# Logical Grammar: More Linear Grammar

Carl Pollard

Department of Linguistics
Ohio State University

July 11, 2011

# Where Do Predicative NPs Come From? (1/2)

- In order for sentences like *Chiquita is lazy* to get the right semantics, the predicational copula must predicate its complement's meaning to its subject's meaning.
- And so its own meaning must be the **predication** combinator $\mathsf{prd} =_{\text{def}} \lambda_{xP}.Px$:

  $\vdash \lambda_{st}.s \cdot \text{is} \cdot t; A \multimap (A \multimap \text{Prd}) \multimap \text{S}; \mathsf{prd}\ (A \leq \text{NOM})$

- But this won't work if the complement is an NP such as *Burrita*; we need a version of *Burrita* (or any other NP that could occur postcopularly) that has tectotype PrdN and a property meaning, in the present case $\lambda_x.x\ \mathsf{equals}\ \mathsf{b}$, where $\mathsf{equals} : \text{e} \rightarrow \text{e} \rightarrow \text{p}$ is subject to the meaning postulate:

$$\vdash \forall_{xyw}.(x\ \mathsf{equals}\ y)@w \leftrightarrow (x = y)$$

# Where Do Predicative NPs Come From? (2/2)

There are a couple of ways to manage this, which are logically indistinguishable (because they are mutually derivable):

1. a nonlogical rule:

$$\frac{\Gamma \vdash a; \mathrm{Neu}; b}{\Gamma \vdash a; \mathrm{PRO} \multimap \mathrm{PrdN}; \mathsf{equals}\ b}$$

   This is likely to look bad to a linguist because they expect rules to be general (or, in logical terms, schematic).

2. a lexical entry:

$$\vdash \lambda_s.s; \mathrm{Neu} \multimap \mathrm{PRO} \multimap \mathrm{PrdN}; \mathsf{equals}$$

   Lexical entries like this are reminiscent of 'null functional heads' in the transformational tradition.

Either way we can derive:

$\vdash$ chiquita $\cdot$ is $\cdot$ burrita; S; $\mathsf{c\ equals\ b}$

# Three Kinds of Prepositional Phrases

The term 'prepositional phrase' is used for (at least) three different kinds of expressions in English:

1. Pedro depends **on Chiquita**. (semantically vacuous)
2. **On Chiquita** is Pepito's favorite place to be. (refers to a location (spatiotemporal region))
3. Pepito is **on Chiquita**. (predicates being at a location)

# Semantically Vacuous Prepositions

- PPs with specific semantically vacuous prepositions can be subcategorized for by verbs, e.g.

  $$\vdash \lambda_s.\text{depend} \cdot s; \text{On} \multimap \text{PRO} \multimap \text{Bse}; \lambda_{yx}.\mathsf{depend}\ x\ y$$

- We analyze them as having different tectotypes, e.g. On, By, For, By, etc., with the meaning of the PP determined by the prepositional object:

  $$\frac{\vdash \lambda_s.\text{on} \cdot s; \text{Acc} \multimap \text{On}; \lambda_x.x \qquad \vdash \text{chiquita}; \text{Acc}; \mathsf{c}}{\vdash \text{on} \cdot \text{chiquita}; \text{On}; \mathsf{c}}$$

- There doesn't seem to be any reason to consider different semantically vacuous prepositions as belonging to a common tectotype.

# Nonpredicative Locative Prepositions

- Some prepositions combine with an NP to form an expression which refers to a certain location associated with the entity denoted by that NP.
- Let us call such expressions **locatives** (Loc) and such prepositions **nonpredicative locative** prepositions.
- Presumably they are (roughly speaking) some kind of NP, but we won't try to answer now the question of how to fit them into our ordering of basic tectotypes.
- Assuming that locations are certain kinds of entities, then the meaning of a locative preposition is a function that maps entities to an associated locations, e.g. $\vdash \mathsf{on} : \mathrm{e} \rightarrow \mathrm{e}$, so that $(\mathsf{on}\ \mathsf{c})$ denotes the 'on Chiquita' location.
- So we have lexical entries like:

$$\vdash \lambda_s.\mathrm{on} \cdot s; \mathrm{Acc} \multimap \mathrm{Loc}; \mathsf{on}$$

