Delayed evaluation as an explanation for various reconstruction effects

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Slides at http://tinyurl.com/cbarker/reconstruction
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How well does semantic reconstruction scale up?

- The Plot (Jacobson 1998/SALT8):
  In a well-regulated variable-free semantics, some reconstruction effects fall out without stipulation.

- Jacobson’s 2003 Variable Free Semantics (VFS): system based on type-shifters g, l, z, m.

Some points of interest:
- “semantic reconstruction”: no movement or copy-movement; reconstruction interpreted as delayed evaluation (explained below)
- Variable-free, direct compositional (e.g., Jacobson 2002)
- Same spirit as Jacobson’s VFS; attempt at broader coverage, different analysis, different truth conditions, exploiting continuations

Some reconstruction effects on the menu for this talk

Quantificational binding:
(1) Which relative of his does everyone love? [Barker 2009]
(2) the relative of his that everyone loves [Jacobson 2003]

Binding of anaphors:
(3) Which picture of herself does Mary like?
(4) the picture of herself that Mary likes

The gifted-mathematician construction [Grosu & Krifka 2007]:
(5) the gifted mathematician that John claims to be


Acknowledging some inspiring ideas

Syntactic and semantic composition
In general ('/' variant):

\[
\begin{array}{c}
\frac{C | D}{A / B} \\
\text{phrase 1} \\
g[f] \\
f
\end{array}
\quad \frac{D | E}{B} \\
\text{phrase 2} \\
h[x] \\
x
\quad = 
\begin{array}{c}
\frac{C | E}{A} \\
\text{phrase 1-phrase 2} \\
g[h[x]] \\
f(x)
\end{array}
\]

Example ('\‘\‘ variant):

\[
\begin{array}{c}
\frac{S | S}{DP} \\
\text{everyone} \\
\forall y, [ ] \\
y
\end{array}
\quad \frac{S | S}{DP \setminus S} \\
\text{left} \\
[ ] \\
left
\quad = 
\begin{array}{c}
\frac{S | S}{S} \\
\text{everyone left} \\
\forall y, [ ] \\
left(y)
\end{array}
\]

Above line, fn composition (roughly!); below line, fn application. ~QR.

Type-shifter: Lift

\[
\frac{A}{B | B} \\
\text{phrase} \\
x
\frac{B | B}{A} \\
\text{Lift}
\]

\[
\begin{array}{c}
\frac{DP}{John} \\
\text{Lift} \\
j
\end{array}
\quad \frac{S | S}{DP} \\
\text{John} \\
j
\quad \frac{S | S}{DP \setminus S} \\
\text{left} \\
[ ] \\
left
\quad \frac{S | S}{S} \\
\text{left}
\quad \frac{S | S}{S}
\]

Behavior: \[ \frac{C | B}{A} \]
functions locally as category \( A \), takes scope over a constituent of category \( B \), and returns a result of category \( C \).

Generalization of Partee’s 1987 LIFT: \[ \frac{[ ]}{j} \equiv \lambda k.k(j) \] is the familiar principle ultrafilter corresponding to John.

Fragment with Pied Piping (9 slides)

Claim: a reasonable basic treatment of wh-fronting will automatically provide an analysis of some reconstruction effects

Categories: Atomic categories are \( DP, S, \) and \( N \).
Complex categories include \( B \setminus A \) and \( A / B \), where \( A \) and \( B \) are any categories.

Continuation mode, for scope-taking:
Complex categories also include \( A \setminus B \) and \( B / A \).

Graphical ('tower') convention: \( C / (A \setminus B) \) can be written \[ \frac{C | B}{A} \]

In the corresponding semantics, \( \lambda k.g[kf] \) can be written \[ \frac{g[f]}{f} \]

Behavior: \[ \frac{C | B}{A} \] functions locally as category \( A \), takes scope over a constituent of category \( B \), and returns a result of category \( C \).
Quantificational binding

\[
\frac{S \mid S}{S} \quad \text{Lower} \quad \frac{S}{S}
\]

\[
\frac{\text{everyone left}}{\forall y, \text{left } y}
\]

\[
\frac{\forall y, \text{left } y}{\forall y, \text{left } y}
\]

(Must restrict B \neq DP \triangleright C to account for weak crossover.)

