SPR4106 – Syntax and semantics in formal terms

Lecture VI: Binding

Syntax-semantics interface

12 March 2015

Binding

(1) a. Per$_i$ vasket seg$_{i/*j}$
b. Peter$_i$ washed himself$_{i/*j}$

(2) a. Per$_i$ vasket ham$_{*i/j}$
b. Peter$_i$ washed him$_{*i/j}$

- Binding is a relation of obligatory referential dependency
- We have seen this before, in control. What's the difference?
  - Not necessarily cross-clausal
  - Bindee but not controllee typically overt
  - Bindee typically non-SUBJ, controllee typically SUBJ

Defining binding

Definition

X binds Y iff X and Y are coindexed and X *outranks* Y

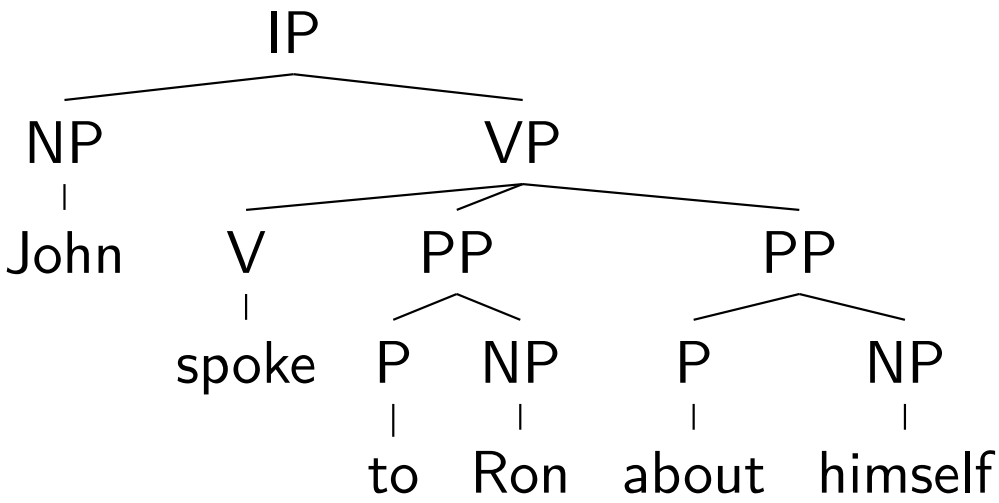
Principle A Reflexives and reciprocals must be bound *locally*

Principle B Pronouns must be free *locally*

- So we need to define the relevant notions of rank and of locality
- LFG assumes that rank is a universal constraint on binding, although the exact notion of rank may vary across languages
- By contrast, the relevant notion of locality differs between lexical items and so the **binding domain** is a lexical property of anaphors
- A note on terminology: Following Falk, anaphors refer to reflexives, reciprocals and pronouns

Rank: the c-structural dimension

(3) a. Joan spoke [to Ron$_i$] [about himself$_i$]
b. *Joan spoke [about himself$_i$] [to Ron$_i$]



- The relevant notion seems to be linear rather than hierarchical

Rank: the a-structural dimension

- Hard to tease apart from relational hierarchy, but may be relevant

(4)
a. We sold the slave to himself.
b. *We sold himself to the slave.
c. We sold the slave himself.
d. *We sold himself the slave.

- The generalization seems to be that the object can bind the second object/oblique
- Alternatively, $\textsc{Beneficiary} \prec \textsc{Theme} \prec \textsc{Goal}$
- Or just linearity?

Rank: the f-structural dimension

(5) a. The derivationalist contradicted himself.
b. *Himself was contradicted by the derivationalist.

- SUBJ binds OBL_θ although in this example, the oblique outranks the subject thematically.

Rank: other relevant hierarchies

Norwegian allows object binders under certain circumstances. A journalist was recently criticized for this:

(6) Han$_i$ spurte Therese Johaug$_j$ om trusene sine$_j$
he$_i$ asked Therese Johaug$_j$ about panties REFL.POSS
'He asked T. J. about her panties'

He would have gotten into even more trouble if he did this

(7) Han$_i$ spurte Therese Johaug$_j$ om trusene sine$_i$
he$_i$ asked Therese Johaug$_j$ about panties REFL.POSS
'He asked T. J. about his panties'

- There are all sorts of hierarchies that exert influence on binding patters (Lødrup 2007)

Rank: Definiteness

- Using questionnaires, Lødrup finds that a. is more acceptable than b.

(8) a. Vi måtte faktisk forsvare dem mot supporterne sine
We must actually defend them against supporters-DEF REFL.POSS

b. Vi vil ikke lenger forsvare spillere mot supporterne sine
We will no longer defend players against supporters-DEF REFL.POSS

- Lødrup claims that *dem* makes for a better binder than *spillere* because it is higher on the definiteness hierarchy

Rank: Topicality (or linearity?)

- Lødrup finds that a. is more acceptable than b.

(9) a. Vi måtte faktisk forsvare dem mot supporterne sine
We must actually defend them against supporters-DEF REFL.POSS

b. Supporterne sine måtte vi faktisk forsvare dem mot
supporters-DEF REFL.POSS must we actually defend them against

- In (9-b) the bindee is more topical than the binder (and also precedes it)

Rank: overtness? genericity?

Full disclosure: I made up the Johaug example. The actual example (from a newspaper) is this

(10) Dette kommer i en annen kategori enn å PRO_i spørre
This comes in another category than to ask
Therese Johaug$_j$ om trusene sine$_j$.
T. J. about panties REFL.POSS
'This is is not in the same ballpark as asking T. J. about her panties.'

It seems that it is easier to get an object binder when the subject is non-overt and generic, as here.

