Predicates *and* Formulas: Evidence from Ellipsis

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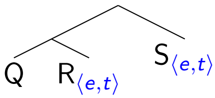
Scope-taking and the syntax-semantics interface



Predicates

Heim and Kratzer (1998); Jacobson (in press); Barker and Shan (in press); most type-logical/ccg analyses

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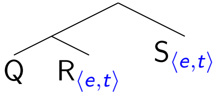
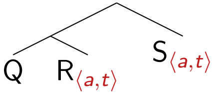




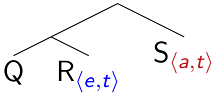
Predicates

Heim and Kratzer (1998); Jacobson (in press); Barker and Shan (in press); most type-logical/ccg analyses

Formulas

Montague (1974); Heim (1997); Heim (1982); Kamp and Reyle (1993) and many (most?) dynamic analyses

Scope-taking and the syntax-semantics interface



Predicates *and* **Formulas**

Chierchia and McConnell-Ginet (1990); Sternefeld (1998, 2001); Kobele (2010); Sternefeld and Zimmermann (2013)

The Dialectic

Basis Unexpected identity constraints in ACD

Thesis Heim's argument for Formulas and against Predicates

Antithesis Jacobson's argument against Formulas and for Predicates

Synthesis Predicates <u>and</u> formulas

- Deriving this in a principled way
- Capturing additional patterns of data in ellipsis

Argument "identity" in ACD

Kennedy (1994) observes contrasts like the following:

(1) a. Polly visited every major city Erik did visit.
b. * Polly visited every major city that is located in a state that Erik did visit.

(2) a. Erik read most of the books that Polly did read.
b. * Erik read most the books that were reviewed in the newspaper that Polly did read.

Argument "identity" in ACD

This is a fact about ellipsis:

(3) a. Polly visited every major city Erik visited.
b. Polly visited every major city that is located in a state that Erik visited.

(4) a. Erik read most of the books that Polly read.
b. Erik read most the books that were reviewed in the newspaper that Polly read.

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(4) a. Erik read most of the books that Polly read.
b. Erik read most the books that were reviewed in the newspaper that Polly read.

It's also a fact about *also* (Jacobson, 2008):

(5) a. * Polly visited every major city that is located in a state that Erik also visited.
b. * Erik read most of the books that were reviewed in the newspaper that Polly also read.

Argument "identity" in ACD

It's also a fact about configuration:

(5) a. Polly visited every major city Erik did visit.

b. * Polly visited every major city that is located in a state that Erik did visit.

Argument "identity" in ACD

It's also a fact about configuration:

(5) a. Polly visited every major city Erik did visit.

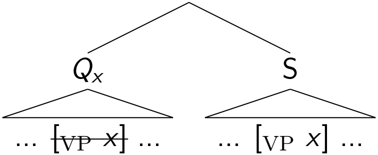
b. * Polly visited every major city that is located in a state that Erik did visit.

(6) a. Polly told us which cities she visited, and Erik told us which states he did visit.

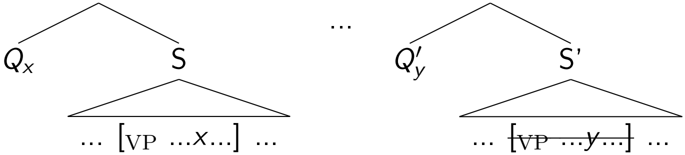
b. Chicago, she's visited. St. Louis, she hasn't visited.

c. Every major city that Polly visited is located in a state that Erik did visit.

