| | Every | boy | HAS | recited | CÎTE | a | poem. |

‘Every boy recited a possibly different poem.’

The English translation captures the exact meaning of the Romanian particle *cîte*, which means the same thing as *possibly different*. That is, *cîte* requires covariation, which is the semantic counterpart of the syntactic notion of narrow scope. To see this, consider the Romanian example in (27) below. The particle *cîte* is licensed by the quantification over times contributed by *din cînd în cînd*$^{u_0}$ (every now and then).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (27) | *Din* | *cînd* | *în* | *cînd*$^{u_0}$*,* | *Linus* | *scotea* | *cîte* | *o*$^{u_1}$ | *bilă* | *din* | *pungă,* |
| | From | when | to | when, | Linus | take.out.impf.3.sg | CÎTE | a | marble | out | bag, |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *se* | *uita* | *la* | *ea* | *cu* | *atenţie,* | *după* | *care* | *o* | *punea* | *la* | *loc.* |
| REFL | look.impf.3.sg | at | it | with | care, | after | which | it | put.impf.3.sg | at | place. |

‘Every now and then, Linus would take out a marble from the bag, look at it carefully, then put it back.’

Importantly, this example is felicitous and true in a situation in which there are several marbles in the bag that are indistinguishable from each other and in which it might very well be that Linus is taking the same marble out of the bag, over and over again. What is important for semantic covariation, hence, for the licensing of *cîte*, is that, every time he took out a marble, it *could* have been a marble that was different from any other particular time he took out a marble – not that it *actually was* a different marble every single time.

The contribution of Romanian *cîte* is the same as the contribution of the English *possibly different*: we rule out situations in which there is a single marble in the bag or in which we know that Linus took out the same marble over and over again, but we allow for situations in which Linus ends up taking out the same marble over and over again as long as, as far as we know, situations in which he takes out distinct marbles are also possible. Semantic covariation requires only that, on any two occasions, the two marbles could – as far as we know, i.e., as far as the common ground knowledge is concerned – be different, not that they actually are.

Thus, stack-based PCDRT provides a framework in which we can define the notion of covariation, i.e., the semantic counterpart of the syntactic notion of narrow scope – while classical (first-order) semantics can only distinguish between lack of covariation and actual covariation, but cannot express the *possibility* thereof. Consequently, stack-based PCDRT enables us to give a novel analysis of dependent indefinites in terms of *possibly different* – and, conversely, dependent indefinites provide independent motivation for the analysis of sentence-internal readings of *same / different* proposed in the present paper.

The compositionally derived PCDRT representation for example (26) above is provided in (28) below. Informally, the $\diamond$ operator expresses possibility and it requires the DRS in its scope to be satisfied relative to some common-ground world. I will not provide here the extension of stack-based PCDRT with modal quantification – see the very similar intensional ('total assignment' based) PCDRT in Brasoveanu (2007).

(28) $\mathbf{max}^{u_0}([boy\{u_0\}]);\ \mathbf{dist}_{u_0}([\diamond([u_1 \mid \mathbf{singleton}\{u_1\}, poem\{u_1\}, recite\{u_0, u_1\}, \mathbf{disjoint}\{u_{1+2}, u_1\}])];$
$[u_1 \mid \mathbf{singleton}\{u_1\}, poem\{u_1\}, recite\{u_0, u_1\}])$

The representation in (28) is very similar to the representation of sentence-internal readings in (13) above. Interestingly, sentence-internal readings are expressed in Romanian by means of the particle *cîte* together with the adjective *alt* (other), which is also used for sentence-external readings – as the examples in (29) and (30) below show. The addition of the adjective *alt* in (30) requires *actual* covariation (for any two boys, their corresponding poems have to be distinct), over and above the *possibility* of covariation that is required by the particle *cîte.*

(29) ***a.*** *Maria a recitat* Corbul. ***b.*** *Apoi, Linus a recitat un alt poem.*
Mary HAS recited *Raven.the* Then, Linus HAS recited a other poem
'Mary recited *The Raven.* Then, Linus recited another poem.'

(30) *Fiecare băiat a recitat cîte un alt poem.*
Every boy HAS recited CÎTE a other poem.
'Every boy recited a different poem.'

# 5 Extensions: Distributing over Times and Events

To conclude, I will only mention that the same kind of distributivity operators can be used to license sentence-internal readings of *same / different* in the scope of distributively interpreted pluralities of time intervals or events, exemplified by *Linus read different poems every day* and *Linus wrote and read the same poem* respectively. We only need to add two more basic types, one for temporal instants (in terms of which we can define temporal intervals) and one for events. We will then be able to distribute over a set of times or a set of events stored in a plural info state in much the same way as we distribute over a set of individuals.

## Appendix. Stack-based Plural Compositional DRT (PCDRT)

### Stack-based Dynamic Ty2

We work with a Dynamic Ty2 logic, i.e., basically, with the Logic of Change in Muskens (1996), which reformulates dynamic semantics (Kamp 1981, Heim 1982) in Gallin's Ty2 (Gallin 1975). We have three basic Types: (*i*) $e$ (individuals, including the set of natural numbers $\mathbb{N}$) – variables: $x, y, ...$; constants: $linus, gabby, ...$; variables over natural numbers: $m, n, ...$, (*ii*) $t$ (truth values) – $\mathbb{T}, \mathbb{F}$; (*iii*) $s$ (stacks) – variables: $i, j, ....$ Four axioms ensure that the entities of type $s$ behave as stacks.

(31) **Ax1** (stack identity in terms of projection functions): $\forall i_s \forall i'_s \forall n((i)_n = (i')_n \to i = i')$
**Ax2** (stacks have finite length): $\forall i_s(\exists n(\mathbf{lng}(i) = n))$[7]
**Ax3** (the empty stack exists): $\exists i_s(\mathbf{lng}(i) = 0)$
**Ax4** (enough stacks): $\forall i_s \forall n \forall x_e(\exists j(i[n]j \wedge (j)_n = x))$

[7]This is equivalent to $\forall i_s(\mathbf{lng}(i) \neq \#)$.

## Stack-based PCDRT

Discourse referents (drefs) $u_0, u_1$ etc. of type $se$ are just projection functions over stacks. Conditions are sets of info states, i.e., sets of sets of stacks (terms of type $(st)t$). DRSs are binary relations between info states / sets of stacks (i.e., terms of type $(st)((st)t)$).

(32) $u_n := \lambda i_s.\ (i)_n$, e.g., $u_0 := \lambda i.\ (i)_0$, $u_1 := \lambda i.\ (i)_1$ etc.

(33) $i[u_n]j := \forall m < n((j)_m = (i)_m) \wedge \forall m > n((j)_m = (i)_{m-1})$[8]

(34) $I[u_n]J := \forall i_s \in I(\exists j_s \in J(i[u_n]j)) \wedge \forall j_s \in J(\exists i_s \in I(i[u_n]j))$

(35) $I_{u_{m_1} \neq \#, \ldots, u_{m_n} \neq \#} := \{i_s \in I : u_{m_1} i \neq \# \wedge \ldots \wedge u_{m_n} i \neq \#\}$

(36) $R\{u_{m_1}, ..., u_{m_n}\} := \lambda I_{st}.\ I_{u_{m_1} \neq \#, \ldots, u_{m_n} \neq \#} \neq \emptyset \wedge \forall i_s \in I_{u_{m_1} \neq \#, \ldots, u_{m_n} \neq \#}(R(u_{m_1} i, \ldots, u_{m_n} i))$
(lexical relations, for any $n$-ary relation $R$ of type $e^n t$, where $e^0 t := t$ and $e^{n+1} t := e(e^n t)$)

(37) $I_{u_n = x} := \{i_s \in I : u_n i = x\}$

(38) $I_{u_n \neq x} := \{i_s \in I : u_n i \neq x\}$

(39) $u_n I := \{u_n i : i_s \in I_{u_n \neq \#}\}$

(40) $u_n = x := \lambda I_{st}.\ u_n I = \{x\}$ (identity between drefs and individuals – needed for proper names)

(41) $u_n = u_m := \lambda I_{st}.\ I \neq \emptyset \wedge \forall i_s \in I(u_n i = u_m i)$ (identity between drefs)

(42) Atomic DRSs: $[C] := \lambda I_{st}.\lambda J_{st}.\ I = J \wedge CJ$

(43) Tests: $[C_1, ..., C_m] := \lambda I_{st}.\lambda J_{st}.\ I = J \wedge C_1 J \wedge\ ...\ \wedge C_m J$

(44) Dynamic conjunction: $D; D' := \lambda I_{st}.\lambda J_{st}.\ \exists H_{st}(DIH \wedge D'HJ)$

(45) Multiple dref introduction: $[u_{m_1}, ..., u_{m_n}] := [u_{m_1}];\ ...\ ; [u_{m_n}]$

(46) DRSs: $[u_{m_1}, ..., u_{m_n} \mid C_1, ..., C_m] := [u_{m_1}, ..., u_{m_n}]; [C_1, ..., C_m]$

(47) Truth: a DRS $D$ of type $\mathbf{t}$ is *true* with respect to an input info state $I_{st}$ iff $\exists J_{st}(DIJ)$.

## Maximization and Distributivity

(48) $\mathbf{max}^{u_n}(D) := \lambda I_{st}.\lambda J_{st}.\ ([u_n]; D)IJ \wedge \forall K_{st}(([u_n]; D)IK \rightarrow u_n K \subseteq u_n J)$

(49) $\mathbf{each}_{u_n}(D) := \lambda I_{st}.\lambda J_{st}.\ u_n I = u_n J \wedge I_{u_n = \#} = J_{u_n = \#} \wedge \forall x_e \in u_n I(D(I_{u_n = x} * I)(J_{u_n = x} * I))$
(based on Nouwen 2007)

(50) $\mathbf{dist}_{u_n}(D) := \lambda I_{st}.\lambda J_{st}.\ u_n I = u_n J \wedge I_{u_n = \#} = J_{u_n = \#} \wedge (|u_n I| = 1 \rightarrow D I_{u_n \neq \#} J_{u_n \neq \#}) \wedge \forall x_e \in u_n I \forall x'_e \in u_n I(x \neq x' \rightarrow D(I_{u_n = x} * J_{u_n = x'})(J_{u_n = x} * J_{u_n = x'}))$

## Compositionality

Given the underlying type logic, compositionality at sub-clausal level follows automatically and standard techniques from Montague semantics become available. In more detail, the compositional aspect of interpretation in an extensional Fregean / Montagovian framework is largely determined by the types for the (extensions of the) 'saturated' expressions, i.e. names and sentences. Abbreviate them as $\mathbf{e}$ and $\mathbf{t}$. An extensional static logic identifies $\mathbf{e}$ with $e$ and $\mathbf{t}$ with $t$. The translation of the English noun *boy* is of type $\mathbf{et}$, i.e. $et$: *boy* $\rightsquigarrow \lambda x_e.\ boy_{et}(x)$. The generalized determiner *every* is of type $(\mathbf{et})((\mathbf{et})\mathbf{t})$, i.e. $(et)((et)t)$: *every* $\rightsquigarrow \lambda S_{et}.\lambda S'_{et}.\ \forall x_e(S(x) \rightarrow S'(x))$. PCDRT assigns the following dynamic types to the 'meta-types' $\mathbf{e}$ and $\mathbf{t}$: $\mathbf{t}$ abbreviates $(st)((st)t)$, i.e. a sentence is interpreted as a DRS, and $\mathbf{e}$ abbreviates $se$, i.e. a name is interpreted as a dref. The denotation of the noun *boy* is still of type $\mathbf{et}$, the determiner *every* is still of type $(\mathbf{et})((\mathbf{et})\mathbf{t})$ etc.

## Basic Translations

(51) *boy* $\rightsquigarrow \lambda v_{\mathbf{e}}.\ [boy_{et}\{v\}]$, i.e. *boy* $\rightsquigarrow \lambda v_{\mathbf{e}}.\lambda I_{st}.\lambda J_{st}.\ I = J \wedge boy_{et}\{v\}J$

(52) *recite* $\rightsquigarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda v_{\mathbf{e}}.\ Q(\lambda v'_{\mathbf{e}}.[recite\{v, v'\}])$

(53) *each* $\rightsquigarrow \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \mathbf{each}_v(P(v))$

(54) *every*$^{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}.\ \max^{u_n}(P(u_n));\ \mathbf{dist}_{u_n}(P'(u_n))$

(55) $\mathbf{singleton}\{u_n\} := \lambda I_{st}.\ |u_n I| = 1$

(56) *a*$^{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}.\ [u_n \mid \mathbf{singleton}\{u_n\}];\ P(u_n);\ P'(u_n)$

(57) *it*$_{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\ [\mathbf{singleton}\{u_n\}];\ P(u_n)$

(58) independent pronouns: *it*$^{+m}_{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\ [\mathbf{singleton}\{u_{n+m}\}];\ P(u_{n+m})$

(59) $u_n \neq \emptyset := \lambda I_{st}.\ u_n I \neq \emptyset$

(60) *they*$_{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\ [u_n \neq \emptyset];\ P(u_n)$

(61) independent pronouns: *they*$^{+m}_{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\ [u_{n+m} \neq \emptyset];\ P(u_{n+m})$

(62) *Linus*$^{u_n}$ $\rightsquigarrow \lambda P_{\mathbf{et}}.\ [u_n \mid u_n = linus];\ P(u_n)$ (where $linus_e$ is an individual constant of type $e$)

[8] Or we can use the stronger version: $i[u_n]j := \forall m < n((j)_m = (i)_m \wedge (i)_m \neq \#) \wedge \forall m > n((j)_m = (i)_{m-1})$.

(63) $\textbf{disjoint}\{u_n, u_{n'}\} := \lambda I_{st}.\ I \neq \emptyset \wedge u_n I \cap u_{n'} I = \emptyset$

(64) $\textsc{different}_{u_n, u_{n'}} := \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \underline{P(u_n)};\ [\textbf{disjoint}\{u_n, u_{n'}\}];\ P(v)$ (presuppositions are underlined)

(65) sentence-external: $\textit{different}_{u_n, u_{n'}} \rightsquigarrow \textsc{different}_{u_n, u_{n'}}$

(66) sentence-internal: $\textit{different}^{+m}_{u_n, u_{n'}} \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \underline{[\textbf{disjoint}\{u_{n+m}, u_n\}]};\ \textsc{different}_{u_{n'+m}, u_{n'}}(P)(v)$

(67) $\textbf{identical}\{u_n, u_{n'}\} := \lambda I_{st}.\ I \neq \emptyset \wedge u_n I = u_{n'} I$

(68) $\textsc{same}_{u_n, u_{n'}} := \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \underline{P(u_n)};\ [\textbf{identical}\{u_n, u_{n'}\}];\ P(v)$

(69) sentence-external: $\textit{same}_{u_n, u_{n'}} \rightsquigarrow \textsc{same}_{u_n, u_{n'}}$

(70) sentence-internal: $\textit{same}^{+m}_{u_n, u_{n'}} \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \underline{[\textbf{disjoint}\{u_{n+m}, u_n\}]};\ \textsc{same}_{u_{n'+m}, u_{n'}}(P)(v)$

(71) $\textit{cîte}^{+m}_{u_n} \rightsquigarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda R_{((\mathbf{et})\mathbf{t})(\mathbf{et})}.\lambda v_{\mathbf{e}}.\ [\diamond(R(Q)(v);\ [\textbf{disjoint}\{u_{n+m}, u_n\}])];\ R(Q)(v)$

# References


Barker, C. (2007). Parasitic Scope. In *Linguistics and Philosophy* 30, 407-444.

Beck, S. (2000). The Semantics Of Different: Comparison Operator And Relational Adjective. In *Linguistics and Philosophy* 23, 101-139.

van den Berg, M. (1996). *Some Aspects of the Internal Structure of Discourse*. PhD dissertation, University of Amsterdam.

Bittner, M. (2001). Topical Referents for Individuals and Possibilities. In *Proceedings of SALT XI*, R. Hastings et al (eds.), Ithaca: CLC, 36-55.

Bittner, M. (2007). Online Update: Temporal, Modal and *De Se* Anaphora in Polysynthetic Discourse. In *Direct Compositionality*, C. Barker & P. Jacobson (eds.), Oxford University Press, 363-404.

Brasoveanu, A. (2007). *Structured Nominal and Modal Reference*. PhD dissertation, Rutgers University.

Brasoveanu, A. (2008). Sentence-Internal Readings of *Same/Different* as Quantifier-Internal Anaphora. Handout, WCCFL XXVII, UCLA, available at `http://abrsvn.googlepages.com/brasoveanu_WCCFL_2008_handout.pdf`.

Carlson, G. (1987). *Same* and *Different*: Some Consequences for Syntax and Semantics. In *Linguistics and Philosophy* 10, 531-565.

Dekker, P. (1994). Predicate Logic with Anaphora. In *Proceedings of SALT IV*, L. Santelmann M. Harvey (eds.), DMLL, Cornell University, 79-95.

Farkas, D. F. (1997). Dependent Indefinites. In *Empirical Issues in Formal Syntax and Semantics*, F. Corblin, D. Godard, J.- M. Marandin (eds.), Peter Lang, 243-267.

Farkas, D. F. (2007). Free Choice in Romanian. In Drawing the Boundaries of Meaning: Neo-Gricen studies in pragmatics and semantics in honor of Laurence R. Horn, John Benjamins, 71-95.

Gallin, D. (1975). *Intensional and Higher-Order Modal Logic with Applications to Montague Semantics*. North-Holland Mathematics Studies.


Gallin, D. (1975). *Intensional and Higher-Order Modal Logic with Applications to Montague Semantics*. North-Holland Mathematics Studies.


Groenendijk, J. & M. Stokhof (1991). Dynamic Predicate Logic. In *Linguistics and Philosophy* 14, 39-100.

Heim, I. (1982).*The Semantics of Definite and Indefinite Noun Phrases*. PhD dissertation, UMass Amherst.

Kamp, H. (1981). A theory of truth and semantic representation. In *Formal Methods in the Study of Language. Part 1*, Groenendijk, J., T. Janssen & M. Stokhof (eds.), Mathematical Center, Amsterdam, 277-322.

Karttunen, L. (1976). Discourse Referents. In *Syntax and Semantics Vol. 7*, J.D. McCawley (ed.), New York: Academic Press, 363-385.

Laca, B. & L. Tasmowski (2003). From Non-Identity to Plurality: French *Différent* as an Adjective and as a Determiner. In *Romance Languages & Linguistic Theory 2001*, J. Quer, J. Schroten, M. Scorretti, P. Sleeman & E. Verheugd (eds.), 155-176.

Matushansky, O. (2007). The Same As? Handout for the *Colloque International sur les Adjectifs*, Université Lille 3, September 13-15, available at *http://mapage.noos.fr/matushansky/Downloads/Lille.pdf.*

Muskens, R. (1996). Combining Montague Semantics and Discourse Representation. In *Linguistics and Philosophy* 19, 143-186.

Nouwen, R. (2003). *Plural Pronominal Anaphora in Context*. PhD Dissertation, University of Utrecht.

Nouwen, R. (2007). *On Dependent Pronouns and Dynamic Semantics*. In *Journal of Philosophical Logic* 36, 123-154.

Vermeulen, K. (1993). Sequence Semantics for Dynamic Predicate Logic. In *Journal of Logic, Language and Information* 2, 217-254.

# Which syntax is required by semantics?

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**Abstract.** There is a number of challenging cases of semantic construction that can be handled in terms of an extremely simple syntax-semantics interface as soon as one assumes movement of words or morphemes on a semantically relevant level of syntax. But if one re-uses the powerful interfaces that have been developed for underspecified accounts of ambiguity then these cases can also be treated on the basis of a surface-oriented syntactic analysis. This strategy is currently pursued in a number of underspecification formalisms, which shows that these challenging cases cannot be used as straightforward arguments for or against specific syntactic analyses.

## 1 Introduction

Semantics considerably influences syntactic theory-building in that the (non-)ability to account for specific semantic intuitions is often adduced as an argument for or against specific syntactic theories. Syntactic theories that include movement of constituents on covert levels of representation seem to have an advantage over surface-oriented syntactic theories in that such movements can mediate between syntactic and semantic structure, thereby considerably facilitating the mapping from syntax to semantics even in challenging cases of semantic construction. Advocates of surface-oriented syntactic approaches such as HPSG (Pollard and Sag, 1994) or LFG (Dalrymple, 2001) must show that they can handle these phenomena as well in that the desired semantic interpretations can be derived from the postulated syntactic structures.

But in recent years, surface-analyses have caught up in this respect, which is due to a general trend in underspecified approaches to ambiguity: The very powerful interfaces needed to build up meta-level semantic representations of ambiguous expressions are more and more (re-)used for tricky cases of semantic construction that do not involve ambiguity at all. The price (the very complex syntax-semantics interfaces) has, as it were, already been paid in order to make underspecified representations of ambiguity possible. This advance in linguistic theory-building adds new insights to the debate on which syntax is needed from a semantic perspective.

I will discuss some challenging cases for semantic construction and show how they can be handled on the basis of a surface-oriented syntactic analysis. In the following, I will concentrate on cases in which morphemes within a word have scope over other words in the same phrase.

The first example is the Turkish (1), where the adjective *yağız* ‘dark brown’ can be in the scope of the affix *-lı* ‘(provided) with’, which yields the interpretation ‘someone with a dark brown horse’:

| (1) | yağız | at | -lı |
|---|---|---|---|
| | *dark.brown* | *horse* | *provided.with* |

In the next example (2), an instance of the so-called *-ip*-construction, two verbs are coordinated and in the first conjunct the full verbal ending is replaced by the suffix *-ip*. Nevertheless, the first conjunct in (2) is interpreted as ‘I will eat’, due to the first person future ending in the second conjunct.[1] This can be modelled by giving the verb ending *-eceğim* wide scope over both verb stems:

[1] ‘F’ glosses a meaningless linking morpheme, ‘FUT’ stands for future, and ‘1sg’, for the first person singular. The future morpheme can occur in different forms due to vowel harmony and assimilation processes.

(2) yi -y -ip iç -eceğ -im
*eat -F -IP drink -FUT -1sg*
'I will eat and drink'

Similarly, in Island (as opposed to Mainland) Scandinavian languages enclitic determiners that are attached to a noun still can have scope over modifiers of the noun, e.g., the Icelandic (3):

(3) rauða hús -ið
*red house -the*
'the red house'

I will offer a general account of (1)-(3) that captures the intuition that their readings are due to the scope of morphemes beyond their word. It will be argued that this scope can be modelled without actually having to move the morpheme in the syntax. The core of this account is a very flexible syntax-semantics interface that can express scope relations for individual morphemes.

The analysis is based on previous work on scope ambiguity as illustrated by the quantifier scope ambiguity in (4). The functional nature of semantic interpretation is preserved for such expressions by setting up a 1-1 correspondence between a single syntactic structure and one underspecified semantic representation that encompasses all the readings of the expression (rather than a a one-to-many correspondence between syntactic and semantic structures).

(4) Every man loves a woman

This strategy has proven fruitful for other kinds of scope ambiguities, too, e.g., for the 'repetitive'/'restitutive' readings of *again*-sentences (5) (von Stechow, 1996; Egg, 2008), and ambiguities in nominal modification (Larson, 1998; Egg, 2008):

(5) Amélie closed the door again (repetitive: she did this before/restitutive: the door was open before)
(6) beautiful dancer 'someone who dances and is beautiful'/ 'someone who dances beautifully'

But once the syntax-semantics interface for these cases of ambiguity is established, it turns out that it can also be felicitously applied to other difficult cases of semantic construction where there is no ambiguity. Consider e.g. Abney's (1987) account of the modification of indefinite pronouns like in (7). Here the challenge is to derive a semantic representation (a set of properties) from the representations of the pronoun (also a set of properties) and of the modifier (a property or a function from properties to properties). Giving the 'every' part of *everyone* wide scope over the modifier would immediately solve this question.

(7) everyone in this room

In a number of papers (Egg, 2004, 2008) I have used underspecification formalisms to model the presented semantic intuitions about cases like (7) on the basis of surface-oriented syntactic structures. I used the expressive power of the syntax-semantics interfaces for the construction of underspecified representations of scopally ambiguous expressions, which allow one to manipulate *parts* of semantic representations of constituents without having to move corresponding morphemes in the syntax - if they exist at all, which might be straightforward for *everyone* in (7), but much less so for *close* in (5).

E.g., in the semantic construction of (7), the semantic representation of *everyone* distinguishes the restriction of the quantification (the propery of being a person, the semantics of the 'one' part, as it were) in a (secondary) fragment of its own. The interface rule for adjunction then states that a modifier (here, *in this room*) takes scope over this secondary fragment of the modified expression. This deliberately leaves open the scope relation of modifier and main fragment of the modified expression, which in the case of (7) means that the adjective can (and must) be inside the restriction of the universal quantification.

This basic interface strategy makes use of a so-called *underspecification formalism*. These formalisms preserve the 1-1 relation between syntactic and semantic structure by capturing the set of readings of a given syntactic structure in terms of a meta-level representation that defines exactly the set of readings (by describing their common ground) without enumerating them disjunctively.

Note that the interface strategy which was illustrated for (7) does not depend on a specific underspecification formalism. Much of my analyses, which are cast in the Constraint Language for Lambda Structures (Egg et al., 2001), could be rephrased directly in other formalisms such as Underspecified DRT (Reyle, 1993), Minimal Recursion Semantics (Copestake et al., 2005), Glue Language Semantics (Dalrymple et al., 1997), or Lexical Tree-Adjoining Grammar (Joshi et al., 2007).

In this paper I will first apply this approach to the difficult cases of semantic construction (1)-(3) and then discuss related work that also tackles such cases. I see the contribution of this paper to the debate of which syntax is needed for semantics in showing that one can compensate for the flexibility that syntactic movement yields for the syntax-semantics interface by using underspecification formalisms to formulate flexible interface rules.

## 2 The formalism

This section introduces the proposed underspecified approach to semantic construction by sketching how it is used to handle the semantic construction of (7) in Egg (2004). As opposed to movement analyses as in, e.g., Kishimoto (2000) und Abney (1987), this analysis assumes a simple syntactic structure for (7), viz., adjunction of the PP to the pronoun (after projection to $\bar{\text{D}}$) which then projects to DP. The mismatch between syntactic and semantic structure is handled in the syntax-semantics interface. The challenge is the derivation of (8), the semantics of (7), from the pronoun meaning (9) and the modifier meaning (10). Note that applying (10) to the underlined part of (9) would yield (8), here the semantics of *this room* is abbreviated as '**R**':

(8) $\lambda P \forall x.\mathbf{person}'(x) \wedge \mathbf{in}'(x, \mathbf{R}) \rightarrow P(x)$
(9) $\lambda P \forall x.\underline{\mathbf{person}'}(x) \rightarrow P(x)$
(10) $\lambda P \lambda x.P(x) \wedge \mathbf{in}'(x, \mathbf{R})$

### 2.1 The representation format

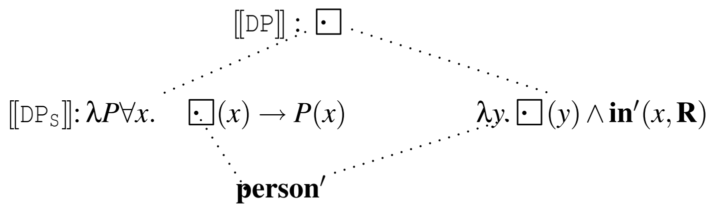
The analysis is based on the underspecification formalism Constraint Language for Lambda Structures (CLLS; Egg et al. 2001). With such a formalism one can define very flexible syntax-semantics interfaces. Its expressions are so-called *constraints* that describe a set of semantic representations, one for each reading of a structurally ambiguous expression. For the purpose of this paper, an abbreviated form of CLLS suffices. Here the described semantic representations are λ-terms. Semantic representations are called *solutions* of a constraint when they are compatible with it. For the present paper, we can restrict ourselves to a subset of solutions, viz., those that comprise only material explicitly mentioned in the constraint. Under this restriction, constraints can be regarded as a *partial order* on a set of fragments of semantic representations.

For instance, the CLLS constraint for the meaning of (7) is given in (11). Please ignore for the time being any labels like '⟦C⟧', I will explain them in subsection 2.2. (11) illustrates the ingredients of simplified CLLS expressions:

- *fragments* of λ-terms
- not yet known parts of these fragments, indicated by '*holes*'
- *dominance relations* (depicted by dotted lines) that relate fragments to holes

Dominance relations between a fragment and a hole indicate that the fragment is an (im-) proper part of what the hole stands for. These dominance relations model scope, and are therefore also used to model quantifier scope ambiguities.

(11)




The semantic representation for the PP constitutes the right hand fragment. The meaning of the pronoun is expressed in the left and the bottom fragment, which together make up (9). The underlined part of (9), viz., the restriction of the quantification, emerges as a fragment of its own in (11).

The fact that there is only a hole on top in (11) indicates that the λ-term described by the constraint cannot yet be specified. However, due to the dominance relations between this hole and the fragments on the right and the left we know that these fragments are the immediate parts of this λ-term. The restriction of the quantification of the pronoun constitutes the bottom fragment, which is dominated by holes in the right and left fragments, thus, ends up in the scope of both the quantification and the modifier. Structures like (11) are called *dominance diamonds*.

To resolve the ambiguity in constraints, information is added monotonically, in particular, by strengthening dominance relations between holes and fragments to *identity*. For (11), there is only one choice, viz., identifying the bottom fragment with the hole in the modifier fragment, and the modifier fragment, with the hole in the left fragment. This returns (8), where the PP pertains only to the restriction of the quantification introduced by the pronoun and is thus in the scope of the 'every' part of the pronoun. The other option is blocked due to the types of the involved fragments. I.e., (11) is an adequate representation of the semantics of (7) and does not overgenerate, because unwanted ambiguity is blocked by the types of the involved fragments. While in this example, the potential ambiguity of the constraint is resolved immediately, the ambiguity is crucial for an analogous analysis of (6), which has two readings. See Egg (2004) for such an analysis in terms of a similar constraint, where the ambiguity is used to derive the two readings of (6).

## 2.2 The interface rules

This subsection describes the syntax-semantics interface that allows the derivation of constraints like (11) on the basis of a surface-oriented underlying syntactic analysis. The interface presumes that the semantic contribution of every syntactic constituent distinguishes a *main* and an embedded *secondary* fragment. In CLLS constraints like (11), '⟦C⟧' indicates the main fragment of a constituent $C$ and '⟦$C_S$⟧', the secondary fragment of $C$. '⟦C⟧:F' expresses that the main fragment of $C$ is defined as fragment $F$. Consider e.g. the lexical entry for the semantics of *everyone*, where the restriction of the quantification is singled out as the secondary fragment, while the rest of the semantic representation shows up in the main fragment:

(12) $[\![\mathtt{D}]\!] : \lambda P \forall x. \boxdot\, (x) \rightarrow P(x)$

$[\![\mathtt{D_S}]\!] : \mathbf{person}'$

Interface rules specify for a constituent $C$ how the constraints $Con_1$ and $Con_2$ of its immediate constituents $C_1$ and $C_2$, inherited by $C$, are combined into a new constraint for $C$. The rules combine $Con_1$ and $Con_2$ by addressing their main and secondary fragments and determine these features for $C$. For instance, the simple rule that non-branching $\bar{\mathtt{X}}$ constituents inherit their fragments from their heads is written as (13):

(13) $[_{\bar{\mathtt{X}}}\ \mathtt{X}] \overset{(SSI)}{\Rightarrow} [\![\bar{\mathtt{X}}]\!] : [\![\mathtt{X}]\!]; \quad [\![\bar{\mathtt{X}}_\mathtt{S}]\!] : [\![\mathtt{X_S}]\!]$

The semantic representation of modification (adjunction) structures like in (7) is constructed by the interface rule (14). The main fragment $[\![\bar{\mathtt{X}}_1]\!]$ of the whole constituent is $[\![\bar{\mathtt{X}}_2]\!]$, the one from the modified expression. In contrast, its secondary fragment $[\![\bar{\mathtt{X}}_{1S}]\!]$ is not inherited from this expression, instead, it consists of an application of the modifier fragment $[\![\mathtt{Mod}]\!]$ to a hole that dominates the secondary fragment $[\![\bar{\mathtt{X}}_{2S}]\!]$ of the modified expression. This yields the bottom half of a dominance diamond, in which $[\![\mathtt{Mod}]\!]$ and $[\![\bar{\mathtt{X}}_1]\!]$ are scopally ambiguous in that they both dominate $[\![\bar{\mathtt{X}}_2]\!]$. Dominance between $[\![\bar{\mathtt{X}}_1]\!]$ and $[\![\bar{\mathtt{X}}_{2S}]\!]$ is specified in the semantic representation of $\bar{\mathtt{X}}_2$ (recall that $[\![\bar{\mathtt{X}}_1]\!]$ is equated with $[\![\bar{\mathtt{X}}_2]\!]$), e.g., it can eventually follow from lexical entries as (12). The equation of the modifier fragments ($[\![\mathtt{Mod}]\!]$: $[\![\mathtt{Mod_S}]\!]$) is introduced to facilitate reading.

(14) $[_{\bar{\mathtt{X}}_1}\mathtt{Mod}\ \bar{\mathtt{X}}_2] \overset{(SSI)}{\Rightarrow} [\![\bar{\mathtt{X}}_{1S}]\!] : [\![\mathtt{Mod}]\!](\ \boxdot\ ) \quad [\![\mathtt{Mod}]\!]\text{: } [\![\mathtt{Mod_S}]\!] \quad [\![\bar{\mathtt{X}}_1]\!]\text{:}[\![\bar{\mathtt{X}}_2]\!]$

$[\![\bar{\mathtt{X}}_{2S}]\!]$

The rule that constructs the upper half of the dominance diamond corresponds to the syntax rule XP -> $\bar{\mathtt{X}}$. The main fragment of the XP is a hole that dominates both fragments of the $\bar{\mathrm{X}}$ constituent:

(15) $[_{\mathtt{XP}}\ \bar{\mathtt{X}}] \overset{(SSI)}{\Rightarrow} [\![\mathtt{XP}]\!] : \boxdot$

$[\![\mathtt{XP_S}]\!]\text{:}[\![\bar{\mathtt{X}}]\!] \qquad [\![\bar{\mathtt{X}}_\mathtt{S}]\!]$

Semantic construction for *everyone in this room* now starts with the semantic representations (12) and (16) of pronoun and PP (whose derivation I cannot go into any further in this paper). Rule (13) states that (12) is the semantics of the $\bar{\mathrm{D}}$ *everyone* too.