Rankings and gradient grammaticality

- We have seen that many different hierarchies are relevant for determining rank in binding
- The most important one is syntactic rank (f-structure in LFG) and violations of this gives ungrammaticality
- Other hierarchies have gradient effects and may serve to increase e.g. the acceptability of object binders in Norwegian
- Gradient grammaticality is a well-known problem for formal syntax and beyond the scope of this course
- But note that constraint-based frameworks such as LFG are in principle well-placed to deal with this as they can measure the number (and perhaps importance) of constraints being violated

First attempt

Nucleus (coargument domain)

A nucleus or coargumentdomain is the subpart of an f-structure consisting of a PRED feature and all the argument functions it selects

Let us assume that this is the relevant binding domain for reflexives, reciprocals and pronouns. We then get

A A reflexive or reciprocal must be bound in its coargument domain

B A pronoun must be free in its coargument domain

Complementary distribution

(11) The dinosaur$_i$ scared himself/*him$_i$.

(12) The dinosaur$_i$ believes that he$_i$/*himself scared the hamster.

(13) The dinosaur$_i$ believes himself/*him$_i$ to have scared the hamster.

Non-complementary distribution

(14) a. (Kirk and Picard)$_i$ admire their$_i$ officers.
b. Kirk and Picard admire each other's officers.

$$\begin{bmatrix} \text{SUBJ} & [\text{“Kirk and Picard”}] \\ \text{TENSE} & \text{PRES} \\ \text{PRED} & \text{‘admire <subj, obj>’} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{‘officer <poss>’} \\ \text{DEF} & + \\ \text{NUM} & \text{PL} \\ \text{POSS} & [\text{PRED} \quad \text{‘pro’}] \end{bmatrix} \end{bmatrix}$$

- The pronoun is free in its coargument domain
- The reciprocal is bound in its complete nucleus (the minimal f-structure with a SUBJ)

Asymmetries of principles A and B

A A reflexive or reciprocal must be bound in its complete nucleus

B A pronoun must be free in its coargument domain

- There is an asymmetry in the binding domains that are relevant for principles A and B
- The LFG view is that this is a *lexical* property of the relevant words
- Norwegian has played an important role here, as there are so many items with different properties: *ham*, *seg*, *seg selv*, *ham selv*, *sin*, *hans*, *hverandre* all seem to have different binding domains

Another binding domain: the finite clause

The traditional claim is that *seg* has a larger binding domain than *seg selv*

- *seg selv* must be bound in its complete nucleus
- *seg* must be bound in its finite clause

(15) Han$_i$ bad oss hjelpe seg$_i$.
He asked us help REFL
'He asked us to help him.'

Since there are two clauses, there are two potential subject binders (subject to feature compatibility):

(16) Per$_i$ ba Jon$_j$ vaske seg.
Peter asked John wash REFL
'Peter asked John to wash him/himself.'

An even larger binding domain: the sentence

In fact, there is evidence that Norwegian reflexives can be bound in even larger domains

(17) Her kan alle som synes turen passer for seg være med
here can all who think trip.DEF suits for REF være med
'All people who think that the trip suits them can join here.'

(18) Klager$_i$ anfører å ha krav på innsyn i
complainant states to have claim for inspection of
opplysninger som gjelder seg selv$_i$.
information that concerns REFL.SELF.
'The complainant states that he has the right to see information that concerns him.'

- Inanimacy of the intervening subject seems to a relevant

Summing up the binding domains

Coargument domain Selected functions in the same f-structure

Complete nucleus : the smallest f-structure with a SUBJ

Finite domain : the smallest f-structure with TENSE

Root domain : the whole f-structure

- All of these come in positive and negative versions, often called binding and disjointness/obviation conditions

Subject orientation

Binders must always outrank bindees, but there may or may not be an additional requirements

Subject binding : the binder must be a SUBJ

GF binding : the binder can have any GF

- Both of these also exist in negative/disjointness/obviative versions
- Combining the various criteria leads to a formal space for the typology of reflexives

Formalizing the binding constraints

(19) Aesop$_i$ said that Grimm$_j$ told Andersen$_k$ a story about himself$_{*i/j/k}$.

- *himself* must be bound by a GF in its minimal complete nucleus, which is the complement clause
- Both *Grimm* and *Andersen* outrank *himself* and so are eligible binders

Formalizing the binding constraints

$$\begin{bmatrix}
\text{SUBJ} & [\text{“Aesop”}] \\
\text{TENSE} & \text{PAST} \\
\text{PRED} & \text{‘say <subj, comp>’} \\
\text{COMP} & \begin{bmatrix}
\text{PRED} & \text{‘tell <subj, obj, obj}_\theta\text{>’} \\
\text{TENSE} & \text{PAST} \\
\text{TYPE} & \text{DECL} \\
\text{SUBJ} & [\text{“Grimm”}] \\
\text{OBJ} & [\text{“Andersen”}] \\
\text{OBJ}_\theta & \begin{bmatrix}
\text{DEF} & - \\
\text{PRED} & \text{‘story <obl}_\theta\text{ obj>’} \\
\text{NUM} & \text{SG} \\
\text{OBL}_\theta & [\text{OBJ} \; [\text{PRED} \; \text{‘pro’}]]
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}$$

- The complement clause is the minimal complete nucleus
- How can we define that “inside-out”, from the perspective of the binder?