Similar role to Groenendijk and Stokhof's (1989=DMG) ‘\(\triangleright\)’ operator

Pronouns as scope-taking identity functions

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TYPE</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP (\triangleright) S</td>
<td>e \rightarrow t</td>
<td>left</td>
</tr>
<tr>
<td>Open proposition: DP (\triangleright) S</td>
<td>e \rightarrow t</td>
<td>He left.</td>
</tr>
</tbody>
</table>

A pronoun functions locally as a DP, takes scope over an S, and turns that S into an open proposition:

\[
\frac{\text{DP} \triangleright S \mid S}{\text{DP} \triangleright S \mid S, \text{left}} \quad \frac{S \mid S}{\text{DP} \triangleright S \mid S, \text{left}} \quad \frac{\lambda y, \text{left } y}{\lambda y, \text{left } y}
\]

\[
= \frac{\text{DP} \triangleright S \mid S}{\text{DP} \triangleright S \mid S, \text{left}} \quad \frac{\text{DP} \triangleright S \mid S}{\text{DP} \triangleright S \mid S, \text{left}} \quad \frac{\lambda y, \text{left } y}{\lambda y, \text{left } y}
\]

Variable-free approach as advocated in Jacobson 1999.

Gaps as a different syntactic flavor of identity function

Predicate: DP \(\backslash\) S e \rightarrow t left

Open proposition: DP \(\triangleright\) S e \rightarrow t He left.

Gapped clause: DP \(\backslash\) S e \rightarrow t does John love -

\[
\frac{\alpha \mid \alpha}{S / S} \quad \text{does} \quad \frac{\text{DP} \mid \alpha}{\text{DP} \mid \alpha}
\]

\[
= \frac{\text{DP} \backslash S \mid S}{\text{DP} \backslash S \mid S} \quad \frac{\text{DP} / S}{\text{DP} / S}
\]

\[
\frac{\alpha \mid \alpha}{\text{DP} \backslash S \mid S} \quad \text{lower} \quad \frac{\text{DP} \backslash S}{\text{DP} \backslash S}
\]

\[
= \frac{\alpha \mid \alpha}{\text{DP} \backslash S \mid S} \quad \text{lower} \quad \frac{\text{DP} \backslash S}{\text{DP} \backslash S}
\]

Gap denotes identity function. (Here choose \(\alpha = \text{DP} \backslash S\) when lifting.)
Type-shifter: Front turns in-situ scope-taking into fronted WH

\[
\frac{(\text{DP}$\backslash$S)$ \backslash$ S}{\text{DP}} \quad \frac{\text{Front} \quad \frac{\text{who}(m)}{\text{who}(\lambda x[])}}{\lambda x, \text{who}(\lambda x, xx)}
\]

\[
\frac{(\text{DP}$\backslash$S)$ \backslash$ S}{\text{DP}} \quad \frac{\text{Front} \quad \frac{\text{who}(m)}{\text{who}(\lambda x[])}}{\lambda x, \text{who}(\lambda x, xx)}
\]

Some reconstruction effects (14 slides)

Semantics unaffected. For in-situ use, just leave off the $F$ feature.

Simple wh examples with pied-piping via Front

\[
\frac{\alpha}{\text{PP}/\text{DP}} \quad \frac{\alpha}{\text{PP}/\text{DP}} \quad \frac{\text{who}(\lambda x[])}{\text{who}(\lambda x[])} \quad \frac{\text{who}(\lambda x[])}{\text{who}(\lambda x[])}
\]

\[
\frac{\text{who}}{\text{who}(\lambda x[])} \quad \frac{\text{who}}{\text{who}(\lambda x[])} \quad \frac{\text{who}}{\text{who}(\lambda x[])}
\]

Which relative of his does everyone love _? (2 slides)

Abbreviate pn ("pronoun") \(\equiv \frac{\text{DP}$\triangleright$S}{\text{DP}}\).

\[
\frac{\alpha}{\text{S} \quad \text{DP}$\triangleright$S \quad \alpha} \quad \frac{\beta}{\text{DP}$\triangleright$S \quad \beta} \quad \frac{\text{pn}$\backslash$S}{\text{S}} \quad \frac{\text{pn}$\backslash$S}{\text{S}}
\]

\[
\frac{(\text{DP}/\text{S}$\backslash$S)$ \backslash$ S}{\text{DP}/\text{S}} \quad \frac{(\text{DP}/\text{S}$\backslash$S)$ \backslash$ S}{\text{DP}/\text{S}} \quad \frac{(\text{DP}/\text{S}$\backslash$S)$ \backslash$ S}{\text{DP}/\text{S}}
\]

\[
\frac{(\text{DP}/\text{S}$\backslash$S)$ \backslash$ S}{\text{DP}/\text{S}} \quad \frac{(\text{DP}/\text{S}$\backslash$S)$ \backslash$ S}{\text{DP}/\text{S}} \quad \frac{(\text{DP}/\text{S}$\backslash$S)$ \backslash$ S}{\text{DP}/\text{S}}
\]

