

# A Denotational View of "Polysemy"

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## Construction of sentence meanings vs. online incremental processing

### *Immediacy and Incrementality*

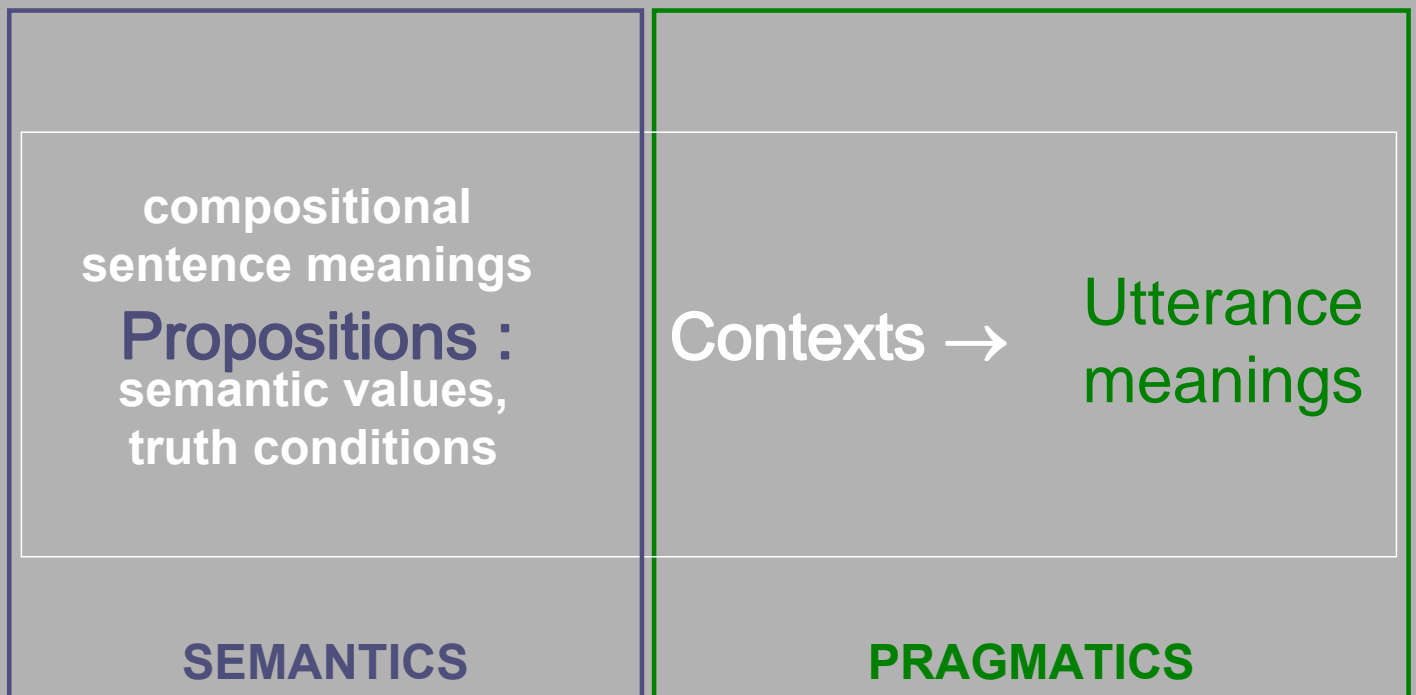
Empirical observation suggests that language comprehension integrates information from linguistic utterances with information that is antecedently or concurrently available from other sources, as soon as the information becomes available to the processor.

### *Sentence meanings*

as constructed compositionally and subsequently adjusted to contextual or background information are hard to fit to the empirical observation incrementality and immediacy.

# The classic division of labour

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## Indexicality

But the classic model causes difficulties already for the<sup>4</sup> treatment of indexicals:

*I am here now*

*You could have been here yesterday*

*This is a computer*

...

These expressions

- *refer* differently in each context, but
- hold their *meanings constant* across contexts, and hence cannot be accounted for in the classic model.

# Kaplan integrates indexicality into the semantics

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compositionally  
constructed  
sentence  
meanings

Characters: Contexts → Contents

semantic values,  
truth conditions

what is said

SEMANTICS

Utterance  
meanings

what is meant

PRAGMATICS

## Context-dependence is captured only in part

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Kaplanian sentence meanings (characters) contain index variables that are evaluated at the utterance context to yield the appropriate truth conditions for sentences (contents).

This conception is geared to index-dependent *variation in reference*.

It cannot cover *other than indexical variation* in utterance interpretation – which may be context-dependent variation too.

It is ill-suited to the incrementality and immediacy assumption: *the utterance context may change in the course of the sentence*.