Formalizing the binding constraints

$$\begin{bmatrix}
\text{SUBJ} & [\text{“Aesop”}] \\
\text{TENSE} & \text{PAST} \\
\text{PRED} & \text{‘SAY <SUBJ, COMP>’} \\
\text{COMP} & \begin{bmatrix}
\text{PRED} & \text{‘TELL <SUBJ, OBJ, OBJ}_\theta\text{>’} \\
\text{TENSE} & \text{PAST} \\
\text{TYPE} & \text{DECL} \\
\text{SUBJ} & [\text{“Grimm”}] \\
\text{OBJ} & [\text{“Andersen”}] \\
\text{OBJ}_\theta & \begin{bmatrix}
\text{DEF} & - \\
\text{PRED} & \text{‘STORY <OBL}_\theta\text{ OBJ>’} \\
\text{NUM} & \text{SG} \\
\text{OBL}_\theta & [\text{OBJ } [\text{PRED } \text{‘PRO’}]]
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}$$

- $((\text{OBJ}_\theta\ \text{OBL}_\theta\ \text{OBJ}\uparrow)\ \text{GF}\ \text{INDEX}) = (\uparrow\text{INDEX})$
- Correct here but doesn't generalize

Formalizing the binding constraints

$$\begin{bmatrix}
\text{SUBJ} & [\text{“Aesop”}] \\
\text{TENSE} & \text{PAST} \\
\text{PRED} & \text{‘SAY <SUBJ, COMP>’} \\
\text{COMP} & \begin{bmatrix}
\text{PRED} & \text{‘TELL <SUBJ, OBJ, OBJ}_\theta\text{>’} \\
\text{TENSE} & \text{PAST} \\
\text{TYPE} & \text{DECL} \\
\text{SUBJ} & [\text{“Grimm”}] \\
\text{OBJ} & [\text{“Andersen”}] \\
\text{OBJ}_\theta & \begin{bmatrix}
\text{DEF} & - \\
\text{PRED} & \text{‘STORY <OBL}_\theta\text{ OBJ>’} \\
\text{NUM} & \text{SG} \\
\text{OBL}_\theta & [\text{OBJ } [\text{PRED } \text{‘PRO’}]]
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}$$

- $((\uparrow \text{COMP GF}^* \text{ COMP GF INDEX}) = (\uparrow \text{INDEX})$
- Also doesn't generalize

Formalizing the binding constraints

$$\begin{bmatrix}
\textsc{subj} & [\text{“}\textsc{Aesop}\text{”}] \\
\textsc{tense} & \textsc{past} \\
\textsc{pred} & \text{‘}\textsc{say}\ \langle \textsc{subj},\ \textsc{comp}\rangle\text{’} \\
\textsc{comp} & \begin{bmatrix}
\textsc{pred} & \text{‘}\textsc{tell}\ \langle \textsc{subj},\ \textsc{obj},\ \textsc{obj}_\theta\rangle\text{’} \\
\textsc{tense} & \textsc{past} \\
\textsc{type} & \textsc{decl} \\
\textsc{subj} & [\text{“}\textsc{Grimm}\text{”}] \\
\textsc{obj} & [\text{“}\textsc{Andersen}\text{”}] \\
\textsc{obj}_\theta & \begin{bmatrix}
\textsc{def} & - \\
\textsc{pred} & \text{‘}\textsc{story}\ \langle \textsc{obl}_\theta\ \textsc{obj}\rangle\text{’} \\
\textsc{num} & \textsc{sg} \\
\textsc{obl}_\theta & [\textsc{obj}\ [\textsc{pred}\ \text{‘}\textsc{pro}\text{’}]]
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}$$

- $((\textsc{gf}^*\ \textsc{gf}\uparrow)\ \textsc{gf}\ \textsc{index}) = (\uparrow \textsc{index})$ is too general
- We want to constrain not the path, but the presence of a $\textsc{subj}$ “off the path”

Offpath constraints

- Ordinary functional uncertainties just let us constrain the path (outside-in or inside-out)
- Off-path constraints let ut constrain the contents of the f-structures along the path
- We use $\rightarrow$ to refer to the current f-structure and build a functional uncertainty from there

GF	any function
$(\rightarrow \mathrm{SUBJ})$	that contains a SUBJ
GF	any function
$\neg(\rightarrow \mathrm{SUBJ})$	that does not contain a SUBJ

Stating binding conditions

Principle A

$$((\ \ \mathrm{GF}^{*}\ \ \mathrm{GF}\uparrow)\ \mathrm{GF}\ \mathrm{INDEX}) = (\uparrow \mathrm{INDEX})$$
$$\neg(\rightarrow \mathrm{SUBJ})$$

Binding by subjects in the minimal finite clause

$$((\ \ \mathrm{GF}^{*}\ \ \mathrm{GF}\uparrow)\ \mathrm{SUBJ}\ \mathrm{INDEX}) = (\uparrow \mathrm{INDEX})$$
$$\neg(\rightarrow \mathrm{TENSE})$$

Exercise: Norwegian binding conditions

Provide equations and example sentences for the following Norwegian items, assuming Falk's description is correct:

ham	may not be bound within its coargument domain
seg	must be bound by a SUBJ in the minimal finite clause but not within its coargument domain
seg selv	must be bound by a SUBJ within its coargument domain
ham selv	must be bound by a nonSUBJ within its complete nucleus
sin	must be bound by a SUBJ within the minimal finite clause
hans	may not be bound by the SUBJ of its complete nucleus
hverandre	must be bound in its complete nucleus

Solution

ham	$(($	GF	$\uparrow)\ \textsc{gf index}) \neq (\uparrow \textsc{index})$
seg	$(($	$\textsc{gf}^{+}$	$\textsc{gf} \uparrow)\ \textsc{subj index}) = (\uparrow \textsc{index})$
	$\neg(\rightarrow \textsc{tense})$		
seg selv	$(($	GF	$\uparrow)\ \textsc{subj index}) = (\uparrow \textsc{index})$
ham selv	$(($	$\textsc{gf}^{*}$	$\textsc{gf} \uparrow)\ \textsc{gf}\backslash\textsc{subj index}) = (\uparrow \textsc{index})$
	$\neg(\rightarrow \textsc{subj})$		
sin	$(($	$\textsc{gf}^{*}$	$\uparrow)\ \textsc{subj index}) = (\uparrow \textsc{index})$
	$\neg(\rightarrow \textsc{tense})$		
hans	$(($	$\textsc{gf}^{*}$	$\uparrow)\ \textsc{subj index}) \neq (\uparrow \textsc{index})$
	$\neg(\rightarrow \textsc{subj})$		
hverandre	$(($	$\textsc{gf}^{*}$	$\uparrow)\ \textsc{gf index}) = (\uparrow \textsc{index})$
	$\neg(\rightarrow \textsc{subj})$		

Examples

ham	Per$_i$ så ham$_{*i/j}$.
seg	Per$_i$ ba Jon hjelpe seg$_i$.
seg selv	Jon$_i$ hjalp seg$_i$ selv.
ham selv	Per ga Jon$_i$ et bilde av ham$_i$ selv.
sin	Per$_i$ ga Jon bildet sitt$_i$.
hans	Per ga Jon$_i$ bildet hans$_i$.
hverandre	Per$_i$ og Jon$_j$ hjalp hverandre$_{i+j}$.