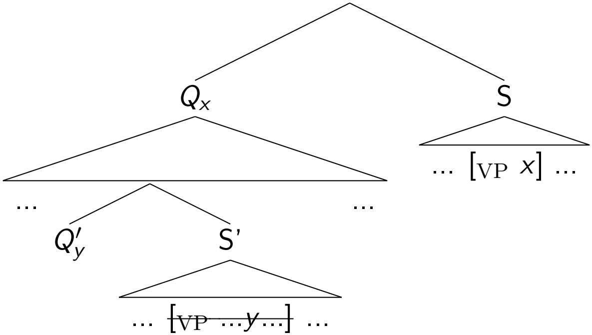
Antecedent containment and "identity:" OK



Non-containment and “non-identity:” OK



Antecedent containment and "non-identity:" Not OK



“Argument contained ellipsis” (ACE)

- **The generalization**
  Ellipsis between VP_e and VP_a, VP_e contained in an expression Q that binds an argument position inside VP_a, is ungrammatical when the semantic value assigned to this argument position is distinct from the semantic value assigned to the corresponding argument position in VP_e. (Kennedy, 1994, modified)

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- **The problem**
  Most theories of ellipsis/binding that let in non-containment and non-identity also let in containment and non-identity.

Heim's solution

Heim (1997) presents an analysis of the ACE pattern that makes crucial use of the following three components:

- Rooth's focus/contrast-based theory of ellipsis (Rooth, 1985, 1992)
- A constraint on variable naming (coindexation)
- The "Formulas" Hypothesis

Ellipsis

Rooth's (1992) analysis of ellipsis consists of two parts: the identity condition in (7a) and the contrast condition in (7b).

(7) a. A deleted VP and its antecedent must have the same lexical material up to indexical values on traces, pronouns, etc.

b. A deleted VP must be contained in a constituent E that contrasts appropriately with some constituent A that contains the antecedent VP.

(8) E contrasts appropriately with A iff:

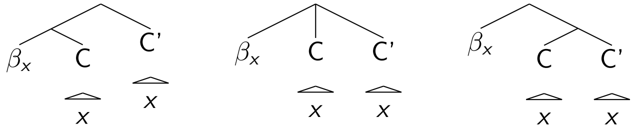
a. E and A don't overlap, and

b. $\forall g : [\![A]\!]^g \in [\![E]\!]^g{}_{ALT}$

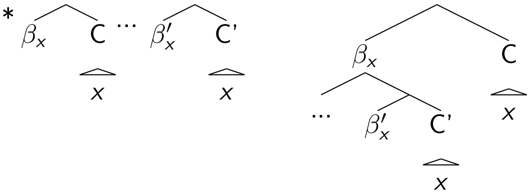
"No Meaningless Coindexing"

(9) If a LF contains an occurrence of a variable v that is bound by a node β, then all occurrences of v in this LF must be bound by the same node β.

(10) a.

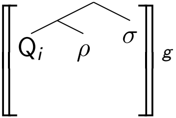


b.



Formulas

(11)



$= 1$ iff for Q x such that $[\![\rho]\!]^{g[x/i]} = 1$, $[\![\sigma]\!]^{g[x/i]} = 1$

Non-containment and non-identity

(12) I know which states$_1$ Polly visited $t_1$$_A$
but not which states$_2$ ERIK did ~~[$_{VP}$ visit t_2]~~$_E$

No Meaningless Coindexing requires variables to be distinct, but this does not matter because:

- The identity condition doesn't care about variable names, and
- There are no free variables inside A and E, so the contrast condition is satisfied: $[\![A]\!]^g \in [\![E]\!]^g{}_{ALT}$ for any g.

Containment and identity

(13) a. Polly visited every major city Erik did.

b. [every$_1$ major city ERIK did ~~[$_{\text{VP}}$ visit t_1]~~$_E$]
Polly PAST [$_{\text{VP}}$ visit t_1]$_A$

The "no overlap" part of the appropriate contrast condition ensures that A is at most as big as shown here, and therefore have assignment-dependent denotations. HOWEVER:

- Since the VP-internal variables are both bound by *every*$_1$, they are allowed to be identical, and so
- The contrast condition is satisfied (even for A/E = VP).

Containment and non-identity

(14) a. * Polly visited every major city that is located in a state that Erik did.