# Context-dependent predicate expressions

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Sometimes it would seem that predicates show an indexical-like variation in their interpretation:

*Point of view*

*My apartment is nearby*

*The department is on the left side of the street*

*Comparison class*

*This was a fast run.*

*(at a national competition or a recreational running event)*

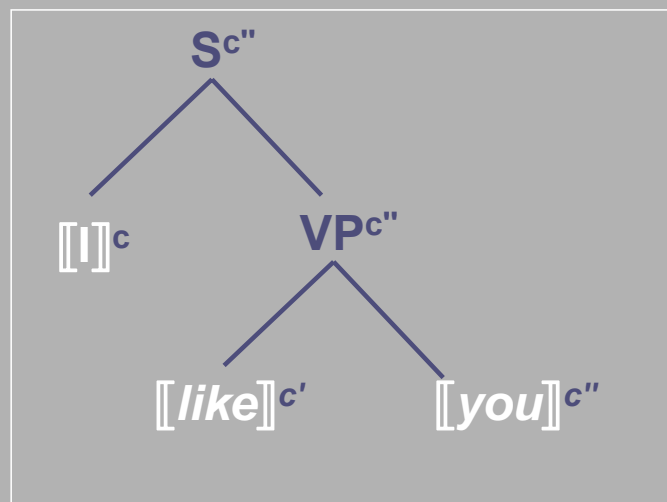
*Lexical meaning*

*This computer is fast.*

*This bike is fast.*

# Immediate context influence

This invites an application of Kaplan's conception to meanings of **constituents** - ultimately lexical items - as they become available consecutively during sentence processing. 8



# Immediate context influence

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We would not any longer compute sentence meanings from lexical meanings, but **sentence denotations from denotations of constituents,**

and context dependence is taken into account not at sentence level, but immediately, during processing.

Evidence from sentence processing would seem to support such a conception.

## Eye tracking for reference resolution (1)

Karabanov, Bosch, König 2007

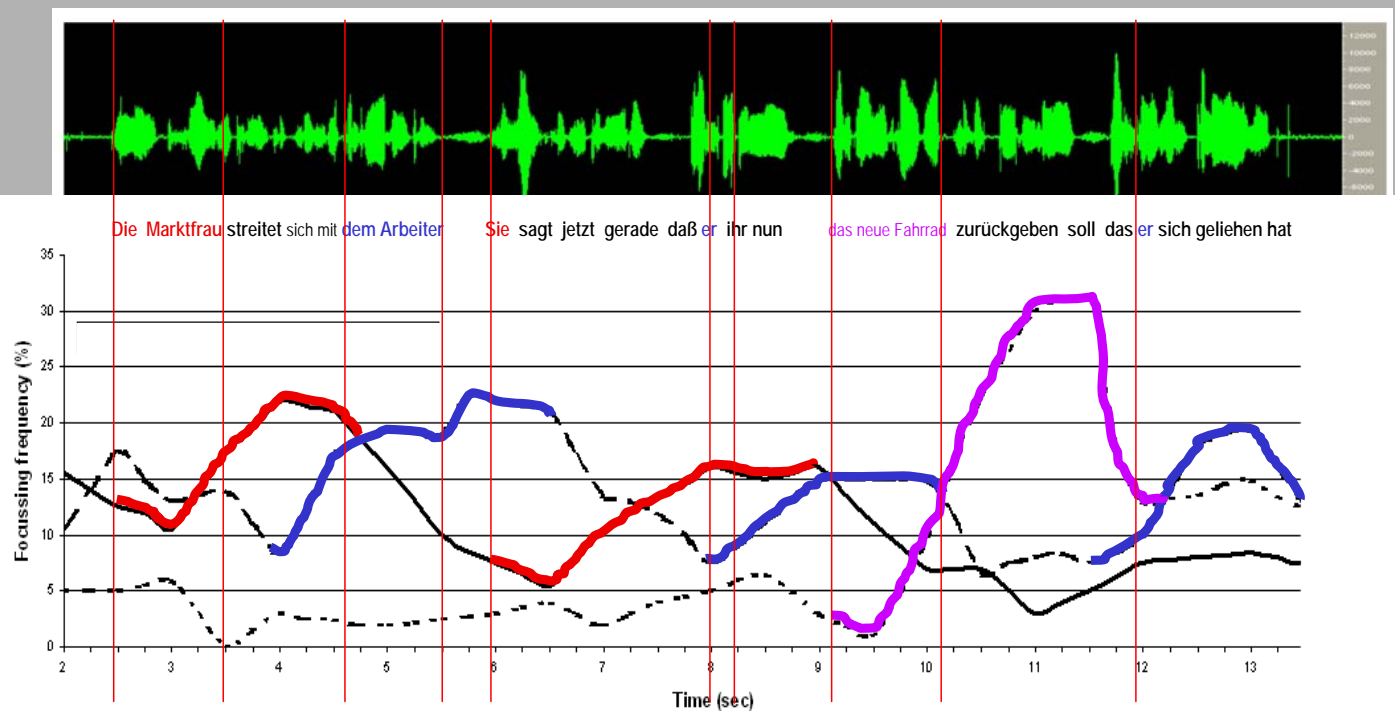


Heute ist Markt im Dorf. Die Marktfrau streitet sich mit dem Arbeiter. Sie sagt jetzt gerade, dass er ihr nun das neue Fahrrad zurückgeben soll, das er sich geliehen hat.

**It's market day in the village. The market woman is quibbling with the worker. She's just saying that he should give the new bike back to her that he borrowed.**

# Eye tracking for reference resolution (2)

Karabanov, Bosch, König 2007



## Immediate evaluation

Experimental evidence indicates that visual and linguistic input are processed simultaneously:

*Referential expressions* are resolved to the utterance context immediately - before sentence meanings are computed.