# Prepositions that Predicate Location (1/2)

- Many prepositions, here analyzed as of tectotype Acc $\multimap$ PrdP, can predicate:

  1. This present is **for** you.
  2. This book is **about** bats.
  3. Your argument is **without** merit.

- Among these are ones that predicate location of the subject denotation at a location associated with the denotation of the prepositional object:

  1. Pepito is on Chiquita.
  2. Chiquita is behind Pedro.
  3. Pedro is beside Maria.

- Let's call these **predicative locative prepositions**.

# Prepositions that Predicate Location (2/2)

- It seems clear that the location at which a predicative locative PP locates the subject denotation is the **same** location as the one denoted by the corresponding nonpredicative locative PP.
- E.g. *Pepito is on Chiquita* locates Pepito at the location denoted by the nonpredicative locative PP *on Chiquita*
- We can analyze this correspondence with a nonlogical rule

$$\frac{\Gamma \vdash s; \mathrm{Loc}; l}{\Gamma \vdash s; \mathrm{PRO} \to \mathrm{PrdP}; \lambda_x.\mathsf{at}\ x\ l}$$

  or the equivalent lexical entry:

  $\vdash \lambda_s.s; \mathrm{Loc} \multimap \mathrm{PRO} \multimap \mathrm{PrdP}; \lambda_{lx}.\mathsf{at}\ x\ l$

- Note that this rule is nonlogical in a strong, semantic sense, because its meaning contribution involves the nonlogical constant at, and so is not a combinator, not even a logical constant.

# More about Nonlogical Rules

- More examples: rules that turn Ns into NPs; rules that turn NP $\multimap$ S into relative clauses; rules for forming absolutives
- Do languages have lots of nonlogical rules, or just a few?
- Are nonlogical rules which are semantically nonlogical the norm or are they exceptional?
- Are the logical-constant meanings of NL nonlogical rules always linear?
- What is the range of possible non-logical meanings for NL nonlogical rules?

# Scope of Quantification NPs (QPs)

- There are as many approaches to this topic as there are syntactic framewords!
  - Chomskyan frameworks: **quantifier raising**, aka **covert movement**
  - Montague Grammar: **quantifying in**, aka **quantifier lowering**
  - type-logical grammar: Moortgat's q-combinator
  - HPSG: Cooper storage
- LG follows Oehrle (1994), which implements a version of quantifier lowering using $\beta$-reduction in the pheno calculus.

# Scope of QPs in LG (1/2)

- For expository simplicity we ignore the subtypes of NPs and just call them NPs, but the quantification theory interacts correctly with the subtyping.
- As in CG generally, quantified nounphrases are analyzed syntactically not as NP but rather as a 'raised' type, and correspondingly in the semantics.
- In LG terms, that means tectotype $(\mathrm{NP} \multimap \mathrm{S}) \multimap \mathrm{S}$, which we hereafter abbreviate as QP. and semantic type $\mathrm{p}_1 \rightarrow p$.
- Correspondingly, determiners are not $\mathrm{N} \multimap \mathrm{NP}$ but rather $\mathrm{N} \multimap \mathrm{QP}$ (with corresponding semantic type $\mathrm{p}_1 \rightarrow \mathrm{p}_1 \rightarrow \mathrm{p}$).

# Scope of QPs in LG (2/2)

- In the simplest case where the QP is the subject of an intransitive, we get derivations lie the following:

$$\dfrac{\dfrac{\vdash \lambda_{s\,f}.f\ (\text{every} \cdot s); \text{N} \multimap \text{QP}; \mathsf{every} \qquad \vdash \text{donkey}; \text{N}; \mathsf{donkey}}{\vdash \lambda_{f}.f\ (\text{every} \cdot \text{donkey}); \text{QP}; \mathsf{every\ donkey}} \qquad \vdash \lambda_s.s \cdot \text{brays}; \text{NP} \multimap \text{S}; \mathsf{bray}}{\vdash \text{every} \cdot \text{donkey} \cdot \text{brays}; \text{S}; \mathsf{every\ donkey\ bray}}$$

The interesting pheno $\beta$-reduction takes place in the last proof step.