Exercise: binding into argument PPs

In LFG, it is common to assume that argument PPs can have three different roles

XCOMP i.e. the PP is predicated of a coargument (typically the OBJ)

OBL_θ – mostly locatives and goals

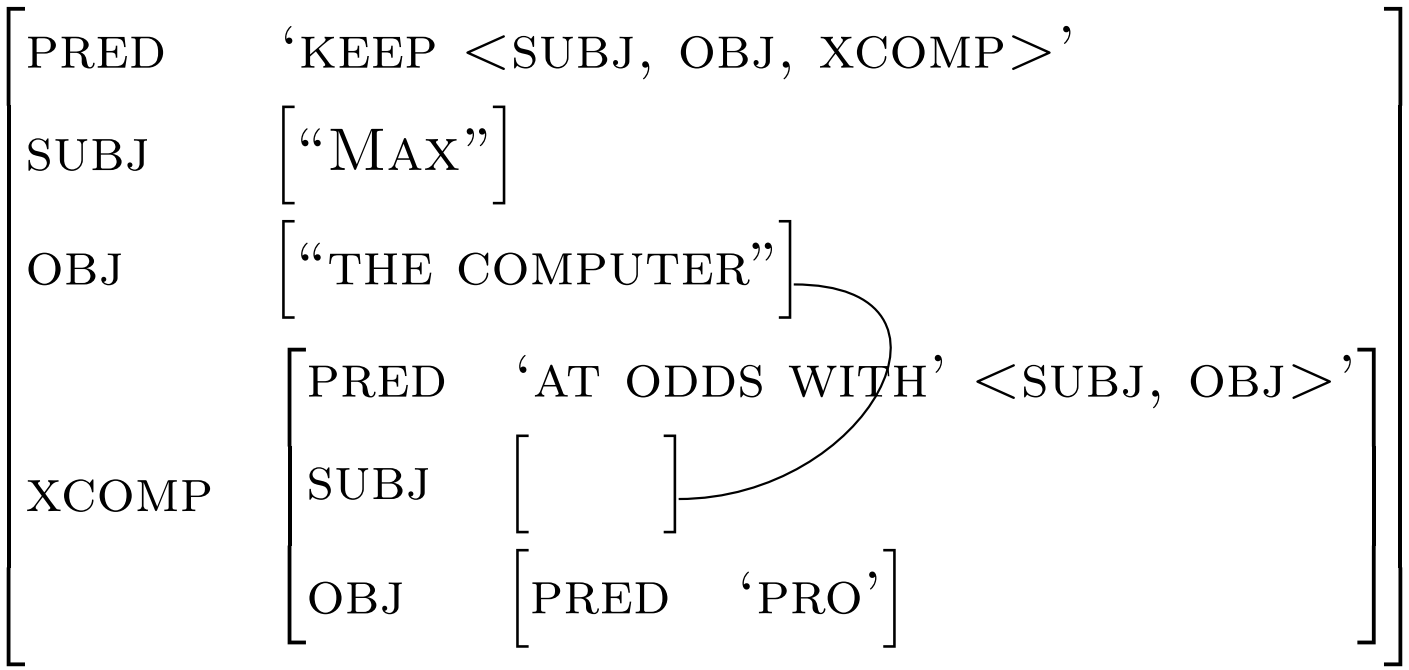
OBL_θ OBJ i.e. the object of P is the real argument of the verb

Three corresponding examples are

1. Max_i kept the computer at odds with him/*himself$_i$.
2. Max_i put the computer near him/himself$_i$.
3. Max_i gave a computer to himself/*him$_i$.

Draw (simplified) f-structures and explain the binding patterns. You can consider *at odds with* a single complex lexical item which is transitive.

Solution 1



- The complete nucleus and the coargument domain of the lower OBJ coincide: it is the XCOMP. The pronoun can be used because it is free in this domain; the reflexive cannot be used because it is not bound in this domain.

Solution 2

$$\begin{bmatrix} \text{PRED} & \text{`PUT <SUBJ, OBJ, OBL}_\theta\text{>'} \\ \text{SUBJ} & \begin{bmatrix} \text{“MAX”} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{“THE COMPUTER”} \end{bmatrix} \\ \text{OBL}_\theta & \begin{bmatrix} \text{PRED} & \text{`NEAR <OBJ>'} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

- The coargument domain of the embedded object is the OBL_θ. The pronoun can be used because it is free in this domain.
- The complete nucleus of the embedded object is the whole f-structure, since that is the only one that contains a SUBJ. The reflexive can be used because it is bound in this domain.

Solution 3

$$\begin{bmatrix} \text{PRED} & \text{`GIVE } <\text{SUBJ, OBJ, OBL}_\theta \text{ OBJ}>\text{'} \\ \text{SUBJ} & \begin{bmatrix}\text{“Max”}\end{bmatrix} \\ \text{OBJ} & \begin{bmatrix}\text{“the computer”}\end{bmatrix} \\ \text{OBL}_\theta & \begin{bmatrix}\text{OBJ} & \begin{bmatrix}\text{PRED} & \text{`PRO'}\end{bmatrix}\end{bmatrix} \end{bmatrix}$$

- The complete nucleus and the coargument domain of the embedded object coincide: it is the whole f-structure. (Notice that this is so because *give* on Falk's analysis selects directly for the OBL_θ OBJ.)
  The pronoun cannot be used because it is not free in this domain.
  The reflexive can be used because it is bound in this domain.

