A Computational Implementation of Syntactic Binding Theory in the Minimalist Program

Sandiway Fong
Departments of Linguistics and Computer Science
University of Arizona
Tucson AZ USA
Joint work with *Jason Ginsburg*  
(University of Aizu, Japan)
Paper and Derivations Available

from my homepage

- (just google my first name)
- http://dingo.sbs.arizona.edu/~sandiway/mpp/

Computation with doubling constituents: Pronouns and antecedents in Phase Theory

Sandiway Pong
University of Arizona

Jason Ginsburg
University of Arizona

Abstract
In this paper, we develop a computational implementation of Optimality Theory (OT) that is designed to incorporate the basic Optimality Theory paradigm of Chomsky (1995). We take this into account in the basic Endogen Theory paradigm of Ponsioen (2001) and together with Ponsioen's (2002) proposal for a derived generative representation of an OT derivation that is not captured. Under standard assumptions about locality and Phase Theory, the assumption itself of the derivation process must assume that the processes operate in a strictly local and endogenously driven mechanism or be licensed independently (i.e., without any data that reduces to the structure). We propose the movement of the representation is organized by an operator of Laia, whereby the representation, under appropriate circumstances, can be generated from a derivation and licensed. We demonstrate, via a computational implementation, how one can produce an OT derivation-independent of those results in which one cannot distinguish between processes and principles for semantic- and functional-sentential properties, LCH, prime, OCH and other constructions.

1 Introduction
As part of an ongoing effort, the Minimalist Program (MP) (Chomsky 1995) focuses on simple and optimal solution to the problem of the nature of human language. It is expected that considerations of efficient computation (within the constraints of the biological system) should contribute to finding solutions the shape or motivations on the space of possible human languages (Chomsky 2002). An unsolved objective of this computational system is the space of sentences that is to be captured, i.e., the principle that allows the computational system to be modeled by a number of basic mechanisms to form an optimal variety of specific structures that encode the variety of language phenomena. Within the frameworks of the MP, it is proposed that simple recursive merges of external and internal (i.e., displacement) effects to generate an arbitrary number of structures, and the move to specify the nature of the underlying processes and principles (Chomsky 2001). Given the recursive merge one can generate arbitrarily complex structures, efficient computation demands that...
Introduction: Data

• Classic Binding Theory data:
  *\(\text{John}_i\) praises him\(_i\)
  \(\text{John}_i\) praises himself\(_i\)
  \(\text{John}_i\) thinks he\(_i\) is smart
  *\(\text{He}_i\) thinks John\(_i\) is smart
  *\(\text{John}_i\) thinks himself\(_i\) is smart
  *\(\text{John}_i\) thinks that Mary likes himself\(_i\)
  \(\text{John}_i\) considers himself\(_i\) to be intelligent
  *\(\text{John}_i\) considers him\(_i\) to be intelligent
Introduction: Data

• Classic Binding Theory data:
  John$_i$ likes his$_i$ dog
  *John$_i$ likes himself$_i$’s dog
  ?*Hannah$_i$ found a picture of her$_i$
  Hannah$_i$ found a picture of herself$_i$
  ?*Hannah found Peter$_i$’s picture of him$_i$
  Hannah found Peter$_i$’s picture of himself$_i$
  Hannah$_i$ found Peter’s picture of her$_i$
  Hannah$_i$ found Peter’s picture of herself$_i$

Note: *picture-DP judgments from Keller & Asudeh’s (2001) study

Binding Conditions: A, B and C
Introduction: Theory

Assumptions:

• Minimalist Program Chomsky (2000, 2001)
  – merge (external/internal)
  – uninterpretable/interpretable features
  – probe-goal search
  – (strong) phase boundaries (v*, c)

  **add**: d headed by *self*
  possessive 's
  “sufficiently complex”
Introduction: Theory

Object Mary is first merged with V like its theta role is identified here.
Introduction: Theory

1. theta merge V & N
2. merge v & V
3. theta merge N & v
4. merge T & v
5. move to spec-T
6. merge C & T

Probe [v*] agrees with goal [n mary]

φ-features of v* are valued by Mary
Mary gets accusative Case from v*
Introduction: Theory

1. theta merge V & N
2. merge v & V
3. theta merge N & v
4. merge T & v
5. move to spec-T
6. merge C & T

John is first merged into spec-v
the VP-internal subject position
its theta role is identified here
Introduction: Theory

1. theta merge V & N
2. merge v & V
3. theta merge N & v
4. merge T & v
5. move to spec-T
6. merge C & T

Probe \([t]\) agrees with goal \([n \text{ john}]\)

\(\phi\)-features of \(t\) are valued by John
John gets nominative Case from \(t\)
Introduction: Theory

Tree Viewer

1. theta merge V & N
2. merge v & V
3. theta merge N & v
4. merge T & v
5. move to spec-T
6. merge C & T

copy theory: only the first occurrence of John is pronounced
Introduction: Theory

1. theta merge V & N
2. merge v & V
3. theta merge N & v
4. merge T & v
5. move to spec-T
6. merge C & T

