Long-distance dependencies, locality and discontinuous constituents

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Overview

Present an argument consisting of five premises and the conclusion that sentences with unbounded topicalization cannot be generated

Discuss three different ways of avoiding the conclusion

Sketch an analysis of long-distance topicalization in terms of discontinuous constituents

Compare briefly with the HPSG 1994 analysis of unbounded dependencies

Conclusion

An argument

1. Grammars consist of formal rules, semantic rules and associations between formal and semantic rules.
2. Semantic entities are structured.
3. Semantic rules are strictly local.
4. Formal entities are strings of words.
5. Formal rules are strictly local

C. Some grammatical sentences, i.e.

`This student, Jim thought that Jo examined.`

cannot be generated/licensed.

First premise – Grammars consist of formal rules, semantic rules and associations between formal and semantic rules

Question: How can we explain that a speaker communicates the linguistic meaning **m** to a hearer by uttering a novel complex expression e?

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2. The speaker encodes the semantic structure of **m** through (parts of) the formal structure $\textsc{FormStruc}(e)$ of e

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$$\begin{array}{ccccccccc} & & & & \mathsf{e}_1 & & & \\ & & & & \updownarrow & & & \\ \mathbf{m} & \leftrightarrow & R^{SEM}_{14} & (& \mathbf{m}_1 & , & \mathbf{m}_2 &) \end{array}$$

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$$
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Question: How can we explain that a speaker communicates the linguistic meaning **m** to a hearer by uttering a novel complex expression e?

1. **m** has the structure SEMSTRUC(**m**)
2. The speaker encodes the semantic structure of **m** through (parts of) the formal structure FORMSTRUC(e) of e
3. The hearer assigns the same formal structure FORMSTRUC(e) to the expression e.

$$\begin{array}{ccccccccc} \mathsf{e} & \leftrightarrow & R_9^{FORM} & (& \mathsf{e}_1 & , & \mathsf{e}_2 &) \\ & & \updownarrow & & \updownarrow & & \updownarrow & \\ \mathbf{m} & \leftrightarrow & R_{14}^{SEM} & (& \mathbf{m}_1 & , & \mathbf{m}_2 &) \end{array}$$

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2. The speaker encodes the semantic structure of **m** through (parts of) the formal structure FormStruc(e) of e
3. The hearer assigns the same formal structure FormStruc(e) to the expression e.
4. The hearer interprets FormStruc(e) as expressing the same semantic structure SemStruc(**m**).

$$\begin{array}{ccccccccc} e & \leftrightarrow & R_9^{FORM} & (& e_1 & , & e_2 &) \\ & & \updownarrow & & \updownarrow & & \updownarrow & \\ \mathbf{m} & \leftrightarrow & R_{14}^{SEM} & (& \mathbf{m}_1 & , & \mathbf{m}_2 &) \end{array}$$

First premise – Grammars consist of formal rules, semantic rules and associations between formal and semantic rules

- Answer: A linguistic meaning **m** can be communicated by means of a novel expression e if both speaker and hearer use:
  - the same associations between formal and semantic entities
  - the same associations between formal and semantic rules

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- The argument for this correspondence and thus for the association of formal and semantic rules is independent of whether rules are viewed as generating or as licensing more complex expressions on the basis of simpler expressions. See Pullum and Scholz (2001) for the difference beteween the two views.

Second premise – Meanings are structured entities

- This explanation of how linguistic meanings are communicated by means of novel expressions presupposes that (at least some) linguistic meanings are structured entities.
- If the linguistic meaning of a sentence were unstructured (e.g. a function from possible worlds to truth values) then the idea of a correspondence between semantic and formal structure would not make sense, and we would lose the core of the explanation of communication by means of novel utterances.

Third premise – Semantic rules are strictly local

What does it mean for semantic rules to be local?