- The truth conditions are given by following theorem of HS:

$$\vdash \forall_{PQw}.(\mathsf{every}\ P\ Q)@W \leftrightarrow \forall_x(P\ x)@w \rightarrow (Q\ x)@w$$

- So if our world is $w_0$, then the sentence is true iff

$$\forall_x.(\mathsf{donkey}\ x)@w_0 \rightarrow (\mathsf{bray}\ x)@w_0$$

# More Examples

Working through these clarifies how the analysis of scope works.

1. Pedro beats every donkey.
   Here, *every donkey* is the major premiss of the last proof step, and it gets 'lowered' into the object position.
2. Every farmer beats Chiquita.
   Here, to get started, we need to posit a trace for the subject. After the verb combines with the trace and the object, we bind the trace and then lower the QP into the subject position!
3. Every farmer beats a donkey.
   Here, depending on the analysis, we get two different semantics:
   a. every farmer $(\lambda_x.\text{a donkey }(\lambda y.x \text{ beat } y))$
   b. a donkey $(\lambda_y.\text{every farmer }(\lambda x.x \text{ beat } y))$

# Control (1/3)

- We saw that the tectotype PRO is used in lexical entries for the unrealized subject of nonfinite verbs (and predicatives) where the subject plays a semantic role (and so dummy subjects are disallowed).
- This lets the verb 'communicate' how its subject should be realized as the subject or object of a higher raising verb.
- But expressions with a PRO subject requirement are not always complements of raising verbs. For example, they can themselves be subjects, as in *to err is normal*. Here the property of being normal is being predicated of another property (the property of erring).
- Expressions with a PRO subject requirement can also be complements of **control** verbs (or adjectives), which (in a sense to be made precise) 'identify' the unrealized subject semantically with one of their own arguments (either the subject or the object)

# Control (2/3)

- Examples:

  1. Chiquita tried to sing.
  2. Pedro persuaded Chiquita to sing.

- Verbs like these are often analyzed as describing a relation between one or two entities and a proposition about one of those entities (in these examples, the proposition about Chiquita that she sings).
- That entity (here, Chiquita), or the corresponding argument position of the higher verb (subject of *tried* or object of *persuaded*), is said to *control* the PRO subject of the complement.
- In such cases the higher verb (or predicative adjective) is called a **control** verb.

# Control (3/3)

- Control verbs are also called **equi** verbs because in early TG they were analyzed by a transformation ('equi-NP deletion') that deleted the complement subject (which was assumed to be identical with the controller).
- By comparsion, raising verbs in TG were analyzed by a different transformation ('raising') that moved the complement subject to a higher position in the tree.
- As in G/HPSG, our LG analysis of control doesn't make a syntactic (= tectogrammatical) connection between the complement subject and the controller, but instead handles the connection in the semantics:

$\vdash \lambda_{st}.s \cdot \text{tries} \cdot t; \text{Nom} \multimap (\text{PRO} \multimap \text{Inf}) \multimap \text{S}; \lambda_{xP}.\mathsf{try}\ x\ (P\ x)$

$\vdash \lambda_{stu}.s \cdot \text{persuades} \cdot t \cdot u; \text{Nom} \multimap \text{Acc} \multimap (\text{PRO} \multimap \text{Inf}) \multimap \text{S}; \lambda_{xyP.}.\mathsf{persuade}\ x\ y\ (P\ y)$

# Grand Finale

- We use everything we know to analyze an example of an **unbounded dependency** construction, traditionally known as **tough**-movement.
- How is it that all these sentences mean the same thing?

  1. To please John is easy for Mary.
  2. It is easy for Mary to please John.
  3. John is easy for Mary to please.

  The last one is the hard one: how did *John* get into the main clause subject position?