(6) a. Who did John speak to? \(\text{who}(\lambda x, \text{speaking}(\text{to}(x)))\)
b. To whom did John speak? \(\text{who}(\lambda x, \text{speaking}(\text{to}(x)))\)
c. Which man did John speak to? \(\text{which}(\lambda f, \text{speaking}(\text{to}(f(x))))\)
d. To which man did John speak? \(\text{which}(\lambda f, \text{speaking}(\text{to}(f(x))))\)

(7) Q. What blocks *Which did John see _ man??

A. English does not allow left-branch gaps (e.g., * \(\frac{(\text{DP}/\text{N}) \backslash S}{\text{DP}/\text{N}}\).

Filters on categories?

Choose \(\alpha = \text{pn}$\backslash$S, \beta = \text{DP}$\triangleright$S.

The gap is a (higher-order) identity function; the quantifier binds a virtual pronoun inside the gap (just as in derivations in Jacobson's VFS).
In what sense is the evaluation of the pronoun delayed? Say that a function is ‘evaluated’ when it undergoes beta reduction. Material to be reconstructed (relative of his) in red; destined to be argument of gap variable $P$ of category $\text{pn} = \frac{DP \triangleright S | S}{DP}$:

$$\begin{align*}
(\lambda y.\text{which}(\lambda f.\gamma(\lambda k\lambda z. k(f(\text{relz}))))(\lambda P.\forall y. P(\lambda w.\text{love} w y)) y)
\approx & \text{which}(\lambda f.\forall y.(\lambda k\lambda z. k(f(\text{relz}))))(\lambda w.\text{love} w y) y) \\
\approx & \text{which}(\lambda f.\forall y.(\lambda k\lambda z. k(f(\text{relz}))))(\lambda w.\text{love} w y) (f(\text{relz})) y) \\
\approx & \text{which}(\lambda f.\forall y.(\lambda k\lambda z. k(f(\text{relz}))))(\lambda w.\text{love} w y) (f(\text{relz}) y) \\
\approx & \text{which}(\lambda f.\forall y.(\lambda k\lambda z. k(f(\text{relz})) y)) \\
\approx & \text{which}(\lambda f.\forall y.(\lambda k\lambda z. k(f(\text{relz}))))(\lambda w.\text{love} w y) (f(\text{relz}) y)
\end{align*}$$

Gloss: for what choice function $f$ does everyone $y$ love $f(y$ ’s relatives)? Possible answer: the tallest.

(Traditional functional answer containing a pronoun—his mother—needs higher types; see Barker 2009.)
(9) Which picture of himself did John see?

\[
\begin{array}{c|c|c}
\alpha & \alpha & \xi \\
\hline
\text{DP/N} & \text{DP} & \text{DP} \\
pic \lambda x. x & \text{DP} & \text{DP} \\
\text{which} & \text{which} & \text{which} \\
[] & [\lambda x. x] & \text{which} \\
\hline
\end{array}
\]

\[
\frac{\text{S} \quad S}{\text{S} \quad \text{S}}
\]

Reconstructing binders instead of bindees

Can we observe reconstruction effects with scope-taking elements that are not pronouns or reflexives?

(13) a. John had to explain

\[
\text{the lowest grade of each student}_1 \text{ to her}_1 \text{ mother.}
\]

b. Which grade of each student

\[
\text{did John have to explain to her}_1 \text{ mother?}
\]

Could the binding in (9b) be direct (= not involving reconstruction)?

(14) a. *She1 resented the lowest grade of each student1.

b. ??Her1 mother resented the lowest grade of each student1.

(15) a. *Which grade of each student1 did he1 resent?

b. ??Which grade of each student1 did his1 mother resent?

- Unclear how to handle (13b) under Jacobson’s VFS.
- Crossover effects predicted here by left-to-right bias built into continuation composition schema; see {Shan, Barker} 2006, 2008.

Reconstructing binders and pronouns simultaneously

(10) a. John saw no pictures of himself.

b. Which picture of himself did John claim Mary liked?

Not so well (the analysis needs refinement to make the right prediction):

(11) *John claimed Mary liked a picture of himself.

Two problems:

- How to guarantee that some scope-taking elements (e.g., everyone, in-situ reflexives) never take scope outside their minimal (tensed) clause, as shown in (11)?
- How to distinguish the behavior of in-situ reflexives, which are clause-bound (witness (11)) from reconstructed reflexives, which can take scope outside of their minimal clause (witness (10b))?

