Levels of ambiguity and underspecification in regular polysemy

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Ambiguity: Perspectives on Representation and Resolution
Workshop at ESSLLI 2018

Sofia University
06.08. – 10.08.2018
Introduction

Working definition (e.g. Sennet 2016)

Ambiguity ~ multiple meanings which are

- defined independently of the context
  - ≠ context sensitivity (e.g. indexicals, ‘I am now here’)
- resolved during interpretation
  - ≠ underspecification (generality)
    - (‘I was planning to attend one of the workshops.’)
- clearly distinguishable
  - ≠ vagueness (boundary cases, precisification means regimentation)
    - (‘a short introduction’)

Example

```
bat
1. mammal capable of flight
2. stout solid stick used for hitting/striking
3. hit/strike something as with a bat
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Introduction

Polysemy (= a special case of ambiguity, or in contrast to it??)

- The different meanings are related to each other.

Regular/systematic polysemy:

- The same meaning relation applies to a class of expressions.

Examples

‘bat’, ‘rake’ – implement || activity (of using the implement)

‘damage’, ‘decoration’ – activity || (implicit) result object
             (of the activity)

‘book’, ‘letter’ – physical information carrier || information
Introduction

Topic of this talk

- The role of ambiguity and underspecification (and context sensitivity) in the analysis of (regular) polysemy.

Motivation

- Contextual information and underspecification play a prominent role in various approaches to the formal modeling of regular polysemy (e.g. Egg 2003, 2011; Asher 2011; Mery and Retoré 2015; Babonnaud et al. 2016).
Inherent vs. selectional (regular) polysemy (e.g. Pustejovský 2011):

- inherent polysemy:
  different facets of interpretation inherent in the (lexical) semantics of a word
  ‘book’ – physical object || information
  ‘lunch’ – food || event
Regular polysemy

**Inherent vs. selectional** (regular) polysemy (e.g. Pustejovský 2011):

- **inherent** polysemy:
  different **facets** of interpretation inherent in the (lexical) semantics of a word
  ‘*book*’ – physical object \|\| information
  ‘*lunch*’ – food \|\| event

- **selectional** polysemy:
  selectional **mismatch** between predicate and argument, resolved by **coercion** (≠ inherent meaning shift)

(1) a. Mary left the **party**.  (event ~→ location)
    b. Mary began the **book**.  (object ~→ activity)
Note: “Selectional polysemy” might be seen as a misnomer.
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“selectional polysemy […] emerges when the word itself is not polysemous, but in context its basic meaning is further specified or modified […]”

[Pustejovsky & Batiukova, to appear]
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“selectional polysemy […] emerges when the word itself is not polysemous, but in context its basic meaning is further specified or modified […]”

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In ‘leave the party’ and ‘begin the book’ neither ‘leave’, ‘party’, ‘begin’ nor ‘book’ undergo a shift of meaning (irrespective of the possible ambiguity/polysemy of these expressions).
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"selectional polysemy […] emerges when the word itself is not polysemous, but in context its basic meaning is further specified or modified […]"

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- In ‘leave the party’ and ‘begin the book’ neither ‘leave’, ‘party’, ‘begin’ nor ‘book’ undergo a shift of meaning (irrespective of the possible ambiguity/polysemy of these expressions).

- There is apparently no ambiguity/polysemy involved in interpreting ‘leave the party’ (under event $\rightsquigarrow$ location).
Regular polysemy