- "when you put together meanings α and β by some semantic rule G, $G(\alpha, \beta)$ may depend only on what α and β are, each "taken as a whole", but may not depend on the meanings that α and β were formed from by earlier semantic rules." (Dowty, 2007, 45)
- "A set of possible worlds has *no internal structure* – no subject, no object, no Agent, and no Patient [. . .] It might have been derived from the meanings of its parts by intersecting one set of worlds with another, but you cannot recover the original sets from the intersection itself." (Dowty, 2007, 46, my emphasis)
- But: "I am not making the claim here that a set of possible worlds is the most appropriate theoretical construct to serve as a proposition". (Dowty, 2007, 46)

Third premise – Semantic rules are strictly local

- I have argued that we should think of linguistic meanings as structured entities, not as unstructured entities.
- Strict locality of saturation: a rule combining an argument with a predicate P can only saturate the placeholders <u>inherent</u> to P.
- Example: **think($\_{A}$, examine(jo, $\_{P}$))** has only one inherent placeholder, namely $\_{A}$. Placeholder $\_{P}$ is not inherent to **think($\_{A}$, examine(jo, $\_{P}$))** but to **examine(jo, $\_{P}$)**.
- Assuming strict locality of saturation, the placeholder $\_{P}$ of **examine(jo, $\_{P}$)** can only be saturated <u>before</u> **examine(jo, $\_{P}$)** combines with **think($\_{A}$, $\_{P}$)**
- If meanings are unstructured entities, then the distinction between inherent and non-inherent placeholders does not make sense.

Fourth premise – Formal entities are strings of words

- If formal entities are strings of words, then the information about the constituent strings of the formal entities is lost and cannot be accessed by the rules.
- Illustration: Given a lexicon L consisting of $\{a, b, c\}$, the concatenation rule $R_1(x, y) = x{\llcorner}y$, and the string $a{\llcorner}b{\llcorner}c$, we do not know whether the constituent structure of this string is $R_1(R_1(a, b), c)$ or $R_1(a, R_1(b, c))$.
- However, rules may access the subparts of this string, e.g. $R_2(a{\llcorner}y, z) = a{\llcorner}z{\llcorner}y$.
- Formal rules may be able to access the substructure of a formal entity but not its constituent structure.

Fifth premise – Formal rules are strictly local

- A rule combining two formal entities x and y is strictly local iff it can access neither the substructure nor the constituent structure of x and y.

  $R_1(x, y) = x\text{␣}y$; $R_1(a\text{␣}b, c) = a\text{␣}b\text{␣}c$

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  $R_1(x, y) = x\textvisiblespace y$; $R_1(a\textvisiblespace b, c) = a\textvisiblespace b\textvisiblespace c$

- A rule combining two formal entities x and y is local iff it can access the substructure but not the constituent structure of x and y.

  $R_2(a\textvisiblespace y, z) = a\textvisiblespace z\textvisiblespace y$; $R_2(a\textvisiblespace b\textvisiblespace c, d) = a\textvisiblespace d\textvisiblespace b\textvisiblespace c$

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- A rule combining two formal entities x and y is local iff it can access the substructure but not the constituent structure of x and y.

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- A rule combining two formal entities x and y is non-local iff it can access both the substructure and the constituent structure of x and y.

  $R_3(x, [\ldots[c]\ldots]) = [\ldots x\ldots]$;
  $R_3([a], [a{\llcorner}[[b]{\llcorner}[c]]]) = [a, [[b]{\llcorner}[a]]]$

The conclusion follows from the five premises

1. If by the third premise semantic rules are local in the sense that they can only saturate inherent placeholders of the entities they apply to (the notion of inherent placeholder only makes sense given the second premise), then **student** (the meaning of ⟨`this␣student`⟩) cannot combine with **think(jim, examine(jo,** $\_{P}$**))** (the meaning of ⟨`Jim␣thought␣that␣Jo␣examined`⟩).
2. Therefore, **student** combines either with **examine**{$\_{A}$, $\_{P}$} (the meaning of ⟨`examined`⟩) or with **examine**{**jo,** $\_{P}$} (the meaning of ⟨`Jo␣examined`⟩).
3. By the first premise the semantic rule combining **student** with say **examine**{$\_{A}$, $\_{P}$} is associated with a formal rule which combines ⟨`this␣student`⟩ and ⟨`examined`⟩.