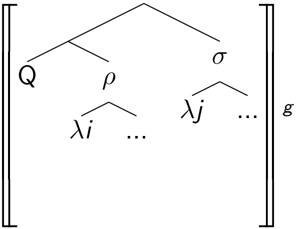
b. [every$_1$ city [t_1 in a$_2$ state ERIK did ~~[$_{\text{VP}}$ visit t_2]~~$_E$] Polly PAST [$_{\text{VP}}$ visit t_1]$_A$

Once again, A can be a most as big as shown here, and so have assignment-dependent denotations.

- The VP-internal variables are bound by distinct binders, and so must be distinct (No Meaningless Coindexing).
- As a result, the contrast condition cannot be satisfied: there will be some assignments such that $[\![A]\!]^g \notin [\![E]\!]^g{}_{ALT}$

What if we had assumed Predicates instead of Formulas?

(15)



$= 1$ iff for Q x such that $[\![\rho]\!](x) = 1$, $[\![\sigma]\!](x) = 1$

Containment and non-identity

(16) a. * Polly visited every major city that is located in a state that Erik did.

b. [every city $\lambda 1[t_1$ in a state $\lambda 2$[ERIK did ~~$[_{\text{VP}}$ visit t_2]~~]$_E$] $\lambda 3$[Polly PAST $[_{\text{VP}}$ visit t_3]]$_A$

A = the scope of "*every city*" and E = the restriction of "*a state*."

- The VP-internal variables are still bound by distinct binders, and so must be distinct (No Meaningless Coindexing).
- But according to Predicates, they are bound within A and E, so A and E do not have assigment-dependent denotations.
- If Predicates were correct, the contrast condition would be satisfied and ellipsis whould be OK.

Advantage: Formulas

Problems

Jacobson (1998) raises a number of challenges for Heim's analysis, the most serious of which is that it makes the wrong predictions for examples like (17).

(17) a. Every major city that Polly visited is located in a state that Erik did.

b. every$_1$ major city that Polly PAST $[_{VP}$ visit $t_1]_A$ is located in a$_2$ state that Erik did ~~$[_{VP}$ visit $t_2]$~~$_E$

A and E are both assignment dependent because they give back different results for their scope terms based on their indexing, so the contrast condition cannot be satisfied.

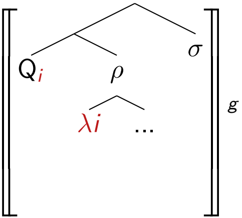
Predicates, on the other hand, has no problem with examples like these, regardless of what we assume about indexing

(18) a. Every major city that Polly visited is located in a state that Erik did.

b. every major city $\lambda 1$[that Polly PAST [$_{\text{VP}}$ visit t_1]]$_A$ is located in a state $\lambda 2$[that ERIK did ~~[$_{\text{VP}}$ visit t_2]~~]$_E$

Advantage: Predicates

Predicates *and* formulas

(19) 

$= 1$ iff for Q x such that $[\![\rho]\!](x) = 1$, $[\![\sigma]\!](g[x/i]) = 1$

Claim 1 This analysis accounts for the full range of facts.

Claim 2 This analysis is not a hack.

Non-containment

When A/E are in restriction terms: *Same as Predicates.*

(20) a. Every major city that Polly visited is located in a state that Erik did.

b. every major city $\lambda 1$[that Polly PAST [$_{\text{VP}}$ visit t_1]]$_A$ is located in a state $\lambda 2$[that ERIK did ~~[$_{\text{VP}}$ visit t_2]~~]$_E$

When A/E are in scope terms: *Same as Formulas.*

(21) I know which states$_1$ Polly visited $t_{1\,A}$
but not which states$_2$ ERIK did ~~[$_{\text{VP}}$ visit t_2]~~$_E$

Containment: ACD

The analysis of ACD is similar to Heim's: there is no way to find a non-assignment-dependent denotation for A without violating the no-overlap condition, but as long as the VP-internal variables are the same, the contrast condition can be satisifed.

(22) a. Polly visited every major city Erik did.

b. every$_1$ major city λ1[ERIK did ~~$[_{\text{VP}}$ visit $t_1]$~~$_E$] Polly PAST $[_{\text{VP}}$ visit $t_1]_A$

Evidently we must give up No Meaningless Coindexing. This looks like a positive result.