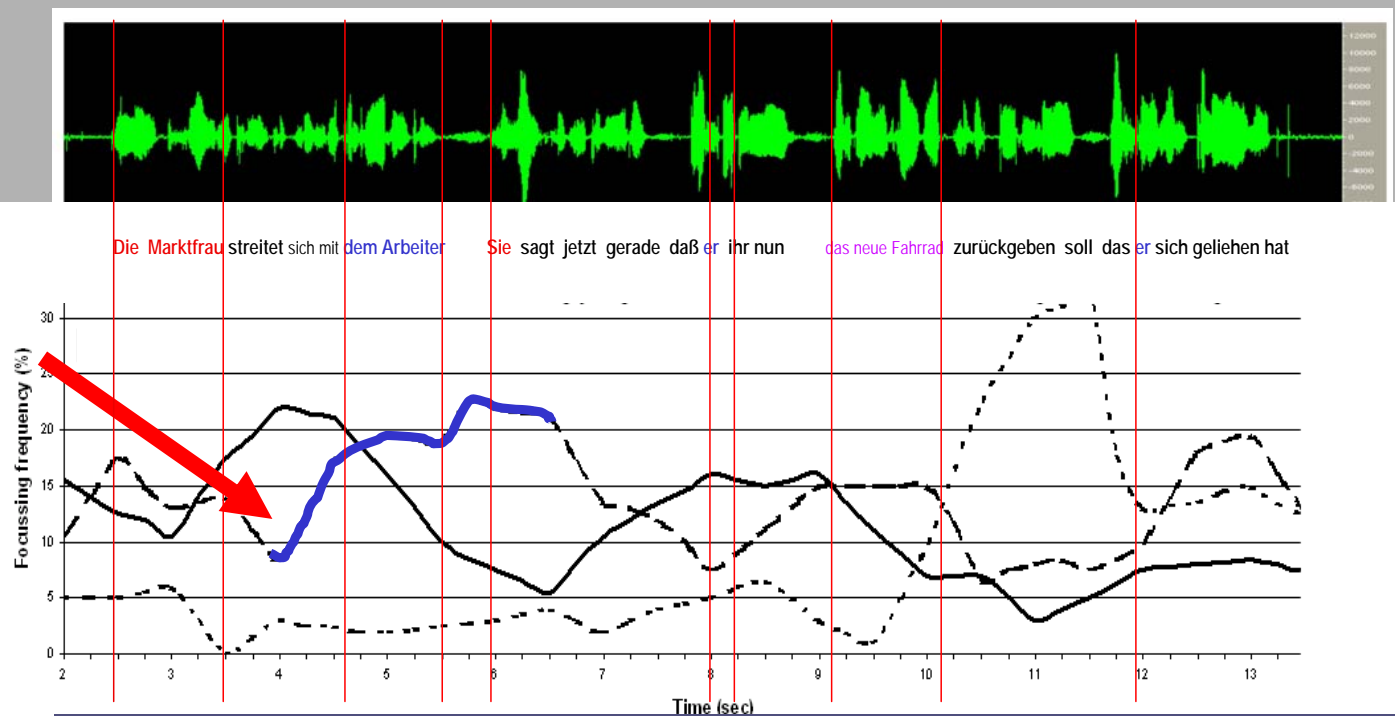
Should this not also be the case for *other than referential expressions* (predicates, unsaturated expressions)?

Anticipation effects in our experiments suggest exactly this

>>

# Eye tracking for reference resolution (2)

Karabanov, Bosch, König 2007



no referent anticipation plausible  
unless "streitet" has already been understood

## Context-dependent predicate expressions

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We already mentioned some cases of context-dependent variation in interpretation:

*Point of view*

*My apartment is nearby*

*The department is on the left side of the street*

*Comparison class*

*This was a fast run.*

*(at a national competition or a recreational running event)*

*Lexical meaning*

*This computer is fast.*

*This bike is fast.*

# Contextual modulation of interpretation

The kind of contextual influence we are interested in<sup>15</sup>

- is a form of modulation that is made and understood *automatically and with no effort*,
- remains *unnoticed by the language user*, and
- is *productive*: it can yield infinitely many variants of arbitrarily fine granularity
- not: non-literal uses!

## Typical cases:

*The {watch / tap / lecture /...} is running.*

*{Fred, my computer, our solution / ...} is working.*

*This is a fast {run / bike / solution /...}.*

*There is a petrol station nearby.*

## Productive modification (i)

where the semantic values of argument expressions contain all information relevant

- |     |                |  |
|-----|----------------|--|
| (1) | <i>to cut</i>  | <i>hair, bread, cake, lawn, ...</i>            |
| (2) | <i>to open</i> | <i>book, letter, door, bottle, buffet, ...</i> |
| (3) | <i>to run</i>  | <i>tap, water, clock, show, dog, ...</i>       |

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## Open questions:

- How many different types of arguments are there?  
What if the list is not finite?  
Generalization to unseen cases?
- What if you only have the *argument expressions* & not their *values*? E.g. "You need to cut it."

# Lexical disambiguation needs access to denotations

lexical items

concept names<sup>17</sup>

Lexicon

$\llbracket work_1 \rrbracket = \lambda x. WORK_1(x)$

$\llbracket work_2 \rrbracket = \lambda x. WORK_2(x)$

Conceptual

$\forall x (WORK_1(x) \vdash DEVICE(x) \dots)$

Representation

$\forall x (WORK_2(x) \vdash HUMAN(x) \dots)$

Lexical disambiguation requires access to semantic values, i.e., to the intended reference situation, and not just to a lexical entry for the arguments:

(2) *Charly isn't working.*

is open to either interpretation, depending on whether *Charly* is intended to refer to a person or to a computer.