(16) $[\![\mathtt{PP}]\!], [\![\mathtt{PP_S}]\!]\text{: } \lambda P \lambda x. P(x) \wedge \mathbf{in}'(x, \mathbf{R})$

By rule (14) the constraints of $\bar{\mathrm{D}}$ and the PP are combined into (17), the lower half of a dominance diamond as a consequence of adjoining the PP to the $\bar{\mathrm{D}}$ *everyone*. Finally, this lower half serves as the input to rule (15), which then yields the dominance diamond (11). Rule (15) applies because the $\bar{\mathrm{D}}$ *everyone in this room* projects to DP.

(17) $[\![\bar{\mathtt{D}}]\!] : \lambda P \forall x. \boxdot(x) \rightarrow P(x) \qquad [\![\bar{\mathtt{D}}_\mathtt{S}]\!] : \lambda x. \boxdot(x) \wedge \mathbf{in}'(x, \mathbf{R})$

$\mathbf{person}'$

## 3 The analysis

In this section I will show how the challenging examples (1)-(3) can be handled on the basis of simple syntactic analyses. For (1), we need a rule that describes the semantic effect of affixing *-lı* to a nominal base.[2] This rule has already been introduced in Egg (2004) for the semantics of English agentive nouns like *dancer* in (6) and can be reused here directly (in a slightly simplified form, since binding the arguments of the base is not an issue here, see Egg 2008):

(18) $[_{\mathtt{X}}\ \mathtt{Bs}\ \mathtt{Aff}] \overset{\text{(morph)}}{\Rightarrow}$

$$\llbracket \mathtt{X} \rrbracket : \llbracket \mathtt{Aff} \rrbracket(\boxdot)$$

$$\llbracket \mathtt{X_S} \rrbracket : \llbracket \mathtt{Bs} \rrbracket$$

In prose: The affix semantics contributes the main fragment of the new constituent X. It applies to a hole that dominates the semantic contribution of the stem, which becomes the secondary fragment.

In the case of *lı*, we get (19) as the affix semantics, a function from properties *P* to the property of being provided with an entity that has *P*, and (20) as the semantics of *atlı* 'someone provided with a horse':

(19) $\llbracket \mathtt{Aff} \rrbracket, \llbracket \mathtt{Aff_S} \rrbracket: \lambda P \lambda x \exists y.P(y) \wedge \textbf{provided-with}'(x,y)$

(20) $\llbracket \mathtt{N} \rrbracket : \lambda x \exists y.\boxdot(y) \wedge \textbf{provided-with}'(x,y)$

$$\llbracket \mathtt{N_S} \rrbracket : \textbf{horse}'$$

Modification of *atlı* then follows the pattern expounded by (7): The interface rules (13)-(15) allow the construction of the dominance diamond (21), which allows the derivation of the desired reading (22) for the example (1):

(21)

$$\llbracket \mathtt{NP} \rrbracket : \boxdot$$

$$\llbracket \mathtt{NP_S} \rrbracket : \lambda x.\boxdot(x) \wedge \textbf{dark-brown}(x) \qquad \lambda x \exists y.\boxdot(y) \wedge \textbf{provided-with}'(x,y)$$

$$\textbf{horse}'$$

(22) $\lambda x \exists y.\textbf{horse}'(y) \wedge \textbf{dark-brown}'(y) \wedge \textbf{provided-with}'(x,y)$

To handle the *-ip*-construction, I propose a structured semantic representation of the inflected verb, where the stem contributes the secondary and the inflection, the primary fragment.

To model tense (albeit in a very simple form), I assume a Davidsonian semantics, i.e., every verb has an *eventuality* argument. (Eventualities are states of affairs of every kind.) The semantics of the 1st person singular future ending in (2) is then glossed as a set of relations between individuals and eventualities. Relations are in this set iff there is an eventuality *e* after the utterance eventuality $e_0$ such that the relation holds for *e* and the speaker. The semantic representation for the second conjunct in (2), *içeceğim* 'I will drink', is thus (23):

(23) $\llbracket \mathtt{V} \rrbracket : \exists e.e_0 < e \wedge \boxdot(\textbf{speaker}')(e)$

$$\llbracket \mathtt{V_S} \rrbracket : \textbf{drink}'$$

[2] This affix undergoes vowel harmony, thus *-lı* is just one of its possible realisations.

In the following, I will concentrate on cases where the *-ip* construction combines two verbs of the same arity. I assume that an *-ip*-expression subcategorises for a $V_1$ and forms another $V_2$ together with this $V_1$. The crucial syntax rule for (2) is thus $[_{\texttt{V2}}\ \texttt{Bs-}\textit{ip}\ \texttt{V1}]$, where ‘Bs’ stands for the base of *-ip*.

The interface builds a semantic representation from this syntactic structure by (24):

(24) $[_{\texttt{V2}}\ \texttt{Bs-}\textit{ip}\ \texttt{V1}] \overset{(SSI)}{\Rightarrow} \quad [\![\texttt{V}_2]\!] : [\![\texttt{V}_1]\!] \quad [\![\texttt{V}_{2S}]\!] : [\![\texttt{Bs}]\!] \& [\![\texttt{V}_{1S}]\!]$

In prose: The main fragment of the emerging $V_2$ is inherited from the subcategorised $V_1$, i.e., the semantics of the inflection of the second constituent is shared by both conjuncts. The secondary fragment of $V_2$ is a generalised conjunction (Rooth and Partee, 1982) of the meaning of the base of *-ip* and of $[\![\texttt{V}_{1S}]\!]$ (the meaning of the stem of the subcategorised conjunct).

For (2), this returns the constraint (25), whose solution (26) claims that there is an eventuality *e* in the future where the speaker eats and drinks:

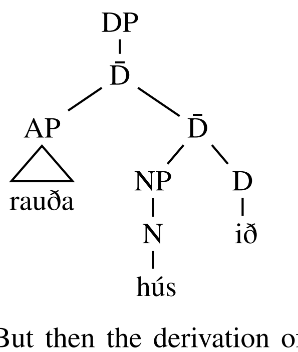
(25) $[\![\texttt{V}_2]\!] : \exists e.e_0 < e \wedge \boxdot\ (\mathbf{speaker}')(e)$

$[\![\texttt{V}_{2S}]\!] : \mathbf{eat}'\ \&\ \mathbf{drink}'$

(26) $\exists e.e_0 < e\ \wedge \mathbf{eat}'(\mathbf{speaker}')(e) \wedge \mathbf{drink}'(\mathbf{speaker}')(e)$

Before applying the analysis of Egg (2004) to the Icelandic data I will first discuss the question of what structure to assign to (3) in a surface-oriented syntactic structure that does not assume movement. I assume that determiner and noun together form a constituent of category $\bar{\text{D}}$, which can by itself project to DP or be modified first. This constituent consists of a D head and its NP complement, in (3), the AP *rauða* adjoins to this constituent, and the result of this adjunction projects to DP:

(27)




But then the derivation of (28), the semantic representation of (3), follows the pattern of (7): Applying the modifier semantics (30) to the restriction of the quantification involved in (29), the semantics of the modified $\bar{\text{D}}$ constituent, yields the desired λ-term.[3]

(28) $\lambda P \exists ! x.[\mathbf{red}'(x) \wedge \mathbf{house}'(x)] \wedge P(x)$
(29) $\lambda P \exists ! x.[\underline{\mathbf{house}'}(x)] \wedge P(x)$
(30) $\lambda P \lambda x.\mathbf{red}'(x) \wedge P(x)$

Both (3) and (7) are cases of a simple adjunction structure, the only difference between the two (apart from the inner structure of the modifier, which is of no avail here) is the fact that in (3) the modified expression is syntactically *complex*.

[3] To maximise the parallel between (7) and (3), I use a Russellian semantics for the definite determiner. $\exists ! x.[P(x)] \wedge Q(x)$ is shorthand for $\exists x.(P(x) \wedge \forall y.P(y) \rightarrow y = x) \wedge Q(x)$.

This suggests an application of the analysis of Egg (2004) to the semantic construction of (7). And, indeed, the interface rules (13)-(15) can be reused for the syntax-semantics interface of Icelandic DPs. These rules handle the modification of the $\bar{D}$ constituent *húsið* (and the subsequent projection of the complete modification structure to DP); in addition, we need one more rule to describe the semantic consequence of forming $\bar{D}$ constituents out of a determiner and its NP complement: The main fragment of such a $\bar{D}$ constituent is the main D fragment applied to the main NP fragment; the NP's secondary fragment becomes the one of the $\bar{D}$.

(31) $[_{\bar{\mathrm{D}}}\ \mathtt{NP}\ \mathtt{D}] \quad \stackrel{\text{(SSI)}}{\Rightarrow} \quad [\![\bar{\mathrm{D}}]\!]: [\![\mathtt{D}]\!]([\![\mathtt{NP}]\!]);\ [\![\bar{\mathrm{D}}_{\mathrm{S}}]\!]: [\![\mathtt{NP}_{\mathrm{S}}]\!]$

Semantic construction for (3) will assign it a semantic representation in analogy to (7). In particular, the secondary fragment of the modified expression will be the restriction of a quantifier in its primary fragment. We start with simple lexical entries for the meaning of the definite article and *hús* 'house', respectively:

(32) $[\![\mathtt{D}]\!], [\![\mathtt{D}_{\mathrm{S}}]\!]: \lambda Q \lambda P \exists ! x.[Q(x)] \wedge P(x)$
(33) $[\![\mathtt{N}]\!], [\![\mathtt{N}_{\mathrm{S}}]\!]$: **house′**

According to (13) these meanings are inherited to the projections of *hús* and *ið* to $\bar{D}$ and $\bar{N}$ level. Next comes the derivation of (34), the semantics of *hús* as a NP constituent, which involves rule (15). Then rule (31) combines (34) with the semantics of *ið* to derive (35), the semantics of *húsið* as $\bar{D}$:

(34) $[\![\mathtt{NP}]\!]$ : $\boxdot$
⋮
$[\![\mathtt{NP}_{\mathrm{S}}]\!]$ : **house′**

(35) $[\![\bar{\mathrm{D}}]\!] : \lambda P \exists ! x.[\ \boxdot\ (x)] \wedge P(x)$
⋮
$[\![\bar{\mathrm{D}}_{\mathrm{S}}]\!]$ : **house′**

(35) is the desired input for the interface rule for modification. Here the restriction of the quantifier introduced by the NP constituent constitutes the embedded fragment of this constituent, which can then be addressed by the modification interface rule (14). The rest of the derivation of the semantics of (3) follows the pattern laid out for (7), by rules (14) and (15) we obtain a dominance diamond whose sole solution is (28).

To sum up, it has been shown in this section that semantic construction is possible for examples (1)-(3) on the basis of surface-oriented syntactic analyses using an interface for an underspecification formalism. In the next section, I will discuss related work.

## 4 Related work

### 4.1 Turkish LFG

In the Turkish LFG that is being developed as part of the ParGram project (Çetinoğlu and Oflazer, 2006), challenges to semantic construction like (1) and (2) have received ample attention. As an example, consider (36), where a modifier, here the adjective *eski* 'old', does not pertain to a morphologically complex modified expression completely, but only to a part of it, which excludes some affixes, here, *-ki* 'that which'. This gives the affix scope over the modifier:[4]

[4] In this gloss, PL stands for plural, LOC, for locative case, and KI is the 'relative suffix' described below that is used for genitive or locative DPs that modify nouns.

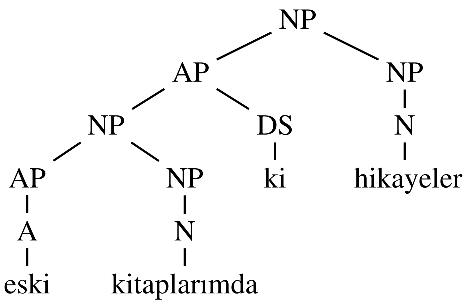
(36)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| eski | kitap | -lar | -ım | -da | -ki | hikaye | -ler |
| *old* | *book* | *PL* | *my* | *LOC* | *KI* | *story* | *PL* |

'the stories in my old books'

Such cases have been tackled by Çetinoğlu and Oflazer (2006) in terms of *inflectional groups* below the word level that show up as nodes in the constituent structure and are thus accessible for processes such as adjunction already in the syntax. The syntactic analysis for (36) is (37):

(37)




Here *kitaplarımda* 'in my books' is identified as an inflectional group and the element *-ki* 'related to' is singled out in a constituent 'DS' (derivational suffix) of its own. One could argue in favour of this analysis by pointing out that *-ki* is indeed not a standard derivational suffix as it (mostly) does not undergo vowel harmony (which characteristically applies at word level) and comes after inflectional suffixes. This has led e.g. Kornflit (1997) to analyse it as a particle, which would be in line with the analysis in (37).

From a semantic point of view, this does not completely solve the problem, however, since semantically, *eski* 'old' pertains to the root *kitap* 'book' exclusively, and not to *kitaplarımda* 'in my books' as a whole: otherwise, the meaning of *eski kitaplarımda* would be predicted to be 'old item(s) located in my books' instead of 'items located in my old books'.

The point here is that the locative has a semantic interpretation of its own, which maps the meaning of *eski kitaplarım* 'my old books' (an individual or a set of properties) onto the property of being located in my books. I.e., this is an instance of *semantic case* (as opposed to structural case), which determines syntactic and semantic properties of the whole DP in which it shows up (Butt and King, 2005). So, from a semantic point of view, one would have to postulate a DS node that comprises (at least) the locative suffix *-da* and *-ki*, which would be much less straightforward than the analysis in (37).

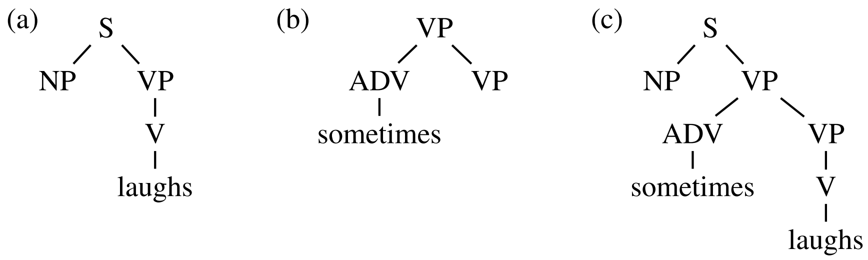
Çetinoğlu and Oflazer (2006) furthermore propose treating *-li* in a similar fashion, which would solve the problem with semantic construction in (1), but does not mesh with the fact that the arguments in favour of the particle status of *-ki* do not carry over to *-li*, which does undergo vowel harmony and does not come after inflectional suffixes.

In sum, a syntactic solution to the discussed challenges for the syntax-semantics interface for Turkish goes some way in representing the fact that modifiers sometimes relate semantically only to a part of the constituent which they modify but cannot fully account for these cases.

### 4.2 Lexical Tree-Adjoining Grammar

In the introduction to this paper I pointed out that the presented analyses could be cast in terms of other underspecification formalisms as well. However, one of these formalisms lends itself particularly well to this goal, viz., Lexical Tree-Adjoining Grammar (L-TAG): The mechanism presented in Joshi et al. (2007) for scope underspecification can be used directly for a representation of cases such as (3).

The reason for this is the philosophy behind (L-)TAG-based approaches: If heads themselves introduce the whole subtree for their own projection (including nodes to be substituted by subtrees for the complements), they must at the same time introduce the semantics for this whole projection. E.g., the tree fragment for *sometimes* (38b) would be inserted at the VP node of the tree (38a) introduced by *laughs*, yielding (38c). (NP substitution is ignored in the following):

(38)



But then the following problem emerges: Adjunction in TAG is modelled by replacing an internal node by a tree fragment, i.e., the original tree is split in two parts, and then the tree fragment is inserted between these two parts. But, if relations between syntactic nodes define semantic scope in the usual way (mostly, c-command[5]), then the adjoined modifier should get intermediate scope with respect to the tree it is adjoined to, i.e., it should only have scope over the tree part below the node in the original tree that has been replaced during adjunction (in (38a), VP).

While this intermediate scope is motivated syntactically, it must be specified in the semantic representation of the tree that can undergo adjunction: This representation determines the scope of a potential modifier. This is exactly parallel to the anticipation of intermediate modifier scope in my approach, where the choice of the secondary fragment eventually determines the intermediate scope of a potential modifier.

Joshi et al. (2007) and Kallmeyer and Romero (2007) present such a formalism in detail. At its core is the semantic feature structure (39) that accompanies the semantic representation $l_1$:*laugh*($\boxed{1}$,$\boxed{2}$), where $\boxed{1}$ is a situation (corresponding to the eventuality argument in my approach), and $\boxed{2}$, an individual. The feature structure anticipates the semantic effect of adjunction of a VP modifier tree fragment by distinguishing for the VP a top and a bottom feature:

(39)
$$\begin{bmatrix} \text{NP} & \begin{bmatrix} \text{TOP}|\text{INDEX} & \boxed{1} \end{bmatrix} \\ \text{VP} & \begin{bmatrix} \text{TOP} & \begin{bmatrix} \text{PROPOSITION} & \boxed{4} \\ \text{SITUATION} & \boxed{3} \end{bmatrix} \\ \text{BOTTOM} & \begin{bmatrix} \text{PROPOSITION} & l_1 \\ \text{SITUATION} & \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

This can be paraphrased as follows. We do not yet know what the top proposition and situation of the VP (and, hence, also of the sentence) are. On the one hand, if there is no adjunction, and only then, TOP and BOTTOM features of the VP are identified, and in that case, top proposition and situation of the VP are identical to $l_1$ and $\boxed{2}$, respectively. On the other hand, if there is modification by a scope-bearing VP modifier such as *sometimes*, the modifier introduces a top proposition and a situation of

[5] The most common definition is that node A c-commands node B in a tree if A is the daughter of a node that also dominates B, and A does not dominate B, and vice versa.

its own. In the case of VP modification, the proposition $l_1$ is in the scope of the modifier, along with its situation argument $\boxed{2}$.

This strategy could immediately be extended to cases like (1) or (3). E.g., a semantic representation for *húsið* that models the very same intuition as the CLLS constraint (35) could be sketched in the following way. The semantics (simplifying scope issues) would be $l_1$:*def*($\boxed{3}$,$\boxed{4}$,$\boxed{5}$), i.e., we have a definite determiner with index $\boxed{3}$, restriction $\boxed{4}$, and scope $\boxed{5}$. The semantic feature structure is (40):

(40)
$$\left[\begin{array}{ll} \text{D} & \left[\begin{array}{ll}\text{TOP} & \left[\begin{array}{ll}\text{PROPOSITION} & l_1\\ \text{INDEX} & \boxed{3}\end{array}\right]\end{array}\right] \\ \text{NP} & \left[\begin{array}{ll}\text{TOP} & \left[\begin{array}{ll}\text{PROPOSITION} & \boxed{4}\\ \text{INDEX} & \boxed{3}\end{array}\right]\\ \text{BOTTOM} & \left[\begin{array}{ll}\text{PROPOSITION} & \boxed{1}\\ \text{INDEX} & \boxed{2}\end{array}\right]\end{array}\right]\end{array}\right]$$

In prose: The restriction and the index of the DP are those determined by *hús* ($\boxed{1}$ and $\boxed{2}$, respectively) only if there is no modification of the NP. Otherwise, the modifier can introduce index and restriction of its own. The division between top and bottom serves precisely the same end as the dominance relation between main and secondary fragment in the CLLS analysis, viz., to indicate the position for the semantic contribution of a modifier within the semantics of the whole adjunction structure.

However, there is a difference between the two approaches: Since in LTAG such intermediate scope effects are ultimatively based on syntactic adjunction structures, LTAG approaches are forced to assume syntactic decomposition in cases like (5)-(7), but such decompositions are not always independently motivated: While one might argue for a decomposition of *everyone* in a determiner *every* and an N(P) *one*, no such syntactic decomposition seems to be readily available for change-of state verbs like *close*, even though their poststate is a possible target of modification.

## 5 Conclusion and outlook

In this paper, I showed that underspecified approaches to semantics, which emerged as attempts to handle ambiguity in natural language, lend themselves for the derivation of difficult cases of semantic construction on the basis of surface-oriented syntactic analyses. The very powerful syntax-semantics interfaces in these approaches provide the necessary machinery to handle these cases of semantic construction. I have reviewed a number of such cases and outlined their semantic construction, comparing the proposed analysis to other competing approaches.

The increasing (re-)use of underspecified approaches to ambiguity for semantic construction is highly relevant for the question of what syntax is necessary from a semantic point of view, because powerful and flexible syntax-semantics interfaces can do a lot of the work of semantic construction themselves, and are less dependent on specific preprocessing of syntactic structures, as e.g. offered in the Logical Form of Generative Grammar. This development is not restricted to scope-related issues as the ones presented in this paper, it is a general trend in the field, which is for instance also present in the analysis of negative concord in Richter and Sailer (2006), which makes use of techniques that allow the representation of specific ambiguities in Afrikaans tense marking (Sailer, 2004).

# Bibliography


Abney, S. (1987). *The English noun phrase in its sentential aspect*. Ph. D. thesis, MIT.

Butt, M. and T. H. King (2005). The status of case. In V. Dayal and A. Mahajan (eds), *Clause Structure in South Asian Languages*, 153–198. Dordrecht: Kluwer.

Çetinoğlu, Ö. and K. Oflazer (2006). Morphology-syntax interface for Turkish LFG. In *Proceedings of the 21st International Conference on Computational Linguistics and the 44th annual meeting of the ACL*, 153–160. Association for Computational Linguistics.

Copestake, A., D. Flickinger, C. Pollard, and I. Sag (2005). Minimal Recursion Semantics. An introduction. *Research on Language and Computation 3*, 281–332.

Dalrymple, M. (2001). *Lexical Functional Grammar*. Number 34 in Syntax and Semantics. New York: Academic Press.

Dalrymple, M., J. Lamping, F. Pereira, and V. Saraswat (1997). Quantifiers, anaphora, and intensionality. *Journal of Logic, Language, and Information 6*, 219–273.

Egg, M. (2004). Mismatches at the syntax-semantics interface. In S. Müller (ed.), *Proceedings of the 11th International Conference on Head-Driven Phrase Structure Grammar*, 119–139. Stanford: CSLI Publications.

Egg, M. (2008). Reference to embedded eventualities. In J. Dölling, T. Heyde-Zybatow, and M. Schäfer (eds), *Event structures in linguistic form and interpretation*, 149–172. Berlin: de Gruyter.

Egg, M., A. Koller, and J. Niehren (2001). The Constraint Language for Lambda-Structures. *Journal of Logic, Language, and Information 10*, 457–485.

Joshi, A., L. Kallmeyer, and M. Romero (2007). Flexible composition in LTAG: Quantifier scope and inverse linking. In H. Bunt and R. Muskens (eds), *Computing Meaning*, Volume 3, 233–256. Amsterdam: Springer.

Kallmeyer, L. and M. Romero (2007). Scope and situation binding in LTAG using semantic unification. *Research on language and computation*. To appear.

Kishimoto, H. (2000). Indefinite pronouns and overt N-raising. *Linguistic Inquiry 31*, 557–566.

Kornflit, J. (1997). *Turkish*. Descriptive Grammars. London: Routledge.

Larson, R. (1998). Events and modification in nominals. In D. Strolovitch and A. Lawson (eds), *Proceedings from SALT VIII*, Ithaca, 145–168. CLC Publications.

Pollard, C. and I. Sag (1994). *Head-driven Phrase Structure Grammar*. CSLI and University of Chicago Press.

Reyle, U. (1993). Dealing with ambiguities by underspecification: construction, representation, and deduction. *Journal of Semantics 10*, 123–179.

Richter, F. and M. Sailer (2006). Modeling typological markedness in semantics: the case of negative concord. In S. Müller (ed.), *Proceedings of the HPSG 06 Conference*, Stanford, 305–325. CSLI Publications.

Rooth, M. and B. Partee (1982). Conjunction type ambiguity and wide scope "or". In *Proceedings of the First West Coast Conference on Formal Linguistics*, 353–362. Stanford University.

Sailer, M. (2004). Past tense marking in Afrikaans. In C. Meier and M. Weisgerber (eds), *Proceedings of Sinn und Bedeutung 8*, 233–248.

von Stechow, A. (1996). The different readings of 'Wieder': A structural account. *Journal of Semantics 13*, 87–138.

# To Reconstruct or Not to Reconstruct
## That is the Question

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**Abstract.** The aim of this study is to use what is traditionally referred as A'-reconstruction in order to compare two possible formalizations of syntax-semantics interface, one based on Generative Grammar and Logical Form (GG), the other built on Categorial Grammar and Variable-Free Semantics (CG-VFS). Considering mainly reconstruction data with resumption in natural language (from French and Jordanian Arabic mostly), I will first give several arguments suggesting that both analyses could be on the right track, both theoretically (both accounts of distributive/reconstructed readings amount to an *e*-type interpretation of the resumptive pronoun) and empirically (both formalizations correctly predict distributive/reconstructed readings within syntactic islands). Finally, I will present two generalizations about resumption which seem to favor the GG account based on actual reconstruction, one concerning the type of distributive reading (functional *vs* pair-list), the other linked to a distinction between weak and strong resumption.

## 1 Reconstruction data

### *1.1 Binding and Scope Reconstruction*

The notion of reconstruction traditionally refers to the interaction between displacement structures (dislocation, topicalization, interrogation, relativization) and interpretation procedures such as binding conditions or scope[1]. The following examples in (1) and (2) (from French, similar examples in many languages such as English, Jordanian Arabic,...) illustrate binding reconstruction and scope reconstruction respectively with interrogation[2]:

(1) *Quelle photo$_1$ de lui$_2$ est-ce que chaque homme$_2$ a déchirée __$_1$?*
'Which picture of him(self) did each man tear?'
*Celle de son mariage.*
'The one from his wedding'

(2) *Quelle femme$_1$ est-ce que chaque homme invitera __$_1$?*
'Which woman will each man invite?'
*Son épouse.*
'His wife'

Both (1) and (2) correspond to what Engdahl (1980) or Jacobson (1999) call functional questions as they can have a distributive reading of the *wh-* constituent with respect to the universal quantifier. Consider indeed possible functional answers for (1) and (2). In terms of reconstruction, such distributivity can be seen as following either from presence of a potentially bound variable in the peripheral constituent (*lui* in (1)), or from the indefinite property of that constituent (*quel patient* in (2)[3]); and more precisely the fact that these two scope-sensitive items could be interpreted as if they were (partly) within the scope of the universal quantifier *chaque*.

[1] Notice here that I'm using the term reconstruction in its broad meaning, referring to the general phenomenon; the term may also refer to a particular analysis of the phenomenon, based on what I will call literal/actual/syntactic reconstruction.
[2] This study focuses mainly on reconstruction of bound variable anaphora, hence binding reconstruction.
[3] For more arguments to analyse interrogative constituents as indefinites, see Reinhart (1997) among others.

### *1.2 Reconstruction and Resumption*

The notion of resumption corresponds to a detachment strategy in natural language by which a pronoun, instead of a gap, occupies the thematic position of the detached constituent, hence resuming or doubling that constituent. As reconstruction is crucially tied to displacement structures, its potential interaction with resumption comes as no surprise. And a major property of resumption first noticed by Aoun et al. (2001) is the fact that it does allow for functional reconstructed readings[4]. Consider indeed the following example of French dislocation:

(3) *La photo de sa$_2$ fille, chaque homme$_2$* ***l'****a déchirée.*
'The picture of his daughter, each man tore it.'

The sentence in (3) is clearly grammatical under the intended reading, one where the dislocated constituent *la photo de sa fille* 'the picture of his daughter' is interpreted distributively with respect to *chaque homme* 'each man'. In other words, the possessive *sa* 'his' can be interpreted as a variable bound by the universal quantifier.

### *1.3 Traditional assumption about reconstruction and distributive readings*

Most traditional accounts of data like (1) to (3) tend to rely on a direct implication between functional reading of a displaced constituent and presence of syntactic movement of that constituent. The implication is obvious when considering the most popular account of binding reconstruction data as in (1). Such data are accounted for through the copy theory of movement, a syntactic mechanism given by Lebeaux (1990), Chomsky (1995) or Sauerland (2004) among others, to license interpretation of a displaced constituent in its base position. Consider indeed the representation of (1) under such assumption:

(4) *Quelle photo$_1$ de lui$_2$ est-ce que chaque homme$_2$ a déchirée ~~photo$_1$ de lui$_2$~~?*
'Which picture of him(self) did each man tear ~~picture of him(self)~~?'

Bound variable interpretation of *lui*, and consequently distributive reading of the interrogative constituent, follows straightforwardly from the structural configuration between the universal quantifier and the copy left by movement of *quelle photo de lui*.

To illustrate the implication with respect to what I call scope reconstruction, consider Engdahl (1980)'s approach to functional questions such as in (2). Her account is essentially based on the existence of complex traces, and more precisely functional traces. The representation in (5) illustrates how the functional reading of (2) is obtained under her account:

(5) *Schema for (2):*
SYN: quelle femme$_1$ est-ce que chaque homme$_2$ invitera $t_{1(2)}$
SEM: $\lambda p \exists g_{\langle e,e\rangle}.[range(g) = woman' \wedge p = \forall y.[man'(y) \rightarrow invite'(y, g(y))]]$
$\Rightarrow$ *What is the function g ranging over women such that every man$_y$ tore g(y)?*

As shown in (5), the functional reading of the question crucially relies on the existence of a complex index on the syntactic trace left by movement of the constituent *quelle femme* 'which woman'.

Notice finally that data such as in (3) where resumption is at stake have also received an account based on syntactic movement in traditional literature. Aoun et al. (2001) thus propose that functional readings in such cases follow from movement of the displaced constituent (what they call *apparent resumption*), and more precisely presence of a syntactic copy adjoined to the resumptive clitic[5].

[4] Aoun et al. (2001)'s study is based on dislocation in Lebanese Arabic, while this paper focuses mainly on French data, and also Jordanian Arabic.
[5] For more details, see Aoun et al. (2001).

To summarize, data involving distributive/functional/reconstructed readings have often found an account essentially based on presence of syntactic movement. The following section will present two accounts, based on two different models of syntax-semantics interface, which do not rely (exclusively or at all) on that direct implication between reconstructed readings and syntactic movement.

## 2 Two models of syntax-semantics interface for two accounts

In this section, I will introduce two novel accounts of data from (1) to (3). The first account, which I will dub the *if I were Irene Heim*'s analysis, corresponds to latest improvements on such issues in Generative Grammar (GG). The second account, the *if were Pauline Jacobson*'s analysis, corresponds to another model of syntax-semantics interface, based on Categorial Grammar and Variable-Free Semantics (CG-VFS).

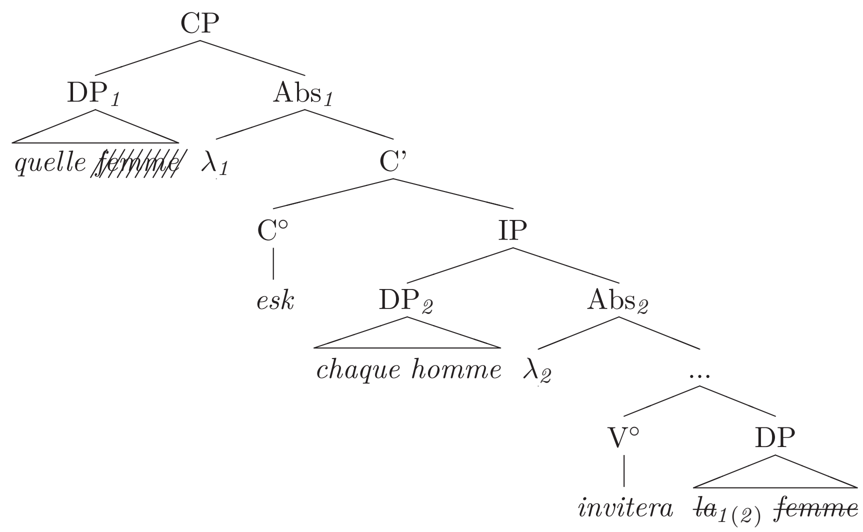
### *2.1 Account #1 (GG): If I were Irene Heim*

Under a GG model of syntax-semantics interface, i.e. if I were Irene Heim (Heim and Jacobson (2005)), I would probably analyse the functional readings in (1), (2) and (3) as cases of literal reconstruction. Under such a view, functional readings (and the bound variable readings of *lui* and *sa*) follow from presence of a syntactic copy of the displaced constituent (in the thematic position), resulting either from syntactic movement, or crucially from ellipsis on the resumptive clitic when resumption is at stake.

**Gaps (traces) as syntactic copies.** In the present account, gaps left by syntactic movement are analysed as syntactic copies. More precisely, Heim and Jacobson (2005), following Fox (2003), argues that syntactic copies can be interpreted as definite descriptions[6]. Consider again example (2) and its Logical Form (LF) and semantic representations below:

(6) *Schema for (2) under a GG account:*

LF:




SEM: $\lambda p \exists g_{\langle ee \rangle}.[p = \forall y.[man'(y) \rightarrow invite'(y, g(y))]]$
presupposition: $\forall g.[g \in C \rightarrow \forall y.[man'(y) \rightarrow woman'(g(y))]]$
$\Rightarrow$ *What is the function* $g_{\langle ee \rangle}$ *such that each* $man_y$ *will invite* $the_{g(y)}$ *woman (with presupposition that contextually salient functions g map men to women)?*

[6] This assumption corresponds to Fox (2003)'s notion of *Trace Conversion*, a syntactic mechanism to transform gaps/traces into definite descriptions composed of a determiner and a predicate restriction (the restriction of the moved item).

As shown in (6), the present account for functional questions relies on (i) presence of a syntactic copy interpreted as a definite description, and (ii) existence of a complex/functional index on the definite determiner, in a similar way that traces could be complex/functional in Engdahl (1980)'s account. Notice here that the definite property of syntactic copies automatically gives rise to a presupposition over the function. Also notice that such analysis straightforwardly account for cases of binding reconstruction in similar context, such as in (3) repeated below:

(7) *Quelle photo$_1$ de lui$_2$ est-ce que chaque homme$_2$ a déchirée $\_\_{}_1$?*
'Which picture of him(self) did each man tear?'
*Celle de son mariage.*
'The one from his wedding'

Bound variable reading of *lui* 'himself' in this example is now predicted, as the anaphoric item can be interpreted within the syntactic scope of the universal quantifier.

**Resumptive pronouns as definite descriptions.** As for functional readings with resumption, a similar account can be given, based on syntactic copies, hence literal reconstruction, but with one further assumption. I argue, following Guilliot and Malkawi (2006) and Guilliot (2006), that the syntactic copy does not result from movement, but rather ellipsis on the resumptive clitic. That assumption corresponds to an analysis of pronouns as definite descriptions in the sense of Elbourne (2002), i.e. a determiner (the pronoun) and an elided restriction[7]. Consider now the syntactic representation for (3) in (8) below:

(8) *La photo$_1$ de sa$_2$ fille, chaque homme$_2$ a déchiré [$_{DP}$ l(a)$_1$ [$_{NP_\delta}$ ~~photo de sa$_2$ fille~~]]*
The picture of his daughter, each man tore [$_{DP}$ it [$_{NP_\delta}$ ~~picture of his daughter~~]]

Distributive reading of both the displaced constituent *la photo de sa fille* and the resumptive clitic *l(a)* in (3) follows nicely from syntactic reconstruction of the anaphoric item *sa* within the scope of the universal quantifier, hence allowing for a bound variable interpretation.