Tree Viewer

```
  c
 / \
 t   t
 / \ / \
 n   v  v
 |   |  |
 john t
```

```
  V
 / \
 like
```

```
  V
 / \
 n
```

```
  n
```

```
  n
```

```
  n
```

```
  n
```
Introduction: Theory

• Add Kayne’s (2002) proposal
  – pronominal and r-expression
  – doubling constituent (DC): [spec head], e.g. [John he]
  – Stipulation: spec can move out of DC after DC moves first
    $$[\text{TP John thinks } [\text{TP [John he is } [\text{AP smart [John he]]]]]]$$

• Our implementation of the DC:

  ![Diagram of DC implementation]

Both pronoun and r-expr
1. uninterpretable Case
2. interpretable ϕ-features
3. need theta-role

reflexive anaphor
4. phase boundary

Other related work:
Zwart (2002)
Heinat (2003)
John thinks he is smart

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th>he</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td>theta, Case</td>
<td>theta, Case</td>
</tr>
<tr>
<td>licensed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
John thinks he is smart
John thinks he is smart

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th>he</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td>Case</td>
<td>theta, Case</td>
</tr>
<tr>
<td>licensed</td>
<td>theta</td>
<td></td>
</tr>
</tbody>
</table>
John thinks he is smart

Scoreboard  |  he  |  John  
--- | --- | --- 
needs  |  | theta, Case 
licensed  |  theta, Case  

John thinks he is smart

Scoreboard | he | John
---|---|---
needs | theta, Case |
licensed | theta, Case |
John thinks he is smart

Scoreboard | he | John
---|---|---
needs | theta, Case | 
licensed | theta, Case |
John thinks he is smart

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th>he</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td></td>
<td>theta, Case</td>
</tr>
<tr>
<td>licensed</td>
<td></td>
<td>theta, Case</td>
</tr>
</tbody>
</table>
John thinks he is smart

Scoreboard | he | John
---|---|---
needs | Case | 
licensed | theta, Case | theta
John thinks he is smart
John thinks he is smart
*John praises him

Scoreboard | he | John
---|---|---
needs | theta, Case | theta, Case
licensed | |
*John praises him*
*John praises him

Now suppose only way r-expr John can extract out of DC is via that operation ...

**Last Resort (LR):** theta merge

Then derivation stops (**crashes**)

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th>he</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td></td>
<td>theta, Case</td>
</tr>
<tr>
<td>licensed</td>
<td></td>
<td>theta, Case</td>
</tr>
</tbody>
</table>
John praises himself

**add**: phase boundary (d when headed by *self*)
John praises himself

Last Resort (LR):
theta merge
Introduction: Data

• Classic Binding Theory data:
  *\( \text{John}_i \) praises him
  \( \text{John}_i \) praises himself
  \( \text{John}_i \) thinks he is smart
  *\( \text{He}_i \) thinks \( \text{John}_i \) is smart

• Kayne’s (2002) proposal
  – DC: [spec head], e.g. [\textit{John he}]
  – only the specifier may move (not the head)
*He*$_i$ thinks John$_i$ is smart

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th><em>he</em></th>
<th><em>John</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td>theta, Case</td>
<td></td>
</tr>
<tr>
<td>licensed</td>
<td>theta, Case</td>
<td></td>
</tr>
</tbody>
</table>
Introduction: Data

- Classic Binding Theory data:
  - *John_i praises him_i*
  - John_i praises himself_i
  - John_i thinks he_i is smart
  - *He_i thinks John_i is smart*
  - *John_i thinks himself_i is smart*
  - *John_i thinks that Mary likes himself_i*
  - John_i considers himself_i to be intelligent
  - *John_i considers him_i to be intelligent*
*John thinks himself is smart

Last Resort (LR):
? theta merge
*John thinks himself is smart

T values Nominative Case of head *he
Lexical gap: *heself
Introduction: Data

• Classic Binding Theory data:
  *John$_i$ praises him$_i$
  John$_i$ praises himself$_i$
  John$_i$ thinks he$_i$ is smart
  *He$_i$ thinks John$_i$ is smart
  *John$_i$ thinks himself$_i$ is smart
  *John$_i$ thinks that Mary likes himself$_i$
  John$_i$ considers himself$_i$ to be intelligent
  *John$_i$ considers him$_i$ to be intelligent
*John thinks that Mary likes himself*

**Last Resort (LR):**
theta merge

Probe \([v^*] \text{ agrees with goal } [d[d\ \text{self}][n\ \text{he}][d!\text{case}!\text{arg}[d][n\ \text{john}]]])\)
*John thinks that Mary likes himself

**Preference:** Merge over Move (Chomsky 2000)
LR move of *John* blocked
derivation crashes
Introduction: Data

• Classic Binding Theory data:
  *John$_i$ praises him$_i$
  John$_i$ praises himself$_i$
  John$_i$ thinks he$_i$ is smart
  *He$_i$ thinks John$_i$ is smart
  *John$_i$ thinks himself$_i$ is smart
  *John$_i$ thinks that Mary likes himself$_i$
  John$_i$ considers himself$_i$ to be intelligent
  *John$_i$ considers him$_i$ to be intelligent