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“selectional polysemy [...] emerges when the word itself is not polysemous, but in context its basic meaning is further specified or modified [...]”

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- In ‘leave the party’ and ‘begin the book’ neither ‘leave’, ‘party’, ‘begin’ nor ‘book’ undergo a shift of meaning (irrespective of the possible ambiguity/polysemy of these expressions).

- There is apparently no ambiguity/polysemy involved in interpreting ‘leave the party’ (under event ~→ location).

- The different possible interpretations of ‘begin the book’ (under object ~→ activity) come about through the different possible interactions with the book being started (reading, writing, translating, memorizing, coloring, mending, etc.)
Is ‘begin the book’ a case of ambiguity/polysemy/underspecification?

Underspecification: No
The type of interaction with the book meant by the expression is usually clear in a given context. e.g., ‘begin doing/to do something with/related to the book’ is not a legitimate paraphrase of ‘begin the book’.

Polysemy: Not really
The different activities involving the book (reading, writing, translating, memorizing, coloring, mending, etc.) do not form a circumscribed set of clearly distinguishable alternatives (even if some of them are more salient than others); they are not clearly related to each other, except for the fact that they potentially involve books.

Ambiguity: Yes
Regular polysemy

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  they are not clearly related to each other, except for the fact that they potentially involve books.

- **Ambiguity:** Yes
Background: LTAG + frame semantics

Frame semantics
Frame semantics

(2) Anna ran to the station.

\[ e \left[ \begin{array}{c}
\text{running} \wedge \text{bounded-motion} \\
\text{AGENT} [1] x \\
\text{FINAL} [\text{loc-stage}] \\
\text{THEME} [1] \\
\text{LOC} y
\end{array} \right] \]

\[ \begin{array}{c}
\text{running} \\
\text{AGENT} \rightarrow x \\
\text{FINAL} \rightarrow \text{THEME} \\
\text{loc-stage} \\
\text{LOC} \rightarrow y
\end{array} \]
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Frame semantics

(2) Anna ran to the station.

\[
\begin{align*}
&\text{e} = \begin{bmatrix}
\text{running} \land \text{bounded-motion} \\
\text{AGENT} : x \\
\text{FINAL} : \text{loc-stage} \\
\text{THEME} \downarrow \\
\text{LOC} : y
\end{bmatrix}
\end{align*}
\]

Attribute-value logic

\[
e \cdot (\text{running} \land \text{bounded-motion} \land \text{AGENT} : x \land \\
\text{FINAL} : \text{loc-stage} \land \text{FINAL THEME} \equiv \text{AGENT} \land \text{FINAL LOC} : y)
\]

Translation into first-order logic

\[
\text{running}(e) \land \text{bounded-motion}(e) \land \text{AGENT}(e, x) \land \\
\exists s (\text{FINAL}(e, s) \land \text{loc-stage}(s) \land \text{THEME}(s, x) \land \text{LOC}(s, y))
\]

Constraints

\[
\text{running} \implies \text{activity} \text{ (short for } \forall e (\text{running}(e) \implies \text{activity}(e)))
\]
\[
\text{loc-stage} \implies \text{THEME} : \top \land \text{LOC} : \top, \ldots
\]
Frame semantics

Basic assumptions

- **Attributes** (features, functional roles/relations) play a central role in the organization of semantic and conceptual knowledge and representation.

  [Barsalou 1992; Löbner 2014]

- Semantic components (participants, subevents) can be (recursively) addressed by **attributes**.

  \[ \leadsto \text{ inherently structured representations (models); composition by unification (under constraints)} \]

- Semantic processing may be seen as the **incremental construction** of **minimal (frame) models** based on the input, the context, and background knowledge (lexicon, ...).
Background: LTAG + frame semantics

Illustration of the syntax-semantics interface

(3) Adam ate an apple.