The GG account proposed here can be summarized with the following generalizations:

**Generalization #1:** *A (resumptive) pronoun can be interpreted as a definite description, i.e. as a determiner and an elided restriction (see Elbourne (2002)).*

**Generalization #2:** *Syntactic copies can be interpreted as definite descriptions (see Fox (2003) or Heim and Jacobson (2005)).*

### *2.2 Account #2 (CG-VFS): If I were Pauline Jacobson*

But if I were Pauline Jacobson (Jacobson (1999) or Heim and Jacobson (2005)), i.e. under a model of syntax-semantics interface based on Categorial Grammar (CG) and Variable-Free Semantics (VFS), I would rather analyse such functional/distributive readings in (1), (2) and (3) without any reference to reconstruction. More precisely, I argue that two fundamental and independent assumptions within Variable-Free Semantics suffice to account for data discussed in Sect. 1. One concerns the way binding is implemented, the other being tied to treatment of anaphoric expressions such as pronouns in VFS.

As pointed out by Jacobson (1999), the primary objective of VFS is to claim that one can dispense with intermediate representations such as Logical Form in order to account for well-known phenomena with respect to syntax-semantics interface. In VFS, semantic calculus is developed directly from surface structure, and results from direct composition of each syntactic

[7] For more details and arguments on the analysis of pronouns as determiners, see Elbourne (2002).

constituent through instances of functional application or compositional rules (similar to type-shifting rules)[8]. Jacobson (1999) also rejects the notion of variable as a theoretical object, and dispenses with indices in syntax. A consequence of such an approach concerns the way pronouns should be interpreted. Pronouns in VFS are analysed as identity functions over individuals or functions ($\lambda x.x$ or $\lambda f_{\langle e,e\rangle}.f$), that individual or function being just provided by the context. To illustrate how semantic composition works, consider the following example:

(9) *He left.*
-$[\![he]\!]$=$\lambda x.x$ (type $\langle e,e\rangle$)
-$[\![left]\!]$=$\lambda y.y\ left$ (type $\langle e,t\rangle$)

Obviously, analysing pronouns as identity functions leads to apparent semantic incompatibility between *he* and *left*. This is where compositional rules come into play, and more precisely what Jacobson (1999) calls *Function Composition*:

(10) ***Function Composition:*** if $\alpha$ and $\beta$ are respectively of type $\langle \sigma,\tau\rangle$ and $\langle a,\sigma\rangle$, then $[\![\alpha\beta]\!]$=$[\![\alpha]\!]\circ[\![\beta]\!]$=$\lambda V_a.[\![\alpha]\!]([\![\beta]\!](\mathrm{V}))$.

The meaning of *he* and *left* can now be composed very easily:

(11) $[\![he\ left]\!]$=$[\![left]\!]\circ[\![he]\!]$=$\lambda x_e.[\![left]\!]([\![he]\!](x)) = \lambda x_e.[\![left]\!](\lambda y.y(x))$=$\lambda x.x\ left$

As you can see from the output of semantic composition, the denotation of *he left* in VFS looks very similar to the denotation of *left*, except that the former is syntactically and semantically saturated: the open slot (here the individual $x$) just needs to be pragmatically saturated, i.e. to be provided by the context. Notice that such composition corresponds to unbound readings of pronouns. More generally, VFS system is developed in such a way that any expression containing an unbound pronoun will have a similar semantic output with an open slot, as shown by the following examples:

(12) a. $[\![Mary\ saw\ him]\!]$= $\lambda x.Mary\ saw\ x$
b. $[\![the\ picture\ of\ his\ daughter]\!]$= $\lambda x.\iota y.y\ is\ the\ picture\ of\ x's\ daughter$

Another crucial aspect of VFS concerns the way binding is implemented, i.e. bound readings of pronouns are obtained. Binding in VFS is crucially based on another compositional rule, the *z-rule*, and crucially not via a syntactic requirement like c-command:

(13) ***z-rule:*** Let $\alpha$ be an expression of the form $\langle[\alpha],[\![\alpha]\!]\rangle$. Then there is an expression $\beta$ of the form $\left\langle [\alpha],\quad z[\![\alpha]\!] = \lambda f_{\langle e,e\rangle}[\lambda x[[\![\alpha]\!](f(x))(x)]]\right\rangle$

Consider now the following example where *z-rule* is at stake:

(14) *John loves his mother.*

Intuitively, a predicate like *love* denotes a relation of type $\langle e,\langle e,t\rangle\rangle$. But, it shifts by *z-rule* to denote a relation of type $\langle\langle e,e\rangle\,,\langle e,t\rangle\rangle$ such that *z(love)* a function $f$ of type $\langle e,e\rangle$ is to be an $x$ such that $x$ ordinary loves $f(x)$. The detailed composition is given below:

(15) $[\![John\ z(loves)\ his\ mother]\!]$=$[\![z(loves)]\!]([\![his\ mother]\!])([\![John]\!])$
=$[\lambda f.\lambda x.[\![loves]\!](f(x))(x)](\lambda y.the\ mother\ of\ y)(John)$
=$[\lambda x.[\![loves]\!]([\lambda y.the\ mother\ of\ y](x))(x)](John)$

[8] In this study, I will only concentrate on VFS, as the account for functional readings in this model does not pertain to syntax (CG) at all. Just bear in mind that that direct composition between the constituents is also restricted by syntax, and each compositional rule has a syntactic correspondence. For more details, please refer to Jacobson (1999).

$$=[\lambda x.[\![loves]\!](the\ mother\ of\ x)(x)](John)$$
$$=[\![loves]\!](the\ mother\ of\ John)(John)$$
$$=[\lambda v.\lambda k.k\ loves\ v](the\ mother\ of\ John)(John)$$
$$=John\ loves\ the\ mother\ of\ John$$

**Gaps as ... nothing.** Having introduced the basic tools of VFS, we can now see how such model can very easily account for functional questions such as the one in (2) repeated here:

(16) *Quelle femme est-ce que chaque homme invitera?*
'Which woman will each man invite?'
*Son épouse.*
'His wife'

Such functional readings come as no surprise in VFS. And compared to the GG account, there is no need to introduce complex/functional indices on traces or copies. Even the notion of trace is not necessary in that system. In other words, gaps are treated as what they are on the surface: merely nothing. Consider indeed what would be the result of semantic composition of *chaque homme invitera* 'each man (will) invite', using only *Function Composition* and *z-rule*:

(17) $\beta$= z(invitera) → type $\langle ee, et\rangle$
$\alpha$= chaque homme → type $\langle et, t\rangle$
$$[\![chaque\ homme\ z(invitera)]\!]=[\![chaque\ homme]\!]\circ[\![z(invitera)]\!]$$
$$=\lambda f_{\langle e,e\rangle}.[\![chaque\ homme]\!]([\![z(invitera)]\!](f))$$
$$=\lambda f_{\langle e,e\rangle}.[\![chaque\ homme]\!]([\lambda h.\lambda x.[\![invitera]\!](h(x))(x)](f))$$
$$=\lambda f_{\langle e,e\rangle}.[\![chaque\ homme]\!](\lambda x.[\![aime]\!](f(x))(x))$$
$$=\lambda f_{\langle e,e\rangle}.[\lambda P.\forall y.homme(y) \to P(y)](\lambda x.[\![aime]\!](f(x))(x))$$
$$=\lambda f_{\langle e,e\rangle}.[\forall y.man(y) \to [\lambda x.[\![aime]\!](f(x))(x)](y)]$$
$$=\lambda f_{\langle e,e\rangle}.[\forall y.man(y) \to [\![aime]\!](f(y))(y)]$$
$$=[\lambda f.[\forall y.man(y) \to [\lambda x.\lambda v.v\ will\ invite\ x](f(y))(y)]]$$
$$=[\lambda f.[\forall y.man(y) \to [\lambda v.v\ will\ invite\ f(y)](y)]]$$
$$=[\lambda f.[\forall y.man(y) \to y\ will\ invite\ f(y)]]$$

What is crucial about this output is the presence of an open slot corresponding to a function $f$ of type $\langle e, e\rangle$, i.e. precisely what is needed to account for the functional reading of the question. That semantic output then presumably occurs as argument of *quelle femme* 'which woman', leading to the following interpretation:

(18) *What is the function* $f_{\langle ee\rangle}$ *ranging over women such that each man y will invite f(y)?*

**Resumptive pronouns as ... pronouns.** Very interestingly, cases of functional readings with resumption can also be given a straightforward account in VFS. Consider again example (3) repeated below:

(19) *La photo de sa fille, chaque homme **l'**a déchirée.*
'The picture of his daughter, each man tore it.'

The basic idea consists in analysing the resumptive clitic as a pronoun, i.e. as the identity function. To account for the functional reading of that clitic, I just argue that it is interpreted as the identity function over skolem functions of type $\langle e, e\rangle$, instead of individuals. As the schema in (20) shows, (3) can now be seen as a kind of coreference over functions (rather than individuals), a coreference between the (resumptive) clitic *l(a)*, introducing an open slot for a skolem function, and the dislocated element *la photo de sa fille*, introducing the context and hence providing that skolem function.

(20) *Schema for (3) under (CG-)VFS:*
-⟦la photo de sa fille⟧ $= \lambda x.\iota y.y\ is\ the\ picture\ of\ x's\ daughter$
-⟦la⟧ $= \lambda f.f$
-⟦chaque homme a déchiré l(a)⟧ $= \lambda f.[\forall x.man(x) \rightarrow x\ tore\ f(x)]$
with $f$ given by the displaced constituent: $f = \lambda x.\iota y.y\ is\ the\ picture\ of\ x's\ daughter$

Intuitively, the resumptive clitic is interpreted as both unbound (absence of *z-rule*) and functional (identity function over skolem functions). Only the context, here the dislocated constituent, provides that skolem function.

To summarize, functional/distributive/reconstructed readings in displacement structures can be given a straightforward account without literal reconstruction if one follows Jacobson (1999)'s model of syntax-semantics interface based on CG and crucially VFS.

## 3 Comparing the Two Accounts

The goal of this section is to compare the two accounts proposed in Sect. 2. I will first give empirical and theoretical arguments in favor of both accounts, before turning to further data concerning resumption that seem to favor the GG account.

### *3.1 Both Accounts on the Right Track?*

Comparing the two accounts both theoretically and empirically, the first conclusion one can give is the fact that both seem to be on the right track. The first argument for such conclusion is theoretical: the fact that whatever the model of syntax-semantics interface, both accounts of functional readings of resumptive pronouns correspond to an $e$-type analysis of resumption. The second argument is empirical: the fact that both account get rid of syntactic movement as initial requirement, hence correctly predicting functional readings in syntactic islands.

**An E-type Phenomenon.** Very interestingly, both accounts proposed in Sect. 2 rely on the same fundamental generalization about resumptive pronouns, the fact that they can be interpreted as $e$-type.

Aside from the traditional bound variable (BV) interpretation, several studies demonstrated that covariation of an anaphoric expression could result from another phenomenon, traditionally referred as $e$-type or *donkey anaphora*. The notion of $e$-type was introduced by Evans (1980) in order to deal with those sentences in which pronouns display a covarying interpretation that cannot be attributed to a BV interpretation. Consider the following classical example of $e$-type phenomenon:

(21) a. *John gave **his paycheck** to his mistress. Everybody else put **it** in the bank.*
b. *Every man loves **his mother**, but no man marries **her**.*

The pronouns *it* and *her* in (21a) and (21b) can have an $e$-type interpretation, i.e. a covarying reading in the sense that it can refer to a different *paycheck* or *donkey* with respect to *each person* or *farmer*. Notice that such covariation can not result directly from BV interpretation.

Intuitively, covariation of $e$-type anaphora can be attributed to distributive potential of the antecedent *his paycheck* or *his mother*, as both contain a potentially bound variable (the possessive *his*). That intuition corresponds precisely to Elbourne (2002)'s formalization of $e$-type anaphora, who proposes to analyse such pronouns as definite descriptions composed of a determiner (the pronoun) and an NP complement which has been elided under identity. Consider now the representation of (21a) under this assumption:

(22) *$John_1$ gave $his_1$ paycheck to his mistress. $Everybody_2$ else put $[_{DP}$ it $[_{NP_\delta}$ ~~paycheck of $him_2$~~$]]$ in the bank.*

Presence of the bound pronoun *him* in the elided copy straightforwardly accounts for the covarying or *e*-type interpretation of *it*. Also recall that functional readings with resumption are given the same account based on presence of an elided copy containing a bound pronoun. In other words, functional reading of the resumptive clitic in (3) just corresponds to an e-type interpretation of the resumptive under a GG account.

Under VFS account, functional readings of resumptive pronouns also correspond to an e-type phenomenon. Jacobson (1999) basically argues that e-type pronouns are interpreted as identity functions over functions in her system. Consider indeed semantic composition of (21b) within VFS:

(23) *Schema for (21b) under (CG-)VFS:*
-$[\![\text{his mother}]\!] = \lambda x.\iota y.y\ is\ x's\ mother$
-$[\![\text{her}]\!] = \lambda f.f$
-$[\![\text{no man marries her}]\!] = \lambda f.[\neg\exists x.man(x) \rightarrow x\ marries\ f(x)]$
with $f$ given by the context: $f = \lambda x.\iota y.y\ is\ x's\ mother$

In the same way that functional readings with resumption can be seen as a coreference over functions between the (resumptive) clitic *l(a)* and the dislocated element in (3), that classical example of *e*-type phenomenon just corresponds to a coreference between the *e*-type pronoun *her* and its potential antecedent *his mother*. So, both examples can be seen as instances of *e*-type phenomenon.

To summarize, the generalization that functional readings with resumption correspond to an *e*-type phenomenon is theoretically reinforced: via NP-ellipsis for GG account (a la Elbourne (2002)), and via identity function over functions ($\lambda f.f$) under VFS. And the fact that both accounts rely on the same generalization also gives more credit to each account of functional readings.

**Islandhood.** Compared to the traditional approach to reconstructed readings based exclusively on presence of syntactic movement, one major argument for the two accounts proposed in the preceding section concerns syntactic islands. As first pointed out in Guilliot and Malkawi (2006), functional readings with resumption also occur in presence of syntactic islands. Consider indeed the following examples from French in (24)[9]:

(24) a. *Le livre$_1$ qu'il$_2$ a emprunté, je suis fâché parce qu'aucun étudiant$_2$ ne* ***l$_1$*** *'a rapporté.*
'The book he had borrowed, I'm furious because no student brought **it** back.'

b. *?Quelle photo$_1$ de sa$_2$ fille est-ce que tu te demandes si chaque homme$_2$* ***l$_1$*** *'a gardée?*
'Which picture of his daughter do you wonder whether each man kept **it**?'

Interestingly, both examples in French are grammatical under the intended reading, one in which the displaced constituent and the resumptive clitic are interpreted distributively. Notice here that any analysis of functional readings relying exclusively on presence of syntactic movement cannot account for such data as syntactic reconstruction would be blocked by presence of the adjunct island in (24a) or the *wh-* island in (24b). Under the two accounts proposed in this study however, functional readings in (24) are correctly predicted, as no syntactic movement is at stake in both cases: the relation between the displaced constituent and the resumptive clitic is based either on ellipsis (for the GG account), or on a kind of coreference over functions (in VFS).

### *3.2 Teasing the Two Accounts Apart*

This section introduces further data with resumption, and more precisely two generalizations about resumption which seem to favor the GG account based on literal reconstruction. The

[9] Similar data in Jordanian Arabic can be found in Guilliot and Malkawi (2006).

first one concerns a famous distinction between two kinds of distributive readings in questions: functional reading *versus* pair-list reading. The second generalization is linked to another well-known distinction between two kinds of anaphoric expressions: weak anaphoric expressions such as clitics *versus* strong anaphoric expressions such as strong pronouns and epithets.

**Pair-list vs Functional Readings.** As pointed out in Sharvit (1997), resumption, contrary to a gap, allows for a functional reading, but does not allow for what is called a pair-list (PL) reading[10]. Consider indeed the following contrast in (25) from French, and more specifically the possible answers for each sentence[11]:

(25) a. *Quelle photo*$_1$ *de lui*$_2$ *est-ce que chaque homme*$_2$ *a déchirée* $\_\__1$*?*
‘Which picture of him(self) did each man tear?’
*Celle de son mariage.* (funct. answer)
‘The one from his wedding’
*Pour Jean, c’est celle de sa naissance; Paul, celle de son mariage,...* (PL answer)
‘For John, the one from her birth; Paul, the one from her wedding,...’

b. *Quelle photo*$_1$ *de sa*$_2$ *fille est-ce que tu te demandes si chaque homme*$_2$ ***l***$_1$*’a gardée?*
‘Which picture of his daughter do you wonder whether each man kept **it**?’
$\surd$*Celle de son mariage* (funct. answer)
‘The one from her wedding’
**Pour Jean, c’est celle de sa naissance; Paul, celle de son mariage,...* (PL answer)
‘For John, the one from her birth; Paul, the one from her wedding,...’

As confirmed by such contrast, the PL reading is only available with a gap, i.e. in absence of any resumptive element. I argue that such contrast can be accounted for in a GG framework whereas it is left unexplained under Jacobson (1999)’s account of functional questions. Notice that the CG-VFS account is empirically based on Engdahl (1980), for whom a pair-list reading just corresponds to the extension of the functional reading. However, such direct implication from functional reading to PL reading incorrectly predicts that PL reading should be available with resumption.

However, such generalization can be accounted for in a GG account if we assume that a PL reading follows from the notion of scope reconstruction (as intuitively stated in the first section). Following Aguero-Bautista (2001), I argue that such PL reading is fundamentally tied to interpretation of the copy as indefinite, and more precisely as a skolemized choice function $f$ (CH) of type $\langle\langle e,t\rangle, \langle e,e\rangle\rangle$[12]. To illustrate the analysis of a PL reading, consider the representations of (25a) given below:

(26) LF: *Quelle* ~~*photo de lui*~~ $\lambda_1$ *est-ce que chaque homme* $\lambda_2$ *a déchirée* ~~$f_1{}^2$ *(photo de lui*$_2$*)*~~*?*
SEM: $\lambda p.\exists f.[CH_s(f) \wedge p = \forall x.[man'(x) \rightarrow tore'(x, f(picture\ of\ x')(x))]]$
$\Rightarrow$ *What is the skolemized choice function* $f_{\langle et,ee\rangle}$ *such that each man*$_x$ *tore* $f_x$*(picture of x)?*

Presence of the skolemized choice function gives rise to the PL reading as it corresponds to a set of arbitrary pairs between a man and a picture of that man. In other words, the relation between the two can be different, contrary a functional reading.

10 Sharvit (1997)’s study was essentially based on data from Hebrew.

11 As shown by the question mark, (25b) is slightly degraded, like any case of resumption with questions in French. Resumption in questions is only acceptable when an island occurs, and still has a marginal status in French.

12 A skolemized choice function takes two arguments, an individual and predicate defining a set of entities, and returns an entity of that set. It was first introduced in Kratzer (1998) to account for specific interpretation of indefinites. For more details, see Kratzer (1998).

**Weak vs Strong Resumption.** Another generalization about resumption might appear problematic under VFS account: the fact that the distinction between weak versus strong resumption plays a role with respect to functional readings of resumption. A pointed out by Guilliot and Malkawi (2007), functional readings with resumption within islands only arise with weak resumptives (clitics), but not with strong resumptives (strong pronouns or epithets), as the contrast in (27) from Jordanian Arabic shows:

(27) a. *[ṭalib-[ha]$_1$ l-kassoul]$_2$ ma ħakjan maʕ [wala mʕallmih]$_1$ gabl-ma tʃuf-uh$_2$ /*
student-her the-bad *Neg* talked.*1pl* with no teacher before saw.*3sf-Cl* /
*-uh$_2$ hu$_2$ l-mudiirah*
-*Cl* he the-principal.*3sf*
'Her bad student, we didn't talk to any teacher before the principal saw him.'

b. **[ṭalib-[ha]$_1$ l-kassoul]$_2$ ma ħakjan maʕ [wala mʕallmih]$_1$ gabl-ma hu$_2$ /*
student-her the-bad *Neg* talked.*1pl* with no teacher before he /
*ha-l-ġabi$_2$ yesal*
the-idiot.*3sm* arrive.*3sm*
'Her bad student, we didn't talk to any teacher before he / this idiot arrived.'

Surprisingly in Jordanian Arabic, when the resumptive clitic is replaced by a strong pronoun or an epithet as in (27b), the functional reading of both the displaced constituent and the resumptive is no longer available. Such contrast is unexpected if we consider VFS account based on interpretation of the resumptive as *e*-type, i.e. as the identity function over functions. Why would such mechanism be blocked when strong resumption is at stake? Strong resumptives, like any anaphoric expression, could in principle be interpreted as identity functions over individuals or functions.

However, such restriction on functional readings can be explained under the GG account just by syntactically constraining ellipsis. Functional readings of resumptives also rely on an *e*-type phenomenon, but more specifically presence of an elided copy as the syntactic restriction of the resumptive. Under such a view, strong resumptives can still have an *e*-type structure, but they will not allow for a functional reading because their complex internal structures will block literal reconstruction. Consider indeed the structures independently suggested by Benmamoun (2000) and Aoun et al. (2001) for strong pronouns and epithets:

(28) a. Strong pronoun: $[_{DP}$ h- $[_{NP}$ $\phi$-morpheme ]]

b. Epithet: $[_{DP}$ ha- $[_{D'}$ l- $[_{NP}$ gabi]]

Contrary to weak anaphoric expressions, strong pronouns and epithets correspond to full DPs, for which the NP restriction is filled. Such assumption suffices to account for absence of syntactic reconstruction of the potentially bound variable *-ha* 'her' in (27b), hence absence of the functional reading of the strong resumptive.

## 4 Conclusion

In this study, I introduced two novel accounts of functional readings with displacement structures relying on two possible formalizations of syntax-semantics interface, one based on Generative Grammar and Logical Form (GG), the other built on Categorial Grammar and Variable-Free Semantics (CG-VFS). Two arguments suggest that both analyses could be on the right track. One is theoretical: the fact that both accounts of distributive/reconstructed readings with resumption amount to an *e*-type interpretation of the resumptive pronoun. The other is empirical: the fact that both accounts correctly predict functional readings within syntactic islands). Finally, I (re)introduced two generalizations about resumption which seem to favor the GG account based on actual reconstruction, one concerning the type of distributive reading (functional *vs* pair-list), the other linked to a distinction between weak and strong resumption.

## References


Calixto Aguero-Bautista. *Cyclicity and the scope of wh-phrases*. PhD thesis, MIT, 2001.

Joseph Aoun, Lina Choueiri, and Norbert Hornstein. Resumption, movement and derivational economy. *Linguistic Inquiry*, 32:371–403, 2001.

Elabbas Benmamoun. The feature structure of functional categories: a comparative study of Arabic dialects. In *Oxford studies in comparative syntax*, pages 3–69. 2000.

Noam Chomsky. *The minimalist program*. MIT Press, 1995.

Paul Elbourne. *Situations and individuals*. PhD thesis, MIT, 2002.

Elisabet Engdahl. *The Syntax and Semantics of Questions in Swedish*. PhD thesis, University of Massachusetts, Amherst, 1980.

Gareth Evans. Pronouns. *Linguistic Inquiry*, 11:337–362, 1980.

Danny Fox. On Logical Form. In Randall Hendrick, editor, *Minimalist Syntax*. Blackwell, 2003.

Nicolas Guilliot. *La reconstruction à l'interface entre syntaxe et sémantique*. PhD thesis, University of Nantes, 2006.

Nicolas Guilliot and Nouman Malkawi. Reconstruction and islandhood in Jordanian Arabic. In Mustafa Mughazy, editor, *Perspectives on Arabic Linguistics XX*. John Benjamins, 2007.

Nicolas Guilliot and Nouman Malkawi. When resumption determines reconstruction. In *Proceedings of WCCFL 25*. Cascadilla Press, 2006.

Irene Heim and Pauline Jacobson. Direct compositionality: binding and ellipsis. Lecture notes (unpublished), LSA Summer Institute, MIT, 2005.

Pauline Jacobson. Towards a variable-free semantics. *Linguistics and Philosophy*, 22:117–184, 1999.

Angelika Kratzer. Scope or pseudoscope? Are there widescope indefinites? In S. Rothstein, editor, *Events in Grammar*. 1998.

David Lebeaux. Relative clauses, licensing and the nature of the derivation. In *Proceedings of NELS 20*, pages 318–332, 1990.

Tanya Reinhart. Quantifier scope. How labour is divided between QR and choice functions. *Linguistics and Philosophy*, 1997.

Uli Sauerland. The interpretation of traces. *Natural Language Semantics*, 12:63–127, 2004.

Yael Sharvit. *Syntax and semantics of functional relative clauses*. PhD thesis, University of New Jersey (Rutgers), 1997.

# Dialogue-Grammar Correspondence in Dynamic Syntax

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**Abstract.** In this paper we argue, contra a trend to classify fragments in terms of sub-types specific to dialogue, that despite their diversity of usage in conversation, such ellipses are analysable in terms of general structure building mechanisms for interpretation growth that have motivation elsewhere in the grammar. The framework adopted is *Dynamic Syntax* (DS, Kempson et al. (2001); Cann et al. (2005)). The fragment types addressed include *reformulations*, *clarification requests*, *extensions*, *corrections* and *acknowledgements* which receive analyses that do not extend the basic apparatus of the model. We argue that incremental use of fragments serves a specific role in dialogue, namely, a means of incrementally narrowing down the otherwise mushrooming structural/interpretational alternatives, a problem known to constitute a major challenge to any parsing system. We conclude that a grammar with inbuilt parsing dynamics can explain dialogue phenomena without constituting a grammar of conversation. On the other hand, these results contribute to the general programme pursued by DS of providing a unitary basis for characterising all elliptical phenomena as indeed context-dependent interpretation fixing; in our view, this becomes possible if a grammar formalism is adopted in which "syntax" is defined as the progressive building up of representations of content reflecting real-time processing.

## 1 Introduction

In confronting the challenge of providing formal models of dialogue, with its plethora of fragments and rich variation in modes of context-dependent construal, it might seem that linguists face two types of methodological choice. Either (a) conversational dialogue demonstrates dialogue-specific mechanisms, for which a grammar specific to such activity must be constructed; or (b) variation arises due to the employment of independent parsing/production systems which are nevertheless based on some mode-neutral grammar formalism. However, as dialogue research continues to develop, there are intermediate possibilities, and in this paper we discuss the approach developed within *Dynamic Syntax* (*DS*, Kempson et al. 2001, Cann et al. 2005), a grammar framework within which, not only the parser, but indeed "syntax" itself is seen as the progressive construction of semantic representations set in context. Here we extend the analyses presented in Kempson et al. (2007) to a range of further fragment types, in particular *reformulations*, *fragment requests* and *corrections* accompanied by *extensions*. From a DS perspective, such apparently dialogue-specific constructions can be seen to result from perfectly general structural processes, despite being characteristic of cross-party conversational data.

Further, we claim that the grammar itself constitutes the basis for parsing strategies that facilitate efficient online processing, structural and semantic. In this respect, the DS dialogue model provides the means of achieving this DURING the course of the sub-sentential construction process, demonstrating that timely application of such generally available "syntactic" mechanisms directly contributes to the human processor's high degree of success in linguistic interaction. We conclude that, contrary to conventional assumptions of the grammar-parser relation whereby exclusively the parser handles disambiguation, grammars, as employed in dialogue, can also be seen as restricting ambiguity provided their formal specification can model this incremental facilitating function.

## 2 Background

The data we focus on are non-repetitive fragment forms of acknowledgements, clarifications and corrections (henceforth, A female, B male):

(1) A: Bob left.
B: (Yeah,) the accounts guy.

(2) A. They X-rayed me, and took a urine sample, took a blood sample.
A: Er, the doctor
B: Chorlton?
A: Chorlton, mhm, he examined me, erm, he, he said now they were on about a slight [shadow] on my heart. [BNC: KPY 1005-1008]

(3) A: Are you left or
B: Right-handed.

(4) A: Bob left.
B: Rob?
A: (No,) (Bob,) the accounts guy.

Even though the NP fragments in (2) - (4) might be characterised as distinct constructions, they illustrate how speakers and hearers may contribute to the joint enterprise of establishing some shared communicative content, in what might be loosely called *split utterances*. Even (1), an *acknowledgement*, can be seen as such, being similar in form to an afterthought *extension* which, instead of being uttered by the same speaker, is combined with an interlocutor's sentential utterance. As (2) shows, joint construction of content can proceed incrementally: B provides a *reformulation* as a *clarification request*, resolved by A within the construction of a single proposition. The attested example in (3) represents an intermediate case, in which the respondent realising what the question is answers AS the *completion* of the question, with the fragment serving both as *question* and *answer*. In (4), the fragment, *the accounts guy*, is a *correction* of B's understanding of A's utterance, illustrating how A and B are having to negotiate in order to secure coordination. Nevertheless such corrections can be also *extensions* in the above sense, providing a single conjoined propositional content DURING which coordination is achieved. At the same time, the fragment also constitutes an *answer* to B's question.

It might seem that such illustration of diversity of fragment uses is ample evidence of the need for conversation-specific rules as part of a grammar. Indeed, this is the view taken by Ginzburg and Sag (2000), Purver (2004), Ginzburg and Cooper (2004), Fernández (2006) a.o. Fernández (ibid) presents a thorough taxonomy, as well as detailed formal and computational modelling of *Non-Sentential Utterances* (NSUs), referring to contributions such as (1) as *repeated acknowledgements* involving *reformulation*. Since such fragments require contextual information singling out a particular constituent of the previous utterance, Fernández models such constructions via type-specific "accommodation rules" which make a constituent of the antecedent utterance "topical". The semantic effect of the acknowledgement is then derived by applying an appropriately defined utterance type for such fragments to the newly constructed context. A distinct form of contextual accommodation is employed to model so-called *helpful rejection* fragments, as in (4) (without the reformulation), whereby a *wh*-question is accommodated in the context by abstracting over the content of one of the sub-constituents of the previous utterance. The content of the rejection is derived by applying this *wh*-question in the context to the content of the fragment (see also Schlangen (2003) for another classification and analysis).

The alternative explored here is whether phenomena such as (1)-(2), both of which are non-repetitive appositional next-speaker contributions, can be handled using the same mechanisms for structure-building made available in the core grammar without recourse to conversation-specific extensions of that grammar and contextual accommodation rules. The range of interpretations these fragments receive in actual dialogue seem to form continua with no well-defined boundaries and mixing of functions (see (3)-(4) and comments in Schlangen (2003)). Thus we propose that the grammar itself simply provides mechanisms for processing and integrating such fragments in the current structure whereas the precise contribution of such fragments to the communicative interaction is either calculated by pragmatic inferencing (as in e.g. Schlangen (2003)) or, as seems most often to be the case, left underspecified. The framework for the analysis is Dynamic Syntax, in which the dynamics of how information accrues in language processing is the core syntactic concept.

One bonus of the stance taken here is its elucidation of the grammar-parser contribution to disambiguation and antecedent resolution. Part of the challenge of modelling dialogue is the apparent multiplicity of interpretive and structural options opened up during processing by the recurrent, often overlapping fragments as seen in (2) above. Due to context-dependence, successful integration of such fragments could be taken to significantly increase the complexity of the interpretive task. If grammar is separated from parsing, either accommodation and construction-specific interpretation rules or a module separate from grammar dedicated to the resolution of context dependency seem to be inevitable. However, the alternative is to see such phenomena as exploitation by interlocutors of the incrementality afforded by the grammar to manage the potential explosion of options. The employment of fragments with different functions enable the interlocutors to immediately address problems arising during the (sub-sentential) processing of a previous utterance, at any relevant point, thereby enabling them to jointly constrain interpretation choices in an ongoing way. Processed in a specific context and relying on this particular context for their interpretation, such fragments do not therefore increase the complexity of the interpretive task but rather facilitate it. Modelling the flexibility of fragment interpretation requires fine-grained control of how the current utterance can be combined with previous contextual (potentially partial) information, provided potentially by another interlocutor. Such control is not available in frameworks in which context dependency of linguistic processing is outside the remit of the grammar or where parsing and generation are independently defined. In such frameworks distinct mechanisms have to be set up accordingly to take care of the fragmented nature of dialogue. However, the tight coordination of parsing and generation defined in *Dynamic Syntax* (Purver et al. (2006)) provides a straightforward basis for how the context-dependence of both tasks allows participants to economise on processing and achieve coordination effectively.

## 3 Dynamic Syntax: A Sketch

*Dynamic Syntax* (*DS*) is a parsing-based approach to linguistic modelling, involving strictly sequential interpretation of linguistic strings. The model is implemented via goal-directed growth of tree structures and the annotations on their nodes (*decorations*). Tree development is formalised using *LOFT* (Blackburn and Meyer-Viol (1994)), with modal operators $\langle\uparrow\rangle, \langle\downarrow\rangle$ defining concepts of *mother* and *daughter*, their iterated counterparts, $\langle\uparrow_*\rangle, \langle\downarrow_*\rangle$, defining the notions *be dominated by* and *dominate*. *Underspecification* and update are core aspects of the grammar and involve strictly monotonic information growth for any dimension of tree structures and decorations. Underspecification is employed at all levels of tree relations (mother, daughter etc.), as well as formulae and type values, each with a *requirement* driving the goal-directed process of update. For example, a node of a tree may have a requirement expressed in DS with the decoration $?Ty(e)$, for which the only legitimate updates are logical expressions of individual type ($Ty(e)$); but requirements may also take a modal form, e.g. $?\langle\uparrow\rangle Ty(e \rightarrow t)$, a restriction that the mother node be decorated with a formula of predicate type. Requirements are essential to the DS dynamics: all requirements must be satisfied if the construction process is to lead to a successful outcome.

Structure is built from lexical and general *computational actions*. Computational actions govern general tree construction processes (introducing/updating structure) and compiling interpretation (introducing/updating decorations for a mother node once the daughters' requirements have been satisfied). This may include the construction of only weakly specified tree relations, with nodes (*unfixed nodes*) characterised simply as dominated by some node from which they are constructed, with subsequent update required to fix the exact position of the node in the tree (unlike van Leusen and Muskens (2003), partial trees are here part of the model). Individual lexical items also provide actions for building structure, *lexical actions*, expressed in exactly the same terms as the more general processes, inducing nodes and decorations. Thus *partial trees* grow incrementally driven by procedures associated with words as encountered, with a *pointer*, $\diamondsuit$, recording the parse progress and hence handling word order restrictions (DS trees do not reflect word order as they are strictly representations of content).