## Productive modification (ii)

where the semantic value of an implicit argument is sensitive to context

- |     |               |                         |
|-----|---------------|-------------------------|
| (1) | <i>nearby</i> | <i>location</i>         |
| (2) | <i>enemy</i>  | <i>person</i>           |
| (3) | <i>left</i>   | <i>point of view</i>    |
| (4) | <i>fast</i>   | <i>comparison class</i> |

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### Open questions:

- How do we know *what expressions* have implicit arguments?
- How do you *find the relevant argument* in the context?

## Productive modulation (iii)

where neither explicit nor implicit arguments help:  
contextual variation in the denotation of "work"

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*Where is Fred?*

(1) *He's working.*

$WORK_i(\text{fred}) \rightarrow \varphi (\text{LOCATION}(\text{fred}))$

*How can Fred afford these expensive holidays?*

(2) *He's working.*

$WORK_j(\text{fred}) \rightarrow \psi (\text{WEALTH}(\text{fred}))$

*Can I speak to Fred, please?*

(3) *He's working.*

$WORK_k(\text{fred}) \rightarrow \sigma (\text{AVAILABILITY}(\text{fred}))$

## Productive modulation (iii)

The variation is inferentially and hence truth-  
conditionally relevant.

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Nothing follows about Fred's location when

*Fred is working*

is an answer to

*How can Fred afford these expensive holidays?*

The variation is stable within the utterance context.

*Fred is working and so is Pete.*

cannot be interpreted as, e.g.,

*Fred is in his office and Pete can afford  
expensive holidays.*

## Productive modulation (iv)

### Shiftable contextuials

Certain contextually specified aspects of meaning are “shiftable”

*Fred said it was raining and Jane did too.*

Location need not be the same (but can be)

Shiftable test (Graham Katz): Reported speech

Peter (Berlin): *“It is raining”*

Graham (Washington): *“It is raining”*

*OK Peter and Graham both said that it was raining*

## Productive modulation (iv)

### Shiftable contextuials and reported speech

Implicit person argument

Bat Man: *“I got rid of the Joker”*

Superman: *“I got rid of Lex Luther”*

Reported as: *Each super hero said he got rid of an enemy.*

Implicit perspective argument

Ted (in town): *“I went to a nearby pub”*

Steve (in the country): *“I went to a nearby bar”*

Reported as: *Ted and Steve each said he went for a drink nearby.*

Implicit comparison class argument

Ted (about his new bike): *“It's really fast”*

Steve (about his new car): *“It's really fast”*

Reported as: *Ted and Steve each said he had a fast vehicle.*

Contextuials that have an implicit speaker-related argument are shiftable within the same utterance context

# Productive modulation (iv)

## Non-Shiftable Contextuals

### Lexical Meanings

Ted ("Where are you?"): *"I'm working"*

Steve ("How can you afford that?"): *"I'm working"*

*#Ted and Steve each said he was working.*

Contextuals without implicit variables are not "shiftable".

How is productive modulation  
to be accounted for?

## What is actually being modulated?

- not lexical meanings (characters)  
(because the variation is productive and correlates with variation in the context)
- but semantic values (contents, denotations)

character: context → content

Semantic values of unsaturated expressions are

*Contextual Concepts*

(Cf. Frege's idea that the values of "predicates" are concepts.)

# What are Contextual Concepts ?

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## Contextual Concepts (CCs) are

- partial functions that are defined for all and only arguments in the intended domain
- constructed on the fly in the course of language production and comprehension
- are linguistically real:  
They define the required notion of identity in VP anaphora, coordination, question-answer coherence; they define units of counting

## Identity of VP denotations

*Fred is working, and so is Pete.*

*Fred is working, and Pete \_\_\_ too.*

*Fred is working, and Pete is working.*

Counting (talking of Fred, Pete, and a few others):

*I wonder how many of them are working?*

Q-A relations:

*Is Fred or Pete working? Pete is working.*

This is NOT identity of meaning, but identity of denotation:

*Fred is working for her, and so is Pete.*

the referent of *her* must be the same for Pete and Fred and forms part of the specification of the CC ascribed to both Pete and Fred.

# How are Contextual Concepts computed?

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The computability of the **content of Kaplanian indexicals** rests on the assumption that it is a process of **variable saturation**: Lexically specified variables are evaluated by the context (*speaker, listener, place, time,...*).

An analogous procedure is responsible for the interpretation of shiftable contextuials, which contain a lexically specified variable (perspective, location, comparison class,...) that is evaluated to the current contextual value and may be bound.

Note1: Indexicals and shiftable contextuials would ordinarily also depend in their interpretation on other contextual parameters, so that any of them maps onto very many different CCs, as in the case of any contextual expression.

Note2: I am uncertain about the distinction between Kaplanian indexicals and shiftable contextuials. Possibly there is none.

# How are Contextual Concepts computed?

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The variable evaluation procedure that operates in the interpretation of indexicals and shiftable contextuials does not work for **predicate denotations that do not contain explicit or implicit variables**

because

- there are **arbitrarily many parameters** with respect to which CCs can differ, and
- there is **no finite parameterisation of contexts** (i.e., there is no context-independent identity of contexts).

# The computation of CCs differs for different information structure status

*Anaphoric expressions* are interpreted with reference to objects in the established discourse representation. There is no modification and no lexical semantics involved.