```
S
  |   VP[1=e]
  |   |
  NP[1=x] V NP[1=y]
    |   |
    'ate'
```

```plaintext
S
  |   VP[1=e]
  |   |
  NP[1=x] V NP[1=y]
    |   |
    'ate'
```
Background: LTAG + frame semantics

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LTAG (Lexicalized Tree Adjoining Grammars):

Tree-rewriting system with

- a finite set of (lexicalized) elementary trees,
- two operations: substitution (replacing a leaf with a new tree) and adjunction (replacing an internal node with a new tree).
Background: LTAG + frame semantics

Components of the syntax-semantics interface

- **Elementary construction**
  
  = elementary tree (argument projection) + semantic frame
  + linking of frame node variables to interface features in the tree

- Semantic *composition* ≈ frame unification via identification of interface variables during substitution and adjunction.
Components of the syntax-semantics interface

- **Elementary construction**
  = elementary tree (argument projection) + semantic frame
  + linking of frame node variables to interface features in the tree

- Semantic **composition** \(\approx\) frame unification via identification of interface variables during substitution and adjunction.

Slogan: **“Simplify globally, complicate locally”**

- A small set of (global) operations for syntactic composition:
  substitution and adjunction.

- Many linguistic regularities and generalizations (including linking rules) are encoded within elementary constructions
  → further decomposition in the so-called **metagrammar**
Modeling inherent polysemy

Two options (at least):

- Posit additional representational units ("dot objects") for a "facet-neutral" representation.
- Represent only the meaning facets (and the relations between them).
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Assumption ($\approx$ second option) for ‘book’:

“Books are physical information carriers.”
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(book ⇒ info-carrier) ⇒ phys-obj ∧ CONTENT : info
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Assumption (≈ second option) for 'book':

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\[ book \Rightarrow \text{info-carrier} \Rightarrow \text{phys-obj} \land \text{CONTENT} : \text{info} \]
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Assumption (≈ second option) for ‘book’:

"Books are physical information carriers."

\[
\text{book} (\Rightarrow \text{info-carrier}) \Rightarrow \text{phys-obj} \land \text{CONTENT} : \text{info}
\]

\[\text{phys-obj} \quad \text{information} \quad \text{CONTENTS} \quad \text{NP}[i=x] \quad \text{‘book’} \quad x \triangleq u \lor x \triangleq u \cdot \text{CONTENTS}\]
(4) Mary **read** the book/rumor/blackboard.
Modeling inherent polysemy

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“Reading consists of looking at a physical information carrier (*perception*) and the processing of the provided information (*info-proc*).”

[e.g., Pustejovsky 1998]
Modeling inherent polysemy

(4) Mary **read** the book/rumor/blackboard.

“Reading consists of looking at a physical information carrier (\textit{perception}) and the processing of the provided information (\textit{info-proc}).”  

\[ \text{reading} \Rightarrow \text{PERC-COMP} : \text{perception} \land \text{MENT-COMP} : \text{info-proc} \land \langle \text{PERC-COMP}, \text{MENT-COMP} \rangle : \text{ordered-overlap} \]
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(4) Mary **read** the book/rumor/blackboard.

“Reading consists of looking at a physical information carrier (**perception**) and the processing of the provided information (**info-proc**).”

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\text{reading} \Rightarrow \text{PERC-COMP : perception} \land \text{MENT-COMP : info-proc} \\
\land \langle \text{PERC-COMP, MENT-COMP} \rangle : \text{ordered-overlap}
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\[
\text{perception} \Rightarrow \text{STIMULUS : phys-obj} \\
\text{info-proc} \Rightarrow \text{CONTENT : info}
\]
Modeling inherent polysemy

(Canonical) **argument structure construction** associated with ‘read’.

$$y \triangleq e \cdot \text{PERC-COMP} \cdot \text{STIMULUS}$$

$$\lor \ y \triangleq e \cdot \text{PERC-COMP} \cdot \text{STIMULUS} \cdot \text{CONTENT}$$
Modeling inherent polysemy

(Canonical) **argument structure construction** associated with ‘read’.

\[ y \triangleq 2 \lor y \triangleq 3 \]

\[ \langle 0, 1 \rangle : \text{ordered-overlap} \]
Modeling inherent polysemy

The “Quantificational Puzzle” [e.g., Asher 2011]

(5) a. Mary carried off every book in the library.
   b. Mary read every book in the library.
Modeling inherent polysemy

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(5) a. Mary carried off every book in the library.
   b. Mary read every book in the library.

Issues related to the analysis of (5b):

- Usually there is **no one-to-one correspondence** between the physical books in the library and the book contents.
- (5b) may be true even if **no physical copy** from the library has ever been used by Mary.
Modeling inherent polysemy

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A meta-level approach: underspecified attribute value formulas

\[ l_1 : \exists u (u \cdot 1), \quad 1 \triangleleft^* l_2, \]
\[ l_2 : \text{phys-obj} \land \text{CONTENT} : 2, \quad 2 \triangleleft^* l_3, \]
\[ l_3 : \text{information} \]

\[ \text{NP}[p=1] \begin{array}{c}
[1=0, p=l_2, \text{TOP}=l_1] \\
\end{array} \]

‘book’

\((h \triangleleft^* l \iff \text{expression } l \text{ is a subexpression of } h.)\)
Modeling “selectional polysemy”

(6) Mary left the party. \([= (1a)]\)

Assumptions:

- *leaving* has a ** THEME ** attribute whose value is of type *location*.
- The object NP denotes either an entity of type *location* or something which has a ** LOCATION ** attribute.

\[
u \triangleq y \lor u \triangleq y \cdot \text{LOCATION}
\]

Corresponding AV formula:
\[
e \cdot (\text{leaving} \land \text{AGENT} : x \land \text{THEME} : (u \cdot \text{location}))
\]
Modeling “selectional polysemy”

(7) Mary began the book.  

[= (1b)]
Modeling “selectional polysemy”

(7) Mary began the book. [= (1b)]

Sketch of a preliminary analysis:

- NP-V-NP construction available for ‘begin’.

```
initiation
  e —AGENT— x
  |   / AGENT
ACTIVITY       
  |   / THEME
  o —AGENT— y

activity
```

Additional requirement: activity needs to be specialized to an appropriate subtype (partly dependent on the type of y).
(7) Mary began the book. \[= (1b)\]

Sketch of a preliminary analysis:

- NP-V-NP construction available for ‘begin’.

- Additional requirement: 
  
  *activity* needs to be specialized to an appropriate subtype (partly dependent on the type of y).
Summary & Conclusion

- Underspecification in the lexicon and at the syntax-semantics interface of inherently polysemous expressions is generally resolved through their integration into the context.

- In certain cases of selectional polysemy, ambiguity or underspecification may not play a role at all, even if disjunctive information is present at the syntax-semantics interface.

- If underspecification plays a role in the analysis of selectional polysemy then necessarily at some intermediate level of the coercion process.
References