Complete individual trees are taken to correspond to predicate-argument structures. More complex structures can be obtained via a general tree adjunction operation defined to license the construction of a tree sharing some term with another newly constructed tree, yielding so-called LINKED TREES (Kempson et al. 2001). The resulting combined information from the adjoined trees is modelled as a conjunction of terms at the node FROM which the link is made. Importantly, adjunction, as other forms of construction and update, can be employed to model how subsequent speakers may dynamically provide fragmentary extensions in response to the previous utterance.

Content underspecification, an obvious property of anaphoric expressions but also affecting many other types of lexical items is modelled uniformly in DS as the provision of initially weak specifications that need to be enriched by means of update in a context. The content underspecification of pronouns is represented as the initial provision of a place-holding metavariable, noted as e.g. $\mathbf{U}$, plus an associated requirement for update by an appropriate term value: $?\exists\mathbf{x}.Fo(\mathbf{x})$. Similarly, *names* are represented as initially introducing place-holders associated with a constraint providing the name of the individual entity picked out. For example, the name *Bill* contributes the decoration $\mathbf{U}_{Bill'(\mathbf{U})}, Ty(e)$. The subscript specification is shorthand for a transition across a LINK relation to a tree whose top node is decorated with a formula $Bill'(\mathbf{U})$, the name being taken as a predicate or name specification of individuals thus restricting possible updates to the metavariable[3]. Names can thus be seen as a procedure for identifying the individual being talked about, with a logical constant (e.g. $m21$, $m23$ etc. picking out uniquely this individual) eventually replacing the metavariable on the emergent tree. According to the DS account, all content underspecification is resolved by substitution, the update of metavariables, which can only be accomplished if the context contains an appropriate term as substituend. *Context* in DS involves storage of *parse states*, i.e., the storing of partial tree, word sequence to date, plus the actions used in building up the partial tree.

A major aspect of the DS dialogue model is that both *generation* and *parsing* are goal-directed and incremental, with parsing as the underlying mechanism and generation parasitic on it. A hearer builds a succession of partial parse trees in order to achieve an interpretation of the speaker's message. A speaker is modelled in DS as doing exactly the same except (s)he also has available a *goal tree* representing what they wish to say. Each possible step in generation, an utterance of a word, is governed by whatever step is licensed by the *parsing* formalism, constrained via the required *subsumption* relation of the goal tree by the thus-far constructed "parse" (partial) tree. Speakers produce a natural language string by associating this growing "parse" tree incrementally with appropriate lexical items.

Now, dialogue requires taking into account both the speaker's goal tree (a thought to be expressed) and the speaker's parse tree (what licenses the utterance of the next word by checking the subsumption of the goal tree). In addition the hearer's parse tree (what (s)he has processed) must be taken into account because in cases of miscommunication it will diverge from the one the speaker is constructing. These, potentially partial, parse trees are stored in the context at all stages and are updated as utterance parts are incrementally processed. For fragment construal, we are interested in the extent to which B has successfully parsed what A has said, i.e., the matching of their partial parse trees. Even with only partial parse trees, the model allows at any stage switching of speaker/hearer roles in order to interrupt to clarify, reformulate, or correct, by either repeating some expression heard or producing an alternative. It is assumed that the parse tree of B as a hearer might diverge from A's only at a node where need of clarification or miscommunication occurs. In such cases, a sub-routine developing it can then be initiated by B now becoming the generator. Notice that because of the incremental nature of DS, B can reuse the already constructed (partial) parse tree in their context, thereby starting at this point, rather than having to rebuild an entire propositional tree or subtree (e.g. of type $e$). This is licensed only if B's (partial) goal tree matches or extends a parse tree in his context which was updated with the relevant subpart of what B took to be A's utterance. Indeed, this update is what B is seeking to clarify, correct or acknowledge. A, now as a hearer, has also the potential of extending her own partial tree in her context for processing B's utterance, she doesn't need to initiate a new tree unless a miscommunication has occurred.

With the assumed parity of representations between speaker and hearer, providing immediate feedback to the previous speaker has the effect to narrow the focus on a specific point of query leaving the rest of the context unchanged for both interlocutors and thus providing the basis for the incorporation of the fragment. Even in the case of fragmental corrections or disagreeements, i.e. when context mismatch occurs, the interlocutors are modelled as exploiting (parts of) the stored

[3] These *linked* structures are suppressed in all diagrams.

contextual components to achieve interpretation of the fragment. The advantage of this emerges in the unified characterisation of any type of *ellipsis* construal as strictly context-dependence. Since context in DS involves the storing of current partial tree, word sequence to date, plus the actions used to date to build the partial tree, ellipsis construal can target any of those stored elements. In particular, for split/joint utterances and any type of feedback this enables switch from hearer to speaker at any arbitrary point in the dialogue, without such fragmental utterances having to be interpreted as propositional in type (as is standard elsewhere, e.g. Purver (2004)).[4] This then captures the general dynamics involved in taking what the other speaker has just uttered, with the potential at any point to update it to accord with one's own emerging understanding of the interaction. In this way, speakers are able to guide each other's interpretations, and thus *jointly* narrow down as early as possible the burgeoning interpretive space.

## 4 NSU fragments in Dynamic Syntax

### 4.1 Non-repetitive Acknowledgement

From a DS perspective, phenomena like *reformulations* as in (1), or *extensions* to what one understands of the other speaker's utterance, (2), can be handled with exactly the same mechanisms as the sentence-internal phenomenon independently identifiable as *apposition* and illustrated below:

(5) A friend of my mother's, someone very famous, is coming to stay.
(6) Bob, the friend of Ruth's, is coming to stay.

According to Cann et al. (2005), appositions are analysed as involving the building of paired terms across a tree transition, building *linked* structures defined to share a term. Reflecting this constraint, the update rule for such structures then takes the pair of type $e$ terms so formed and yields a term whose compound restrictor is made up of the predicative content from each.

We now have the basis for analysing extensions and non-repetitive acknowledgements which build on what has been previously said by way of confirming the previous utterance. Recall examples (1) and (2). There are two ways in which such fragments which reformulate an interlocutor A's utterance are produced: either (a) as interruptions of A's utterance in which case immediate confirmation of identification of the individual concerned is provided, see (2), or (b) as confirmations/extensions of A's utterance after the whole of her utterance has been integrated, see (1). Both are modelled by DS as incremental additions.

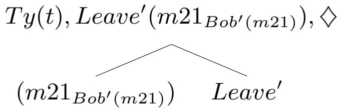
Turning to (1), B's response *(Yeah,) the accounts guy*[5] constitutes both a reformulation of A's utterance, as well as an extension of A's referring expression, in effect providing the appositive expression 'Bob, the accounts guy'. This means that B has processed A's original utterance, according to some identification of the individual associated with the name *Bob*: that is to say, they have constructed a full content representation for this utterance. B's reformulation has the effect of acknowledgement because it signals to A that he has processed/understood her asserted content, and, moreover, has no objection to the content, *unless* mistaken in that identification.

In DS terms, B's context consists of the following tree after processing A's utterance:

[4] Given the DS concept of linked trees projecting propositional content, we anticipate that this mechanism will be extendable to fragment construal involving inference (see e.g. Schlangen (2003), Schlangen and Lascarides (2003))

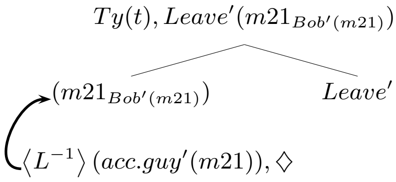
[5] Words like *yeah* and *no* are analysed as discourse markers which do not contribute truth conditional content, hence are not represented on the trees

(7) B's Context for 'Yeah'



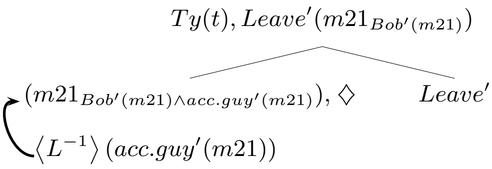

It is now open to B to re-use this representation, stored in his context, as the point of departure for generating the expression *the accounts guy*. In this case his own goal tree will now be decorated with a composite term made up both from the term recovered from parsing A's utterance and the new addition. Simplistically, all this requires is attaching a *linked* tree to the correct node, and then processing the content of the apposition in order to produce the words required. The defined steps include shifting the pointer to the appropriate node, projection of a *linked* tree from that node and processing the words *the accounts guy* (the *linked* tree is condensed below):

(8) B's "parse" tree licensing production of *the accounts guy*: LINK adjunction



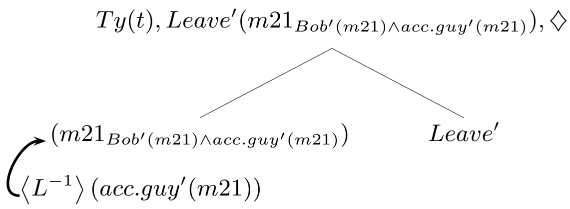

Updating this representation according to the DS processing protocol involves adding the acquired restrictions at the node from which the *linked* tree is projected (individual stages here suppressed):

(9) Updating B's "parse" tree licensing production of *the accounts guy*




Finally, the information is passed up to the top node of the main tree, completing the parse tree to match B's goal tree in uttering the expression *the accounts guy* :

(10) Completing B's "parse" tree licensing production of *the accounts guy*



### 4.2 Non-repetitive Clarification

In the acknowledgement case above, the term relative to which the *linked* structure is built is fixed; but the very same mechanism can be used when the interlocutor needs clarification. In (2), B again takes as his goal tree a tree decorated with an expansion of the term constructed from parsing A's utterance but nevertheless picking out the same individual. Using the very same mechanism as in (1) of building a *linked* structure constrained to induce shared terms, B provides a distinct expression, the name *Chorlton*, this time before he has completed the parse tree for A's utterance. This name, contributing a metavariable plus the constraint that the individual picked out must be named *Chorlton*, is used to decorate the linked node so that it makes explicit the additional predicative constraint on the individual being described. The outcome of this process, when the linked structure is evaluated, is a composite term $m21_{Doctor'(m21) \wedge Chorlton'(m21)}$. This process, therefore, is identical to that employed in B's utterance in (1), though to a rather different effect at this intermediate stage in the interpretation process, namely a clarification. This extension of the term is confirmed by A, this time trivially replicating the composite term which processing B's utterance has led to (see Kempson et al 2007 for such trivial goal tree-parse tree matches). The eventual effect of the process of inducing *linked* structures to be decorated by coreferential type $e$ terms may thus vary across monologue and different dialogue applications but the mechanism is the same.

### 4.3 Correction

It might be argued nonetheless that correction is intrinsically a dialogue phenomenon. Consider (4) for example, reproduced below:

(4) A: Bob left.
B: Rob?
A: (No,) (Bob,) the accounts guy.

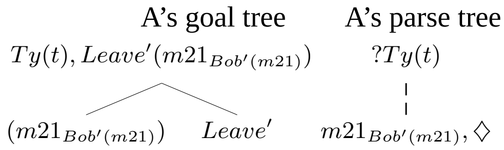
As one alternative, we assume here that B has misheard and requests confirmation of what he has perceived A as saying. A in turn rejects B's utterance and provides more information. Presuming rejection as simple disagreement (i.e. the utterance has been understood, but judged as incorrect), in DS terms, this means that A has in mind a goal tree that licensed what she had produced, which is distinct from the parse tree derived by processing B's clarification. As shown in Kempson et al. (2007), this means that A has been unable to process B's clarification request as an extension of her own context. Instead, she can parse the clarification by exploiting the potential for introducing an initially structurally underspecified tree-node to accommodate the contribution of the word *Rob*. Subsequently, by utilising the actions stored in context previously by processing her own utterance of the word *left*, she is able to complete the integration of the fragment in a new propositional structure.

In order to produce the following correction, what is required is for A to establish as the current most recent representation in context her original goal tree. This can be monotonically achieved by recovering and copying this original goal tree to serve as the current most immediate context[6]. Under these circumstances, given the DS grammar-as-parser perspective, several strategies are now available. A is licensed to repeat the name *Bob* by locally extending the node in the

[6] Corrected representations must be maintained in the context as they can provide antecedents for subsequent anaphoric expressions.

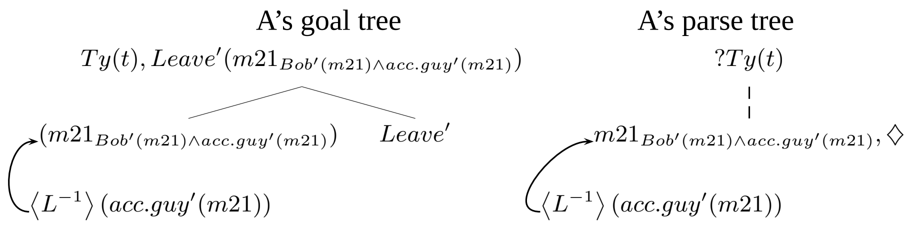
context tree where the representation of the individual referred to is located by using the rule of LATE*ADJUNCTION, a process which involves building a node of type $e$ from a dominating node of that type (illustrated in Kempson et al. 2007). An alternative way of licensing repetition of the word *Bob* is to employ one of the strategies generally available for the parsing of long distance dependencies i.e. constructing initial tree nodes as unfixed (*ADJUNCTION). We will now illustrate briefly the parsing steps showing how the latter strategy can be exploited to license the production of the fragment. Firstly an unfixed node is constructed and this provides the environment appropriate for the (test-)parse of the word *Bob*. As this development leads to a partial tree that subsumes the goal tree, production of *Bob* is licensed:

(11) Licensing production of a correction by *ADJUNCTION:



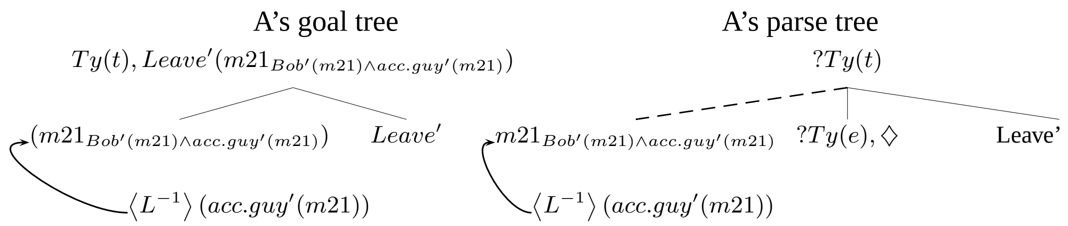

An option available to A at this point is to introduce, in addition or exclusively, a reformulation of her original utterance in order to facilitate identification of the named individual which proved problematic for B previously. She can answer B's utterance of *Rob* with *(No,) (Bob,) the accounts guy*, as in (4) or simply with *(No,) the accounts guy*. Both are licensed by the DS parsing mechanism without more ado. The structure derived by processing such an extension is exactly that of (1) above (compare the goal tree in (15) below and the tree in (10)). So, as previously, a linked tree can be constructed to (test-)parse the expression *the accounts guy* and as subsumption is satisfied at this stage this parse can be pursued in order to achieve a complete match of goal and parse trees:

(12) LINK ADJUNCTION and checking goal tree subsumption:



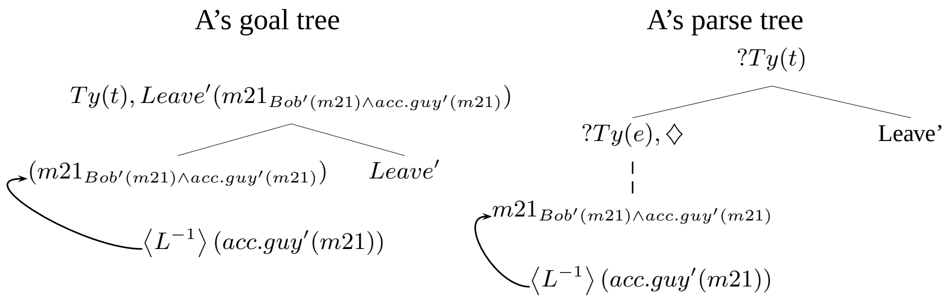

As we mentioned before, *context*, as defined in DS, keeps track not only of tree representations and words but also of the actions contributed by the words and utilised in building up the tree representations. Production of the correction in (4) is licensed to be fragmental because the original actions for parsing/producing the word *left* are available in the context and can be recalled to complete the structure initiated by processing/producing the name *Bob*. So at this stage, the actions for *left* stored in the context can be retrieved and applied to the newly constructed tree; this provides the required predicate without the need to pronounce the word as subsumption is satisfied:

(13) Retrieving and running the actions for *left*, pointer return to subject node and checking goal tree subsumption:

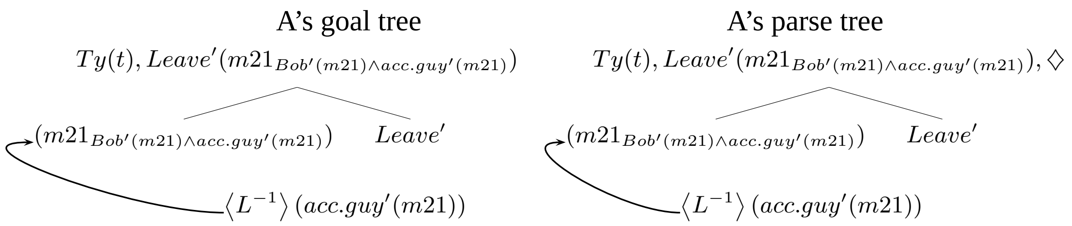



Now the unfixed node that was constructed by (test-)parsing the fragment can unify with the subject node as the only licensed subsequent move. Further standard computational actions will complete the parse tree:

(14) Preparation for UNIFICATION and checking goal tree subsumption:




(15) UNIFICATION and completion of parse tree to match the goal tree:




The result is a parse tree that completely matches the goal tree, hence the fragment *(Bob,) the accounts guy* can be produced as it can be licensed in this particular context.

### 4.4 Combining Dialogue Functions in a Single Structure

In the examples considered so far, we have seen how a single type of mechanism can serve distinct functions. A more striking case is (3), where the hearer, B, is able to leap to a hypothesis as to how A's question is going to be completed, and provides that completion by way of answer. Here we have the case again where more than one function can be fulfilled even by a single utterance. As in (1)-(2), license for such a use turns on taking the context that was constructed by parsing input from the interlocutor as the point of departure. That B is extending the structure set up by A's utterance is self-evident; but in addition, both A's utterance, if she had completed it, and B's utterance, as presented, are elliptical as to the second disjunct. The success of this particular form of split utterance turns on the fact that what A is presenting is a duplex *yes-no* question with both possible answers provided by the two disjuncts. So in completing it by providing just the second disjunct, B can succeed in answering the question while simultaneously completing it. Though there is more to say here, the significance of (3) lies in the use of the single expression *right-handed* to fulfil two functions, both the completion of a question and the provision of an answer. In DS this can be modelled, reflecting the phenomenon itself, without having to assume the superimposition of two distinct structures, one upon the other. Incidentally, this is a case contradicting what is supposedly unique to such interrupting completions, namely,that they require acknowledgement by the hearer before proceeding.

## 5 Conclusion

As these fragments and their construal have demonstrated, despite serving distinct functions in conversation, the mechanisms which make such diversity possible are general strategies for tree growth available in any type of genre, dialogue or monologue alike. In all cases, the advantage which use of fragments provides is a "least effort" means of re-employing previous content/structure/actions which constitute the *context*. As modelled in DS, it is more economical to reuse information from context rather than constructing representations afresh (via costly processes of lexical retrieval, choice of alternative parsing strategies, etc.).

A further quandary in dialogue construal is that, no matter what avenues for economising their efforts interlocutors may make use of, they are nevertheless faced with an increasing set of interpretative options at any point during the construction of representations. One option available to hearers is to delay a disambiguating move until further input potentially resolves the uncertainty. However, as further input is processed and parsing/interpretive options increase potentially rapidly, maintenance of these open options becomes difficult for a human processor. The incremental definition of the DS formalism allows for the modelling of an alternative available to hearers: at any point they could opt to intervene immediately, and make a direct appeal to the speaker for more information at the maximally relevant point during construction. It seems clear that the latter would be the favoured option and this is what clause-medial fragment interruptions as in (2) illustrate.

The phenomena examined here are also cases where a speaker's and a hearer's representations, despite attempts at coordination may, nevertheless, separate sufficiently for them to have to seek to explicitly "repair" the communication (see especially (4)). In the model presented here, the dynamics of interaction allow fully incremental generation and integration of fragmental utterances so that interlocutors can be taken to constantly provide optimal evidence of each other's representations with necessary adjuncts being able to be incrementally introduced. Unlike other accounts, in this model, fragment construal is modelled sub-sententially with no lifting devices to yield a propositional unit as part of some putative discourse grammar. Indeed, no structures/strategies are posited specific to individual discourse functions to which a fragment is put. From a more general point of view, the analyses presented here provide further evidence (see also Cann et al. (2007)) that a unitary basis for characterising elliptical phenomena as indeed context-dependent interpretation fixing becomes possible if a grammar formalism is adopted in which ”syntax” is defined as the progressive building up of representations of content to reflect real-time processing.

**Acknowledgements**

This work was supported by grants ESRC RES-062-23-0962 and Leverhulme F07 04OU. We are grateful to three anonymous reviewers for their comments.

# Bibliography


Blackburn, Patrick, and Wilfried Meyer-Viol. 1994. Linguistics, logic and finite trees. *Bulletin of the IGPL* 2:3–31.

Cann, Ronnie, Ruth Kempson, and Lutz Marten. 2005. *The dynamics of language*. Oxford: Elsevier.

Cann, Ronnie, Ruth Kempson, and Matthew Purver. 2007. Context and well-formedness: the dynamics of ellipsis. *Research on Language and Computation* .

Fernández, Raquel. 2006. Non-sentential utterances in dialogue: Classification, resolution and use. Doctoral Dissertation, King's College London, University of London.

Ginzburg, Jonathan, and Robin Cooper. 2004. Clarification, ellipsis, and the nature of contextual updates in dialogue. *Linguistics and Philosophy* 27:297–365.

Ginzburg, Jonathan, and Ivan A. Sag. 2000. *Interrogative investigations*. CSLI Publications.

Kempson, Ruth, Andrew Gargett, and Eleni Gregoromichelaki. 2007. Clarification requests: An incremental account. In *Proceedings of the 11th Workshop on the Semantics and Pragmatics of Dialogue (DECALOG)*.

Kempson, Ruth, Wilfried Meyer-Viol, and Dov Gabbay. 2001. *Dynamic syntax: The flow of language understanding*. Blackwell.

van Leusen, Noor, and Reinhard Muskens. 2003. Construction by description in discourse representation. In *Meaning: The dynamic turn*, ed. J. Peregrin, chapter 12, 33–65. Elsevier Ltd.

Purver, Matthew. 2004. The theory and use of clarification requests in dialogue. Doctoral Dissertation, University of London.

Purver, Matthew, Ronnie Cann, and Ruth Kempson. 2006. Grammars as parsers: Meeting the dialogue challenge. *Research on Language and Computation* 4:289–326.

Schlangen, David. 2003. A coherence-based approach to the interpretation of non-sentential utterances in dialogue. Doctoral Dissertation, University of Edinburgh.

Schlangen, David, and Alex Lascarides. 2003. The interpretation of non-sentential utterances in dialogue. In *Proceedings of the 4th SIGdial Workshop on Discourse and Dialogue*, 62–71. Sapporo, Japan: Association for Computational Linguistics.

# Functional Quantification in Distributivity and Events: A View from Chinese*

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**Abstract**

Despite the large bulk of literature on *dou*-quantification in Chinese, the adverbial quantification over events of *dou* (hence DOE for short) in mono-clausal sentences hasn't received sufficient, proper semantic attention. By investigating the (in)compatibility of *dou*-quantification with the stage-level vs. individual-level predicates, once-only predicates, episodic vs. non-episodic events and overt antecedent events, I show how the DOE *dou* works. Since it hasn't been successful to render *dou*'s DOE as a special case of *dou*'s DOI (distributivity over individuals) even at the extra cost of (direct) compositionality, I choose the other way around. I present a novel analysis for DOE *dou* by arguing that *dou* has a portmanteau semantic structure, viz. its semantics is the semantics of a standard universal quantifier plus a matching function which contributes the distributivity and show how this idea solves the problems regarding *dou*'s DOE and promises a unified account for both the DOI and DOE.

## 1 *Dou*-Distributivity in Chinese: A First Look

Distributivity is always modeled by positing a distributive operator (D-operator), overt or implicit, with or without a cover, which contributes the distributive semantics (cf. Scha (1981); Dowty & Brodie (1984); Schwarzschild (1996); Lasersohn (1998); Link (1991, 1998); Brisson (2003); to name only a few).

(1) a. The boys $^{D}$ walked home.
b. $\forall y(y \in \iota boy \rightarrow walked\ home(y))$
c. Die Kinder bekamen *je* einen Apfel. 'The children received an apple each.' (Link 1998: 129)
d. $\forall x(x \leq {}^*children \rightarrow \exists y\ [apple\ (y)\ \&\ received\ (x, y)]]$
e. The vegetables $^{D}$are too heavy for the grey scale and too light for the black scale.
f. $[[D]]=\lambda P \lambda X \forall y(y \in X \& y \in [[Cov]] \rightarrow P(y))$ (in set-theoretic terms)

It has been argued in a number of works that Chinese offers a supporting evidence for the above analysis, i.e. Chinese has an overt, lexically realized D-operator, *dou*, which is similar to Germain *je* but differs from English *each* in their (in)sensitivity to the internal structure of the pluralities (Lee (1986); Cheng (1996); Lin (1998); etc.):

(2) a. Tongxue men dou mai-le zhe-ben shu. 'The students {all, each} bought this book.'
Students dou buy-Asp Dem-cl book
b. Tongxue men dou zhongwu jianmian. (from Lee (1986)) 'The students {all, *each} meet at noon.
students dou at noon meet
c. Mei-ge tongxue dou mai-le zhe-ben shu. 'Every student {*all, *each} bought this book.'

* I am indebted to Martin Everaert, Henriette de Swart, Alexis Dimitriadis, Joost Zwarts, Rick Nouwen, Nilsen Oystein, Andrea Gualmini, Eddy Ruys at Utrecht and Shen Yang, Guo Rui at Beida for valuable suggestions and comments. Part of the work has been presented at the second Kermit lecture at Utrecht in November 2007 and the fourth Formal Semantics in Moscow (FSiM 4) in April 2008 and I am grateful to the questions and comments of the audience, among them are Barbara Partee and Manfred Krifka. The author alone is responsible for all the errors, omissions and mistakes in the article.

Every-cl student dou buy-Asp Dem-cl book
d. ?? Mei-ge tongxue dou zhongwu jianmian.

(3) a. The students {each, all} bought the book.
b. The students {all, *each} meet at noon.
c. Every student {*all, *each} meets at noon.

Lin (1998) (following Schwarzschild (1996) and followed by Yang (2001), Tomioka & Tsai (2005) and many others) argues that *dou* is a lexically realized, cover-based D-operator:[1]

(4) $[[\text{dou}]] = \lambda P \lambda X \forall y[\, y \subsetneq X \,\&\, y \subseteq \|Cov\| \rightarrow P(y)]$, where $P \in D_{<e,t>}$

In the literature, the following generalization (G1) has been proposed to capture the distribution of *dou*:

Generalization I (G1): The distribution of *dou*
(a) *dou* must occur pre-verbally;
(b) the domain of *dou* must be located to the left side (within its m-commanding domain);
(c) *dou* can only quantify over a plural denotation.

(5) a. [$_{NP}$ Zhe-xie xuesheng] dou xihuan Haolaiwu de dianying.
Dem-pl. student dou like Hollywood GEN movies
'These students all like the Hollywood movies.'
b. * [$_{NP}$ Zhe-xie xuesheng] xihuan dou Haolaiwu de dianying.

(6) a. [$_{NP}$ Zhe-xie shu] wo dou xihuan. (topic) 'as for these books, I like them all.'
Dem-pl. book I dou like
b. * Wo dou xihuan zhexieshu.

(7) a. [$_{NP}$ Zhe-xie xuesheng] dou lai le. (subject) 'These students all came.'
Dem-pl. student dou come PER
b. * Dou lai-le zhe-xie xuesheng.

(8) a. [$_{NP}$ Zhe-san-ge xuesheng] dou xuan-le jufaxue. 'All the three students chose syntax.'

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[1] Lin's semantics of *dou* is indeed over-generating, inheriting the problems of any cover-based analysis. Consider two examples. First, the following (1):

(1) a. # Napolun, Buluke he Weilingdun dou zai Huatelu zhihui yi-zhi jundui.
Napoleon, Blucher and Wellington dou at Waterloo command one-cl army
b.# Napoleon, Blucher and Wellington each commanded an army at Waterloo. (Link: 121)

If our historical knowledge is not wrong, viz. Napoleon alone commanded an army and Blucher and Wellington together commanded an army at Waterloo, then (5a) is infelicitous.

Second, let Let D = {France, China, Egypt, South Africa, Brazil, the U. S.}, his semantics would predict the following sentences (2a) and (2b) have the same truth conditions and are both felicitous, which are not (indeed, (2a) is ungrammatical and (2b) is infelicitous in this context):

(2) a. [#/?]*Mei-ge guojia dou zai tong-yi-pian dalu shang.*
Every-cl country dou at same-one-cl continent LOC (D = ∪[[**country**]]= ∪(PRT[[**country**]]))
b.[#] *Zhe-xie guojia dou zai tong-yi-pian dalu shang.*
Dem-cl(pl.) country dou at same-one-cl continent LOC

Dem-three-cl student dou choose-ASP syntax
b. * [$_{NP}$ Zhe-ge xuesheng] dou xuan-le jufaxue.
Dem-Cl.(sing.) student dou choose-ASP syntax

The contrast between (5a-b), (6a-b), (7a-b) and (8a-b) respectively follows from G1. For instance, (8b) is out because there is no plural denotation within *dou*'s m-commanding domain. G1 has a clear prediction: whenever we could find a proper plural denotation within *dou*'s syntactically proper domain (say, topic, subject, the object of the disposal marker 'ba', etc.), *dou* is predicted to be licensed.

## 2 **Adverbial Quantification: a Challenge**

However, natural language data have never been as tame as they are desired to be. Considering the following examples:

(9) a. [$_{NP}$ Wo] dou [$_{VP}$ mai ni-zi de yi-fu]. Approx. 'I always buy woolen clothes.'
I dou buy woolen NOM clothes
b. [$_{NP}$ Ta] dou [$_{VP}$ jiejiao (xie) bu-san-bu-si de ren].
he dou know Cl(pl.) not-three-no-four NOM person
Approx. 'He always makes friends with gangsters.'
c. [$_{NP}$ Ni] dou [$_{VP}$ chi-le xie shenme]? Approx. 'What do you always eat?'
You dou eat-ASP Cl(pl.) what
d. [$_{NP}$ Wo] dou [$_{VP}$ zai xue-yi chi de mianbao]. Approx. 'I always eat bread at Canteen One.'
I dou at canteen-1 eat NOM bread
e. [$_{NP}$ wo] dou shuo yingyu. Approx. 'I always speaks English.'
I dou speak English

The examples under (9) poses two noteworthy problems for the DOI operator *dou* as shown in (4) and its variants. First, these sentences fail G1, since there is no plural denotation of individuals within *dou*'s m-commanding domain, but they are still grammatical; second, the D-operator analysis of *dou* which presents a success story in the literature cannot apply to them, as evidenced by the following nonsensical formulae:

(10) a. * $\forall x\ (x \in I \rightarrow x \in \text{BUY WOOLEN CLOTHES})$
b. * $\forall x\ (x \in \text{HE} \rightarrow x \in \text{MAKE FRIENDS WITH GANGSTERS})$
c. * $\forall x\ (x \in \text{YOU} \rightarrow \exists y\ (x\ \text{EAT}\ y\ \&\ \text{THING}(y)))$
d. * $\forall x\ (x \in I \rightarrow x \in \text{EAT BREAD IN CANTEEN ONE})$
e. * $\forall x\ (x \in I \rightarrow x \in \text{speak English})$

A more comprehensive examination on the relevant data indicates that in the sentences of (9), what *dou* quantifies over are not individuals (or at least the individuals in canonical sense), but events. The following four more observations are the supporting evidence:

A. **Dou-quantification and the stage-level vs. individual-level predicate distinction**: *dou* is incompatible with individual-level predicates (cf. de Swart (1993), Krazter (1995))

(11) a. * Zhang San dou hen gao. 'Zhang San is always tall.'
Zhang San dou very tall
b. ? Zhang San dou hen congming. 'Zhang San is always intelligent.'
Zhang San dou very intelligent

(11b) is acceptable unless it is interpreted as 'Zhang San always behaves intelligently', a stage-level one.

B. **Once-only predicate and *Dou*** (cf. de Swart (1993)): once-only predicates are incompatible with *dou*

(12) a. * Zhe-li dou guafeng de rizi dapo yikuai boli.
Here-Loc dou wind NOM day break-open one-cl glass
'Here one piece of glass is always broken on windy days.'
b. Zhe-li dou guafeng de rizi dapo boli.
'Here the glass is always broken on windy days.'

'dapo yi-kuai boli' (break one piece of glass) contains a quantized object, thus a once-only predicate. On the contrary, 'dapo boli' contains a homogeneous plural object, and is not necessarily a 'once-only' predicate. *Dou* is incompatible with the 'once-only' predicates.

C. **Episodic vs. non-episodic distinction and *dou***: *dou* is allowed in non-episodic contexts but not in episodic contexts

(13) a. *Wo dou mai ni-zi de yi-fu*. (non-episodic)
I dou buy woolen NOM clothes(s)
b. * *Wo dou mai-guo nizi de yifu* .(episodic)
I dou buy-EXP woolen GEN clothes(s)

(14) a. *Wo dou du Qiaomusiji de shu*. (non-episodic)
I dou read Chomsky NOM book(s)
b. * *Wo dou kan-guo Qiaomusiji de shu*. (episodic)
I dou read-EXP Chomsky NOM book(s)

In Chinese, the experiential marker 'guo' is used to mark the episodicity of the event. (13) and (14) shows the episodic event (a singleton set of event) is not able to license *dou*.