*Focal expressions* are interpreted via their lexical entries, plus modification.

But modification is a conceptual process and operates on conceptual representations: We are concerned with reasoning, not with linguistic semantics in any narrow sense.

## Anaphoric vs. focal occurrence

*Is Fred **working**?*

focal occurrence

anaphoric occurrence

a. *No, he isn't **working**. He's sick.*

a'. *No, he isn't. He's sick.*

If both (a) and (a') mean the same, and have the same truth-conditions, then the lexical semantics of "working" in (a)

*can't be making a semantic contribution:*

*it just copies its denotation from the preceding question.*

# Computing values for anaphoric expressions

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*Anaphoric expressions* select their denotation from a small and finite domain: the discourse representation.

The information used in their interpretation is structural information (incl. salience status) and high level semantic class information. - The interpretation is taken care of by mechanisms of *anaphora resolution*.

The typical case are anaphoric pronouns.

# Computing values for focal expressions

Focal expressions are mapped onto their values in two steps:

- i. the expression selects a lexical entry, which contains a pointer to a lexical concept.

----- the semantics ends here -----

The concept is part of a conceptual representation and is linked to other concepts via its internal structure, via subsumption, and via various axioms.

It is still largely underspecified with regard to what may be needed in the semantic values.

- ii. Conceptual processes and information from arguments, modifiers, and discourse, as well as non-linguistic sources complete the construction of semantic values.

## (i): Transitive-Intransitive alternation

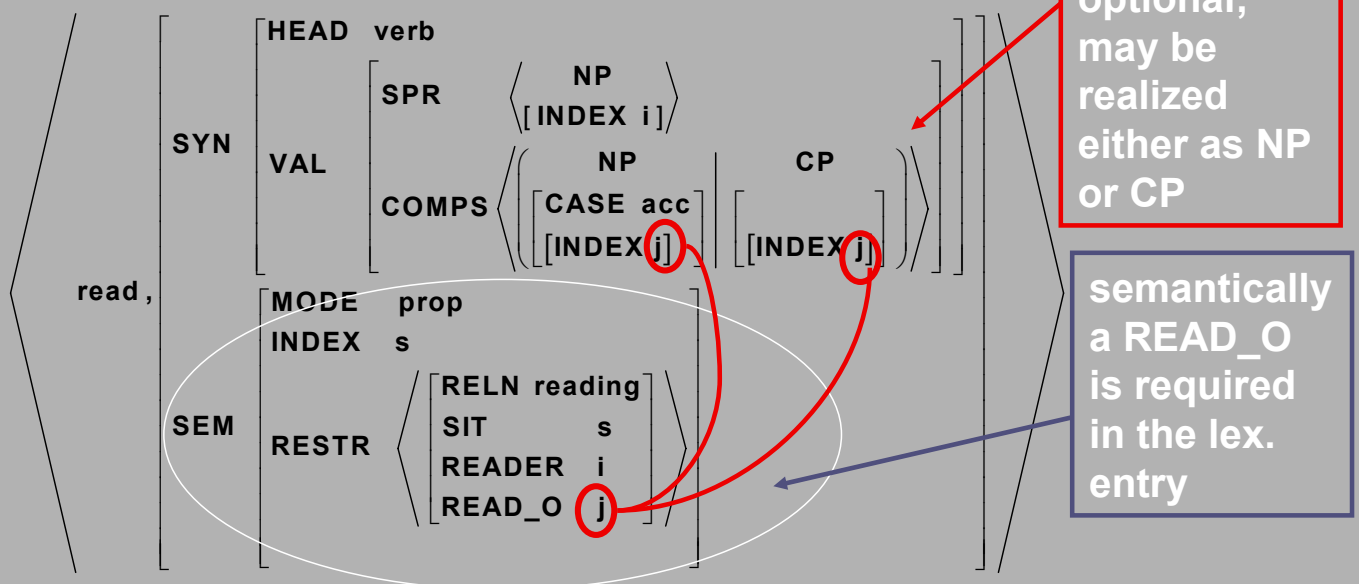
- (1a) *Fred is reading a novel.*  
(1b) *Fred is reading.*

## (ii): Argument (Re-)Interpretation

- (2a) *Fred began reading a novel.*  
(2b) *Fred began a novel.*

(1a) *Fred is reading a novel.*      (1b) *Fred is reading.*

a lexical entry:



(1a) *Fred is reading a novel.*      (1b) *Fred is reading.*

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**The lexical concept  $[[\text{read}]] =$**

$\text{READ} = \lambda j \lambda i . \exists s (\text{READING}(s) \wedge \text{READER}(i, s) \wedge \text{READ\_O}(j, s))$

- is subsumed by a more general concept

$\text{READ} \subset \lambda y \lambda x (\exists e (\text{EVENT}(e) \wedge \text{AGENT}(x, e) \wedge \text{THEME}(y, e)))$

- is inferentially related to other concepts

$\forall s (\text{READING}(s) \vdash \exists x (\text{READER}(x, s) \wedge \exists y \text{READ\_O}(y, s)))$

(1a) *Fred is reading a novel.*      (1b) *Fred is reading*

?