The ACE configurations are also analyzed in roughly the same way as in Heim's analysis:

(23) a. * Polly visited every major city that is located in a state that Erik did.

b. [every$_1$ city $\lambda 1$[t_1 in a$_2$ state $\lambda 2$[ERIK did ~~[$_{\text{VP}}$ visit t_2]~~$_E$]] Polly PAST [$_{\text{VP}}$ visit t_1]$_A$

The ACE configurations are also analyzed in roughly the same way as in Heim's analysis:

(23) a. * Polly visited every major city that is located in a state that Erik did.

b. [every$_1$ city λ1[t_1 in a$_2$ state λ2[ERIK did ~~[$_{VP}$ visit t_2]~~$_E$]] Polly PAST [$_{VP}$ visit t_1]$_A$

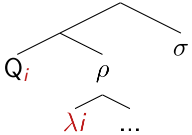
c. [every$_1$ city λ3[t_3 in a$_2$ state λ1[ERIK did ~~[$_{VP}$ visit t_1]~~$_E$]] Polly PAST [$_{VP}$ visit t_1]$_A$

But how to rule out a parse in which variable names are "accidentally" identical in a way that would license ellipsis?

No Coindexing

In fact, we can get by with an arguably more natural constraint that forbids coindexing across the board, *except* in the particular configuration in (24a). This may sound ad hoc...

(24) a.



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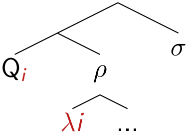
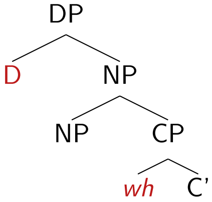


b.



...but indices are features, and the configuration we are interested in is the one in (24b), so this "exception" can be analyzed as agreement between D and *wh* (cf. agreement of ϕ-features).

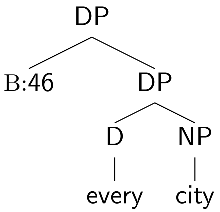
Not a hack

Predicates and Formulas looks like a stipulation, but in fact it can be very naturally implemented using well-worked out, existing proposals that have been justified on independent grounds:

- Bring assignment functions into the model theory and reanalyze all expressions as functions from assignments to their "regular" denotations (Sternefeld 1998, 2001; Kobele 2010; Jacobson in press; cf. Montague 1970).
- Distinguish "binding" indices from names of variables (Heim, 1993), and analyze the former as functions from expressions of type $\langle\langle e, t\rangle, t\rangle$ to $\langle\langle a, t\rangle, t\rangle$.

Compositional details

(25)



(26) $[\![\textit{every}]\!] = \lambda R \lambda S \lambda g . R(g) \subseteq S(g)$

- R,S: $\langle a, \langle e, t \rangle \rangle$

(27) $[\![\mathrm{B}{:}i]\!] = \lambda Q \lambda p . Q(\lambda g \lambda x . p(g[x/i]))$

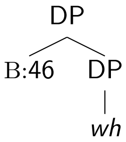
- Q: $\langle \langle a, \langle e, t \rangle \rangle, \langle a, t \rangle \rangle$
- p: $\langle a, t \rangle$

(28) $[\![\mathrm{B}{:}46]\!]([\![\textit{every city}]\!]) =$
$\lambda p \lambda g . \textbf{city}(g) \subseteq \lambda x . p(g[x/46])$

(29) $[\![\text{every city}_{46}]\!]([\![\text{Polly visited } t_{46}]\!]) =$
$[\lambda p \lambda g . \textbf{city}(g) \subseteq \lambda x . p(g[x/46])](\lambda g' . \textbf{visted}(g'(46))(\mathbf{p})(g')) =$
$\lambda g . \textbf{city}(g) \subseteq \lambda x . \textbf{visited}(x)(\mathbf{p})(g[x/46])$

Compositional details

(30)