The conclusion follows from the premises

4. If by the fourth premise formal entities are strings of words, then the result of combining the strings ⟨`this␣student`⟩ and ⟨`examined`⟩ is also a string, e.g. ⟨`examined␣this␣student`⟩.
5. By the fifth premise the formal rules cannot access the substring ⟨`this␣student`⟩ of the resulting string.
6. Therefore, the string

   `This student, Jim thought that Jo examined.`

   cannot be generated.

Ways of avoiding the conclusion (1)

Assume that formal rules are non-local.

- Give up strict locality of formal rules, and assume instead that formal rules can access the complete constituent structure of the formal entities they combine.
- If this is the case, then the constituent [this␣student] in the bracketed string

  [Jim␣[thought␣[that␣[Jo␣[examined␣[this␣student]]]]]]

  can be accessed and manipulated, resulting for example in:

  [[this␣student]$_1$␣[Jim␣[thought␣[that␣[Jo␣[examined␣t$_1$]]]]]]

Ways of avoiding the conclusion (2)

Assume that saturation is not strictly local.

- Then every placeholder of a semantic entity can be saturated, irrespective of whether it is inherent or not.
- If this is the case, then **student** can combine with **think(jim, examine(jo, $\_P$))**, resulting in **think(jim, examine(jo, student))**, and ⟨`this␣student`⟩ can combine with ⟨`Jim␣thought␣that␣Jo␣examined`⟩, resulting in ⟨`this␣student␣Jim␣thought␣that␣Jo␣examined`⟩
- This allows us to keep all the other assumptions, while still being able to derive the sentence:

  `This student, Jim thought that Jo examined.`

Ways of avoiding the conclusion (3)

It is possible to avoid the conclusion <u>without</u> assuming that either formal or semantic rules are non-local.

- Instead of assuming that formal entities are bracketed strings, assume that they are pairs (or more generally *n*-tuples) of strings and that formal rules can only access the strings in the tuples as a whole, but not the substructure of the strings (such rules are called non-combinatorial in Groenink (1997)).
- These rules are local, since they can access the substructure of the pair (i.e. the two strings as a whole) but not the complete constituent structure of the pair.
- Illustration: Assume that string $\langle \mathtt{a} \rangle$ combines with the pair of strings $\langle \mathtt{b}, \mathtt{c} \rangle$ resulting in $\langle \mathtt{b}, \mathtt{a}{\llcorner}c \rangle$. Then $\langle \mathtt{a} \rangle$ is an immediate constituent, but it cannot be accessed by the formal rules since it does not constitute a string in the pair of strings. On the other hand, the string $\langle \mathtt{a}{\llcorner}c \rangle$ can be accessed although it is not a constituent of $\langle \mathtt{b}, \mathtt{a}{\llcorner}c \rangle$.

Long-distance topicalization with discontinuous constituents

The present framework combines the concept of simple Literal Movement Grammars from Groenink (1997) with the concept of sign grammar from Kracht (2003).

- formal structure recognisable in polynomial time
- strict separation of formal and semantic structure
- weak direct compositionality in the sense of Jacobson (2002) (weak because more than concatenation of strings is assumed, direct because interpretation is computed as formal entities are built).

Long-distance topicalization with discontinuous constituents

First step: local combination of the signs (with formal entities) $\langle \texttt{examine} \rangle$ and $\langle \texttt{this\_student} \rangle$:

$$R_1\left(\begin{bmatrix} \langle \texttt{examine} \rangle \\ \textbf{examine}(\_\mathbf{A}, \_\mathbf{P}) \end{bmatrix}, \begin{bmatrix} \langle \texttt{this\_student} \rangle \\ \textbf{student} \end{bmatrix}\right) =$$

$$\begin{bmatrix} \langle \texttt{this\_student}, \texttt{examine} \rangle \\ \textbf{examine}(\_\mathbf{A}, \textbf{student}) \end{bmatrix}$$