Compositionality

Frege's principle

The meaning of a composite expression is a function of the meaning of its immediate constituents and the way these constituents are put together.

- "the way these constituents are put together" $\approx$ syntax, so syntax is an important input to semantics
- However, it is clearly not the case that the way meanings are put together reflect the way constituents are put together in the surface structure
- We have already seen *raising*

Control and raising

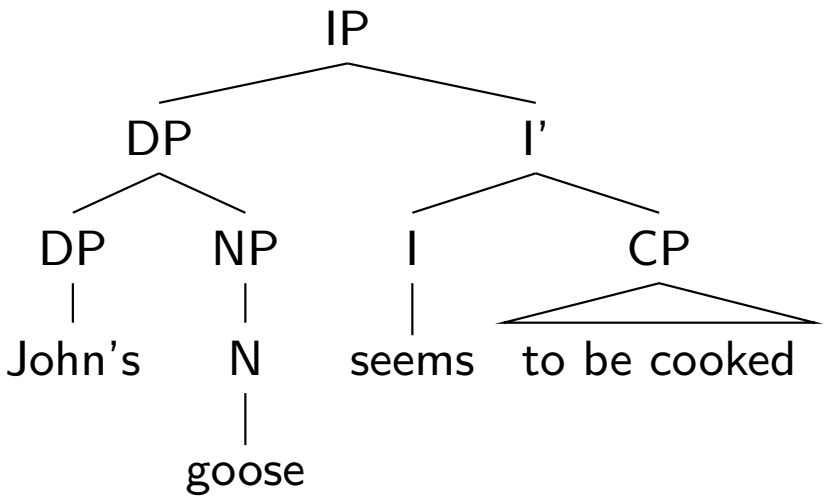
(20) a. John's goose seems [to be cooked].
b. #John's goose tried [to be cooked].

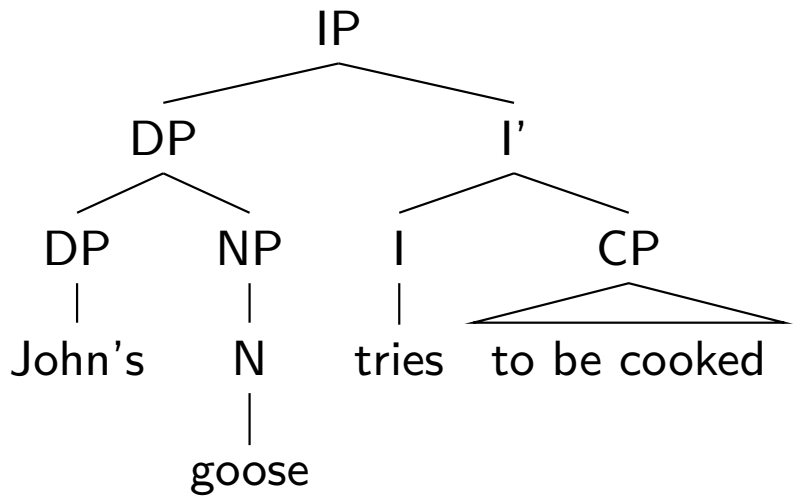
(21) a. I believe John's goose [to be cooked].
b. #I persuaded John's goose [to be cooked].

- With some verbs, we are allowed to "reconstruct" the idiom *x's goose is cooked* before interpretation; with others not

C-structure of control and raising

Recall that LFG does not distinguish between control and raising in the c-structure:

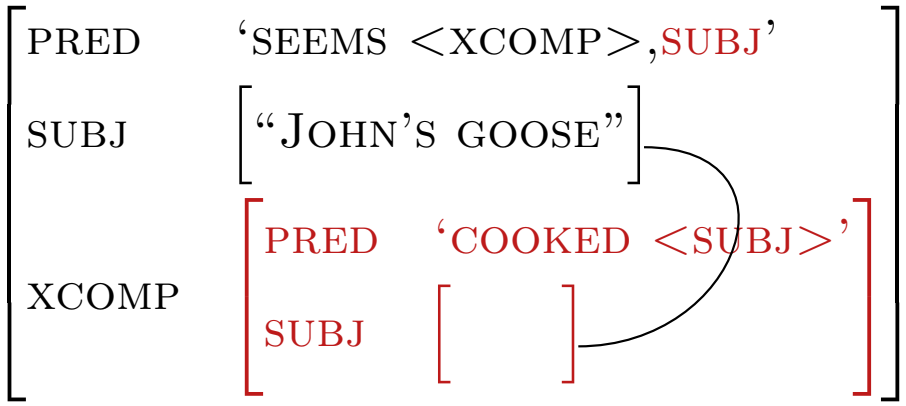


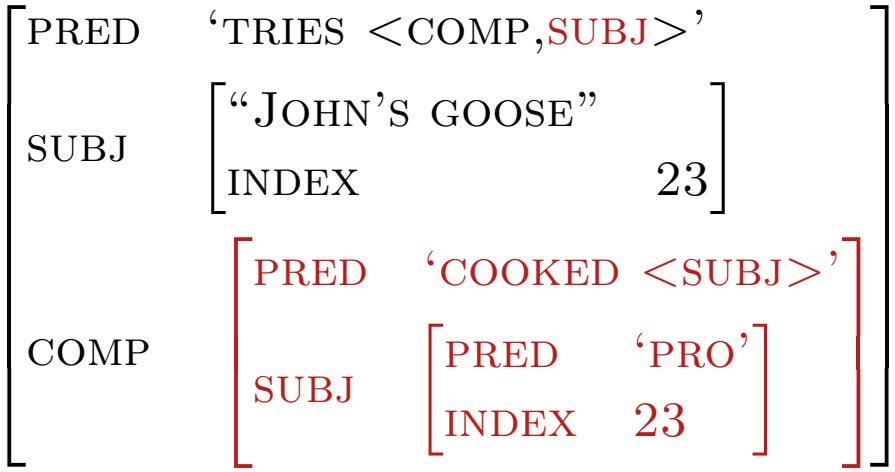


Modularity in LFG

- c-structure is where we account for "overt syntax" – word order and constituency
- it is a level that represents a lot of cross-linguistic varation
- $\rightarrow$ not suitable as the input to semantics
- by contrast, f-structure is more abstract, less variable across languages – and more suitable as the input to semantics