(31) $[\![wh]\!] = \lambda F \lambda g . F(g)$

- F: $\langle a, \langle e, t \rangle \rangle$

(32) $[\![\mathrm{B}{:}i]\!] = \lambda Q \lambda p . Q(\lambda g \lambda x . p(g[x/i]))$

- Q: $\langle \langle a, \langle e, t \rangle \rangle, \langle a, \alpha \rangle \rangle$
- p: $\langle a, t \rangle$

(33) $[\![\mathrm{B}{:}46]\!]([\![wh]\!]) = \lambda p \lambda g \lambda x . p(g[x/46])$

(34) $[\![\text{wh}_{46}]\!]([\![\text{Erik visited } t_{46}]\!]) =$
$[\lambda p \lambda g . \lambda x . p(g[x/46])](\lambda g' . \textbf{visted}(g'(46))(\textbf{e})(g')) =$
$\lambda g \lambda x . \textbf{visted}(x)(\textbf{e})(g[x/46])$

Summary

- In essence, all binding configurations involve "formulas," because binders are functions of type $\langle\langle a, t\rangle, \langle a, t\rangle\rangle$.
- But the syntactic/semantic function of some expressions (e.g., relative *wh*-words) is to turn "formulas" into "predicates."
- This can all be done in a fully compositional manner, without syncategorematic rules, by bringing assignment functions into the model theory, à la Sternefeld 1998, 2001; Kobele 2010; Jacobson in press; etc.
- Unlike Predicates or Formulas, this analysis captures the full range of ellipsis facts.

Advantage: Predicates and Formulas

The role of nominal content

Sauerland (2004) argues for an analysis of the ACE data in terms of the Copy Theory of movement, based on contrasts like:

(35) a. * Polly visited every town that is near the lake that Erik did.
b. Polly visited every town that is near the town that Erik did.
c. Polly visited every town that is near the one Erik did.

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(36) a. * Polly visited every town that is near the lake Erik did ~~[$_{VP}$ visit lake]~~
b. Polly visited every town that is near the town Erik did ~~[$_{VP}$ visit town]~~

The role of nominal content

But the improvement in acceptability is linked to the definiteness of the second DP:

(37) a. Sterling touched every circle that was located above the one that Julian did.

b. ? Sterling touched every circle that was located above the circle that Julian did.

c. * Sterling touched every circle that was located above a circle that Julian did.

d. * Sterling touched every circle that was located above two circles that Julian did.

e. * Sterling touched every circle that was located above no circles that Julian did.

This suggests that something else is going on here.

Pied-Piping

Jacobson (1998) observes the following contrast:

(38) a. Any country the capital of which Erik does, Polly visits.

b. * Any country the capital of which Erik visits, Polly does.

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(39) Any$_1$ country which$_1$ Erik PAST ~~$[_{\text{VP}}$ visit the capital of $t_1]$~~$]_E$ Polly PAST $[_{\text{VP}}$ visit $t_1]$ $]_A$

a. $\text{ALT(E)} = \{\lambda g \lambda x.\textbf{visit}(f(g(1)))(x) \mid f \in D_{\langle e,e \rangle}\}$

b. $\text{A} = \lambda g \lambda x.\textbf{visit}(g(1))(x)$

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b. $\text{A} = \lambda g \lambda x.\textbf{visit}(\textbf{id}(g(1)))(x)$

(40) Any$_1$ country [which$_1$ Erik PRES $[_{\text{VP}}$ visit the capital of $t_1]_A$] Polly does ~~$[_{\text{VP}}$ visit $t_1]_E$~~

a. $\text{ALT(E)} = \{\lambda g \lambda x.\textbf{visit}(g(1))(x)\}$

b. $\text{A} = \lambda g \lambda x.\textbf{visit}(\textbf{capital}(g(1)))(x)$

We need to give up the syntactic identity condition on ellipsis, but we already believed that (Merchant, 2001).

More pied-piping

Heim (1997 lecture notes) worries about examples like (41a-b):

(41) a. Polly read each of the books Erik did.

b. Polly read 10 pages of every book Erik did.

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(41) a. Polly read each of the books Erik did.