D. **Episodic vs. non-episodic distinction and 'all-the-time' modification**

(15) a. *Wo {yizhi/conglai} dou mai ni-zi de yi-fu*. (non-episodic)
I all-the-time dou buy woolen NOM clothes(s)
b. * *Wo {yizhi/conglai} dou mai-guo nizi de yifu*. (episodic)
I all-the-time dou buy-EXP woolen NOM clothes(s)

(16) a. *Wo {yizhi/conglai} dou du Qiaomusiji de shu*. (non-episodic)
I all-the-time dou read Chomsky NOM book(s)
b. * *Wo {yizhi/conglai} dou kan-guo Qiaomusiji de shu.* (episodic)
I all-the-time dou read-EXP Chomsky NOM book(s)

## 3. The Problem

Although the DOE *dou* has been known among some descriptive Chinese linguists for quite a while (cf. Ma (1983)), it hasn't received sufficient proper semantic treatment. Under the paradigmatic D-operator analyses, people somehow take for granted that the DOE *dou* is not a trouble-maker. In the literature, it is often mistaken as a special instantiation of the DOI *dou,* or claimed to be such a one. This assumption is problematic, not to mention any meaningful results the facts might lead to.

### *3.1 The existing literature*

To maintain a unified D-operator analysis of *dou*, the immediate way left is to assume some implicit domain for *dou*, a line of thinking that has been pursued, recently, in Jiang (1998) and Pan (2006).

Jiang claims that in the sentences like (9b) (repeated here as (17a)), for example, the domain of *dou* is not determined by the syntactic structure, but provided by pragmatic presuppositions.

(17) a. [$_{NP}$ *Ta*] *dou* [$_{VP}$ *jiejiao (xie) bu-san-bu-si de ren*].
he dou know (Cl-pl.) not-three-not-four NOM person
b. presupposition: λx [ he makes friends with x]
assertion: x = gangsters
∀x (HE MAKES FRIENDS WITH x → x = GANGSTERS)

**The insight of Jiang**: the quantificational structure of the DOE sentences seem to be more sensitive to context than to syntactic structure (we will come to the compositionality issue later one). There is a number of ways the domain of quantification of the DOE *dou* can be pragmatically/contextually determined, as long as they can be contextually accommodated.
**Problems:** But sentences like (17a) allow a family of interpretations, and (19b) is just one of them. Do we have to make a presupposition-assertion partition for each specific context? Can't there be a general way to capture the fact? Why is the DOE *dou* sensitive to context rather than to the information given by syntactic structure as the DOI *dou*? How does the pragmatics determine the partition of the quantificational structure of *dou*? And above all, what does syntax feed semantics in this respect? These questions remain unanswered.

Like Jiang, Pan (2006) also argues that in the examples like (9), the domain of *dou* is not the denotation of the NP to its left side (although in most cases, it is the denotation of the NP to the right side of *dou* that forms its domain). Unlike Jiang, Pan discards the role played by contextual restrictions and argues that the syntactic structure alone plays a crucial role for the partition of the quantificational structure.

Pan provides the following means to derive the semantics of the DOE *dou*:

(18) The Quantificational Structure of *dou* is provided by
(i) topic-focus articulation, when *dou* associates with a focus, then the focus provides the Nuclear Scope for *dou*, the other elements provide the Restriction; or
(ii) when there is no focus, then the strategy of normal tripartite quantification applies (the typical DOI case).

Simply put, Pan treats the examples like (9) above as the focus-sensitive constructions, and by definition, rule (18i) should be applied to them. His semantics for the sentences in (9) is given as follows (the sentences are repeated here as (19)):

(19) a. *Wo dou mai ni-zi de yi-fu.* ∀x (I buy x & clothes (x) → x = woolen clothes)
b. *Ta dou jiejiao xie bu-san-bu-si de ren.* ∀x (he makes friends with x→ x=gangsters)
c. *Ni dou chi-le xie shenme?* ∀x (you eat x → Qy (x=y & thing (y))
d. *Wo dou zai xue-yi chi-de mianbao.* ∀x (I eat x at Canteen One→ x= bread)

As for (9e), Pan thinks what is quantified over is a set of situations:

(20) a. *Wo dou shuo yingyu.*
I dou speak English
b. ∀x (I speak x → x = English) (Jiang)
c. ∀s (s∈ a set of situations → I speak English in s) (Pan)

**Problems:** But as he fails to notice that *dou* is sensitive to context, Pan faces even more problems than Jiang.

First, the rule (18) faces an empirical challenge. People might wonder where the focus has gone in the

DOI cases. It is unclear when to apply which rule and when to apply both to derive the correct semantics. And it is also unclear why the focus doesn't affect the partition of the quantificational structure in the typical (DOI) *dou*-quantification cases.

Second, as evidenced by Pan's treatment of (20), it is unclear what the syntactic source of the situation argument is. Do all predicates have a situation argument or only some of them in some constructions have? The relevant syntactic argument is lacking. (NB: Pan's *situation* is different from the *situation* semantics currently adopted in works of von Fintel, Krazter, etc.)

Third, Pan's semantics for *dou* is sometimes empirically wrong:

(21) a. [$_{NP}$ *Wo*] *dou* [$_{VP}$ *mai ni-zi de yi-fu*].
I dou buy woolen GEN clothes
b. ∀x [I buy x & clothes (x) → x = woolen clothes] (Pan's semantics)

(21b) predicts if I buy polyester shirts sometimes, (21a) is false. But consider the following scenario:

(22) The buying-woolen clothes scenario
I go shopping every Saturday. Over the past ten weeks, I bought clothes every week. I bought woolen clothes eight times and for the two remaining Saturdays, I bought both woolen clothes and polyester shirts.

| | Eight times | Two times |
|---|---|---|
| The clothes I bought | Woolen clothes | Woolen clothes + polyester shirts |

I checked the sentence against the situation with my informants (who are native speakers of Chinese), and most of them judge the sentence to be felicitous under the scenario in (22), even if 'woolen clothes' is spoken with a focal accent. This is unexpected under Pan's analysis, which would expect (21a) to be false.

Nota Bene: the insight of Jiang, viz. DOE *dou* is *special* and its quantificational structure is sensitive to the factors outside the syntactic surface structure, should be given proper credit to. But there is reason to believe the presuppositional accommodation and topic-focus articulation might be independent of domain restriction in adverbial quantification. It is not easy to tease these factors apart and further works are needed notwithstanding.

*3.2 The Issue of Direct Compositionality: What Syntax Feeds Semantics*

The existing literature that has been critically examined in the previous section doesn't exhaust the means of rendering the DOE *dou* as a special case of DOI *dou*, though. But whatever mean is adopted, there would always be a price to pay, namely, direct compositionality. Chinese is known to be a language that wears its scope on its sleeves, i.e., its scope is always isomorphic to its surface syntax (cf. Huang (1982); Lee (1986) for convincing arguments). Literally, this means what is displayed at surface syntax is transparent to semantic scope and interpretation. The role played by LF is neutralized in this language, and it is often assumed that covert movements like QR are not needed in Chinese (contra Huang's original idea). Returning to *dou*'s DOE, we have shown that the surface syntactic information doesn't provide enough clues for the semantics. Two options are available: a richer LF involving complex covert movement or a complex semantic operation (including limited contextual information, perhaps). For the scope-transparent languages like Chinese, there is reason enough to give priority to the second option.

That said, one question paralleling to 'what syntax feeds semantics' is: what semantics needs.

*3.3 The Extension of the D-operator dou to the Domain of Events*

Question to consider: how to identify the domain and range of quantification for *dou* in a focus-neutral contexts, if topic-focus articulation and presuppositional accommodation are independent of domain restriction in quantification?

(23) a. [$_{NP}$ Wo] dou [$_{VP}$ mai ni-zi de yi-fu].

b. ∀e (I buy clothes (e) → I buy woolen clothes (e))

The immediate way to the problem of DOE *dou* is to extend *dou* to domain of events. For instance, (23) might be represented as (23b) within an event semantics framework. (23b) says for all the event of my buying clothes, I buy woolen clothes. The two (set of) events in the Restriction and Nuclear Scope are identical. Are they actually the events of the same type? Could the extension to domain of events be so straightforward? In the following, I offer three arguments to show that the events in the Restriction and Nuclear Scope should be events of different type.

**A. *dou* and *zhi* 'only'**

(24) a. [$_{NP}$ Wo] zhi [$_{VP}$ mai ni-zi de yi-fu].

b. ∀e (I buy clothes (e) → I buy woolen clothes (e))

In the framework of event semantics, (24a) might be represented by the identical logical form as (23a). But the difference between (23a) and (24a) is very similar to the difference between 'always' and 'only' (cf. Beaver & Clark (2003) for details).

(25) a. $^{?}$Zhang San dou xihuan [Lin Meimei]$_F$, Zhang San ye dou xihuan [Xue Baochai]$_F$.
Zhang San dou like Lin Meimei Zhang San also dou like Xue Baochai
'Zhang San always likes Lin Meimei, and Zhang San also always likes Xue Baochai.'

b.$^{*}$ Zhang San zhi xihuan [Lin Meimei]$_F$, Zhang San ye zhi xihuan [Xue Baochai]$_F$.
Zhang San only like Lin Meimei Zhang San also only like Xue Baochai
'Zhang San only likes Lin Meimei, and Zhang San also only likes Xue Baochai.'

(26) a. ∀x (person(x) & Zhang San_like(x) → x = Lin Meimei)) ∧ ∀x (person(x) & Zhang San-like(x) → x = Xue Baochai))

b. ∀e (∃x (person (x) & Zhang San likes a person (x))(e) → Zhang San like Lin Meimei (e)) ∧ ∀e (∃x (person (x) & Zhang San like a person (x))(e) → Zhang San like Xue Baochai (e))

(26a) and (26b) are truth-conditionally equivalent. They either state Zhang San likes nobody or Lin Meimei is Xue Baochai. This (contradictory) semantics correctly rules out (25b), but (25a) is not that odd is unexpected. Why?

**B. Adverbial quantification with an overt antecedent**

Another argument comes from the sentences with overt antecedents. To consider the following sentence:

(27) a. (Dang) Zhang San nacuo-le shenme dongxi de shihou, ta *(dou) shi yitianhou cai zhidao.
When Zhang San took-wrongly-ASP what thing NOM time he dou be one-day-after know
'When John wrongly takes away anything, he realizes it one day later.'

b. # ∀e (ZS wrongly takes away something (e) → (he realizes it (e) & one day later (e, e))

(27) says the identical event occurs one day later, a nonsensical logical formulae.

(28) a. (Dang) zhanghu bei zema de shihou, qizi *(dou) toutou-di ku.
When husband Passive rebuked NOM time wife dou secretly cry
'When the husband is being rebuked, the wife cries secretly.'

b. # ∀e (the husband is being rebuked (e) → (the wife cries (e) & secretly (e))

If the two events are taken to be identical, then we expect the manner adverb 'secretly' also modifies the antecedent event, viz., the husband is being rebuked secretly. But this runs into a problem: (28a) is true under the situation that the husband isn't being rebuked secretly.

The problems discussed above will disappear if the antecedent event and the consequent event are distinct! (NB: Similar arguments for adverbial quantification in bi-clausal sentences have already been proposed by de Swart , Rothstein, Zimmermann.)

**C. (Un)selective quantification and Parsons' event semantics**

In addition to the empirical argument, there is a methodological motivation suggesting that we cannot treat the events in the Restriction and Nuclear Scope as identical events. Parsons (1990) claims that at sentence level, we receive an existential closure over the event variable, and the adverbials are modifiers of the events. Although this is not inherently in conflict with the unselective quantificational approach, there is a point to be made here:

(29) a. Wo mai nizi de yifu.

$\exists$e (buy(e) & Agent(e) = I & Theme (e) = woolen clothes)

b. Wo dou mai nizi de yifu.

$\exists$e (buy(e) & Agent(e) = I & Theme (e) = woolen clothes & dou (e))

(in conflict with the unselective idea)

$\forall$e ((I buy clothes (e) $\rightarrow$ I buy woolen clothes (e))

(empirically problematic and in conflict with Parsons' event semantics)

How to make both ends met? An immediate possibility is not to treat the events in the Restriction and Nuclear Scope as identical events, and one of them must be existentially bound, following Parsons. The ensuing questions are (a) how to identify the domain of quantification and (b) how to establish a relationship between the events within the Restriction and that in the Nuclear Scope.

*3.4 Facing the Problem: a Proposal*

Following de Swart (1993), Rothstein (1995), Zimmermann (2002), Beaver & Clark (2003), I have the following (preliminary) proposal:

(32) The truth conditions of the DOE sentences with the form 'NP dou VP' (preliminary):

$\forall e(E(e)\rightarrow \exists e' (\rho(e') \wedge \pi(e) = e'))$

(E: contextually provided topical set; $\pi$: matching function; $\rho$: the denotation of 'NP VP'*)*

**4. A novel proposal**

*4.1 Choosing an Appropriate Model*

**A. The model**

My model for distributivity within an event semantics is a sextuple: M =<E, D,$\eta$, IN, $\leq$, $\pi$>

| | Notations |
|---|---|
| E = {$E_1$, $E_2$ } | domains of events with parametric variables $e_1$, $e_2$, $e_3$, … and $e_1$', $e_2$' and $e_3$'… respectively. |
| D | domain of individuals with parametric variables x, y, z, u, v, w, etc. |
| $\eta$ | a homomorphism from E into D |
| IN | an unspecified predicate that relate the individuals to events (it can be thematic roles, spatial-temporal relations, etc.) |
| $\leq$ | the partial order defined on E and D |
| $\pi$ | the matching function that maps $E_1$ into $E_2$. |

(a) The events in $E_1$ and $E_2$ can be defined by means of cumulativity and quantization a la Link and Krifka. Both $E_1$ and $E_2$ contains sums and atoms, which can be defined as follows (cf. Link 1998 and Krifka 1998 for details).

(b) D contains atoms and sums ($*D - D_{AT} = {}^{\star}D$)[2]
(c) η is a homomorphism from E into D, i.e. $\eta(x \leq y) = \eta(e_1) \leq \eta(e_1)$ (cf. Krifka 1998)
(d) '≤' is the partial order defined on E and D: ( $x \leq y \Leftrightarrow x \vee y = y \Leftrightarrow x \wedge y = y$; $e1 \leq e2 \Leftrightarrow e1 \vee e2 = e2 \Leftrightarrow e1 \wedge e2 = e1$)

**B. The event semantics**
John swims = swim(John)(e)
NB: 'e is a swim by John' ≠ 'e is an event that contains a swim by John' or 'e is an event in which John swims' (There is a built-in minimality requirement.)

**C. Examples**
Let D = {a, b, c}, then * D = {a, b, c, a⊕b, b⊕c, a⊕c, a⊕b ⊕c}, ⋆ D = {a⊕b, b⊕c, a⊕c, a⊕b⊕c}
$D_{AT}$ = {a, b, c}

**D. Remaining issues**
It is possible to render the typical DOI as a by-product of DOE, since the domain of individuals is isomorphic to the corresponding domain of events. With regard to *dou*-quantification, we have two options left: (a) the DOI *dou* is different from the DOE *dou*; (b) the same *dou* involved and *dou* uniformly quantifies over events (here 'event' is adopted in its neutral sense) and the DOI is a special case of DOE. The second option promises unified account.

I have rejected the analysis that *dou* is a D-operator in strict sense and argued that *dou* is basically a universal quantifier. This left a problem open: if the distributivity is indeed there, as the universal quantifier doesn't necessarily lead to distributivity, then something is missing. What is missing? What contributes the distributivity effects?

*4.2 Choosing an Appropriate Function*
To imagine a scenario: every time I search some data, I visit Google. What is the relationship between the plural event of my searching data and the event of my visiting Google? Informally put, it says: each event of my searching data is matched with an event of my visiting the Google. That is to say, if I search data ten times, there must be ten times I correspondingly visit the Google, but not vice versa.

(33) Wo dou shang Gooogle.
Matching Effect: e —INTO→ e'
{e: I search data} {e': I visit Google (e')}
e1 → e'1
e2 → e'2
e3 → e'3
… e'4

For our present purpose, we might definite the matching function which contributes the matching effect as follows:

(34) π: A → b is a matching function iff
(a) A ⊆ B; (b) For all subsets A' and B' of A and B respectively, $A \subset B \Rightarrow \pi(A) \subset \pi(B)$; (c) $\forall x_1$,

[2] Nota Bene: empirically, both the set-theoretical approach and algebraic-theoretical approach can model the plural events. The only difference between them is ontological: a union set of two atomic sets is set of sets (but consider Quine's Innovation), while the sum of two atomic individuals is still an individual. I apologize for interchangeably using them sometimes. What is crucial here is the importance to model the plural event in adverbial quantification.

$x_2 \in A$:

$x_1 \neq x_2 \Rightarrow \pi(x_1) \neq \pi(x_2)$; (d) Undefined otherwise

(34a) captures the fact that among my one 100 time's visiting of Google, even if ten of which are related to my searching data, the sentence is still true under the specified context. (34b) is a condition about structure-preserving. (34c) is about one-to-one, a unique property manifest in distributivity of events. The conditions work together to capture the distributivity in *dou*-quantification and they correctly predict, since the matching effect doesn't always lead to exhaustivity, (21a) is true in the scenario of (22).

*5.3 Choosing an Appropriate Anaphoric Event*

It is non-trivial to identify the contextually provided antecedent event. Jiang points out that it is the presupposition-assertion articulation that provides the clue and Pan thinks it is the topic-focus articulation provided by syntactic structure that decides the partition of the quantificational structure.

Can any contextual information enter the identification of the antecedent event? What is the semantic requirement in this respect?

(35) PROP (E)

E is the PROP (E) along certain spatial-temporal dimensions for e iff E contains no proper part in which e is not true or E contains a part which is inconsistent with e.

(36) Zhang San dou wanshang xuexi. 'John *dou* studies at night.'

$\forall e(e \in PROP(E) \rightarrow \exists e'$ (John studies $(e')$ & $\pi(e) = e'$)) (B is the PROP(E) for e)


It is always the PROPER event that forms the appropriate antecedent event. Beside the syntactic information provided by syntax, the semantic interpretation is also open to pragmatic knowledge, in a very limited way, though.

*4.4 The Semantic Derivations and Discussions*

Synthesizing the previous discussion, the properties of the DOE *dou* can be captured by the following generalization G2, incorporating G1:

Generalization II (G2): *Dou'*s DOE

(i) *dou* has a portmanteau semantic structure: it is a universal quantifier but it also introduces a matching function that takes members of the quantifier's Restriction and matches them with an existentially introduced variable in the Nuclear Scope of the quantifier;

(ii) there are a DistKey and a DistShare in *dou*'s quantificational structure: the DistKey forms the domain of quantification for the universal quantifier as long as it has the topical status (either due to structural OR contextual factors) and the DistShare forms the Nuclear Scope;

(iii) the matching function is a contextually-restricted variable over monomorphic functions.

Such said, I propose the following semantics for *Dou*:

(37) $[[dou]] = \lambda x\lambda P\lambda e\forall e'(e'\leq PROP(e) \rightarrow \exists e''(P(e'')(x) \wedge \pi(e'') = e'))$

(38) a. Wo dou [VP mai ni-zi de yi-fu].

b. [TopP =e… [$_{TP}$ [ wo [ dou [$_{VP}$ mai nizi de yifu]]]]]

i. $[[mai\ nizi\ de\ yifu]] = \lambda e\lambda x(buy(e) \wedge Th(e) = woolen\ clothes \wedge Ag(e) = x)$

ii. $[[dou]]([[mai\ nizi\ de\ yifu]]) = \lambda x\lambda P\lambda e\forall e'(e'\leq PROP(e) \rightarrow \exists e''(P(e'')(x) \wedge \pi(e'') = e'))$ $(\lambda e\lambda x\ (buy(e) \wedge Th(e) = woolen\ clothes \wedge Ag(e) = x))$ (functional application)

$= \lambda x\ \lambda e\forall e'(e'\leq PROP(e) \rightarrow \exists e''(buy(e'') \wedge Th(e'') = woolen\ clothes \wedge Ag(e'') = x \wedge \pi(e'') = e'))$

iii. $[[wo\ dou\ mai\ nizi\ de\ yifu]] = \lambda e\forall e'(e'\leq PROP(e) \rightarrow \exists e''(buy(e'') \wedge Th(e'') = woolen\ clothes \wedge Ag(e'') = I \wedge \pi(e'') = e'))$

The antecedent event e is contextually provided, thus we have,

iv. $\forall e'(e'\leq PROP_C(e) \rightarrow \exists e''(buy(e'') \wedge Th(e'') = woolen\ clothes \wedge Ag(e'') = I \wedge \pi(e'') = e'))$

The semantics offered here has several other advantages. First, it offers a straightforward explanation for the contrast between (25a) and (25b):

(39)a. $^?$ *Zhang San dou xihuan [Lin Meimei]$_F$, Zhang San ye dou xihuan [Xue Baochai]$_F$.*

b. $\forall e\ ((PROP_i(e)\ \&\ IN\ (e, Zhang\ San) \rightarrow \exists e'\ (Zhang\ San\_like\_Lin\ Meimei\ (e') \wedge \pi\ (e) = e'))) \wedge \forall e\ ((PROP_j\ (e)\ \&\ IN\ (e, Zhang\ San) \rightarrow \exists e'\ (Zhang\ San\_like\_Xue\ Baochai\ (e') \wedge \pi\ (e) = e')))$

If the PROP(E) is parameterized (say, Zhang San likes Lin Meimei at a specific time $T_1$ and he likes Xue Baochai at a specific time $T_2$, and $T_1$ is different from $T_2$, so are their respective PROP(E)) then (39b) isn't contradictory, and (39a) is expected to be acceptable. However, to assign different values in a discourse is not easy, if not totally impossible. This explains the oddness of (39a).

The second advantage of the proposed analysis is it can readily capture the fact that the DOE sentences allow rich interpretations without losing the descriptive power, since the context that could be identified as the topical set for *dou* is rich, and $\pi$ is licensed so long as it can be contextually accommodated.

### *4.5 Extension of the Proposed Analysis: A Unified Suggestion*

So far we haven't shown how the semantics of the DOE *dou* could be extended to the canonical DOI sentences with *dou*-quantification to yield a unified account. The only difference between them, however, lies in the ways by which the DistKey is provided. In the canonical DOI sentences, the DistKey is formed mainly by overt structural information:

(40) a. Tongxue-men dou lai le. 'Students dou came.'

b. $\forall y(y\leq \sigma x^*student(x) \rightarrow \exists e\ (came(e)(y)\ \&\ \pi\ (e) = y))$

(40b) says for each student y, there is a distinct event of coming containing y. The distributivity has been happily captured by the matching function defined above. Consider another example:

(41) a. Tongxue-men dou ban-le yi-jia gangqin. 'The students {all, each} carried a piano.'

Student-pl. dou carry-Asp one-cl piano

b. $\forall y(y\leq \sigma x^*student(x) \rightarrow \exists e\ (carry(e)\&Ag(e)=y\ \&\ Th(e)=a\ piano\ \&\ \pi\ (e) = y))$

Although the verb 'carry' allows both the individual interpretation and the collective interpretation, however, (41a) only has the individual reading, i.e. each student is involved in a distinct event of carrying a (different) piano. (41b) readily captures this reading.

## 5 Conclusion

It has been shown that (i) the prevailing analyses that endorse a distributivity operator (D-operator) are inadequate to deal with the adverbial quantification wrt *Dou*-quantification, which is difficult to be rendered as a special case of DOI even at the expense of direct compositionality and (ii) it is not so straightforward to extend the D-operator *dou* to events, and a matching function is independently needed. By deconstructing the distributive quantification by means of a portmanteau semantic structuring, this study thus not only offers a novel account for *distributive* quantification in Chinese, but also suggests some new light for distributivity across languages and forces us to re-examine the standard wisdom about distributivity we have received.

A question paralleling to 'what syntax feeds semantics' is 'what semantics needs'. Logically, there are four possibilities about the mapping between syntax and semantics: (a) the (surface) syntax provides enough information for semantics, and the mapping is strictly isomorphic; (b) the syntax provides enough information for semantics, and the mapping is homomorphic (not strictly isomorphic); (c) the syntax alone does not provide sufficient information for semantics, the mapping is strictly isomorphic; (d) the syntax doesn't provide sufficient information, and the mapping is not strictly isomorphic. Among them, the first possibility is about strict direct compositionality and it leads to the neutralization of LF and (covert) syntactic operations on it (cf. Barker & Jacobson 2007). This study examines the third possibility and argues that a combination of (a) syntax; (b) richer semantic operations and (c) limited contextual-restriction is needed for the semantics to work adequately and properly in this case.

## References


Barker, Chris & Jacobson, Pauline. 2007. Introduction: Direct Compositionality. In Chris Barker & Pauline Jacobson (eds.), *Direct Compositionality*, OUP, Oxford.

Beaver, David & Clark, Brady. 2003. *Always* and *Only*: Why Not All Focus-Sensitive Operators are Alike. *Natural Language Semantics* 11: 323-362.

Brisson, Christine.2003. Plurals, *ALL*, and the Nonuniformity of Collective Predication. *Linguistics and Philosophy* 26: 129-184.

Cheng, Lai-sheng Lisa. 1995. On Dou-quantification. *Journal of East Asian Linguistics* 4:197-234.

Dowty, David & B. Brodie. 1984. The Semantics of 'Floating Quantifiers' in Transformational Grammar. In *Proceedings of WCCFL 13*, CSLI Publications, Stanford, pp. 75-90.

Gil, David. 1995. Universal Quantifiers and Distributivity. In E. Bach et al. (eds.), *Quantification in Natural Languages*, Kluwer, Dordrecht, pp. 321-362.

Krazter, Angelika. 2006. Situations in Natural Language Semantics. Ms. University of Massachusetts at Amherst.

Krifka, Manfred. 1998. The Origins of Telicity. In Rothstein, Susan (ed.), *Events and Grammar*, Kluwer, Dordrecht.

Lee, Thomas. 1986. *Studies on Quantification in Chinese*, PhD dissertation, UCLA.

Lin, Jo-wang. 1998. Distributivity in Chinese and Its Implications. *Natural Language Semantics* 6: 201-243.

Link, Godehard. 1998. *Algebraic Semantics in Language and Philosophy*. CSLI, Stanford.

Parsons, Terence. 1990. *Events in the Semantics of English: A Study in Subatomic Semantics*. The MIT Press, Cambridge.

Rothstein, Susan. 1995. Adverbial Quantification over Events. *Natural Language Semantics* 3:1-31.

Schwarzschild, Roger. 1996. *Pluralities*. Kluwer, Dordrecht.

de Swart, Henriette. 1993. *Adverbs of Quantification: A Generalized Quantifier Approach.* Garland, New York and London.

Zimmermann, Malte. 2002. *Boys Buying Two Sausages Each: On the Syntax and Semantics of Distance-Distributivity,* LOT dissertations series 62.

# What syntax doesn't feed semantics

## Fake indexicals as indexicals*

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**Abstract.** Argues that the first person pronoun is always directly referential, against more recent findings of Heim (1991, 2008), Kratzer (1998, 2008) and others. Shows how purported evidence of syntactically bound or 'fake' indexical *I*, involving sloppy ellipsis and *only*, and *de se* attitude reporting can be reconciled with a strict Kaplanian semantics. Proposes alternative treatments of these phenomena that bypass the syntactic LF level, going straight from surface to semantics/pragmatics.

## 1 Introduction

Kaplan (1989) proposes an elegant way to reconcile the meaningfulness of *I* with its immunity to embedding and lack of propositional content. In his two-dimensional semantics indexicals are context-dependent and intensionally rigid, while descriptions carry intensional content (but are contextually inert): $[\![\text{I}]\!]^c_w =$ the speaker of $c$; $[\![\text{the speaker}]\!]^c_w =$ the speaker of $w$. The semantics emerging from this distinction has proven very successful in analyzing such key notions of semantics as context-dependence, proposition, meaning and attitudes. I defend Kaplan's analysis of *I* against the recently popular view of *I* as a syntactically bindable variable, like *he*.

That *I* resists binding by other speakers than the one uttering the very words, seems clear enough:

(1) Every speaker$_i$ has difficulty stopping when I$_{*i}$ should [Partee 1989]

But how about first person pronouns bound by other first person pronouns? At first sight, it may seems hard to distinguish variable binding from rigid coreference in such cases. But the linguistics literature provides a number of constructions supposed to tease them apart. Tests that indicate bound *I*'s include sloppily bound first person pronouns under *only* and in ellipsis, and *de se* bound ones in first person attitude reports. I investigate the argumentation behind these tests, and argue that they provide insufficient basis for discarding Kaplan by proposing syntax-free alternative analyses that do not violate direct reference.

* I thank the anonymous referees for insightful comments. This research is supported by the Netherlands Organization of Scientific Research (NWO), grant 446-07-004.

This paper is structured as follows. In section 2 I start with the sloppy binding phenomena. After reviewing Heim's original examples and line of argumentation, I first point out that her analysis depends on a rather questionable non-conservative quantifier *only*. Then I present my alternative accounts, starting with the higher-order unification account of ellipsis (following Dalrymple et al. 1991), and then applying that general mechanism in a focus-based account of *only* (following Pulman 1997). In section 3 I discuss the *de re/de se* ambiguity in first person reports. I first show how Heim uses Chierchia's (1989) syntactic analysis to argue that the first person subject of a *de se* report is a bound variable. Then I again present a simpler, syntax-free alternative analysis (following Lewis 1979 and others). All three alternatives proposed in these sections however, seem to overgenerate sloppy and *de se* readings, for instance when coreferential names replace the pronouns. In section 4 I propose a pragmatic mechanism to keep this proliferation of sloppiness and *de se* in check.

## 2 Sloppy *I* under *only* and ellipsis

> Kaplan's analysis implies that when there are several occurrences of *I* (or its case forms *me*, *my*) in a sentence, each of them refers to the speaker. This is not true, 1st person pronouns are in fact just like 3rd person pronouns in that they can be interpreted as bound variables rather than referring terms

Thus, Heim (1991) initiates the attack on Kaplan. The crucial examples purported to bring out this bound variable behavior of the first person are:

(2) a. Only I did my homework [Heim 1991]
b. I did my homework, but my classmates didn't [Heim 1991]

Both have two readings, a strict one, where nobody else did my homework, and a sloppy one, where nobody else did their own homework. Heim argues as follows: Logically, *my* in the sloppy reading of (2a) plays the role of a variable ranging over everybody in the domain. And in the sloppy reading of (2b), the elided VP (*did their homework* can only be reconstructed from the source clause (=first clause), if that source already contained a bound variable *my*. As I will show, this argumentation depends on some non-trivial and unnecessarily limiting assumptions about the syntax/semantics of the constructions involved.

### 2.1 *Only* as a non-conservative quantifier?

One such assumption in Heim's analysis of (2a) is that *only* is a quantifier:

(3) $(\texttt{only(i)})(\lambda \texttt{x}[\texttt{did\_homework\_of(x,x)}])$

This logical form captures the sloppy reading, but to derive it from the surface requires non-trivial syntactic machinery: the possessive *my* can be bound by $\lambda\texttt{x}$ because of *feature agreement*, since the abstracted $\texttt{x}$ gets its features from the quantifier *Only I*, which in turn inherits its from *I*. Note that the first person feature has thus become purely morphosyntactic, not semantic, as can be brought out by adding $\mathtt{x}$'s alleged first person feature as a semantic condition ($\mathtt{x} = \mathtt{i}$) to the sloppy lf in (3):

(4) $(\mathtt{only}(\mathtt{i}))(\lambda \mathtt{x}[\mathtt{x} = \mathtt{i} \wedge \mathtt{did\_homework\_of}(\mathtt{x}, \mathtt{x})])$ [$\not\equiv$ (3)]

In words: 'I am the only one who is a homework-maker that coincides with me', which is a much weaker, nonsensical statement. We can attribute this problem to the fact that Heim's quantifier *only* is *non-conservative*, i.e. $only(X,Y) \neq only(X, X \cap Y)$, while conservativity is generally considered a global constraint on natural language quantifiers. I conclude that Heim's analysis of (2) relies on the dubious assumptions that *only* is a non-conservative quantifier and that the first person feature of *I* is a purely morphosyntactic affair.

### 2.2 Sloppy ellipsis through higher-order unification

The argument from ellipsis, (2b), does not involve such a questionable quantifier, but similarly depends on a very syntactic conception (of ellipsis), in which the strict/sloppy ambiguity corresponds to an ambiguity in the source clause. I apply Dalrymple et al.'s (1991) semantic/pragmatic alternative based on Higher-Order Unification (henceforth HOU) to restore the transparent Kaplanian semantics of strict and sloppy *my* in (2b).

In the HOU account of ellipsis, the first conjunct gets a classic, compositional interpretation: $\mathtt{did\_homework\_of}(\mathtt{i}, \mathtt{i})$. In the second conjunct *didn't* introduces a free, 2nd order variable $\mathtt{P}$, to be resolved by HOU at the next stage of interpretation. The compositionally derived 'preliminary logical form' of the entire sentence thus looks like:

(5) $\mathtt{did\_homework\_of}(\mathtt{i}, \mathtt{i}) \wedge \forall \mathtt{x}[\mathtt{classmate}(\mathtt{x}, \mathtt{i}) \rightarrow \neg \mathtt{P}(\mathtt{x})]$ [pre-lf of (2b)]

The next step is to determine what it is that the classmates didn't do, i.e. to resolve *P*. This is done by first finding the parallel, contrasting elements in the two conjuncts. In this case, there's a clear contrast: *my classmates* didn't do *P* but *I* did. Moreover, it is stated that I did my homework, so we equate *I did P* with *I did my homework* to get a second-order matching equation:

(6) $\mathtt{P}(\mathtt{i}) \doteq \mathtt{did\_homework\_of}(\mathtt{i}, \mathtt{i})$

Among the unifying substitutions that solve this equation we find:

(7) a. $\mathtt{P} \mapsto \lambda \mathtt{y}[\mathtt{did\_homework\_of}(\mathtt{y}, \mathtt{y})]$
b. $\mathtt{P} \mapsto \lambda \mathtt{y}[\mathtt{did\_homework\_of}(\mathtt{y}, \mathtt{i})]$

The last step is to apply these substitutions to the pre-lf, deriving both the strict and the sloppy readings, without having to resort to ambiguity in the source clause or non-referential *my*:

(8) $\mathtt{did\_homework\_of}(\mathtt{i}, \mathtt{i}) \wedge \forall \mathtt{x}[\mathtt{classmate}(\mathtt{x}, \mathtt{i})$

a. $\to \neg\mathtt{did\_homework\_of}(\mathtt{x},\mathtt{x})]$ [sloppy]

b. $\to \neg\mathtt{did\_homework\_of}(\mathtt{x},\mathtt{i})]$ [strict]

### 2.3 *Only* as focus particle

Pulman (1997) extends the HOU analysis of ellipsis resolution to the interpretation of focus and focus particles like *only*. I apply a simplified version to Heim's *only* example. The simplest account would be a full reduction, analyzing (2a) literally as (2b). However, (2b) asserts rather than presupposes, derives, or implicates that I did my homework. As the exact status of this information in (2a) is the subject of an ongoing debate that does not concern us here, it would be better to leave it unspecified (as Heim does too). This leads to the following analysis.