Control and raising at f-structure





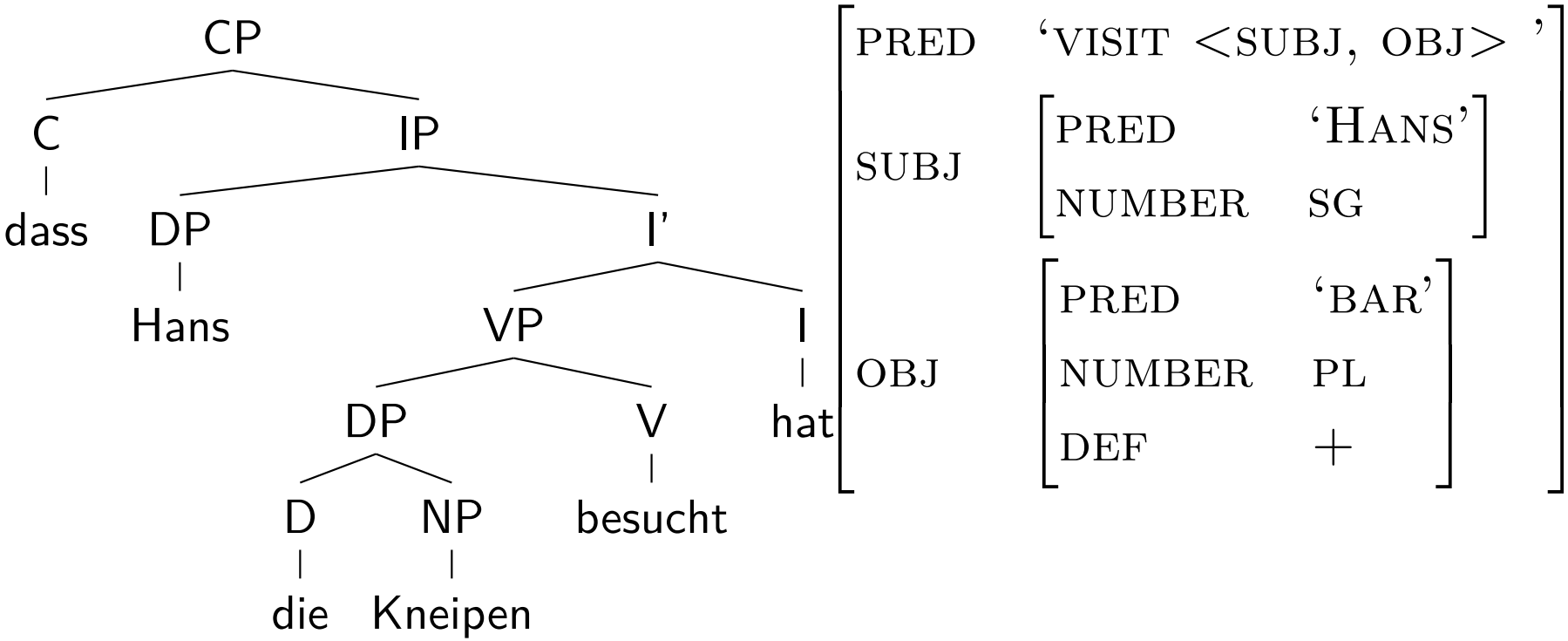
- In raising but not control the f-structure *does* piece together the idiom
- Moreover, the f-structure tells us that the upper subject position is only interpreted in control structures, not in raising

Prodrop

$$\begin{bmatrix} \text{PRED} & \text{`SING } <\text{SUBJ}>\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PERSON} & 3 \end{bmatrix} \end{bmatrix}$$

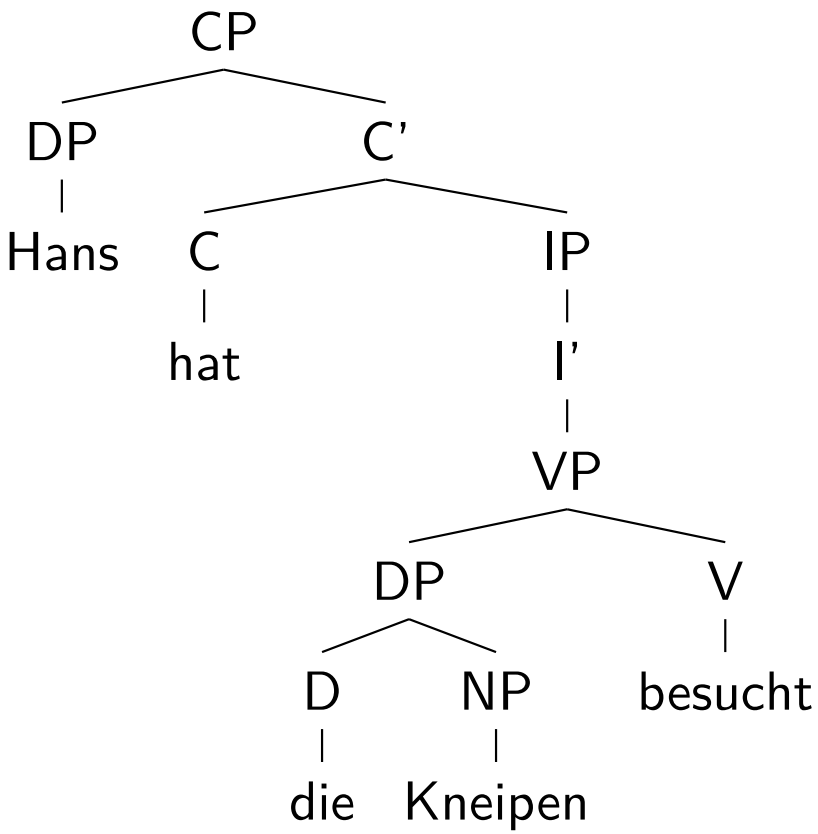
- We need a subject for the semantics!
- The c-structure has too little information