**What happens if the linguistic utterance doesn't provide an object argument?** <sup>36</sup>

- syntactically it's not required
- semantically, it's still assumed that there is one,

cf. the discourse:

*Fred is reading. But he's bored by the book.*

*#Fred is walking. But he's bored by the book*

Definiteness requires a unique denotation for the noun *book*. - The concept READ in the discourse representation already contains the feature (argument) READ\_O, which unifies with the denotation of *book*.

**The conceptual discourse representation is the integration point for all relevant information, independent of their source.**

# From lexical to contextual concepts

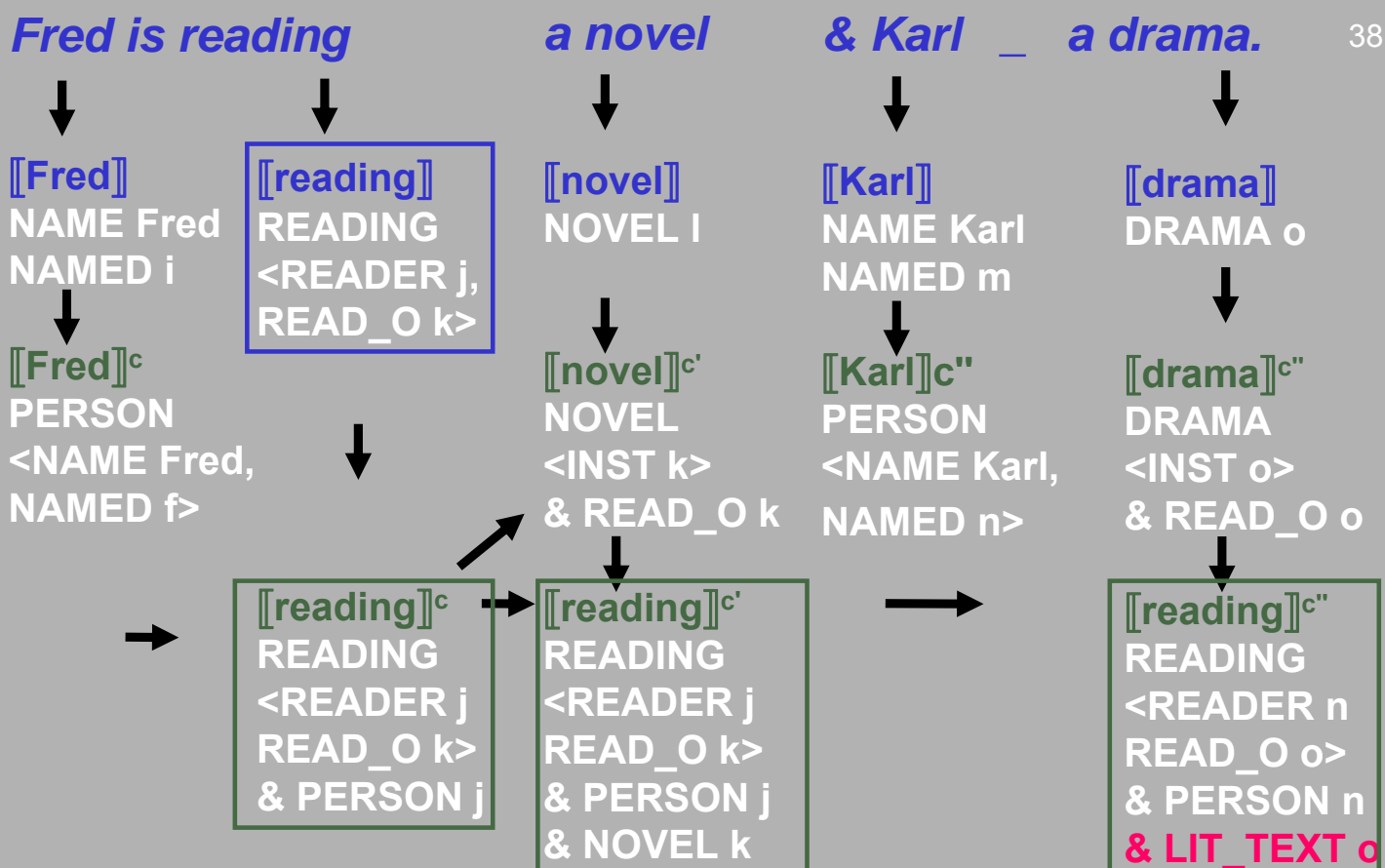
*Fred is reading something.*  
*Fred is reading that he won the pools.*  
*Fred is reading an inscription.*  
*Fred is reading a novel.*  
*Fred is reading "Finnegan's Wake"*  
*Fred is reading the daily paper.*  
*Fred is reading "Ratnasiri Wickremanayake".*