Exceptional Case Marking (ECM)
John considers himself to be intelligent

Scoreboard | he | John
---|---|---
needs | Case | theta, Case
licensed | theta |
John considers himself to be intelligent

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th>he</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td>Case</td>
<td>theta, Case</td>
</tr>
<tr>
<td>licensed</td>
<td>theta</td>
<td></td>
</tr>
</tbody>
</table>
John considers himself to be intelligent.
John considers himself to be intelligent

<table>
<thead>
<tr>
<th>Scoreboard</th>
<th>he</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td>needs</td>
<td></td>
<td>Case</td>
</tr>
<tr>
<td>licensed</td>
<td>theta, Case</td>
<td>theta</td>
</tr>
</tbody>
</table>
John considers himself to be intelligent
John considers himself to be intelligent
*John_i considers him_i to be intelligent

Recall, only way r-expr John can extract out of DC is using **Last Resort (LR)**: theta merge derivation stops (**crashes**).
Introduction: Data

• Classic Binding Theory data:
  John\(_i\) likes his\(_i\) dog
  *John\(_i\) likes himself\(_i\)’s dog
  ?*Hannah\(_i\) found a picture of her\(_i\)
  Hannah\(_i\) found a picture of herself\(_i\)
  ?*Hannah found Peter\(_i\)’s picture of him\(_i\)
  Hannah found Peter\(_i\)’s picture of himself\(_i\)
  Hannah\(_i\) found Peter’s picture of her\(_i\)
  Hannah\(_i\) found Peter’s picture of herself\(_i\)

Note: *picture-DP judgments from Keller & Asudeh’s (2001) study
John\(_i\) likes his\(_i\) dog

Assume *his* = \textit{he} + \textit{'s}

\[ [\textit{he John}][\textit{'s} [\textit{dog}]] \]

d (possessive) is a phase boundary

**Last Resort (LR):**
theta merge applies
John\textsubscript{i} likes his\textsubscript{i} dog

d (possessive) is a phase boundary
John_{i} likes his_{i} dog
*John likes himself's dog

LR move of John to subject position blocked

actually, there’s a more subtle subcase of LR move blocking that needs to be considered when self-he-John is merged with ‘s-dog

LR move blocked by Merge over Move
*John likes himself’s dog

Why didn’t John get a chance to move earlier?

Two ways to think about it
1. LR move to spec-D blocked by Merge over Move
2. Internal merge (move) can only apply to already merged syntactic objects.
   LR move is (still) an instance of internal merge
   Once self-he-John merges with ‘s-dog, it’s too late
Introduction: Data

• Classic Binding Theory data:
  
  John$_i$ likes his$_i$ dog
  *John$_i$ likes himself$_i$’s dog
  ?*Hannah$_i$ found a picture of her$_i$
  Hannah$_i$ found a picture of herself$_i$
  ?*Hannah found Peter$_i$’s picture of him$_i$
  Hannah found Peter$_i$’s picture of himself$_i$
  Hannah$_i$ found Peter’s picture of her$_i$
  Hannah$_i$ found Peter’s picture of herself$_i$

Note: picture-DP judgments from Keller & Asudeh’s (2001) study
Hannah found Peter’s picture of her
Hannah found Peter’s picture of her
Hannah found Peter’s picture of her
Hannah found Peter’s picture of herself

judgment from Keller & Asudeh (2001)

LR move of Hannah to subject position blocked
Other data

To-do list ...

- **transitivity of coreference**
  - John$_i$ says he$_i$ thinks he$_i$’s smart
    (Kayne 2002:157)

- **circularity**
  - [His$_i$ wife]$_j$ just saw [her$_j$ husband]$_i$
    (Kayne 2002:156)

- **wh-constructions**
  - Which book that John$_i$ wrote does he$_i$ like best
    (Zwart 2002)
  - Who that John$_i$ knows does he$_i$ admire?
    (Chomsky & Lasnik 1995:106)
  - Which stories about Diana$_i$ did she$_i$ most object to?
    (Zwart 2002)
  - *How many stories about Diana$_i$ does she$_i$ want us to invent.
    (Heycock 1995:558f), per Zwart 2002)

- **anaphors and pronouns in non-complementary distribution**
  - Lucie counted five tourists in the room apart from herself$_i$/her$_i$
    (Reinhart & Reuland 1993:661)
  - Lucie saw a picture of herself$_i$/her$_i$
    (Reinhart & Reuland 1993:661)
  - Max likes jokes about himself$_i$/him$_i$
    (Reinhart & Reuland 1993:661)
Summary

• computational implementation
  \( \text{theory verification} \)
• accounts for bunch of classic Binding Theory facts
  \( \text{sans Conditions A, B and C} \)
• theory:
  basic MP (Chomsky 2000)
  + doubling constituent (Kayne 2002)
  + some DPs are phases
  + LR move
    \( \text{extra mechanism... yes} \)
    But doesn’t impact efficient computation
    e.g. creates no extra choice points
    LR theta merge: competes with external Merge
  \( \text{also Chomsky (2006), Svenonious (2004), Hiraiwa (2005)} \)