Variable head position



- Opposite problem: too much information in the c-structure

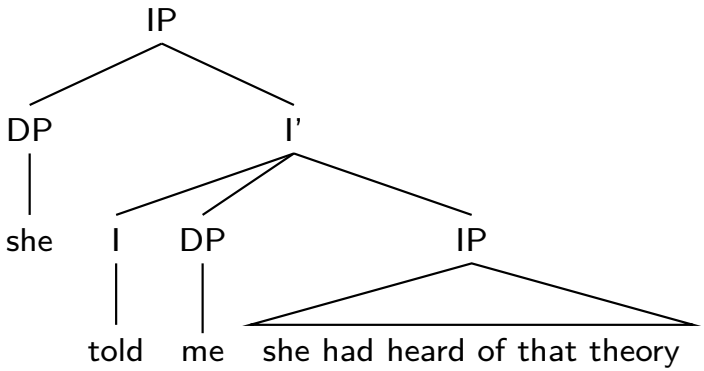
Variable head position



$$\begin{bmatrix} \text{PRED} & \text{`VISIT <SUBJ, OBJ>'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`HANS'} \\ \text{NUMBER} & \text{SG} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`BAR'} \\ \text{NUMBER} & \text{PL} \\ \text{DEF} & + \end{bmatrix} \end{bmatrix}$$

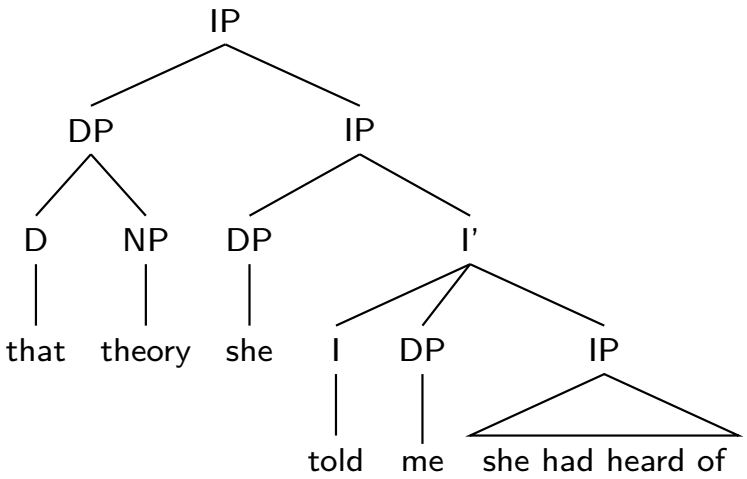
- Opposite problem: too much information in the c-structure

Topicalization



$$\begin{bmatrix} \text{PRED} & \text{TELL } \langle \text{SUBJ, OBJ, COMP} \rangle \\ \text{SUBJ} & \begin{bmatrix} \text{“SHE”} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{“ME”} \end{bmatrix} \\ \text{COMP} & \begin{bmatrix} \text{PRED} & \text{‘HEAR } \langle \text{SUBJ, OBL}_\theta \rangle \text{ ’} \\ \text{SUBJ} & \begin{bmatrix} \text{“SHE”} \end{bmatrix} \\ \text{OBL}_\theta & \begin{bmatrix} \text{“THAT THEORY”} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Topicalization



$$\begin{bmatrix} \text{PRED} & \text{TELL } \langle \text{SUBJ, OBJ, COMP} \rangle \\ \text{TOPIC} & \boxed{1}\ [\text{“THAT THEORY”}] \\ \text{SUBJ} & [\text{“SHE”}] \\ \text{OBJ} & [\text{“ME”}] \\ \text{COMP} & \begin{bmatrix} \text{PRED} & \text{‘HEAR } \langle \text{SUBJ, OBL}_\theta \rangle\text{’} \\ \text{SUBJ} & [\text{“SHE”}] \\ \text{OBL}_\theta & \boxed{1} \end{bmatrix} \end{bmatrix}$$