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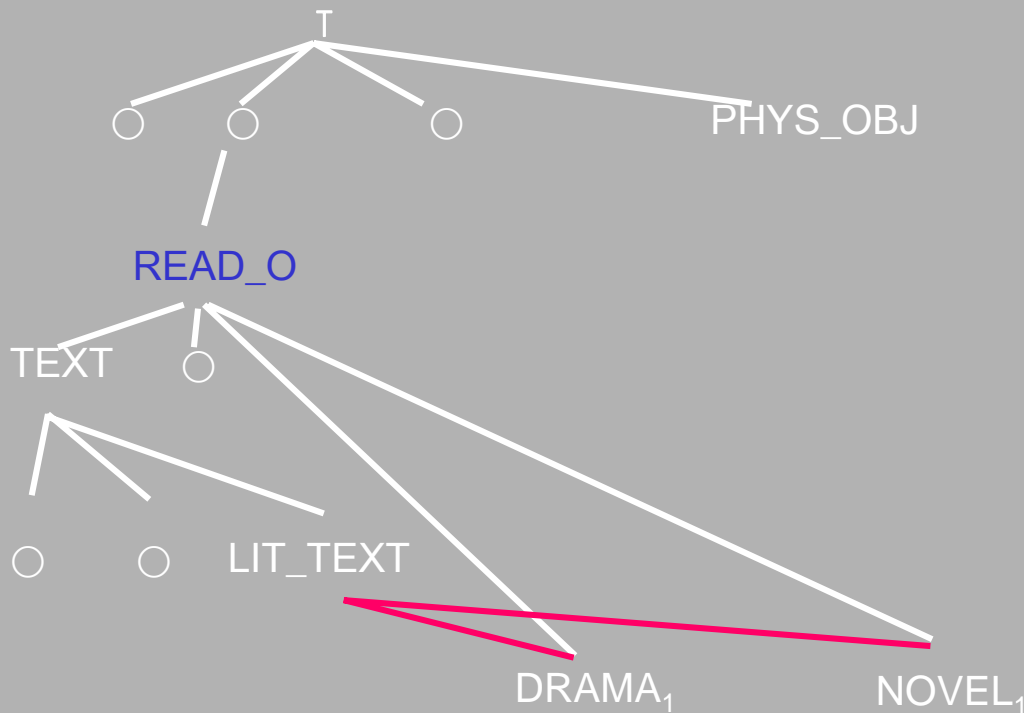
...

*One lexical concept, but already the sentential context suggests that the denoted CCs will normally be different*

## Incremental construction of CCs: An example



# Unification of DRAMA and NOVEL



## Lexical concepts & Contextual Concepts

A **lexical concept** is part of the lexical entry, and provides a link to a vastly underspecified concept in the conceptual representation.

Concepts (= sorts, types) in the conceptual representation

- inherit information from their super-concepts,
- provide inferential links to other concepts,
- integrate information from the utterance as well as non-linguistic sources to build contextual predicate denotations, i.e., CCs.

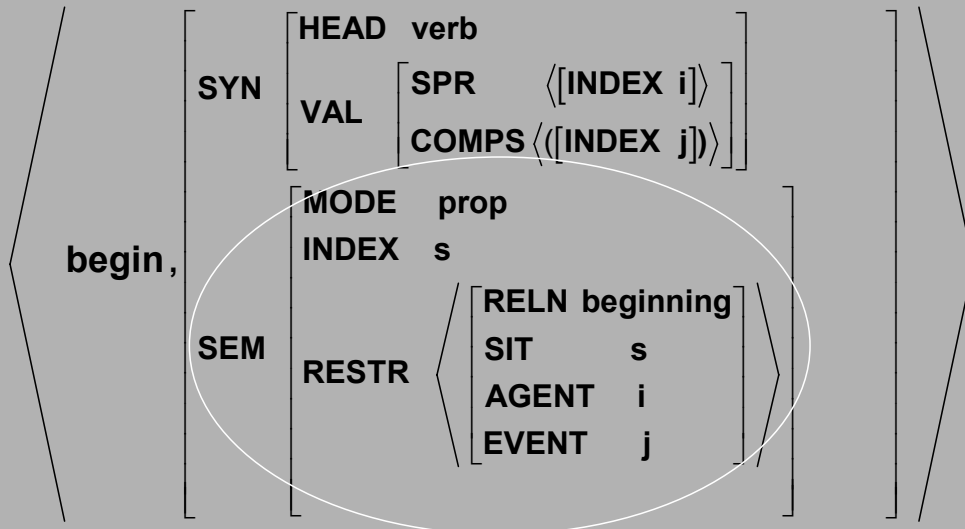
## (ii) Argument (Re-)Interpretation

(2a) *Fred began reading (a novel).*

(2b) *Fred began a novel.*

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The lexical entry for *begin*:



(2a) *Fred began reading (a novel).*

(2b) *Fred began a novel.*

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The lexical concept:

[[begin]] =

$$\lambda y \lambda x . \exists s (\text{BEGINNING}(s) \wedge \text{AGENT}(x,s) \wedge \text{EVENT}(y,s) \\ \wedge \forall z (\text{PART\_OF}(z,y) \wedge \neg \text{EARLIER\_THAN}(z,s))$$

(... plus more content)

Where does the processor find the needed event argument for *Fred began a novel*?

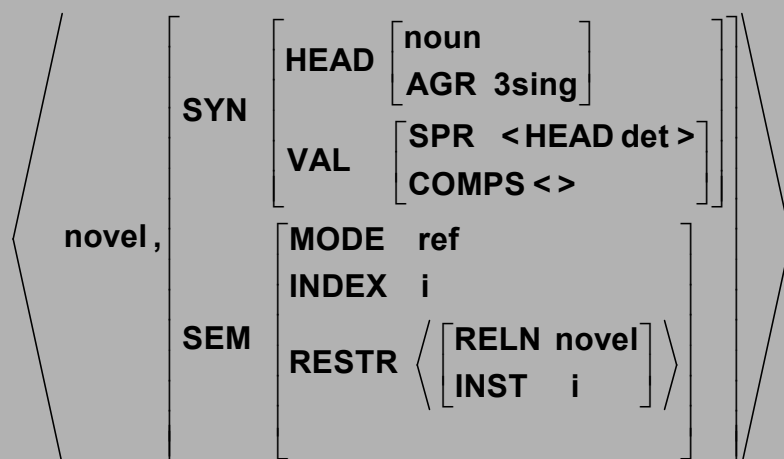
[[reading (a novel)]] ⊆ EVENT

but also: [[a novel]] ⊆ EVENT

# a lexical entry for "novel"

a lexical entry:

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$[[novel]] = \lambda x .NOVEL(x)$

not very informative ?