We assume that the focus is given (say, by intonation), in this case as *I* (lf: $\mathtt{i}$). Where there's a focus, there's also a background, and we are going to use HOU precisely to determine that background ($\mathtt{B}$), because the asserted contribution of the *only* sentence depends on it: everybody distinct from the focus does not have the background property:

(9) $\forall\mathtt{x}[\mathtt{x} \neq \mathtt{i} \to \neg\mathtt{B}(\mathtt{x})]$ [pre-lf of (2a)]

The next step is to construct a suitable matching equation to solve $\mathtt{B}$. We assume the sentence minus *only* ($\mathtt{did\_homework\_of}(\mathtt{i},\mathtt{i})$) consists of the background applied to the focus, which gives rise to the following matching equation, unifying substitutions and outputs:

(10) $\mathtt{B}(\mathtt{i}) \doteq \mathtt{did\_homework\_of}(\mathtt{i},\mathtt{i})$ [cf. (6) ]

a. $\mathtt{B}{\mapsto}\lambda\mathtt{y}[\mathtt{did\_homework\_of}(\mathtt{y},\mathtt{y})]$ [cf. (7a) ]

$\rightsquigarrow \forall\mathtt{x}[\mathtt{x} \neq \mathtt{i} \to \neg\mathtt{did\_homework\_of}(\mathtt{x},\mathtt{x})]$ [cf. (8a), sloppy]

b. $\mathtt{B}{\mapsto}\lambda\mathtt{y}[\mathtt{did\_homework\_of}(\mathtt{y},\mathtt{i})]$ [cf. (7b) ]

$\rightsquigarrow \forall\mathtt{x}[\mathtt{x} \neq \mathtt{i} \to \neg\mathtt{did\_homework\_of}(\mathtt{x},\mathtt{i})]$ [cf. (8a), strict]

Again, the semantic HOU approach allows *my* to be interpreted as a regular Kaplanian indexical (in the matching condition (10)), even in the derivation of the sloppy reading. Note also that the strict/sloppy ambiguity is no longer a matter of syntactic ambiguity, but rather of semantic underspecification inherent in HOU.

## 3 First person *de re* and *de se* belief reports

Heim's (1991) next argument against rigid *I* involves first person belief reports in Kaplan's mistaken self-identity scenario: Kaplan is thinking about the time he saw a guy on TV whose pants were on fire without him noticing it (yet). A second later he realized he was watching himself through the surveillance camera system and it was his own pants that were on fire. He reminisces:

(11) I thought I was at a safe distance from the fire

What he thought at the time was "I am at a safe distance from the fire", which makes (11) true *de se* (i.e. from a first person perspective). However, the coreferential first person report construction can also report a 3rd person *de re* belief that just happens to be about the subject himself:

(12) I thought that I was remarkably calm

The reported thought here must be something like "That guy is remarkably calm!" with *that guy* really referring to Kaplan, the belief subject himself.

### 3.1 From Chierchia's ambiguity to Heim's bound *I*

Chierchia (1989) postulates a syntactic/semantic ambiguity: the lf of (11) features a $\lambda$-abstractor binding the embedded *I* to turn the complement into a self-ascribed property (*being at a safe distance from the fire*):

(13) $\mathsf{Bel}_{\mathtt{i}}^{[\text{self-ascr}]}\lambda\mathtt{x}[\mathtt{safe}(\mathtt{x})]$ [cf. (11), *de se*]

In (12) on the other hand, the speaker simply believes the (singular) proposition expressed by the complement with its Kaplanian, rigid *I*:[1]

(14) $\mathsf{Bel}_{\mathtt{i}}[\mathtt{calm}(\mathtt{i})]$ [cf. (12), *de re*]

On this account, the *de se* reading of a first person report comes about by derigidifying and binding the embedded *I*. So, arguably, we have another example of a first person pronoun *I* interpreted not as a rigidly referential expression, but as a bound variable.

Note that the argument clearly depends on Chierchia's analysis of the *de re/de se* distinction. Heim herself notices this dependence on Chierchia and, as counterargument, points out that one alternative, Higginbotham's, also requires a nonstandard semantics of belief embedded *I*. As with the previous section's bound *I*, however, there are perfectly viable alternatives that leave the Kaplanian semantics of *I* intact. In the next example I discuss a well-known unified analysis of *de se* and *de re* reports that fits the bill.

### 3.2 *De re/de se* unification through acquaintance relations

Based on Kaplan's (1969) and Lewis' (1979) work on *de re* and *de se* attitudes, Cresswell & Von Stechow (1982) reduce the semantics of *de re* and *de se* reports to 'relational lfs' featuring acquaintance relations as modes of presentation of the object of belief. Thus, coreferential reports (*x believes that x is ...*) are underspecified for belief modality (*de re* or *de se*): a report like (11) or (12) is true if the belief in question is held under any acquaintance relation that holds

[1] For uniformity, note that belief in a proposition can be reduced to self-ascription of the property of inhabiting the worlds picked out by the proposition (Lewis 1979), so (14) may be paraphrased as $\mathsf{Bel}_{\mathtt{i}}^{[\text{self-ascr}]}\lambda\mathtt{x}[\mathtt{calm}(\mathtt{i})]$

between matrix and embedded subject, where acquaintance relations can encode either the first person perspective (*de se*) or any relevant second or third person one (*de re*). The lfs of both (11) and (12) are thus of the following form:

(15) I believe that I am $P$

$$\exists \mathtt{R}[\mathtt{R}(\mathtt{i},\mathtt{i}) \wedge \mathsf{Bel}_{\mathtt{i}}^{[\text{self-ascr}]} \lambda \mathtt{x}[\mathtt{P}(\imath \mathtt{y}[\mathtt{R}(\mathtt{x},\mathtt{y})])]]$$

Paraphrase: I was acquainted with myself in a certain way ($R$) and I believed (through property self-ascription) that whoever I was $R$-acquainted with had property $P$.

The *de se* reading of (11) is verified by taking R to be equality, the non-*de se* reading required for (12) to, say, $\mathtt{R} \doteq \lambda \mathtt{x} \lambda \mathtt{y}[\mathtt{see\_on\_tv}(\mathtt{x},\mathtt{y})]$. This immediately brings out one of the main advantages of this approach over Chiercha and Heim: we need not postulate a syntactic ambiguity in coreferential reports to get both *de re* and pure *de se* truth-conditions.

On the other hand, I am well aware that subsequent data on the *de re*/*de se* distinction pose severe challenges for the relational approach (e.g. reports with PRO+infinitive, or *only* embedded reports), but also for the ambiguity approach (e.g. universally quantified reports). For an overview of these issues and a defense and further development of the relational approach I refer to Maier (2006).

For our purposes, the important thing to note is that on a relational analysis the embedded *I* is in effect moved outside the belief and represented logically as i (the second one in (15)'s $\mathtt{R}(\mathtt{i},\mathtt{i})$), that is, as a standard Kaplanian indexical. Thus, we get representations that correctly predict the felicity of both (11) (*de se*) and (12) (*de re*) without giving up Kaplan's analysis of *I* as a rigid designator.

## 4 Overgenerating sloppy and *de se* readings of coreferential proper names?

We have seen analyses of Heim's sloppy *only*, sloppy ellipsis, and first person *de se* examples where the first person is treated as a regular Kaplanian indexical, rather than as a bound variable. The proposed analyses relied solely on coreference of the first person forms to get both strict and sloppy, and *de re* and *de se* readings; no syntactic binding and accompanying ambiguity was required.

It has been objected[2] that this overgenerates sloppy and *de se* readings, in particular, when the pronouns are replaced with coreferring proper names. In this section I explore these objections and give counterarguments, first for the strict/sloppy examples, then for the *de re*/*de se* reports.

### 4.1 How to avoid sloppy names

Replace the pronouns of Heim's *only* example (2) with coreferential proper names, which, like indexicals are usually analyzed as directly referential:

[2] The problem of the overgeneration of sloppy readings was also raised by two of the referees. For *de se* it has been noted by Chierchia (1989:22), cf. also Maier (2006:128–9) for further discussion.

(16) Only John did John's homework [only strict]

The result is slightly odd due to a "Principle C effect". Some context or just some extra stress on the first name will make such sentences perfectly felicitous. The relevant observation is that, if and when such sentences are felicitous they allow only a strict reading, that is, nobody else did John's homework. This contrasts with Heim's first person variant (2a), which also allows (and even prefers) a sloppy reading, where nobody else did their homework.

With ellipsis we find the same contrasts between coreferring names and indexicals:

(17) John did John's homework, (?but) his classmates didn't [only strict]

The first clause is fine with some extra stress on either of the two *John*s. The ellipsis however does not allow a sloppy reading, (which makes the contrastive *but* rather odd).

It seems that first person pronouns behave differently from names, the paradigm of direct reference. In allowing both strict and sloppy readings, *I* indeed patterns more with third person pronouns than with names:

(18) John did his homework, but his classmates didn't [strict/sloppy]

This seems to directly support Heim's claim, cited in section 2 above, that "1st person pronouns are in fact just like 3rd person pronouns [rather than like names]" against my claims to the contrary.

To answer this challenge, I propose a pragmatic account to block the sloppy readings that HOU indeed generates for any coreferring terms in constructions like the above. The crucial observation is that *I* differs from *John*, not in being a pronoun and thus allowing a non-referential interpretation, but in having no 'lighter' alternative means of expression. In other words, the highly marked principle C violating sentences have perfectly fine paraphrases with third person pronouns: (18) for (17), and (19) for (16).

(19) Only John did his homework [strict/sloppy]

To express the fact that the only student that did his homework was John (sloppy), a speaker generally prefers (19) over the repeated proper name (and that over variants with demonstratives or definite descriptions coreferring to John). If the speaker would nonetheless choose a 'heavier' (e.g. more content) or otherwise more 'marked' (e.g. Principle C violation) form, she must have some ulterior motive for choosing that form. What could be the motive for repeating the name? Apparently the speaker wants to emphasize that it's John whose homework is under discussion, i.e., that it's John's homework that the others didn't do—the strict reading. Thus, the very fact that the repeated coreferential name has a lighter pronominal alternative helps us to block the sloppy reading. For coreferential first person pronouns there is no easier alternative means of expression. This explains why we find both strict and sloppy readings in Heim's first person examples, but not with proper names.[3]

Note that the same argument explains that, *a forteriori*, an even heavier coreferring term, such as a demonstrative or description, would have only a strict interpretation as well:

(20) a. Only John did that guy's [pointing to John] homework [only strict]
b. I did that guy's [pointing to myself on TV] homework, (?but) my classmates didn't [only strict]

### 4.2 Blocking unwanted *de se* names

More or less the same argument and counterargument hold with the *de re*/*de se* examples. It has been noted many times that coreferring third person pronouns allow both *de re* and *de se*, just like the first person case in section 3:

(21) a. Kaplan thought he was at a safe distance from the fire [*de se*]
b. Kaplan thought he was remarkably calm [*de re*]

With coreferential proper names, Chierchia (1989:22) claims, *de se* readings are unavailable:

(22) #Kaplan thought Kaplan was at a safe distance from the fire

The contrast between names and pronouns here is not as clear as in the previous subsection, but we'll assume that Chierchia's judgment is valid.

It seems that the unifying proposal of section 3.2 would indeed overgenerate a true reading for (22), as the logical form, (23), includes the possibility of an egocentric acquaintance relation of equality:

(23) $\exists \mathtt{R}[\mathtt{R}(\mathtt{k},\mathtt{k}) \wedge \mathsf{Bel}_{\mathtt{i}}^{[\text{self-ascr}]} \lambda \mathtt{x}[\mathtt{safe}(\imath \mathtt{y}[\mathtt{R}(\mathtt{x},\mathtt{y})])]]$

The same pragmatic reasoning as in 4.1 can block out this *de se* possibility. The violation of Principle C in (22) indicates that the speaker must have wanted to emphasize that it's Kaplan who was thought to be at a safe distance from the fire. This kind of emphasis seems appropriate only if the speaker wanted to report Kaplan as having a rather marked mistaken identity thought of the form "Kaplan is at a safe distance from the fire". Such a thought however did not occur in the scenario described. What Kaplan thought was simply "I am at a safe distance from the fire". Assuming that the marked/stressed name was meant to indicate that the name was a noteworthy constituent of the reported thought, we predict that (22) is indeed infelicitous in the given context. Again, in the first person case, there is no simpler alternative, which explains the difference between names and pronouns in allowing *de se* interpretations.

[3] My pragmatic account predicts that in Motherese, Legalese and Lolspeak dialects, where certain repeated coreferential descriptions or names are unmarked, we would get sloppy readings: *Mommy can clap Mommy's hands, can Baby do that too?*

The proposed account does one further prediction, namely that a repeated proper name report doesn't just block *de se*, it also blocks most *de re* construals. In particular, though Kaplan does believe *de re* about himself that he was remarkably calm, we cannot report this with (24a). If we want to use a name or description rather than the unmarked, all-purpose (*de re*/*de se*) third person pronoun, we have to use one that matches the actual acquaintance relation of the belief reported, as in (24b):[4]

(24) a. #Kaplan thought that Kaplan was remarkably calm
b. Kaplan thought that the guy on TV was remarkably calm

As far as I can tell, this prediction is borne out. Moreover, there is nothing in the syntactic Heim-Chierchia account to explain the contrast in (24), because it concerns different referential terms for which that account only predicts the absence of *de se* readings.

## 5 Conclusion

To account for sloppy and *de se* readings of the first person pronoun *I*, Heim and others introduce a syntactic LF level, a non-conservative quantifier, and a purely morphosyntactic first person. I claim that we can bypass the LF level and go straight from the surface to the semantics. I've shown how Heim's data are captured by (i) a straightforward Kaplanian semantics of *I* as a rigid designator, (ii) a simple analysis of *only* as a focus particle rather than a non-conservative quantifier, (iii) a pragmatic account of ellipsis and focus relying on HOU to generate strict and sloppy readings, (iv) a unified analysis of *de re* and *de se* as relational attitudes, and (v) a pragmatic mechanism of blocking by lexical alternatives to constrain the semantic overgeneration of sloppy and *de se* readings for constructions with non-pronominal co-referential items.

## References

Chierchia, G.: Anaphora and attitudes *de se*. In Bartsch, R., van Benthem, J., van Emde Boas, P., eds.: Semantics and Contextual Expression. Volume 11 of Groningen-Amsterdam Studies in Semantics. Foris (1989)

Cresswell, M., von Stechow, A.: *De Re* belief generalized. Linguistics and Philosophy **5**(4) (1982) 503–35

Dalrymple, M., Shieber, S., Pereira, F.: Ellipsis and higher-order unification. Linguistics and Philosophy **14**(4) (1991) 399–452

Heim, I.: Notes on the first person (1991) [class notes].

Heim, I.: Features on bound pronouns. In Harbour, D., Adger, D., Bejar, S., eds.: Phi-theory: Phi-features across modules and interfaces. OUP (2008).

Kaplan, D.: Quantifying in. In Davidson, D., Hintikka, J., eds.: Words and Objections. D. Reidel Publishing Company (1969)

[4] In fact, reports like (24b) with descriptions that match the reported belief's content as well as its 'mode of presentation' could well be classified as *de dicto* reports

Kaplan, D.: Demonstratives. In Almog, J., Perry, J., Wettstein, H., eds.: Themes from Kaplan. Oxford University Press, New York (1989) 481–614

Kratzer, A.: More structural analogies between pronouns and tenses. In Strolovich, D., Lawson, A., eds.: Proceedings of SALT VIII, Ithaca, NY, CLC Publications (1998) 36–54

Kratzer, A.: Making a pronoun: Fake indexicals as windows into the properties of pronouns (2008) to appear in: *Linguistic Inquiry*.

Lewis, D.: Attitudes *de dicto* and *de se*. The Philosophical Review **88** (1979) 513–543

Maier, E.: Belief in Context: Towards a unified semantics of *de re* and *de se* attitude reports. PhD thesis, Radboud University Nijmegen (November 2006)

Partee, B.: Binding implicit variables in quantified contexts. In et al., C.W., ed.: CLS. Volume 25., Chicago (1989) 342–65

Pulman, S.G.: Higher-order unification and the interpretation of focus. Linguistics and Philosophy **20**(1) (1997) 73–115

# Simple Trees with Complex Semantics: On Epistemic Modals and Strong Quantifiers

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**Abstract.** Lechner (2006) presents an analysis of the scopal interaction of English epistemic modal verbs with negated strong quantifiers in the framework of Transparent Logical Form, which constructs semantic representations as extensions of syntax trees. Noting conceptual and empirical shortcomings of this approach, we propose an analysis in Lexical Resource Semantics, a constraint-based semantics framework embedded in Head-driven Phrase Structure Grammar. Our analysis treats the original English data as well as semantically parallel constructions in German, although the syntax of the German constructions is substantively different from English. The LRS framework views syntax and semantics as independent modules connected by a complex interface employing modern underspecification techniques. It permits a surface-oriented syntactic analysis without a multitude of additional empty categories, which has clear advantages for the application of efficient parsing algorithms. At the same time, the LRS analysis elegantly captures crosslinguistic generalizations about the semantic phenomenon under investigation.

## 1 Introduction

In this paper we present empirical and conceptual arguments in favor of a syntax-semantics interface that links a surface-oriented syntax to a semantic representation in a well-established logical language, here Ty2 (Gallin 1975). This interface uses techniques of underspecified semantics to overcome mismatches between the syntactic structure and the semantic representation. We look at an especially intriguing case of such a mismatch, the scopal interaction of an epistemic modal verb with a negated strong quantifier.

We contrast our analysis with the one presented in (Lechner 2006) within the framework of Transparent Logical Form (Stechow 1993, Heim and Kratzer 1998). Transparent Logical Form is designed to derive scope ambiguities from differences in the syntactic structure: A sentence with two different scope readings must have two different syntactic representations. We show that such an architecture leads to undesirable consequences for both the syntactic and the semantic analysis. A problem for syntax occurs if two languages differ with respect to their (surface) syntactic properties but allow the same scopal readings in a particular constellation. In this situation, Transparent Logical Form is forced to treat the syntactic properties of the two languages more alike than they are. On the other hand, in some cases a restriction on the scoping possibilities depends on aspects of the semantic representation, but not on aspects of the syntax. If this is the case, Transparent Logical Form must turn semantic properties into syntactic features. The example that we are using in this paper will allow us to illustrate both types of problems.

Our own approach stands in the tradition of surface-oriented syntax. In such frameworks, the same syntactic structure can be associated with different scopal readings. There are several techniques to achieve this goal. One of the best-known is Cooper storage (Cooper 1975). Alternatively, type-shifting can be assumed (Hendriks 1993) to construct a semantic combinatorics which uses a categorial grammar set-up in parallel to a constituent-based syntactic parse. While these approaches assume a single syntactic structure, they use distinct semantic derivations for ambiguous sentences, and consequently, distinct semantic representations at the nodes in the syntactic tree. From a computational perspective, this is still a severe shortcoming since it multiplies the number of outputs for each sentence just as two distinct syntactic analyses do.

To overcome this problem systems of underspecified semantics were developed (Pinkal 1996). These systems combine a surface-oriented syntactic analysis and a reading-independent semantic construction, while the combinatorics still restricts the possible readings of a sentence in the appropriate way. Within Head-driven Phrase Structure Grammar (HPSG), the syntactic framework assumed in this paper, a number of variants of such approaches have been proposed, including (Egg 2004), (Richter and Sailer 2004), and (Copestake, Flickinger, Pollard and Sag 2005).

In the present paper we focus on *Lexical Resource Semantics* (LRS, (Richter and Sailer 2004)), demonstrating the way in which syntax and semantics are seen as modules which impose their own restrictions and which are linked to each other by constraints. As a consequence, LRS is immune to the two problems mentioned for Transparent Logical Form: First, even if two languages differ in their syntactic structure, we can derive identical readings. Second, we can express constraints that refer to semantic properties of constituents without having to encode them as syntactic properties.

## 2 Split Readings in LF Syntax

The sentences in (1) have a reading in which the epistemic modal intervenes between the negation and the universal quantifier. This reading constitutes a genuine challenge for semantic composition as the semantic contribution of the subject NP seems to be split by that of the modal. We will refer to this type of reading as the *split reading*.

(1) a. Not every boy can make the basketball team. $\neg \succ$ **CAN** $\succ \forall$
"It is not possible that every boy makes the basketball team" (Lechner 2006)

b. Nicht jeder kann gewinnen. $\neg \succ$ **CAN** $\succ \forall$
not everyone can win "It is not possible that everyone wins."

Lechner (2006) cites this reading as evidence of head movement at a syntactic level of LF. To derive the reading in the context of a theory of raising, he has to make four assumptions:

L(i) strong NPs do not reconstruct under raising verbs,
L(ii) NPs of the form *not NP* contain a semantically vacuous *not* but require to be contained in a NegP which contributes the negation,
L(iii) the NegP is high in the tree but has a variable position,
L(iv) an epistemic modal can move over the subject in the syntax.

This results in the structure in (2):

(2) The structure of (1-a) according to Lechner (2006):
$[_{NegP}$ NEG $[_{Neg^0}$ *can*$_i$ $[_{TP}$ *not every boy*$_j$ $[t_i$ $[_{VP}$ $t_j$ make the team ]]]]]]
$\lambda p.\neg p$ $\lambda p$**CAN**$(p)$ $\lambda P.\forall x($**boy**$(x) \rightarrow P(x)$ $\lambda x.$**make-team**$(x)$

Crucially, the assumptions L(i)–L(iv) do not follow from any other aspect of the grammar. They capture the empirical observations with the mechanisms of Lechner's framework. Henceforth we will refer to analyses couched in this type of framework as LF-Syntax (LFS) analyses. Their hallmark is the fact that they state semantic generalizations as conditions on appropriately extended syntax trees, or on their derivations. The advantage of the LFS analysis at hand is that the semantics can be read off the (LF-) syntactic structure directly. The price to pay is a highly complex syntactic derivation with many empty and functional categories for which there is no purely syntactic evidence and which make the approach unattractive for standard theories of computational syntax and semantics.

Newmeyer (2008) argues against this type of approach from a methodological perspective, showing that the inclusion of semantic distinctions in syntactic analyses makes it almost impossible to derive the basic syntactic generalizations about English modals: English modal verbs differ syntactically from non-modal verbs, but their syntactic behavior is independent of their epistemic or deontic interpretation, and of their scope.

Further problems for this approach arise when we take a different perspective and consider crosslinguistic data. Linguists generally agree that the syntactic constraints which govern the placement of finite verbs in German and English are fundamentally different. German does not exhibit syntactic distinctions between modal or auxiliary verbs and other finite verb forms. Instead, fronting of the finite verb to second position behind a sentence-initial constituent uniformly applies to all finite verb forms in V2 root clauses. However, the possible readings of the modals in (1-a) and (1-b) are the same. It seems impossible that this could be due to a syntactic parallelism related to L(iv), given that the syntax of the finite (modal) verb actually differs in the two languages. We take the clear semantic parallelism as further evidence that the split reading in (1) is not due to the availability of syntactic head movement.

A further argument against a syntactic theory of split readings with modal verbs comes from the behavior of strong quantifiers in argument positions of other verbs. L(i) describes the fact that universal quantifiers as subjects of raising verbs do not have de dicto readings in English (3-a). (3-b) is evidence that other quantifiers are not subject to this restriction. However, the fact that L(i) is a syntactic condition on raised NPs misses a generalization: Zimmermann (1993) shows that strong quantifiers also lack de dicto readings in the direct argument position of opaque verbs such as *seek*, as seen in (3-c). This suggests that an adequate formulation of L(i) should not be restricted to raised NPs and should not be syntactic in nature.

(3) a. Every student seems to have passed the test. (only de re)
b. A student seems to have passed the test. (de re/de dicto)
c. John seeks every unicorn. (only de re)
$\forall x(\mathbf{unicorn}(x) \rightarrow \mathbf{seek}(w', \mathbf{john}, \lambda w'' \lambda P.P(w'', x)))$
# $\mathbf{seek}(w', \mathbf{john}, \lambda w'' \lambda P.\forall x(\mathbf{unicorn}(x) \rightarrow P(w'', x)))$

Although epistemic modals are raising verbs, they are exceptional in that they may take scope over strong quantifiers in subject position. To account for this apparent violation of constraint L(i), Lechner (2006) introduces the head-movement option L(iv) for epistemic modals to derive (1-a). But then the syntactic generalizations only capture part of a semantic phenomenon that, in our view, should receive a uniform account which has nothing to do with the syntactic position of the verb: If a strong quantifier occurs in a (surface) argument position of an opaque non-modal verb, it must take scope over the verb.

## 3 An LRS Analysis

We propose a syntax-semantics interface built on the syntactic structure (4-a) for all readings of sentence (1-a). The syntactic structure of the corresponding German sentence, which has the same readings, is shown in (4-b).

(4) a. [$_S$ [$_{NP}$ Not every boy] [$_{VP}$ can [$_{VP}$ make the team]]]
b. [$_{\overline{S}}$ [$_{NP}$ Nicht jeder]$_j$ [$_S$ kann$_i$ [$_{VP}$ t$_j$ gewinnen t$_i$]]]

A simpler syntax without functional categories such as (4-a) and, *mutatis mutandis*, the German structure (4-b), requires a more elaborate syntax-semantics interface, as also advocated by Culicover and Jackendoff (2005). Our surface-oriented syntax is provided by HPSG, while the interface to semantics is couched in *Lexical Resource Semantics* (LRS, (Richter and Sailer 2004)). There is a clear division of work: The syntactic structure reflects syntactic generalizations. Constraints on readings express the semantic generalizations at the interface. Using techniques of underspecified semantics, the interface conditions are formulated in terms of scope specifications in lexical entries and general scope principles. There is no empty abstract negation NEG, and the words *not* and *nicht* themselves contribute semantic negation, in contrast to the assumptions L(ii) and L(iii) of the LFS analysis above.

The core idea of the LRS interface is that the semantic representations of sentences result from accumulating the meaning contributions and semantic constraints associated with lexical entries in accordance with general phrase-level semantic principles. Here we will associate complex constraints on semantic representations with lexical and phrasal signs. These constraints are not themselves semantic representations. They state which fragments of semantic representations occur in a sign and what is known about their mutual relationships. This means that these constraints *denote* semantic representations. An important principle about the interpretation of utterances ultimately requires that the semantic representations which are associated with an utterance (a) use all and only those logical symbols which are introduced in the LRS constraints of the signs contained in the utterance, and

(b) respect all the restrictions on the mutual relationship of their subterms which are either lexically introduced or imposed by phrase-level semantic principles. Our semantic representations are expressions of a higher-order logic (two-sorted type theory, Ty2), but the representations of utterances are not derived by the lambda calculus like in most systems with representations from a type-theoretic higher-order language. Instead, the logical representations of syntactic daughters are combined by unification.[3]

To derive the truth-conditions of utterances in a principled fashion, LRS distinguishes different aspects of the semantic representation(s) associated with each sign. Three aspects of the semantics of phrases and words will be important in our discussion: (a) the main content of a lexical item (written as an underlined formula, $\underline{\phi}$), (b) the internal content of a lexical item (put between curly braces, $\{\psi\}$) and (c) its external content (prefixed with '^', $^\wedge\chi$) to mark scope boundaries within a head projection. Their significance is as follows: All operators that combine with a lexical sign along its head projection take scope over the internal content of the lexical head. The external content marks the term which includes the operator with the widest scope at the highest syntactic projection of a sign. The main content represents the core semantic contribution of a sign, and may also be viewed as its lexical meaning. The main content as well as the external and internal content are inherited along head projections and are therefore locally available to constraints at each phrasal projection. This is crucial for the principles of the combinatoric system, since they essentially operate at the phrase level and establish relationships between the main, internal and external content of syntactic daughters. In doing so, they enforce mutual restrictions (such as possible subterm relationships or necessary identities between subterms) in accordance with the requirements of the syntax-semantics interface. We will introduce all relevant principles as our discussion proceeds. Since the subterm-relation is a particularly important type of constraint in many LRS principles, it receives a special notation in CLLRS. Subterm conditions often come together with *meta-variables*, notated as upper-case letters. Meta-variables stand for nodes in the term tree that are still underspecified. $A : [\phi_1, \ldots, \phi_n]$ means that $A$ comprises the subexpressions $\phi_1$ to $\phi_n$.

### 3.1 Epistemic Modals in Split Readings in English

We now turn to the analysis of the English sentence (1-a). The LRS constraint associated with the infinitival VP *make the team* is shown in (5). The main content of the VP, which we underline, is the constant **make-team**. The internal content of the VP (in curly braces) consists of the main content, applied to all its arguments, i.e. it is the expression **make-team**$(w', x)$. We also mark the external content, which the VP does not specify any further. Note that the internal content is a subexpression of the external content. This is not an accidental fact of this expression, but it is required by an independent LRS principle.

(5) LRS constraint of the VP *make the team*: $^\wedge A : [\{\underline{\textbf{make-team}}(w', x)\}]$

LRS inherits the simple lexical linking mechanism from traditional approaches to semantics in HPSG such as (Pollard and Sag 1994). A verb has access to the SYNSEM value of its syntactic arguments. Under an attribute CONTENT *synsem* structures contain lexical aspects of the semantic structure, the referential variable associated with the syntactic argument and its main content. In contrast, the external content, the internal content and other parts of the content of the selected element are not visible to the selector. The availability of the referential variable of the subject, here $x$, allows us to link it directly to the right argument slot of the functor **make-team**. Local access to the main content is also needed to impose selectional restrictions (Soehn 2006).

Modals contribute quantification over possible worlds. The restrictor specifies the type of modality in terms of an appropriate accessibility relation between possible worlds, **acc**:

[3] In feature logical specifications of LRS, it is not unification but equality of substructures of logical representations that is employed in the grammar principles. Below we will use the computational specification language of LRS, CLLRS (Penn and Richter 2005), since its linear notation is more readable and more compact than feature logic descriptions. Computations with CLLRS do employ unification, and we use the term in this computational sense as a convenient metaphor for explaining the effect of LRS constraints on constructing semantic representations.

(6) LRS constraint of the verb *can*: $^\wedge\lambda w.A : [\exists w'(\underline{\mathbf{acc}}(w,w') \wedge B : [w', \{C\}])]$

In the present analysis, we do not use an index (eventuality) variable for verbal projections as in previous LRS analyses. The linking between the modal verb and its VP complement is instead encoded by means of the VP's main content. We require that the main content of the complement VP be a subexpression of the modal's internal content $C$.

(7) Linking constraint in the lexical entry of *can*:
The main content of the VP complement is a subexpression of *can*'s internal content.

Our analysis of modal verbs is taken from (Richter and Sailer 2004, Sailer 2006). The key idea is that modal verbs identify their internal content with that of their complement VP. This permits both wide scope and narrow scope of the modal with respect to the subject and to complements of the infinitival VP. Consequently, our analysis of modals achieves the same effect as the optional syntactic head-movement rule of modals in the LFS analysis (L(iv)) with respect to subjects. In contrast to L(iv), however, it also accounts for the scoping possibilities of complements.

The INTERNAL CONTENT RAISING PRINCIPLE enforces the identity of the internal contents of a modal and its VP complement. It is independently motivated by the analysis of opaque verbs (see (14) below) and of neg raising constructions (Sailer 2006). Here we make a few minor changes to its exact formulation compared to previous versions since it was previously formulated in the context of a less elaborate lexical analysis of modals and with reference to an eventuality index of verbs. Our revised formulation is given in (8).

(8) INTERNAL CONTENT RAISING PRINCIPLE (ICRP):
In a head-complement structure,
*if* the main content of the head is not a subexpression of its internal content,
and the index or the main content of the complement is a subexpression of the head's internal content,
*then* the internal content of the head and internal content of the complement are identical.

The ICRP leads to unification of the meta-variable $C$ with the internal content of the VP, which is the expression $\mathbf{make\text{-}team}(w', x)$ according to (5). This results in the new LRS constraint shown in (9):

(9) LRS constraint of the VP *can make the team*:
$^\wedge\lambda w.A : [\exists w'(\underline{\mathbf{acc}}(w,w') \wedge B : [w', \{\mathbf{make\text{-}team}(w', x)\}])]$

Next we consider the LRS constraint of the NP *not every boy*, (10). The universal quantifier marks the external content of the NP. The negation must take scope over the external content, but there may be semantic material intervening between the negation and the quantifier, as the meta-variable $D$ indicates.

(10) LRS constraint of the NP *not every boy*: $\neg D : [^\wedge\forall x(\{\underline{\mathbf{boy}}(x)\} \rightarrow E : [x])]$

The combination of a verbal projection with a quantified argument is subject to a sub-clause of the LRS SEMANTICS PRINCIPLE. Since we only need this one sub-clause, we introduce it here as a separate principle. It requires that the argument take scope over the internal content of the VP. For ease of reference we will call it the QUANTIFIER-HEAD PRINCIPLE. It ensures that all quantified dependents of a head take scope over the head's internal content. An analogon of this principle belongs to most systems that work with semantic underspecification, including (Egg 2004) and MRS (Copestake et al. 2005).

(11) QUANTIFIER-HEAD PRINCIPLE (QHP):
In a head complement structure, if the nonhead is a quantifier, then the head's internal content is a subexpression of the nonhead's scope.

In (10) the scope of the quantified subject is marked by the meta-variable $E$. When the finite VP combines with the subject, two subexpression constraints apply: First, The QHP requires that the internal content of the VP, the expression $\mathbf{make\text{-}team}(w', x)$, be a subexpression of $E$. Second, the principles guiding the accumulation of semantic constraint information ensure that all meaning contributions of the subject be part of the external content of the utterance. In our example, the external content of the utterance is identical to the external content of the clause.[4] This leads to the LRS constraint in (12). Note that the meta-variable $A$ is constrained to contain the LRS constraint of the finite VP from (9) ($\exists w'(\ldots)$) and the LRS constraint of the subject from (10) ($\neg D : [\ldots]$)):

(12) LRS constraint of sentence (1-a):

$$^\wedge\lambda w.A : [\exists w'(\underline{\mathbf{acc}}(w, w') \wedge B : [w', \{\mathbf{make\text{-}team}(w', x)\}]), \neg D : [\forall x(\mathbf{boy}(x) \rightarrow E : [\mathbf{make\text{-}team}(w', x)])]]$$

In Figure 1 we summarize the LRS analysis of sentence (1-a). Into each node in the tree we write the LRS constraint on the semantic representation of the relevant node. At branching nodes we indicate the effect of the ICRP and the QHP.