Extended coherence

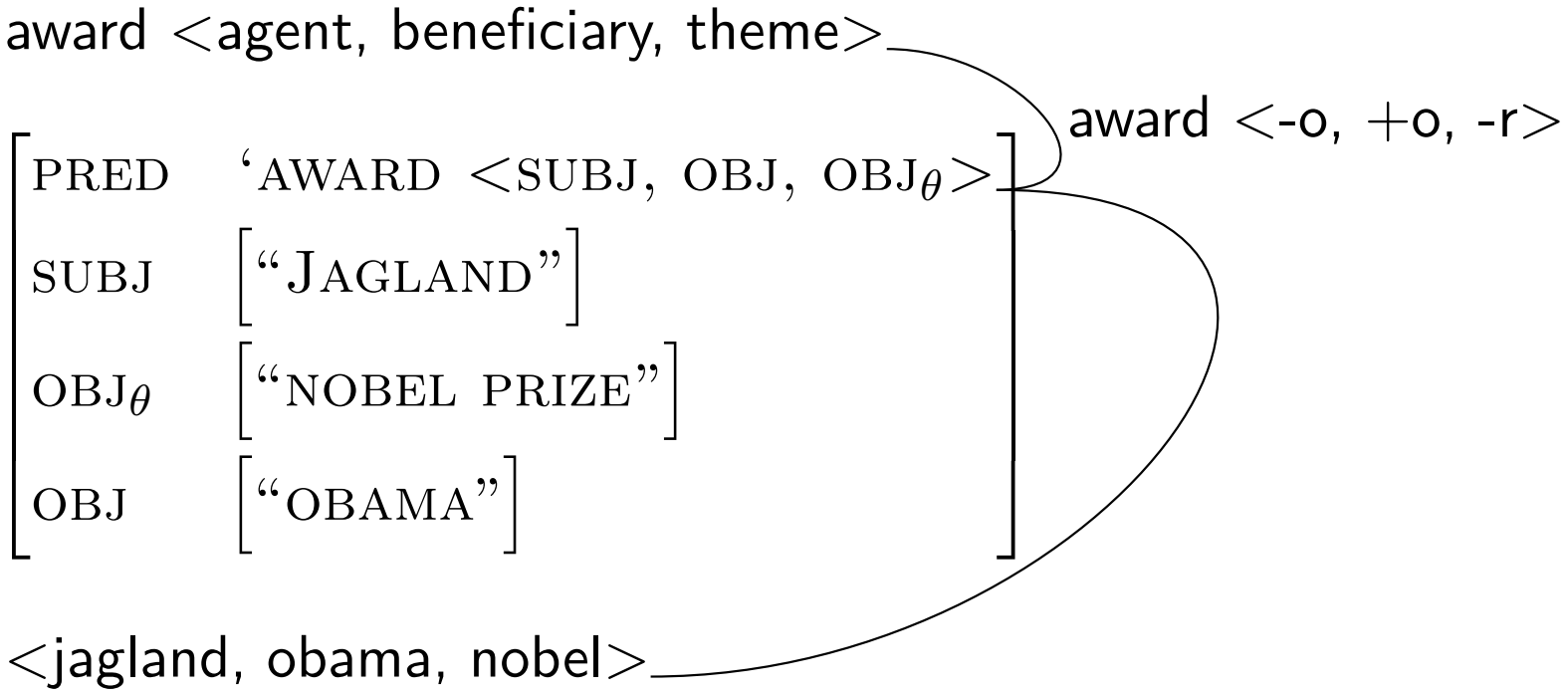
All functions in an f-structure must be incorporated into the semantics. Argument functions are subject to the Coherence condition. Discourse functions must be identified with arguments or adjuncts. Adjuncts must be in f-structures containing PREDs.

Towards the syntax-semantics interface

- Although f-structures are considerably closer to semantics than c-structures, the modular architecture of LFG still insists that it is a *syntactic* structure
- There is a separate semantic structure and there is a mapping between f-structure and s-structure
- In practice, all frameworks need to assume an interface mapping from abstract syntax to the input to semantics, although some will do this in the syntax itself (logical form)

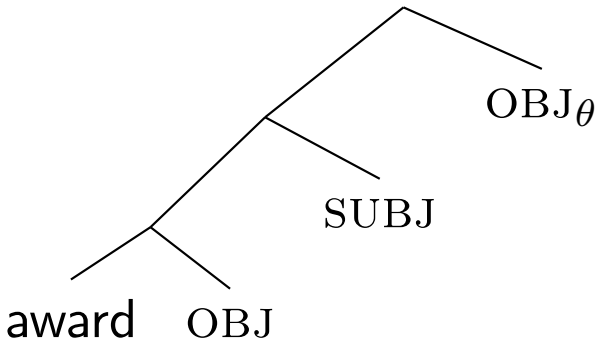
Relating f-structures and semantics

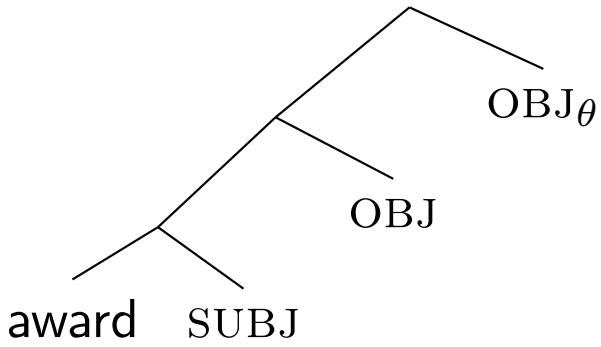
- As you will see later in the course, the *extension* of the verb *award* is the set of triples $< x, y, z >$ such that x is the agent, y the beneficiary, z the theme of an award

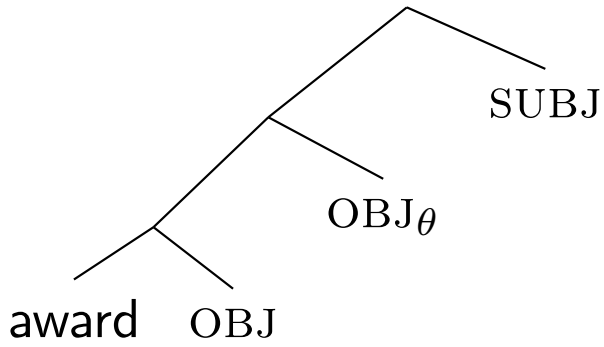


Binary branching

- There is a nice correspondence between the thematic structure, the functional structure and the semantics of the whole
- "The meaning of a composite expression is a function of the meaning of its immediate constituents and the way these constituents are put together."
- An PRED like 'award <SUBJ, OBJ, OBJ_θ> is "flat" in the same way – like the corresponding semantics – but this also means there's no obvious notion of immediate constituents
- Notice that we can "binarize" this in a number of ways







Take home message

- The abstract f-structure syntax is the input to semantics
- You can break it down to a binary tree, not necessarily respecting the corresponding c-structure (although we don't need to violate it without any reason either)
- For example, it is not necessary for the semantic composition to proceed in different ways in languages with different word order