(12) a. Which picture of himself_b11 does John1 think Bill_b saw?

a. How happy with himself_b11 does John1 think Bill_b is? [Cinque &

(16) Which of her1 drawings of each man1 did every woman1 show _ to him1?

No man gave [which of each girl’s drawings of him] back to her1.

(17) Which of each girl1’s drawings of him1 would no man1 give _ back to her1?

- Predicted good by syntactic reconstruction and the theory here
- At some point, even the most optimistic theory is going to have to expect processing complexity to dominate grammaticality.
Relative clauses via Front

(18) a. [Which relative of his] does everyone love _?
   b. [the relative of his] that everyone loves _
   c. [Which picture of herself] does Mary like _?
   d. [the picture of herself] that Mary likes _

\[
\frac{\left((\text{DP/N}?)S_f\right) S}{\text{DP}_f\mid S} \quad \frac{\text{DP}_f\mid S}{\text{DP/N}}
\]

\[ \frac{\text{which}}{\text{which} (\lambda f.[[]])} \quad \frac{\text{the}}{\text{the} (\lambda f.[[]])} \]

(19) a. Which relative of his does everyone love _? (the tallest)
   b. which (\lambda f.\forall y.\text{love}(f(\text{rel} y))) y
   c. the relative of his that everyone loves _ (is the tallest)
   d. the (\lambda f.\forall y.\text{love}(f(\text{rel} y))) y

In addition to ordinary dets, category DP/N; worry about stacked RCs.

Arriving at a referent

(20) a. the picture of herself that Mary likes
   b. the (\lambda f.\text{likes}(f(\text{pic} m) m))

To arrive at a referent, the must take a property of choice functions and return an individual. The appropriate function is intuitively simple, but hard to express succinctly:

\[
\text{the} \equiv \lambda \kappa. \forall x. \forall f, (\forall P. P x \rightarrow (f P = x)) \rightarrow \kappa f
\]

Gloss: given \(\kappa\), a property of choice functions, return the unique object \(x\) such that any choice function that returns \(x\) whenever possible has property \(\kappa\).

...or at least at an individual

Equational Intensional ‘Reconstruction’ Relatives

(21) the gifted mathematician that John claims to be the (\lambda f.\text{claim} (\text{be}(f(\text{gifted-math'} n))) j)
(22) the gifted mathematician that claims to be John

- Discussed in detail in Grosu & Krifka 2007
- Evaluation of \text{gifted mathematician} delayed till under \text{claim}
- Described individual need not be gifted-math’n in evaluation world
- Description can refer to John (likewise in some other Igs.)
- Many restrictions on availability in English and cross-linguistically
- Need intensions and perhaps individual concepts to explore fully
- Fully directly compositional (no movement)

Relative pronouns with pied piping

(23) a. the man who John saw
   b. the man whose mother John saw
   c. the man the mother of whom John saw

(24) Reconstructing bindees:
John is a man [[whose opinion of her_1] every woman_1 respects _]

(25) Reconstructing binders:
a. a theory every proponent_1 of which _ cites only her_1 own students
b. a theory every proponent of which \{she_1/?her_1 mother\} loves _

(26) Reconstructing reflexives (unexpectedly bad):
??a novelist whose description of herself no woman recognizes

(27) Reconstruction chaining:
\[
\text{the relative of his (}\text{whom harping on his faults everyone hates }_1) \quad \sim \quad \text{the} (\lambda f.\forall x. \text{hates}(f(\text{rel} x))) x
\]

No in-situ version; need syntactic refinement to prevent stacking
Some details on the chaining derivation

\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/N} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]
\[ \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \quad \text{DP/NS} \]

Key References


Conclusions

- [Jacobson] At least some reconstruction effect fall out from a transparent category system.
- Handling a wider range of examples requires a robust, integrated account of extraction (i.e., gaps) and scope-taking...
- ... such as the Shan/Barker continuation-based approach: a composition schema plus type-shifters: Lift, Lower, Bind, and Front.
- To the extent that Front, or something equivalent, is needed just to handle basic wh questions, the reconstruction effects treated here come for free
- Explicit fragment modeling the interaction of scope, binding, reflexives, wh-froneting, relative clause formation, and crossover.
- Directly compositional, variable-free; no movement, no QR.
- Pronouns, gaps, and wh-words all express various flavors of identity and near-identity functions.
- Bound elements find their binders by taking scope [Dowty].
- Semantic reconstruction gives a reasonable second-order fit of the data.