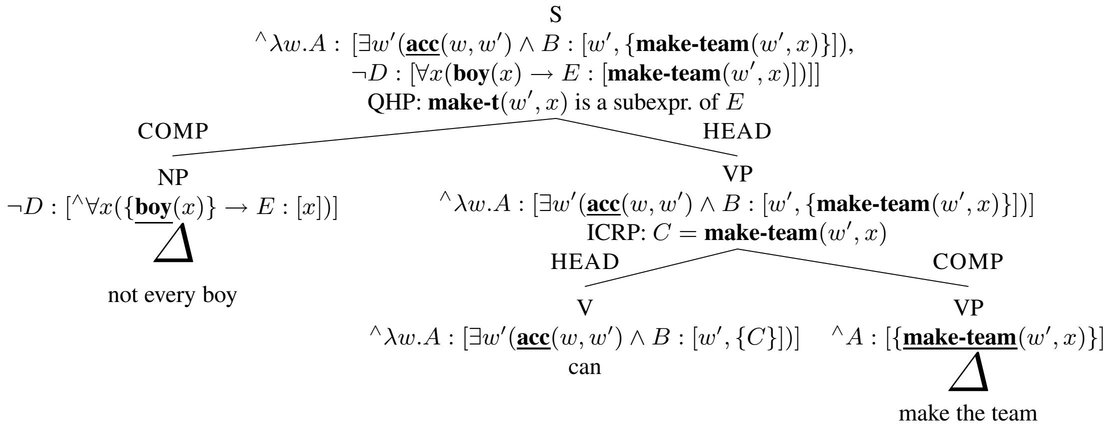


**Fig. 1.** Sketch of the analysis of sentence (1-a)

The LRS constraint (12) is resolved by assigning the meta-variables subexpressions from (12) which respect the given scoping relations. There are three possible resolutions for (12). In (13-a) we state the resolution that yields the split reading. The resulting expression is shown in (13-b).[5]

(13) a. $A = \neg D$, $B = \forall x(\mathbf{boy}(x) \rightarrow E)$,
$D = \exists w'(\mathbf{acc}(w, w') \wedge B)$, $E = \mathbf{make\text{-}team}(w', x)$

b. Semantic representation resulting from the meta-variable assignment in (13-a):

$$\lambda w.\neg\exists w'(\mathbf{acc}(w, w') \wedge \forall x(\mathbf{boy}(x) \rightarrow \mathbf{make\text{-}team}(w', x)))$$

With the analysis of the split reading in English we have achieved the main goal of revising the LFS analysis. The remaining question now concerns the predictions of the two analyses with respect to related syntactic constructions such as raising, and related semantic phenomena such as the behavior of strong quantifiers as arguments of opaque verbs.

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[4] See Section 4 for examples with more than one clause.

[5] The other possible resolutions provide two more readings. These are in fact available but will be ignored since they are not immediately relevant for our discussion of the two alternative syntax-semantics interfaces.

(i) a. $\lambda w.\neg\forall x(\mathbf{boy}(x) \rightarrow \exists w'(\mathbf{acc}(w, w') \wedge \mathbf{make\text{-}team}(w', x)))$
(It is not the case that every boy can make the team.)

b. $\lambda w.\exists w'(\mathbf{acc}(w, w') \wedge \neg\forall x(\mathbf{boy}(x) \rightarrow \mathbf{make\text{-}team}(w', x)))$
(It is possible that not every boy makes the team.)

To address these issues, we have to take another look at the LFS rule L(i). L(i) states that strong quantifiers do not reconstruct below raising verbs. In our critique of the LFS approach we suggested that the empirical scope of this rule should be extended to take into account the more comprehensive observation that a strong quantifier in an argument position of a non-modal verb must take scope over that verb. In other words, in this syntactic constellation we do not find de dicto readings of strong quantifiers.

To see how LRS captures this generalization, we need to start with the relevant parts of the lexical entries of raising verbs and opaque verbs. The lexical specification of the verbs *seem* and *seek* according to the analysis of opaque verbs in (Richter and Sailer 2004) looks as in (14).

(14) a. LRS constraint of the verb *seem*: $^\wedge\lambda w.A : [\underline{\textbf{seem}}(w, \lambda w'.B[w', \{C\}])]$
b. LRS constraint of the verb *seek*: $^\wedge\lambda w.A : [\underline{\textbf{seek}}(w, x, \lambda w'.B[w', \{C\}])]$

The full specifications of the lexical entry of *seem* and *seek* include the appropriate argument linking. In the case of *seek* the index of the direct object NP must occur within the internal content of the verb. For *seem*, the main content of the VP complement must be a subexpression of the raising verb's internal content. As a direct consequence, the ICRP will identify the internal content of the opaque verbs with the internal content of their complements. This is the same effect that we already saw with modal verbs.

At this point we would predict that both a de re and a de dicto reading is available for all sentences in (3), contrary to fact: Whereas the scope of strong quantifiers relative to epistemic modals is not fixed, they outscope other opaque verbs. The difference between epistemic modals and other verbs follows from the principle in (15), which restricts the scope of strong quantifiers that bind variables in the syntactic arguments of verbal functors.

(15) STRONG QUANTIFIER RESTRICTION (SQR):
For each verb $v$ and each NP $n$ that is selected by $v$: $n$'s index value may not be bound by a strong quantifier inside an argument position of $v$'s main content.

Note that (15) is a typical interface principle since it refers to syntactic and semantic properties of the lexical items. We emphasize that the SQR is a lexical principle that constrains the syntax-semantics interface in verbs.

The split reading of (1-a) obeys the SQR since the main content of the modal is the accessibility relation (**acc**) whose arguments are worlds. The type system already excludes the occurrence of the strong quantifier in an argument position of **acc**. The observed scope ambiguity is due to the interaction of the strong quantifier with the existential quantifier that comes with the modal.

With non-modal raising verbs the semantic representations are crucially different. (16) shows the de re and the unavailable de dicto reading of a strong quantifier with *seem*. The main content of *seem* is **seem**. In (16-b) the strong quantifier appears inside an argument position of **seem**, violating the SQR (15).

(16) Everyone seems to sleep.
a. $\lambda w.\forall x(\textbf{human}(w, x) \rightarrow \underline{\textbf{seem}}(w, \lambda w'.\textbf{sleep}(w', x))$ (de re)
b. $\#\lambda w.\underline{\textbf{seem}}(w, \lambda w'.\forall x(\textbf{human}(x) \rightarrow \textbf{sleep}(w', x))$ (de dicto)

The SQR in (15) is a stipulation at the syntax-semantics interface, but so is the LFS restriction L(i) on the reconstruction of strong quantifiers after syntactic raising. In contrast to the LFS constraint, the SQR also accounts for obligatory de re readings of strong quantifiers in the object position of verbs like *seek*. To see how, consider the two potential readings indicated in (3-c). In the hypothetical de dicto reading the index of the direct object is bound by a strong quantifier inside an argument slot of the verb's main content, the constant **seek**. The SQR correctly rules out this reading, whereas the LFS analysis has nothing to say about it.

### 3.2 Epistemic Modals in Split Readings in German

The LRS interface forms a layer of constraints between syntax and semantics which shields semantic generalizations from the particulars of syntactic structure and *vice versa*. The advantages of this modular architecture become clear when we now consider the analysis of the split reading in German. Recall from (1) that corresponding finite sentences in English and German with negated strong quantifiers as subjects of epistemic modals exhibit parallel semantic behavior despite the differences in the syntax of the finite verb. In this section we will demonstrate that all substantial differences between the HPSG-based LRS analyses of the corresponding constructions in English and German are located in syntax. The semantic principles remain untouched, as one should expect in a situation with identical semantic generalizations. Most of this section will therefore consist of an explanation of the syntactic analysis and of how the new syntactic structures are hooked up to the interface. The interface neutralizes the syntactic differences, and the semantic constraints that govern the relationship between epistemic modals and strong quantifiers stay firmly in place.

Figure 2 reveals details of our HPSG analysis of sentence (1-b). We choose a syntactic representation with a trace, $t_i$, of the finite verb *kann*$_i$ in verb second position, because this analysis of German sentence structure is most similar to other frameworks. The constituent in the vorfeld, *nicht jeder*$_j$, is extracted from the mittelfeld using the most conservative HPSG analysis of unbounded dependency constructions, which introduces a trace at the bottom of the unbounded dependency.[6]

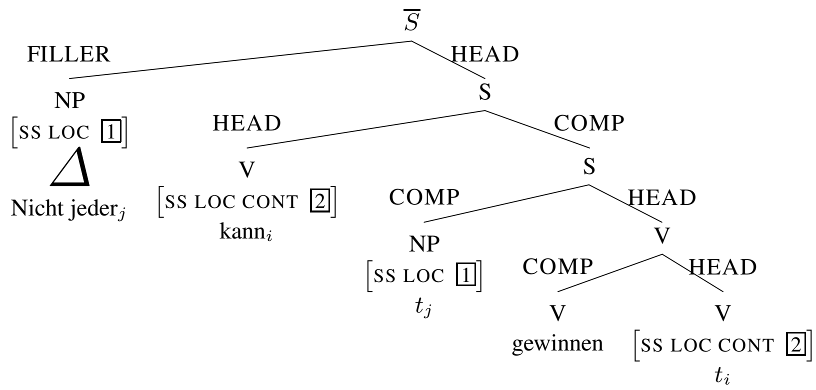


**Fig. 2.** Syntactic analysis of sentence (1-b).

From the bottom of the tree up to the lower S node, the syntactic structure consists of head-complement combinations like in English. In contrast to English, however, the head of the finite verbal projection is a trace, and so is the NP subject. The verb trace is related to the overt modal in verb second position, indicated here by the identity of subscripts, and the NP trace is related by the identity of LOC values to the topicalized filler constituent.

Before we turn to the traces, let us briefly review those parts of the structure that are already familiar from English. There are no differences between the LRS constraints associated with the non-finite verb *gewinnen* (win) in (17) and the negated strong quantifier *nicht jeder* (not everyone) in (18) compared to their English counterparts. The former correspond to the constraints associated with *make the team* and the latter to the constraints of *not every boy*.

(17) LRS constraint of the verb *gewinnen* (win): $\hat{}A : [\{\underline{\mathbf{win}}(w', x)\}]$

[6] The choice of analysis for German sentence structure has only minor consequences for the analysis of the phenomenon under investigation. A linearization-based account of verb second would eliminate the verb trace, and a traceless theory of complement extraction would eliminate the subject trace by locating the source of the unbounded dependency in the verb. Both changes would in fact make the connection from syntax to the LRS interface more similar to the analysis of English. The syntax of Figure 2 is the most interesting choice in the sense that it brings out best the flexibility of our syntax-semantics interface.

(18) LRS constraint of the NP *nicht jeder*: $\neg D : [{}^\wedge \forall x(\{\underline{\textbf{person}}(x)\} \rightarrow E : [x])]$

In the syntactic analysis of the relationship between the finite verb in verb second and its trace we follow Müller (2007), who assumes that they are ultimately related by lexical rules. We derive the trace $t_i$ and the verb second form of *können* from the same underlying base form.[7] As the surface position of the finite verb has no influence on scope in German, it is generally thought that the verb trace has the same semantics as the verb when it appears in final position. We follow this line of reasoning and assume that the LRS constraint of the modal verb *kann* (can), given in (19), is identical to that of the verb trace.[8]

(19) LRS constraints of the lexeme *kann* (can) and its verb trace $t_i$:
$${}^\wedge \lambda w.A : [\exists w'(\underline{\textbf{acc}}(w, w') \wedge B : [w', \{C\}])]$$

When the verb trace combines with the non-finite verb the ICRP applies. The resulting LRS constraint of the verbal complex corresponds to the one we saw for the VP *can make the team* in (9).

(20) LRS constraint of *gewinnen* $t_i$: ${}^\wedge \lambda w.A : [\exists w'(\underline{\textbf{acc}}(w, w') \wedge B : [w', \{\textbf{win}(w', x)\}])]$

The subject trace shares its entire LOCAL value with the filler phrase. Since the *local* structure comprises the CONTENT value, the subject trace shares the referential variable and the main content, both located under CONTENT, with the overt constituent. In contrast to the verb trace, the subject trace does not contribute the same LRS constraints as the fronted constituent. It only contributes those parts that are identical with the filler, the referential variable $x$ and the main content.

(21) LRS constraint of the subject trace $t_j$: ${}^\wedge F : [\{x\}, \underline{\textbf{person}}]$

When the subject trace combines with the VP *gewinnen* $t_i$, its LRS constraint is added to the constraint from the verbal projection:

(22) LRS constraint of $t_j$ *gewinnen* $t_i$: ${}^\wedge \lambda w.A : [\exists w'(\underline{\textbf{acc}}(w, w') \wedge B : [w', \{\textbf{win}(w', x)\}]), x, \textbf{person}]$

Since the verb trace is associated with the same LRS constraint as the finite verb, the latter does not contribute new restrictions. When *kann* combines with its complement in a head-complement structure, its restrictions on external content, internal content and main value unify with those of the complement. Since they are necessarily a subset of the restrictions accumulated in the complement, the LRS constraint at the mother node is identical to the one at the complement.

(23) LRS constraint of *kann*$_i$ $t_j$ *gewinnen* $t_i$ :
$${}^\wedge \lambda w.A : [\exists w'(\underline{\textbf{acc}}(w, w') \wedge B : [w', \{\textbf{win}(w', x)\}]), x, \textbf{person}]$$

We already saw the LRS constraint of the subject NP in (18). It combines with the verbal projection in a head-filler structure according to standard HPSG principles. While verb second movement does not have an effect on the truth conditions of a sentence, the fronting of an NP is not semantically neutral. Fronting fixes the maximal scope of the quantifier: A fronted quantifier cannot take scope in a higher clause. Head-filler structures obviously introduce restrictions on semantic composition that are different from head-complement clauses, and we need a separate sub-clause of the SEMANTICS PRINCIPLE to treat them:

[7] See (Soehn 2006, pp. 188–193) for a discussion of how the right correspondence of trace and verb is guaranteed and for details of the LRS analysis of verb second in German with lexical rules and a verb trace.

[8] In (Soehn 2006) the relationship of the LRS constraint of the finite verb and the trace is mediated by phrase-level LRS principles which lead to the same result that we specify lexically. Our lexicalized alternative might in fact be computationally more attractive.

(24) FILLER SCOPE PRINCIPLE (FSP):
In a head-filler structure, the external content of the filler must be a subexpression of the external content of the head.

Applying the FSP, we obtain the LRS constraint in (25):

(25) LRS constraint of sentence (1-b): $^\wedge\lambda w.A : [\exists w'(\underline{\mathbf{acc}}(w,w') \wedge B : [w', \{\mathbf{win}(w',x)\}]),$
$x, \mathbf{person},$
$\neg D : [\forall x(\mathbf{person}(x) \rightarrow E : [x])]]$

Figure 3 summarizes our analysis. The LRS constraint at the top node has exactly the same resolutions as that for the corresponding English example in Figure 1. In particular the resolution seen in (13-a) yields the split reading.

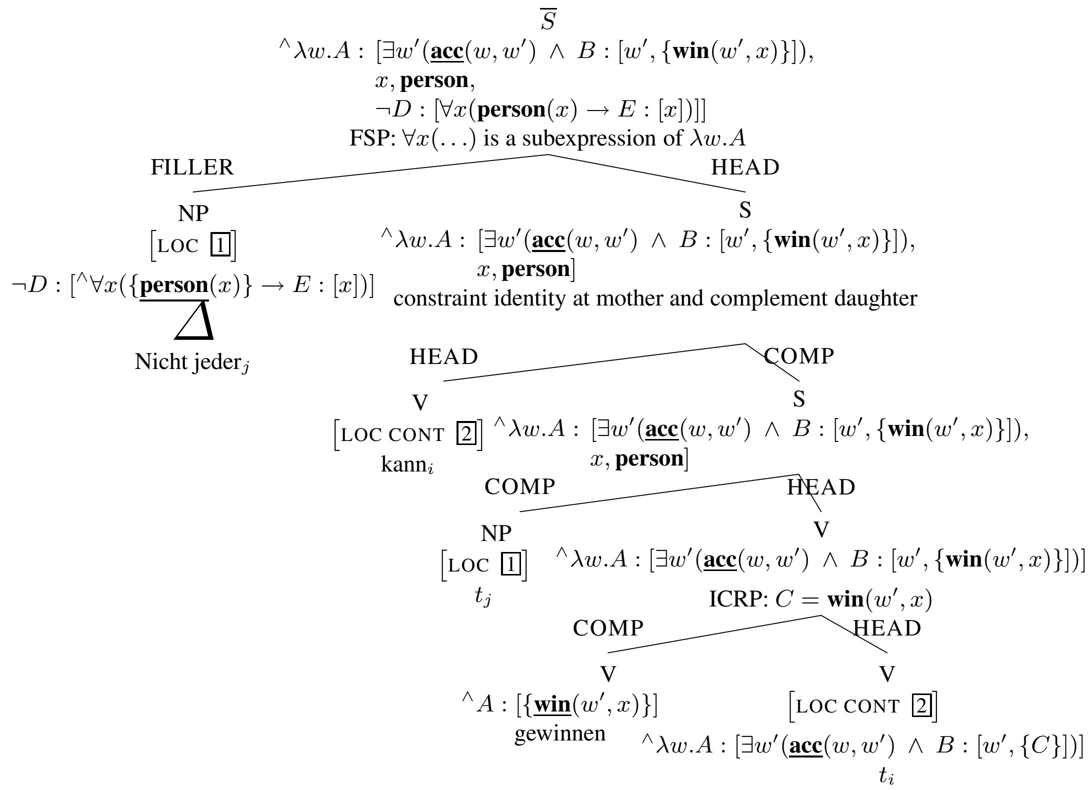


**Fig. 3.** Sketch of the LRS analysis of sentence (1-b).

Note that, everything else being equal, the SQR, which distinguishes epistemic modals from other raising verbs and opaque verbs such as *suchen* (seek), will apply exactly as it did in English.

## 4 Further Remarks on Quantification Domains in LRS

In the previous sections we introduced three constraints that restrict the domain of quantification: (i) The QHP in (11) ensured that the scope of a quantifier includes at least the internal content of the head. (ii) The SQR in (15) formulated the idea of the minimal scope of a quantifier and distinguished between the scoping options of strong and weak quantifiers. (iii) The FSP in (24) imposed a restriction on the maximal scope of a quantifier: A moved quantifier may not take scope outside the clause of its surface position.

The QHP and the FSP are sensitive to particular syntactic constructions, the SQR is a lexical constraint on verbs. This expresses the insight that the scoping options of a quantifier may be contingent on its structural position. Possible scopings depend on whether or not a quantifier is extracted, on the type of the quantifier (strong or weak), and on the type of verb whose argument it is. As far as we can see, all three constraints are language-independent, and we take them to belong to the core system of combinatorial constraints in LRS.[9] The SQR was already discussed at the end of Section 3.1. Here we would like to elaborate on the differences between the QHP and the FSP.

In contrast to the QHP, the FSP does not establish a relation between the internal content of the head and the scope of a quantifier in the filler. However, as our German example illustrated, a fronted quantifier binds a variable $x$ in the internal content of the head. In Figure 3 this implied that $\textbf{win}(w', x)$ was in the scope of the extracted universal quantifier. Let us now take a second look at the FSP on the basis of topicalization and wh-movement constructions in English.

The internal content of the utterance in the two complex sentences in (26) is the constant **claim** combined with its arguments. The two utterances share the same readings (27): In a Montagovian treatment of the indefinite NP *a man from Sweden*, there is a de re and a de dicto reading.

(26) a. Chris claims that Pat loves a man from Sweden.
b. A man from Sweden, Chris claims that Pat loves.

(27) a. de re: $\lambda w.\exists x(\textbf{man-f-Sweden}(x) \wedge \textbf{claim}(w, \textbf{chris}, \lambda w'.\textbf{love}(w', \textbf{pat}, x)))$
b. de dicto: $\lambda w.\textbf{claim}(w, \textbf{chris}, \lambda w'.\exists x(\textbf{man-f-Sweden}(x) \wedge \textbf{love}(w', \textbf{pat}, x)))$

In (26-a) the QHP requires that the internal content of the complement clause, $\textbf{love}(w', \textbf{pat}, x)$, be in the scope of the existential. This is the case both for the de re and the de dicto reading.[10] Both readings are also available if the quantifier is fronted such as in (26-b). In the de dicto reading, the internal content of the matrix verb is $\textbf{claim}(w, \textbf{chris}, \lambda w'.\exists x(\textbf{man-from-Sweden}(x) \wedge \textbf{love}(w', \textbf{pat}, x)))$. It follows that the fronted quantifier is contained in the matrix verb's internal content.

On the other hand, when a quantifier is fronted within the complement clause, it cannot take scope beyond its surface position. (28) does not have a reading in which the moved existential takes scope over the matrix verb, and only the reading in (27-b) is available.

(28) Chris claims that a man from Sweden Pat loves.

The clauseboundedness of the scope of a syntactic filler was also observed with wh-phrases. Let us suppose a quantificational treatment from (Karttunen 1977). Karttunen's sentence (29) contains three wh-phrases. What is interesting in the context of our discussion are the scopal options of the two wh-phrases in the complement clause: The clause-initial wh-phrase *where* is fronted and in a filler-head construction. The wh-phrase *which book* remains in situ. The sentence has two readings, indicated by the two possible types of answers.

(29) Who remembers where Mary keeps which book?
a. Bill remembers where Mary keeps which book.
b. Joe remembers where Mary keeps Aspects and Max remembers where Mary keeps Syntactic Structures. (Karttunen 1977, p. 26)

In the first answer, (29-a), *which book* is interpreted as taking scope inside the complement clause. In the second answer, (29-b) the direct object wh-phrase takes scope in the matrix clause. The data are parallel to the scope options in sentence (26-a): An in-situ quantifier can take scope within its clause or outside of its clause. The complement clause in (29) contains a further wh-phrase, *where*. In both

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[9] Language-specific constraints on the semantic combinatorics for modeling the typological variation of negative concord in several languages are discussed in (Richter and Sailer 2006).

[10] It is well-documented that an in-situ strong quantifier must take scope inside the clause in which it appears (Stechow 1993). There is no de re reading for (i). To impose this restriction, we could assume a principle such as (ii):

(i) Chris claims that Pat loves every Swedish dish.

(ii) For each clause $c$: Every strong quantifier that is contributed in $c$ must be a subexpression of $c$'s external content.

readings of the question, the scope of *where* is restricted to the complement clause. This is what we expect as a consequence of the FSP.

## 5 Conclusion

We argued that the syntactic structure of a sentence should not be made dependent upon the semantic interpretation of scopal elements such as modal verbs, and the semantic interpretation of a scope-taking expression should not necessarily have an effect on the syntactic representation. Syntactic representations and semantic representations should be separate modules which are connected by a flexible interface that enables the linguist to state linguistic generalizations in the appropriate part of the grammatical system. A flexible syntax-semantics interface, based on underspecification techniques, can capture the ambiguities of modal verbs and negated strong quantifiers in a principled fashion. LRS permits the formulation of the necessary scope constraints in a direct way. The overall architecture of the interface is not more complicated than the analysis based on LF syntax since our system is not bound to cast its conditions in terms of syntactic operations. A modular interface of the type we proposed offers a number of clear advantages, such as a significant independence from details of the syntactic representation in the formulation of semantic generalizations, and syntactic and semantic representations that are suitable for computational implementation.

## References


Cooper, R.: 1975, *Montague's Semantic Theory and Transformational Grammar*, PhD thesis, University of Massachusetts, Amherst.

Copestake, A., Flickinger, D., Pollard, C. and Sag, I. A.: 2005, Minimal Recursion Semantics: An introduction, *Journal of Research on Language and Computation* **3**, 281–332.

Culicover, P. W. and Jackendoff, R.: 2005, *Simpler Syntax*, Oxford University Press.

Egg, M.: 2004, Mismatches at the syntax-semantics interface, *in* S. Müller (ed.), *Proceedings of the HPSG-2004 Conference, Center for Computational Linguistics, Katholieke Universiteit Leuven*, CSLI Publications, Stanford, pp. 119–139.

Gallin, D.: 1975, *Intensional and Higher-Order Modal Logic*, North-Holland, Amsterdam.

Heim, I. and Kratzer, A.: 1998, *Semantics in Generative Grammar*, Blackwell.

Hendriks, H.: 1993, *Studied Flexibility*, ILLC Dissertation Series 1995-5, Institute for Logic, Language and Computation, Amsterdam.

Karttunen, L.: 1977, Syntax and semantics of questions, *Linguistics and Philosophy* **1**(1), 3–44.

Lechner, W.: 2006, An interpretive effect of head movement, *in* M. Frascarelli (ed.), *Phases of Interpretation*, Mouton de Gruyter, Berlin und New York.

Müller, S.: 2007, *Head-Driven Phrase Structure Grammar. Eine Einführung*, Stauffenburg, Tübingen.

Newmeyer, F. J.: 2008, Semantic evidence and syntactic theory, *in* N. Choeb and B. Zeisler (eds), *Pre-Proceedings of the International Conference on Linguistic Evidence: Empirical, Theoretical, and Computational Perspectives*, Universität Tübingen, Tübingen, pp. 58–60.

Penn, G. and Richter, F.: 2005, The other syntax: Approaching natural language semantics through logical form composition, *in* H. Christiansen, P. R. Skadhauge and J. Villadsen (eds), *Constraint Solving and Language Processing. First International Workshop, CSLP 2004, Roskilde, Denmark, September 1-3, 2004, Revised Selected and Invited Papers*, Vol. 3438 of *Lecture Notes in Computer Science*, Springer, pp. 48–73.

Pinkal, M.: 1996, Radical underspecification, *in* P. Dekker and M. Stokhof (eds), *Proceedings of the Tenth Amsterdam Colloquium*, ILLC/Department of Philosophy, University of Amsterdam, pp. 587 – 606.

Pollard, C. and Sag, I. A.: 1994, *Head-Driven Phrase Structure Grammar*, University of Chicago Press, Chicago and London.

Richter, F. and Sailer, M.: 2004, Basic concepts of Lexical Resource Semantics, *in* A. Beckmann and N. Preining (eds), *ESSLLI 2003 – Course Material I*, Vol. 5 of *Collegium Logicum*, Kurt Gödel Society Wien, Vienna, pp. 87–143.

Richter, F. and Sailer, M.: 2006, Modeling typological markedness in semantics. The case of negative concord, *in* S. Müller (ed.), *Proceedings of the 13th International Conference on Head-Driven Phrase Structure Grammar, Varna 2006*, CSLI Publications, Stanford, pp. 305–325.

Sailer, M.: 2006, *Don't Believe* in underspecified semantics. Neg raising in Lexical Resource Semantics, *in* O. Bonami and P. Cabredo Hofherr (eds), *Empirical Issues in Formal Syntax and Semantics*, Vol. 6, CNRS, Paris, pp. 375–403. *http://www.cssp.cnrs.fr/eiss6/sailer-eiss6.pdf

Soehn, J.-P.: 2006, *Über Bärendienste und erstaunte Bauklötze. Idiome ohne freie Lesart in der HPSG*, Peter Lang, Frankfurt am Main. Ph.D. thesis, Friedrich-Schiller-Universität Jena.

Stechow, A. v.: 1993, Die Aufgaben der Syntax, *in* J. Jacobs, A. von Stechow, W. Sternefeld and T. Vennemann (eds), *Syntax. Ein internationales Handbuch zeitgenössischer Forschung*, Vol. 1, Walter de Gruyter, Berlin and New York, pp. 1–88.

Zimmermann, T. E.: 1993, On the proper treatment of opacity in certain verbs, *Natural Language Semantics* **1**(2), 149–179.

# Uniform structure for multiple scope readings*

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**Abstract.** This paper argues for an analysis of QNP scope which does not generate $n$ syntactic structures for $n$ scope readings. The main argument is that QNP scope is not reducible to a standard movement phenomenon that requires structure modification. Instead, I analyze QNP scope as a result of a lexical/phrasal operation that applies specifically to the local functor that takes the QNP as an argument. Some merits and demerits of the proposal are discussed.

## 1 Introduction

Working in Categorial Grammar, I argue that what the syntax feeds into the semantics for the sentence in (1) are the two logical forms in (2).

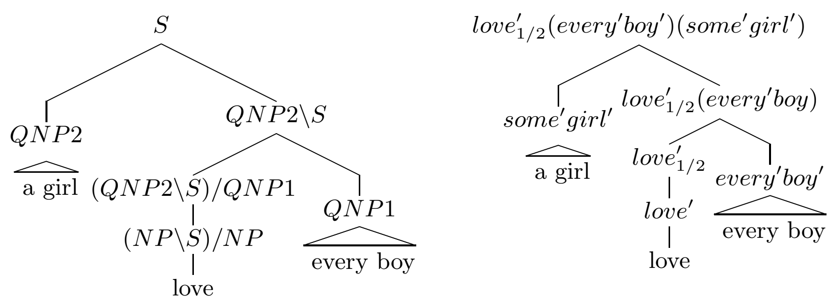
(1) A girl loves every boy. (Surface scope: $\exists > \forall$. Inverse scope: $\forall > \exists$.)

(2) a. $\exists > \forall$: $love'_1(every'boy')(some'girl') = some'girl'(\lambda y.every'boy'(\lambda x.love'xy))$
where $love'_1 := \lambda Q1_{(et)t}.\lambda Q2_{(et)t}.Q2(\lambda y_e.Q1_{(et)t}(\lambda x_e.love_{e(et)}{}'xy))$

b. $\forall > \exists$: $love'_2(every'boy')(some'girl') = every'boy'(\lambda x.some'girl'(\lambda y.love'xy))$
where $love'_2 := \lambda Q1_{(et)t}.\lambda Q2_{(et)t}.Q1(\lambda x_e.Q2_{(et)t}(\lambda y_e.love_{e(et)}{}'xy))$

The syntactic structure is the same for the two logical forms, as shown in (3), where $QNP2$ and $QNP1$ abbreviate the categories $S/(NP\backslash S)$ and $(S/NP)\backslash S$ respectively. Given the lexically assigned category $(NP\backslash S)/NP$ and functor term $\lambda x.\lambda y.love'xy$ (= $love'$) of type e(et) for *love*, the logical functors $love'_1$ and $love'_2$ are derived by way of a modified version of Hendriks' (1987) Argument Raising, as shown in (4). I call the rule 'Arguement-slot raising' or ASR.

(3)




(4) a. $(NP\backslash S)/NP \Rightarrow ((S/(NP\backslash S))\backslash S)/((S/NP)\backslash S)$

b. $\lambda x.\lambda y.love'xy \Rightarrow \lambda Q1.\lambda y.Q1(\lambda x.love'xy) \Rightarrow \lambda Q1.\lambda Q2.Q2(\lambda y.Q1.(\lambda x.love'xy))$

c. $\lambda x.\lambda y.love'xy \Rightarrow \lambda x.\lambda Q2.Q2(\lambda y.love'xy) \Rightarrow \lambda Q1.\lambda Q2.Q1(\lambda x.Q2.(\lambda y.love'xy))$

* Many thanks to Annabel Cormack, Ruth Kempson, Glyn Morrill, Michael Moortgat, Neil Smith and Rob Truswell for discussions. I am also grateful to the workshop organizers and anonymous reviewers.

Argument-slot raising of the transitive verb category $(NP\backslash S)/NP$ is not provable with regard to the object argument-slot in the non-associative Lambek Calculus NL. That is, $(NP\backslash S)/NP \nvdash_{NL} (NP\backslash S)/((S/NP)\backslash S)$. However, instead of modifying the general/global rules of the grammar to incorporate the effect of Hendriks' Argument Raising, as in Moortgat (1991) and Bernardi (2002), I define ASR as a special lexical/phrasal rule that applies to local functors so that they can take QNPs, instead of their lexically specified NPs, as syntactic arguments. Because ASR generates ambiguity only in terms of the resultant logical functor terms (with the same category/type), the syntactic structure stays the same for both the readings. This allows us to explain the binding asymmetry between the subject position and the object position as in (5) with the simple requirement that the binder must be merged later than the pronoun in the syntactic derivation.[1] I argue that excluding (5b) by postulating a covert A-bar movement such as May's QR together with Weak Cross Over violation between *every lecturer$_1$* and *he$_1$* (or by instantiating an analogous mechanism in Categorial Grammar) is not explanatory, given that A-bar movement (e.g. Wh-movement) and QNP scope are subject to different locality constraints, as Johnson (2000) showed.

(5) a. Every lecturer$_1$ met a student that he$_1$ once supervized.
    b. *A student that he$_1$ once supervized met every lecturer$_1$.

My analysis switches scope by applying ASR to the local functor that takes the QNPs in question as co-arguments. In (6a), the string inside the brackets counts as a complex predicate to which we can apply ASR, whereas in (6b), the string inside the square brackets does not count as one.[2] Thus, the scope switch is possible only with (6a) in my analysis.[3]

(6) a. A linguist [*tried to review*] every paper. $\forall > \exists$; $\exists > \forall$
    b. A linguist [*told me that Bill would review*] every paper. $\forall > \exists$; $*\forall > \exists$

This paper does not discuss the so-called 'exceptional scope' of indefinites which can apparently cross a tensed clause.[4] But following Fodor and Sag (1982), Ruys (1992), Winter (2001), among others, I assume that the apparent non-tensed-clause-bound scope of indefinites is not a matter of quantificational scope. If the indefinite *three students* in (7a) could take quantificational wide scope over the matrix clause subject *two teachers*, we should be able to get the reading in (7b) with the sentence in (7a), contrary to our judgment.

(7) a. *Two teachers* reported that *three students* smoked at school.
    b. *There are three students and for each of them, a different pair of teachers reported that he/she smoked. (I.e. there are six teachers involved.)
    c. There are (specific) three students about whom (the same) two teachers reported that they smoked at school. (I.e. there are only two teachers.)

[1] The binding in *Every boy's$_1$ mother came to meet him$_1$* requires some work. See Uchida (2008).

[2] An anonymous reviewer argues that there is no linguistic substance to this claim. But as we see in section 2.1, I argue that QNP scope stays inside the minimal proposition that contains the QNP. The 'complex predicate' is then defined as the core predicate of each proposition. In (6a), *tried to review* is the core predicate of the whole proposition. In (6b), the core predicate of the embedded proposition is *would review.*

[3] Büring's B-accent/A-accent pattern allows scope switch across sentence boundaries more easily, for example, */SOME boy said that he likes E\very girl*, with which we can get the inverse scope *every* > *some* more easily ('/' informally indicates a rising tone contour and '\' indicates a falling tone contour). I abstract away from some effects from such special intonation contours. See Büring (1995) for some discussion. Thanks to an anonymous reviewer for reminding me of this point.

[4] See Uchida (2005b) for my analysis of indefinites.

The main claim is that QNP scope switch in the basic case is not a matter of syntactic/structural ambiguity. Instead, it is a result of a semantically motivated special operation that allows (verbal) functors to consume QNPs as syntactic arguments without applying a structure modification operation for that purpose. Because QNPs are consumed as arguments of their local functors (which may be complex predicates if the grammar can independently generate them as such), the analysis predicts that QNP scope stays inside the final output of this local functor, which is S in categorial grammar or the local TP in Minimalism, without adding the tensed-clause locality constraint as an extra addition to the QNP scope taking algorithm itself. The analysis also explains why QNPs occupy the same PF positions as normal NPs in almost all the natural languages.