Long-distance topicalization with discontinuous constituents

Second step: combination of the resulting sign with the sign (with formal entity) $\langle \texttt{Jo} \rangle$:

$$R_2(\left[\begin{array}{l}\langle \texttt{this\textvisiblespace student}, \texttt{examine}\rangle \\ \textbf{examine}(\_{\textbf{A}}, \textbf{student})\end{array}\right], \left[\begin{array}{l}\langle \texttt{Jo}\rangle \\ \textbf{jo}\end{array}\right]) =$$

$$\left[\begin{array}{l}\langle \texttt{this\textvisiblespace student}, \texttt{Jo\textvisiblespace examine}\rangle \\ \textbf{examine}(\textbf{jo}, \textbf{student})\end{array}\right]$$

Long-distance topicalization with discontinuous constituents

Last step: linearization of the sign (with formal entity) $\langle \texttt{this␣student}, \texttt{Jim␣thought␣that␣Jo␣examined} \rangle$:

$$R_7\left(\begin{bmatrix} \langle \texttt{this␣student}, \texttt{Jim␣thought␣that␣Jo␣examined} \rangle \\ \textbf{think(jim, examine(jo, student))} \end{bmatrix}\right) =$$

$$\begin{bmatrix} \langle \texttt{this␣student␣Jim␣thought␣that␣Jo␣examined} \rangle \\ \textbf{think(jim, examine(jo, student))} \end{bmatrix}$$

Long-distance topicalization with discontinuous constituents

1. $R_1^{FORM}(\langle \texttt{examined}\rangle, \langle \texttt{this␣student}\rangle) = \langle \texttt{this␣student}, \texttt{examined}\rangle$
2. $R_2^{FORM}(\langle \texttt{this␣student}, \texttt{examined}\rangle, \langle \texttt{Jo}\rangle) = \langle \texttt{this␣student}, \texttt{Jo␣examined}\rangle$
3. $R_2^{FORM}(\langle \texttt{this␣student}, \texttt{Jo␣examined}\rangle, \langle \texttt{that}\rangle) = \langle \texttt{this␣student}, \texttt{that␣Jo␣examined}\rangle$
4. $R_2^{FORM}(\langle \texttt{this␣student}, \texttt{that␣Jo␣examined}\rangle, \langle \texttt{thought}\rangle) = \langle \texttt{this␣student}, \texttt{thought␣that␣Jo␣examined}\rangle$
5. $R_2^{FORM}(\langle \texttt{this␣student}, \texttt{thought␣that␣Jo␣examined}\rangle, \langle \texttt{Jim}\rangle) = \langle \texttt{this␣student}, \texttt{Jim␣thought␣that␣Jo␣examined}\rangle$
6. $R_7^{FORM}(\langle \texttt{this␣student}, \texttt{Jim␣thought␣that␣Jo␣examined}\rangle) = \langle \texttt{this␣student␣Jim␣thought␣that␣Jo␣examined}\rangle$

Brief comparison with HPSG analyses

- no trace
- The trace principle (every trace must be subcategorized by a substantive head) is replaced by a restriction on what kinds of formal entities can be "put on hold".
- The head-filler rule is replaced by a rule which linearizes a pair (or tuple) under certain conditions.
- In HPSG unbounded dependencies are essentially analysed by making the tectostructure more complex. In the present analysis unbounded dependencies are essentially analysed by making the phenostructure more complex.
- Unlike in the present framework, in HPSG the relation between formal and semantic structure is not exhaustively characterised by formal rules, semantic rules, and associations between formal and semantic rules.

Conclusion

- A strong direct compositional analysis of long-distance dependencies is not possible if saturation is strictly local.
- An analysis of long-distance dependencies does not require giving up the locality of formal or semantic rules.
- Instead it is sufficient to assume that formal entities are pairs of strings, as opposed to strings or bracketed strings.

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Thank you!

Slides will be available at:

http://www.ilg.uni-stuttgart.de/klein/