$[[novel]] = \lambda x .(NOVEL(x) \wedge$

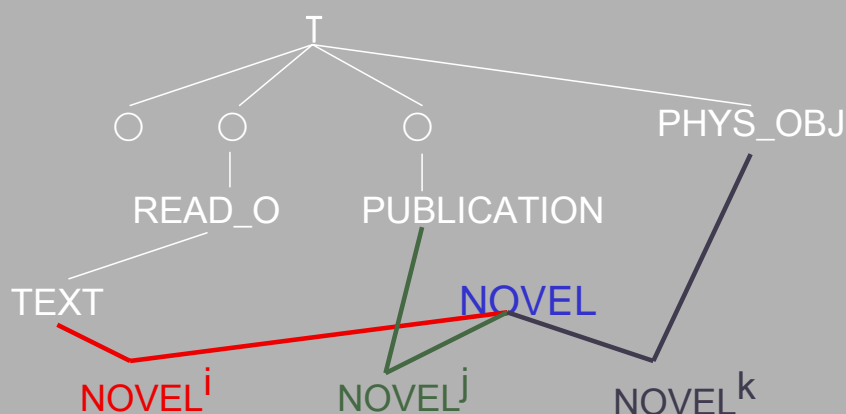
RELATED\_TO\_A\_BOOK\_LENGTH\_PROSE\_NARRATIVE(x))

we want to make do with just one lexical entry and one grossly underspecified lexical concept.

# polysemous senses of "novel"

The various polysemous senses are generated in the conceptual representation as different "views" of this concept. Views are fairly general CCs.

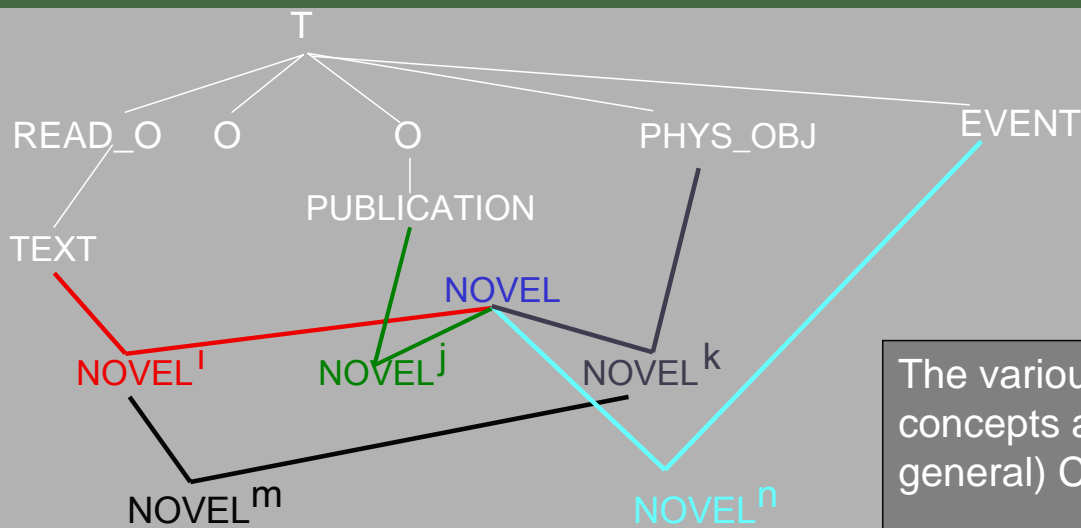
**Views** are subordinate concepts of the lexical concept and inherit additional features and roles from those superconcepts that determine the view.



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## polysemous senses of "novel"

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*Peter was reading the novel he had found on the train.*

*Fred began a novel.*

The various NOVEL<sup>x</sup> concepts are (fairly general) CCs.

They are further enriched by information from

- subcategorization and predication
- additional discourse and situational information

## is this not the same as "Coercion"?

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It's similar. – But coercion in the Generative Lexicon approach

- does not access contextual knowledge
- does not allow for varying **views** of concepts
- is limited to a fixed set of parameters ("qualia")

## Summary (i)

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### A sketch for an account for contextual variation in predicate denotation

#### 1. The methodology

- assumptions of incrementality and immediacy (to keep closer to processing)
- compositionality (to account for productivity and learnability), but at the level of denotations
- computability

## Summary (ii)

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#### 2. Some of the features

- Polysemy disappears from the lexicon and is located in the conceptual representation.
- There is no productivity in the lexicon, the lexicon is not "generative" (leaving aside questions of word formation, possibly lexical rules)
- The observed productivity is a conceptual, not a linguistic phenomenon.
- Semantic information in the lexicon is reduced to a concept link (disquotational lexicon) and subcategorization (domain restriction on arguments).
- Conceptual representation integrates constraints collected from argument selection, predication, and discourse and utterance context.