Section 2 explains the basic QNP scope algorithm. Section 2.1 explains my analysis informally. Section 2.2 explains Hendriks' Argument Raising with its problems. I reformulate Hendriks' argument raising in section 2.3. Section 3 explains why I do not modify the basic rules of the grammar so that the grammar could derive Hendriks' AR as a theorem.

As we have seen in (6) above, my analysis works only if we can treat *tried to review* in (6a) as a complex predicate without recognizing *told me that Bill would review* in (6b) as one. To achieve this in TLG would require a controlled introduction of structural rules. In section 4, I informally show how we can extend the basic grammar system with controlled introduction of structural rules in such a way that the extension does not allow QNPs to take scope across tensed clauses.[5] Section 5 provides some concluding remarks.

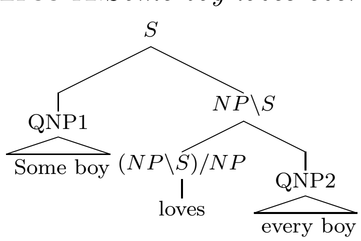
## 2 Proposal

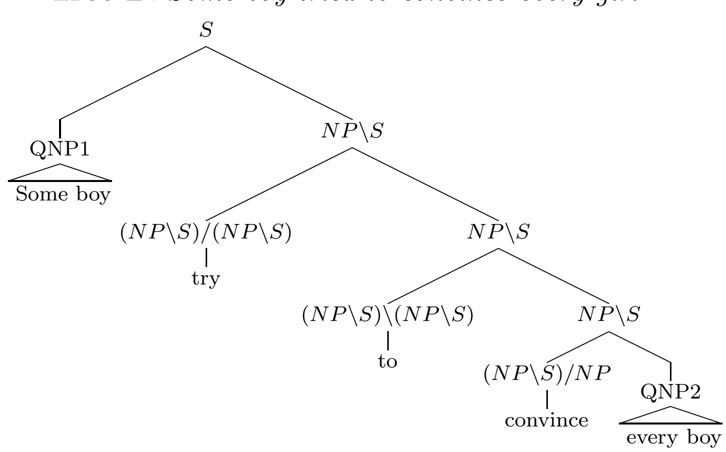
### 2.1 Informal proposal

My basic proposal is that QNPs are interpreted in-situ as arguments of the local verbal functor and thus, their scope stays inside the final output category of the functor, which, in categorial grammar, is the local $S$. In the semantics, the local $S$ corresponds to the local type t expression. Thus, the QNP scope stays inside the minimal proposition that contains it.

If we apply this idea by pretending as if QNPs could saturate the NP argument slots of the verbs, as in Tree A∼Tree C below, then, my analysis would naturally lead to the tensed-clause locality constraints on QNP scope. That is, it would exclude the scope switch only for Tree C in the following three cases, **Tree A∼Tree C**:

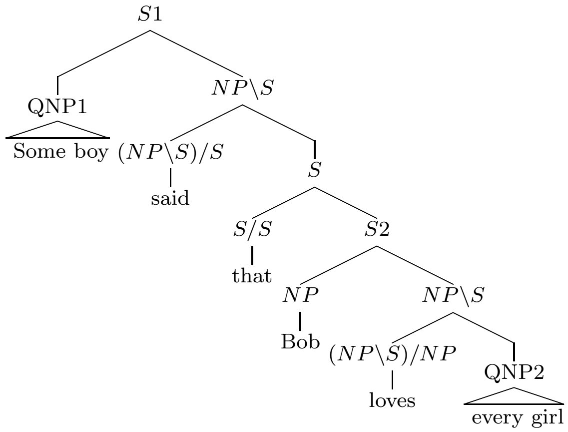
**Tree A**:*Some boy loves every girl*, **Tree B**: *Some boy tried to convince every girl*




[5] For a more formal exposition, see Uchida (2008).

**Tree C**: *Some boy said that Jack loves every girl.*




In Tree A above, the final output category of the local functor *love* is $S$, and thus, the proposal implies that the scope of a QNP argument of this functor stays within this $S$. In Tree B, the local functor for the object QNP *every girl* is *convince*. However, the saturation of the external NP argument slot of this functor is 'postponed' by way of the categories of the higher functors, *try* and *to*, which both select $NP\backslash S$ as their first arguments. This means that the minimal $S$ containing the object $QNP$ would become the root node $S$, which contains the subject QNP *Some boy*. Thus, my informal proposal would switch scope between the two QNPs in Tree B. In contrast, in Tree C, the minimal $S$ that contains QNP2 *every girl* is $S2$ and the scope of this QNP2 would stay inside $S2$. Thus, QNP2 would not take scope over the matrix subject.

The informal proposal is simple, but instantiating it in Type Logical Grammar is not. First, we need to treat $QNPs$ as 'arguments' of the verb. In order to do this, I adopt Hendriks' idea of argument raising (AR) with some modification.

## 2.2 Hendriks' argument raising (AR) and its problems

**Basics:** In order to treat QNPs as arguments of a (verbal) functor, I adopt the basic idea of Argument Raising (AR) in Hendriks (1987), which is provided in (8).

(8) a. Type Shift: $(\boldsymbol{a},(b,(\boldsymbol{c},t))) \Rightarrow (\boldsymbol{a},(((b,t),t),(\boldsymbol{c},t)))$

b. Semantics: $P \Rightarrow \lambda \boldsymbol{x}.\lambda Q.\lambda \boldsymbol{y}.Q(\lambda z.P(\boldsymbol{x})(z)(\boldsymbol{y}))$

Types of variables. P: $(\boldsymbol{a},(b,(\boldsymbol{c},t))), Q:((b,t),t), \boldsymbol{x}:\boldsymbol{a}, \boldsymbol{y}:\boldsymbol{c}, z:b$

N.B. $\boldsymbol{a}, b, \boldsymbol{c}$ are meta-variables for some types, where $\boldsymbol{a}$ and $\boldsymbol{c}$ are such that

$(\boldsymbol{a},(b..)) = (b..),(e,(b..)),(e,(e,(b..))),(e,(e,(e,(b..))))$, etc.

and $(\boldsymbol{c},t) = t,(e,t),(e,(e,t)),(e,(e,(e,t)))$, etc.

(cf. Hendriks 1987: 109)

If a functor has an argument slot of type $b$, we can raise it to type $((b,t),t)$, so that the resultant functor can take a type $((b,t),t)$ argument. The meta-variables $\boldsymbol{x}$ of type $\boldsymbol{a}$ and $\boldsymbol{y}$ of type $\boldsymbol{b}$ mean that the functor $P$ can have any number of arguments (including zero arguments) before and after the argument $z$ of type $b$, which is type-raised by the rule.

**Problems of Hendriks' argument raising**: Hendriks' system allows scope alternation between any co-arguments of a functor. However, the so-called frozen scope in the double object construction provides a counter example for this, as reported in Bruening (2001: 235).

(9) a. The teacher showed a (*different) student every book. $*every > a, a > every$

b. The teacher showed a (different) book to every student. $a > every$, $every > a$

The scope relation between the two object QNPs is fixed for the double object (DO) construction, as is shown in (9a), whereas the prepositional ditransitive construction (PP) allows the two object QNPs to switch scope, as in (9b). If we apply the rule in (8) to the functor *show′* of type (e(e(et))), then Hendriks' analysis cannot block the unattested inverse scope reading with the DO construction in (9a). We can apply AR to *show′* with regard to its two object argument slots in two orders, deriving the two scope readings.

(10) a. Type Shift: $(e,(e,(e,t))) \Rightarrow (((e,t),t),(e,(e,t))) \Rightarrow (((e,t),t),(((e,t),t),(e,t)))$

b. Semantics: $show' \Rightarrow \lambda Q1.\lambda y.\lambda z.Q1(\lambda x.show'(x)(y)(z))$
$\Rightarrow \lambda Q1.\lambda Q2.\lambda z.Q2(\lambda y.Q1(\lambda x.show'(x)(y)(z)))$

(11) a. Type Shift: $(e,(e,(e,t))) \Rightarrow (e,(((e,t),t),(e,t))) \Rightarrow (((e,t),t),(((e,t),t),(e,t)))$

b. Semantics: $show' \Rightarrow \lambda Q2.\lambda y.\lambda z.Q2(\lambda y.show'(x)(y)(z))$
$\Rightarrow \lambda Q1.\lambda Q2.\lambda z.Q1(\lambda x.Q2(\lambda y.show'(x)(y)(z)))$, Types, $Q1, Q2 : (et)t$, and $x, y, z : e$

Applying the outputs of (10) and (11) to two QNP objects of type ((et)t) and to a normal type e subject such as *Tom* in (12a) derives the two scope readings shown in (12b) and (12c).

(12) a. Tom showed some student every book.

b. $Some'(student')_{(et)t}(\lambda x.Every'(book')_{(et)t}(\lambda y.give'(x)(y)(tom')))$ $Some > Every$

c. $Every'(book')(\lambda y.Some'(student')(\lambda x.give'(x)(y)(tom')))$ $Every > Some$

To prevent this over-generation of scope readings, I reformulate Hendriks' argument raising in categorial calculus. I assign uncurried category $(NP\backslash S)/(NP \bullet NP)$ to ditransitive verbs.[6]

Another problem of Hendriks' analysis is its lack of locality constraints. As I have suggested before, argument raising should naturally lead to certain locality constraints on scope-taking; scope of a QNP should stay within the final output of the 'local functor' which takes the QNP as an argument. However, because Hendriks uses a fully associative grammar system (i.e. $L$) with an abstraction rule, a QNP can take scope beyond the final output of its local functor, by treating an indefinitely long phonological string as a complex functor.

(13) a. Some student [*said that Tom read*] every book.

b. Undesirable logical form:
$Every'(book')(\lambda y.Some'(student')_{(et)t}(\lambda x.say'_{(t(et))}(read'(e(et))(y)(tom'))(x)))$

Given (13a), association (re-bracketing) and $\lambda$ abstraction allow us to treat the string *said that Tom read* as a complex functor of type (e(et)). We can then apply argument raising to this complex functor in terms of its two type e argument slots.[7] This derives the unacceptable scope reading '*every* > *some*,' as shown in (13b).

In order to solve these problems, I modify Hendriks' argument raising in a non-associative and non-commutative grammar system NL.

[6] For my analysis of double object constructions, I refer the reader to Uchida (2006).
[7] See Hendriks (1987:112-115) for details.

### 2.3 Reformulating argument raising in TLG

I make the following two assumptions in deriving the scope of QNPs in categorial calculus.

(14) a. In the lexicon, the number of **syntactic arguments** of a functor is maximally one on both sides, i.e.,
OK: $NP\backslash S, (NP\backslash S)/NP, (NP\backslash S)/(NP \bullet NP)$
Not OK: $((NP\backslash S)/NP)/NP$ Cf. Morrill (1994:128)

b. Argument raising applies to any of the functors satisfying (14a) with regard to its maximally two NP argument slots.

(14a) means that scope switch between QNPs 'normally' occurs in the configuration in (15).[8]

(15) $QNP1 + (Functor + QNP2)$,
where $QNP1$ and $QNP2$ are co-arguments of $Functor$.

(14b) incorporates directionality of categorial selection. I call this special rule **argument slot raising**, or ASR. Given the requirements as in (14), ASR in syntactic categories is as in (16).

(16) Argument slot raising (ASR), syntax:

a. $(NP2\backslash T)/NP1$, where $T$ is normally $S$.

b. $(NP2\backslash T)/NP1 \Rightarrow (NP1\backslash T)/((S/NP2)\backslash S) \Rightarrow ((S/(NP1\backslash S))\backslash T)/((S/NP2)\backslash S)$

c. $(NP2\backslash T)/NP1 \Rightarrow ((S/(NP2\backslash S))\backslash T)/NP1 \Rightarrow ((S/(NP2\backslash S))\backslash T)/((S/NP1)\backslash S)$

ASR may be applied to all items that have a categorial form as in (16a).[9] Note that in (16), the final output categories are the same, in whichever order we apply ASR.

As we see later, the raising of the object argument slot is not provable in the non-associative calculus NL which I adopt as the base grammar. However, instead of increasing the expressive power of the base grammar system to make ASR provable using its basic axioms, I define ASR as a special lexical/phrasal operation that is only applied to certain items.

Though the two orders of applications in (16) leads to the same output category, the different orders lead to different scope readings in the semantics, as is shown in (17)~(18).

(17) ASR, semantics, Surface Scope:

a. Type Shift: (e(et)) ⇒ (((et)t), (e, t)) ⇒ (((et)t), (((et)t), t))

b. Semantics: $P \Rightarrow \lambda Q1.\lambda y.Q1(\lambda x.P(x)(y)) \Rightarrow \lambda Q1.\lambda Q2.Q2(\lambda y.Q1(\lambda x.(P(x)(y))))$
Variable types, $Q1, Q2$: (et)t; $x, y$: e

(18) ASR, semantics, Inverse Scope:

a. Type Shift: (e(et)) ⇒ (e, ((et)t), t) ⇒ (((et)t), (((et)t), t))

b. Semantics: $P \Rightarrow \lambda x.\lambda Q2.Q2(\lambda y.P(x)(y)) \Rightarrow \lambda Q1.\lambda Q2.Q1(\lambda x.Q2(\lambda y.(P(x)(y))))$

For example, application of ASR to a transitive verb *like* derives (19).

[8] There are exceptional cases in which independently motivated structural ambiguities lead to scope ambiguity. See chapter 6 of Uchida (2008) for some examples.

[9] We can apply ASR to a functor that has a complex NP argument slot, e.g., a ditransitive verb of category $(NP\backslash S)/(NP \bullet NP)$. It can also be applied to a functor *to* of category $(NP\backslash(NP \bullet NP))/NP$, to derive scope switch between two objects in the PP ditransitive construction in (9b). See Uchida (2005a) for details.

(19) Transitive verb with two QNPs.

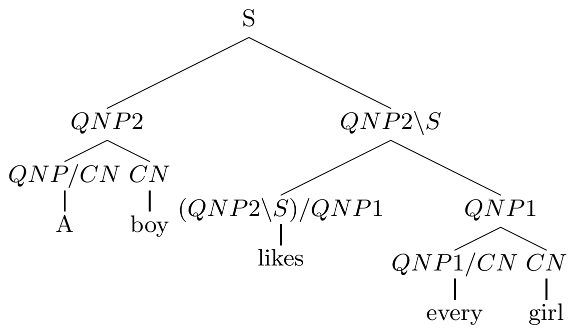
a. A boy **likes** every girl. $(a > every\ ;\ every > a)$

b. like: $(NP\backslash S)/NP; \lambda x.\lambda y.like'(x)(y)$

c. Surface scope ($like_1$):
$((S/(NP2\backslash S))\backslash T)/((S/NP1)\backslash S); like'_1 := \lambda Q_1.\lambda Q_2.Q_2(\lambda y.Q_1(\lambda x.like'xy))$

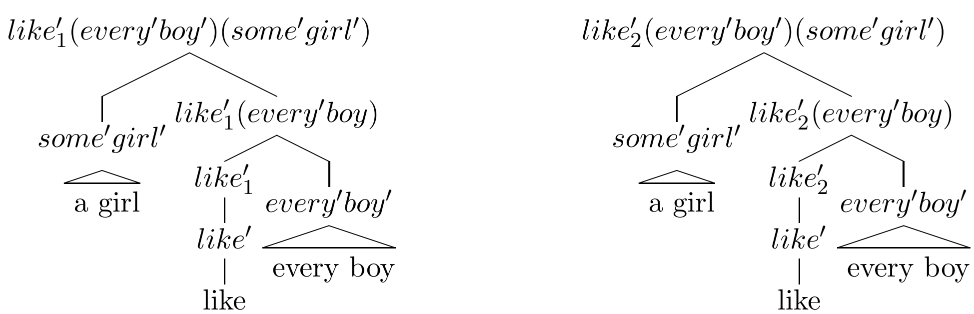
d. Inverse scope ($like_2$):
$((S/(NP2\backslash S))\backslash T)/((S/NP1)\backslash S); like'_2 := \lambda Q_1.\lambda Q_2.Q_1(\lambda x.Q_2(\lambda y.like'xy))$

(19c) and (19d) derives the same output category, and thus the same structure in Tree D:
**Tree D** (Abbreviation: $QNP2 = S/(NP2\backslash S)$; $QNP1 = (S/NP1)\backslash S$):




From this uniform syntactic structure, we can derive the two scope readings, as shown in (20).

(20) Surface Scope reading, $\exists > \forall$ Inverse scope reading, $\forall > \exists$




Surface scope: $like'_1(every'boy')(some'girl') = some'(boy')(\lambda y.every'(girl')(\lambda x.like'xy))$
Inverse scope: $like'_2(every'boy')(some'girl') = every'(girl')(\lambda x.some'(boy')(\lambda y.like'xy))$

Compare this with an alternative analysis that uses function composition to generate the inverse scope reading. For example, Steedman (2000).[10] Consider (21).

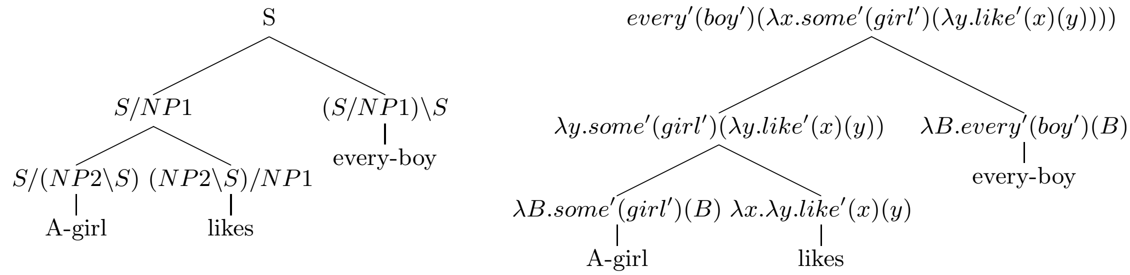
(21) a. Forward composition (fc):
Syntax: $(C/B, B/A) \vdash_{fc} C/A$
Semantics: $(g_{(b,c)}, f_{(a,b)}) \vdash_{fc} (g \bullet f)$, where $(g \bullet f)_{(a,c)} = \lambda x_a.g(f(x))$

b. (21a) applied to *A girl likes* *(every boy).*
Syntax: $(S/(NP\backslash S), (NP\backslash S)/NP) \vdash_{fc} S/NP$
Semantics: $(\lambda B.some'(girl')(B), \lambda x.\lambda y.like'xy) \vdash_{fc} \lambda x.some'(girl')(\lambda y.like'xy)$
Cf. Steedman (2000: 40)

[10] Steedman uses Combinatory Categorial Grammar (CCG), and the composition is achieved in terms of $B$ combinator, such as '$(B(g(f))) = \lambda x_a.g(f(x))$' for (21a). In (21), I omit the combinator for convenience.

This function composition with directional GQ categories for the subject and the object QNPs leads to the derivation as in Tree E for the inverse scope reading, '$\forall > \exists$.'

**Tree E** for an alternative analysis:




I argue that the following binding asymmetry between the subject and the object positions suggests that the structure in Tree E above is ill-motivated.[11]

(22) a. *Her$_1$ mother met every girl$_1$.

b. *A boy who she$_1$ liked met every girl$_1$.

An analysis that generates Tree E predicts that we can merge the object QNP later than the subject QNP. Thus, whatever binding mechanism that licenses the binding of the pronoun in the surface scope structure, as in *[[Every girl]$_1$ [met [her$_1$ mother]]]*, should license the binding for the sentences in (22) as well, contrary to our data judgments.

Some might argue that the existence of a bound pronoun inside the subject (Q)NP in (22) somehow precludes the availability of the structure in Tree E. However, such an explanation should be accompanied by some well-stated binding mechanism that stops the function composition from applying between the subject QNP and the transitive verb functor only when the subject QNP contains a pronoun that is bound by the object QNP. Stating such mechanism would complicate the categorial calculus beyond necessity. Note that the inverse scope reading is available when the pronoun is interpreted referentially, as in *A boy who she (e.g. Meg) liked met every girl* ($\exists > \forall$ or $\forall > \exists$). The inverse scope reading is also available if the pronoun is bound by a higher operator, as in *An editor$_i$ said that a linguist who she$_{i/*j}$ knew interviewed every candidate$_j$* ($\exists > \forall$; $\forall > \exists$). In the latter sentence, the pronoun inside the subject would be in a right structural position in Tree E so that it can be bound by the main clause subject *an editor*, but we would have to prohibit the potential binding by the object which would generate the unattested binding relation marked by the index $j$.

After arguing against the structure in Tree E for explaining the inverse scope, I do not object to the use of such a structure to explain coordination data, to explain a sentence such as *Every boy loved, but every girl hated, a philosophy professor*. I do not argue that the merge of the subject and the transitive verb before we merge the result with the object never occurs. For coordination, we might use the lexical entry of *and* as a trigger for a structural association rule. But the interaction of such association and scope data must be carefully investigated.[12]

[11] As for Steedman's analysis, though Steedman (2000)'s scope switch system leads to the alternative syntactic structure as in Tree E for the inverse scope, he does not define his binding conditions on the syntactic tree. Instead, he defines his binding conditions in terms of the logical expressions which are independent of the syntactic structures to a certain degree. See Steedman 2000: 66-69. However, this analysis introduces extra complexity to the level of logical forms, as I argue in Uchida (2008).

[12] Thanks to Alex Lascarides for reminding me of the relevance of the coordination structures.

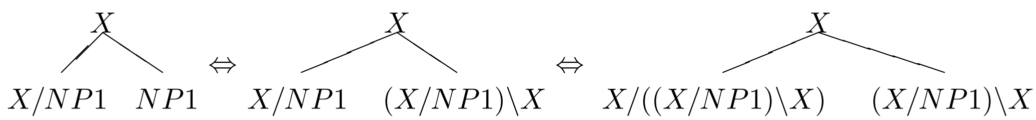
## 3 Argument slot raising as a ‘lexical/phrasal’ rule

As I indicated above, argument slot raising of a functor category with regard to its object NP argument slot is not provable/derivable in NL. Without going into formal details, this is because NL does not accept structural association (i.e. ‘re-bracketing’ of the structures).

(23) Argument slot raising wrt the object NP slot is **not provable** in NL.

a. $(NP2\backslash S)/NP1 \vdash_{NL} ((S/(NP_2\backslash S))\backslash S)/NP_1 \nvdash_{NL} ((S/(NP_2\backslash S))\backslash S)/((S/NP_1)\backslash S)$

b. Functor-argument status alternation between the sisters (derivable in NL):




NL does not structurally distinguish the functor and the argument that are merged. Thus, changing the functor-argument relation between the sisters is free. This licenses argument slot raising with regard to the subject NP. However, without association, NL can only raise the object NP argument slot of $(NP\backslash S)/NP$ to $((NP\backslash S)/NP)\backslash(NP\backslash S)$, rather than $(S/NP)\backslash S$.

I could introduce structural association in a modally controlled way, but then I would have problem explaining binding data as we have seen with (22).[13]

Using a special lexical/phrasal rule that is not fully supported by the rules of the base grammar poses a question about when we can postulate such a special rule. It also makes the grammar incomplete with regard to the intended interpretations. However, I take the current proposal as a provisional way of differentiating QNP scope from the overt extraction phenomena in the syntax, such as A-bar movement, or from A-movement/Control phenomena, for which I use modally controlled structural rules in different ways, as we see later. As a benefit of postulating such a special rule, the analysis only uses one syntactic structure for two scope readings. In other words, the special rule helps support my linguistic claim that scope ambiguity is basically a semantic phenomenon and we do not have enough syntactic motivation to generate two syntactic structures for generating two scope readings.

## 4 QNP scope in Control/raising/auxiliary constructions

As we have seen already, the subject control construction as in (24a) exhibits scope ambiguity.[14] The ambiguity is also observed in the raising and the modal auxiliary constructions, as is shown in (24b) and (24c).

(24) a. A student *tried to review* every paper. $\forall > \exists$; $\forall > \exists$

b. A student *seems to review* every paper. $\exists > \forall$; $\forall > \exists$

c. A student *must review* every paper. $\exists > \forall$; $\forall > \exists$

On the other hand, scope switch across a tensed clause (or across a more complex island which contains a tensed clause) is impossible, or at least significantly more difficult to get.

[13] I analyse the binding data in terms of Jacobsonian argument identification in the syntactic derivation, as in Jacobson (1999), and thus cannot resort to the LF representations to explain the binding data, as in Steedman (2000). See Uchida (2005a).

[14] Though object control constructions seem to block the scope switch between the main clause subject QNP and the embedded object QNP. See chapter 7 of Uchida (2008) for an analysis of this.

(25) a. Some/a boy said that Bob likes every girl. $\exists > \forall; *?\forall > \exists$

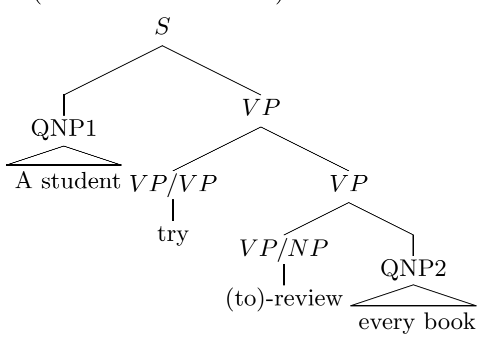
b. Some/a boy heard the rumor that Bob likes every girl. $\exists > \forall; *\forall > \exists$

c. Some/a boy will be happy if every girl comes to the party. $\exists > \forall; *\forall > \exists$

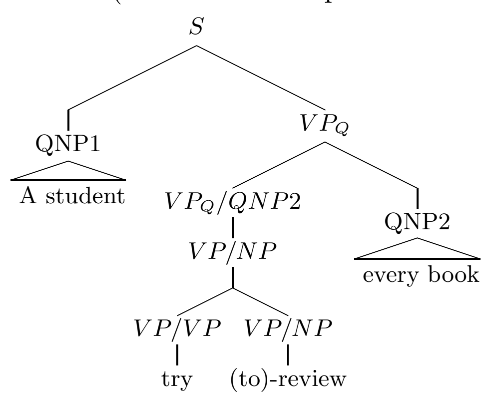
According to my informal analysis in section 2.1, both the QNPs in (24a) are contained in the same minimal $S$ category in the derived syntactic tree, whereas in the tree for (25a), the minimal $S$ expression containing the embedded object QNP *every boy* does not contain the matrix subject *Some/a boy.* Given the standard category assignments, the raising construction in (24b) and the auxiliary construction as in (24c) are assigned structures analogous to (24a), whereas (25a)∼(25c) lead to the structures in which the root-node $S$ categories contain an embedded $S$ category that dominates only the universal QNP. Thus, my informal analysis predicts that the scope ambiguity is available only with (24) and not with (25).

On the other hand, in order to formulate this informal analysis to generate scope ambiguity for the cases in (24) by way of the proposed argument slot raising, we should be able to treat the expressions in italics in (24) as complex predicates with category $(NP\backslash S)/NP$, so that we can apply argument slot raising to the derived predicates in two different orders, deriving the scope ambiguity. As we can see informally by comparing the two structures Tree F and Tree G below, this would require use of structural association.

**Tree F** (the basic structure).[15]




**Tree G** (structure for scope-switch in (24a))




N.B. $VP$ abbreviates $NP\backslash S$ and $VP_Q$ abbreviates $QNP1\backslash S$ $(= (S/(NP\backslash S))\backslash S)$.

The structure in Tree G requires function composition between the higher functor *try* and the lower functor *(to) review.* In TLG, this means we need to introduce structural association rule to NL. However, in order to do so without collapsing the whole system NL to an associative system such as L, we must discard a unimodal system and adopt a multi-modal deductive system, such as Multi-Modal Type Logical Grammar in Moortgat (1997).

Also, we want to introduce structural rules in such a way that it does not license scope switch across a tensed clause, given the data in (25). This means that we want to introduce structural association in a different way from how we use such a rule to explain Wh-extraction phenomena, where Wh-movement is known to cross a tensed clause. Without going into formal details, I provide the rough picture of the proposed grammar system as in (26).

(26) a. The grammar system: $NL_{\diamond+ASR}$, Non-associative Lambek Calculus enriched by a family of connectives that include residuated unary operators, $\diamond, \Box^{\downarrow}$, and with argument slot raising (ASR) as a special rule.

[15] I ignore the contribution of the infinitival *to* here, for convenience.

Cf. Moortgat (1997), Bernardi (2002) and Vermaat (2006).

b. QNP scope is explained in terms of argument slot raising (ASR) that is applied specifically to the local functor that takes the QNP in question as an argument. Thus, the scope of a QNP cannot exceed the final output of this local functor. Cf. Hendriks (1987).

c. Control/raising/modal construction may produce a complex predicate via structural rules constrained by a specific pair of modes of combination (e.g., the pair of $\circ_i, \circ_j$, as in, $will \circ_i (play \circ_j tennis) \Rightarrow (will \circ_i play) \circ_j tennis$). This structural rule can go only as far as a (verbal) projection line, such as,

$$T \circ_i (v \circ_i (V \circ_j NP)) \Rightarrow (T \circ_i (v \circ_i V)) \circ i\ \mathbf{NP}.$$

Such complex predicates can be local functors of QNPs.

d. A-bar movement is explained in terms of structural rules constrained by unary operators, $\Diamond, \Box^{\downarrow}$, whose use is required by the category encoded with the Wh-expression. The association is not constrained by the modes of merge between the 'Wh operator' position and the 'trace' position. That is,

$$What \circ_x (did \circ_y (\cdots \circ_z (Meg \circ_j (like \circ_j \Diamond\Box^{\downarrow} t))))$$
$$\Rightarrow\ What \circ_x ((did \circ_y (\cdots \circ_z (Meg \circ_j like))) \circ_j \Diamond\Box^{\downarrow}\mathbf{t})$$

The base grammar system is NL, which is non-associative and non commutative, but to explain certain natural language syntax phenomena which we cannot ignore by any means, which correspond roughly to A-movement and A-bar movement phenomena, I adopt the enriched system $NL_{\Diamond}$, which introduces certain degree of structural association/permutation under modal control. Together with the special semantically motivated rule argument slot raising for QNP scope, which does not influence the syntactic structure but still remains to be a rule of the proposed system, I call the total system $NL_{\Diamond+ASR}$.

For A-movement, I introduce structural rules under the control of merge mode specification, as is indicated in (26c). The indices on the structural connective '$\circ$' indicate the modes of merge, and structural rules apply only if we have certain combinations of such merge modes. Chapter 7 of Uchida (2008) shows how we can use this system to introduce association/permutation within each verbal projection line, which roughly corresponds to the projection line indicated by each sequence of T-$v$-V in Minimalism. The mechanism allows us to create a complex functor within each projection line. Because argument slot raising can apply to such a complex functor, it allows a QNP to take scope within the final output of each verbal projection line. For Wh-extraction, which can cross a tensed boundary, I introduce structural rules under the control of unary operators $\Diamond$ and $\Box^{\downarrow}$, as is indicated in (26d). These structural rules do not expand the scope of QNPs and thus the tensed clause boundary remains valid after the addition of these structural rules. Both the ways of introducing structural rules have already been used by Moortgat and his followers, as in Versmissen (1996), Moortgat (1997), Bernardi (2002) and Vermaat (2006), though they do not distinguish Wh-extraction structure from Controls/raising/modal structures in this way.

## 5 Conclusion

I have argued that QNP scope does not exhibit the properties of standard movement phenomena which require some structure modification operation in Type Logical Grammar. Instead, QNP scope is explained by way of a lexical/phrasal operation that specifically applies to the local functor of the QNP in question. Incompleteness of the grammar is a major problem.

# References


Barwise, J. and R. Cooper (1981). Generalized quantifiers and natural language. *Linguistics and Philosophy 4*, 159–219.

Bernardi, R. (2002). *Reasoning with Polarity in Categorial Type Logic*. Ph. D. thesis, Utrecht University, Utrecht, The Netherlands.

Bruening, B. (2001). QR obeys superiority: Frozen scope and acd. *Linguistic Inquiry 32*, 233–273.

Büring, D. (1995). The great scope inversion conspiracy. In M. Simons and T. Galloway (Eds.), *Proceedings from Semantics and Linguistics Theory V*, pp. 37–53.

Fodor, J. D. and I. A. Sag (1982). Referential and quantificational indefinites. *Linguistics and Philosophy 54*, 355–398.

Hendriks, H. (1987). Type change in semantics: the scope of quantification and coordination. In E. Klein and J. van Benthem (Eds.), *Categories, Polymorphism and Unification.*, Chapter 6, pp. 96–119. Centre for Cognitive Science, University of Edinburgh. Institute for Language, Logic and Information. University of Amsterdam.

Jacobson, P. (1999). Towards a variable-free semantics. *Linguistics and Philosophy 22*, 117–185.

Johnson, K. (2000). How far will quantifiers go? In R. Martin, D. Michaels, and J. Uriagereka (Eds.), *Step by Step*, pp. 187–210. Cambridge, Mass: The MIT Press.

Moortgat, M. (1991). Generalized quantification and discontinuous type constructors. Technical report, Institute for Language and Speech, University of Utrecht.

Moortgat, M. (1997). Categorial type logics. In J. van Benthem and A. ter Meulen (Eds.), *Handbook of logic and language*, Chapter 2, pp. 93–178. Cambridge, Mass: The MIT Press.

Ruys, E. G. (1992). *The scope of Indefinites*. Ph. D. thesis, Utrecht University, Utrecht.

Steedman, M. (2000). *The Syntactic Process*. Cambridge, Mass: The MIT Press.

Uchida, H. (2005a). Double-object in categorial grammar. In J. Gervain (Ed.), *Proceedings of the Tenth ESSLLI student session*, pp. 377–388.

Uchida, H. (2005b). Indefinites: an extra argument slot analysis. In S. Blaho, L. Vicente, and E. Shoorlemeer (Eds.), *Proceedings of Console XIII. ISSN: 1574-499X*, pp. 377–401.

Uchida, H. (2006). Frozen scope in type logical grammar. *UCL Working Paper in Linguistics 18*, 205–237.

Uchida, H. (2008). *Scope Alternation and Type Logical Grammar*. Ph. D. thesis, University College London, London.

Vermaat, W. (2006). *The Logic of Variation; a cross-linguistic account of Wh-question formation*. Ph. D. thesis, Utrecht University, Utrecht, The Netherlands.

Versmissen, K. (1996). *Grammatical Composition: Modes, Models, Modalities, Logical and linguistic aspects of multimodal categorial grammars*. OTS Dissertation series. Utrecht, The Netherlands: LEd.

Winter, Y. (2001). *Flexibility Principles in Boolean Semantics: coordination, plurality and scope in natural language*. Cambridge, Mass: The MIT Press.