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(41a) is not a problem if *each* is the head of DP and *wh* agrees with it in the usual way:

(42) each$_1$ of the books wh$_1$ Erik did ~~[$_{\text{VP}}$ read t_1]~~$_E$
Polly PAST [$_{\text{VP}}$ read t_1]$_A$

More pied-piping

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(42) each$_1$ of the books wh$_1$ Erik did ~~$[_{\text{VP}}$ read $t_1]$~~$_E$
Polly PAST $[_{\text{VP}}$ read $t_1]_A$

And (41b) is not a problem if the measure term stays inside VP:

(43) every$_1$ book *wh*$_1$ Erik did ~~$[_{\text{VP}}$ read 10 pages of $t_1]$~~$_E$
Polly PAST $[_{\text{VP}}$ read 10 pages of $t_1]_A$

More pied-piping

But there seems to be an ambiguity in (41b):

(44) Polly read 10 pages of every book Erik did.

a. Polly read 10 pages of every book Erik read 10 pages of.

b. Polly read 10 pages of every book Erik read.

More pied-piping

But there seems to be an ambiguity in (41b):

(44) Polly read 10 pages of every book Erik did.

a. Polly read 10 pages of every book Erik read 10 pages of.

b. Polly read 10 pages of every book Erik read.

And neither of the potential logical forms for (44b) allows ellipsis:

(45) a. * every$_1$ book *wh*$_1$ Erik did ~~[$_{\text{VP}}$ read t_1]$_E$~~
Polly PAST [$_{\text{VP}}$ read 10 pages of t_1]$_A$]

b. * every book *wh*$_1$ Erik did ~~[$_{\text{VP}}$ read t_1]$_E$~~
10$_2$ pages of t_1
Polly PAST [$_{\text{VP}}$ read t_2]$_A$

In effect, the analysis requires the measure expression to be interpreted in both the antecedent and elided VPs.

More pied-piping

Note, however, that (44a) entails (44b), so maybe the b-reading is an illusion?

More pied-piping

Note, however, that (44a) entails (44b), so maybe the b-reading is an illusion? In fact, when the the measure term is non-monotonic, the entailment does not go through, and the b-reading disappears:

(46) Polly read exactly 10 pages of every book Erik did.

a. *read 10 pages of*

b. * *read*

(47) Polly read at most two sections of every book Erik did.

a. *read at most two sections of*

b. * *read*

Conclusion

- Predicates and Formulas plus a (fully semantic) version of Rooth's theory of ellipsis provides a full account of the pattern of argument identity effects in ellipsis
- This approach to scope-taking/binding is fully compatible with direct compositionality, if we follow Sternefeld and Kobele in bringing assignment functions into the model. (Stating the ellipsis condition may be trickier.)
- It is, however, crucially not variable-free.
  - Jacobson (2008): a variable-free alternative
  - Main difference: J's analysis rucially relies on a *propositional* statement of the contrast condition.

Persistence!

Los Angeles, December 1993

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Jacobson 2008

(48) a. Polly visited every major city that Erik did ~~$[_{VP}$ visit$]$~~

b. *Defined only for those individuals such that it's salient whether someone other than Erik visited them*

(49) a. * Polly visited every major city that's located in a state that Erik did ~~$[_{VP}$ visit$]$~~

b. *Defined only for those individuals such that it's salient whether someone other than Erik visited them*

salient whether ≈ there is a QUD whether

(48) a. Polly visited every major city that Erik did ~~[$_{VP}$ visit]~~

b. *Defined only for those individuals such that it's salient whether someone other than Erik visited them*

(49) a. * Polly visited every major city that's located in a state that Erik did ~~[$_{VP}$ visit]~~

b. *Defined only for those individuals such that it's salient whether someone other than Erik visited them*

salient whether ≈ there is a QUD whether

(50) a. Every city that Polly visited was located in a state that Erik did ~~[$_{VP}$ visit]~~

b. *Defined only for those individuals such that it's salient whether someone other than Erik visited them*

(51) * Every city that Polly visited was located in a state that Erik also visited.