Polysemy, Meanings & Concepts
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1. Motivation from language processing
2. Indexicality as a model
3. Some of the problems
4. Contextual concepts
5. Sketching solutions

Interactive processing of linguistic and visual information – Visual World eye tracking

German default descriptions:
- der (masc) gelbe Hut (masc)
  the yellow hat
- die (fem) blaue Rakete (fem)
  the blue rocket
- der (masc) blaue Stern (masc)
  the blue star
- das (neut) gelbe Hufeisen (neut)
  the yellow horse shoe

condition: target object singled out by determiner gender alone

The denotation of the definite determiner is commonly modelled as a partial function, defined only for a domain in which its nominal complement has a unique denotation (Heim & Kratzer 1998):

\[ \lambda f \in D_{\text{det}} \& \exists ! x \ f(x) = 1. \ y \ [f(y) = 1] \]

Suppose this is actually part of an entry in the mental lexicon:
Then the determiner could not have any processing effect, as long as \( f \) is not known, i.e., not before the offset of the NP.

But some information about \( f \) is already available with the determiner: the gender of the basic level noun denoting \( f \), and the experiment shows that this information is used immediately.

The role of linguistic knowledge

2
Let's look at the information the processor has available:

**Visual information** from the display limits the referential choice to 4 objects, for each of which linguistic experience provides the knowledge of basic level common nouns.

**Linguistic knowledge** contributes the determiner denotation and the information that only one of the basic level nouns is gender-congruent with the determiner.

So the processing effect of the determiner may be explained by postulating:

1. the knowledge the processor has of the German basic level common nouns for all objects in the display, incl. minimal lexical information:  
   - **Hut** [gen:masc], [sem:Hut]
   - **Rakete** [gen:fem], [sem:[Rakete]]
   - **Stern** [gen:masc], [sem:[Stern]]
   - **Hufeisen** [gen:neut], [sem:[Hufeisen]]

2. the identification of exactly one display object as an instance of **Rakete**, presupposing sufficient conceptual and visual information

3. and a lexical entry for the determiner **die** including gender information: \( \exists x \in D_{<e,t>} \& \exists y \in (t) \& g(BCN(x), fem) = 1 \& g(f(y)) = 1 \)

But only some of this is linguistic knowledge!

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Experimental evidence indicates that visual and linguistic input, as well as linguistic knowledge and knowledge from experience, are processed immediately and simultaneously.

Referential expressions are resolved to the utterance context as soon as the sufficient information is available and before sentence meanings or even constituent meanings are computed.

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

Anticipation effects in much experimental work suggest exactly this.

The kind of modulation I am interested in:

- is a form of "sense" modulation that is made and understood automatically and with no effort,
- typically remains unnoticed by the language user, and
- is productive, i.e., it can yield infinitely many variants of arbitrary fine granularity.

Typical cases:

- *The {watch / tap / lecture /…} is running.*
- *(Fred, my computer, our solution /…} is working.*
- *This is a fast {run / bike / solution /…}.*
- *Fred {read, published, found} a novel.*

NB: I am not concerned with nonliteral uses!
If the kind of contextual modulation is productive, our task is to find the productive mechanisms.

The strategy I propose is to keep meanings to an absolute minimum, and derive the productivity from an interaction of meanings and other cognitive resources, specifically world knowledge.

The identity of "meanings" shown in classic tests (VP ellipsis etc.) then turns out not to be sensitive to meanings, but to denotations that result from interactions of meanings with contexts.

Meaning is a function, roughly speaking, that takes contextual parameters as arguments and yields local, contextual concepts, as values. - The obvious model behind this approach is David Kaplan’s model for the semantics and pragmatics of indexicals.

Intuitively speaking, indexical expressions - refer differently in each utterance context, - but hold their meanings constant across contexts

Sentences that contain indexicals - have potentially different content, i.e., say something different, in each context - but do not change their meaning across contexts

Contextual modulation as indexicality

David Kaplan’s model (1978)

compositional sentence meanings
sentence intensions

Character : Context \rightarrow Content:

Contextual modulation as indexicality

David Kaplan’s model (1978)

compositional sentence meanings
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Character : Context \rightarrow Content:

Utterance meaning

What is meant
Can the Kaplan model be extended?

Kaplan’s sentence meanings contain index variables that are evaluated at the utterance context to yield the appropriate truth conditions for the utterance. This conception is primarily geared to account for the context-dependent variation in the reference of indexical expressions.

- Can the same model be used for context dependence quite generally?
- Can it also account for the context-dependent variation that we find in polysemy?

Productive modulation (i)

where the semantic value of an argument expression modulates the semantic value of the functor, or the value of a functor modulates the value of an argument expression

1. I cut {the hair, the bread, the lawn,…}
2. I opened {a book, a letter, a door, a bottle, a buffet,…}
3. I lost {my glove, my face, my father, my job,…}
4. She {read, found, started, published,…} a novel.

- How many different types of semantic values are there for different argument expressions/functors? Is the list finite? Generalization to unseen cases?
- What if you only have the argument expressions & not their values? e.g., “You need to cut it.”
- What if the semantic value of the functor is underspecified? e.g., “She regarded the novel as….”

Productive modulation (ii)

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

1. I live nearby. place
2. She saw an enemy. person
3. The office is left of the entrance. perspective
4. That was a fast run. comparison class
5. It’s raining. place, time

Open questions:
- How do we know which expressions have explicit arguments?
- How do we find the relevant argument in the context?

Productive modulation (iii)

where neither explicit nor implicit arguments seem involved: “free” contextual modulation

Where is Fred?
1. He’s working. WORK(fred) → φ (LOCATION(fred))

How can Fred afford these expensive holidays?
2. He’s working. WORK(fred) → ψ (WEALTH(fred))

Can I speak to Fred, please?
3. He’s working. WORK(fred) → φ (AVAILABILITY(fred))

Productive modulation (iii)

where neither explicit nor implicit arguments seem involved: “free” contextual modulation

The modulation is inferentially and hence truth-conditionally relevant:

- Nothing follows about Fred’s location when Fred is working.
- is an answer to How can Fred afford these expensive holidays?

The modulation 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.

What is it that is being modulated in productive modulation?

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

For unsaturated expressions the denotations are

Contextual Concepts

(Cf. Frege’s notion that the values of “predicates” are concepts.)
Contextual Concepts

- are the values of character functions, applied to a set of context parameters as arguments
- they are themselves partial functions that are defined for all and only arguments in the intended domain (they “live” in their own context and do not survive it)
- they may be arbitrarily abstract or concrete and may contain context-specific and other contingent information

- represent all the semantic constraints at the level of a discourse representation, integrating information from all sources available to the processor
- they are computed on the fly in the course of language production and comprehension
- they are, in Frege’s terms, not individual or subjective ideas (Vorstellungen), but objective concepts (Begriffe) that can be grasped and shared by others.

- are necessarily stable within their context (because they are values of functions that only have contexts as arguments), and can be anaphorically resumed within that context (they are contextual entities).

Thus it is CCs – not meanings or senses – that remain constant in VP anaphora, VP ellipsis, or VP repetition:

Fred is working, and so is Pete.
Fred is working, and Pete Ø too.
Fred is working, and Pete is working.

CCs are denotations, not meanings

Note, again, that CCs are not meanings, but the denotations of linguistic expressions: the denotation of a VP may depend on referential expressions and their presuppositions, and it fails to denote a CC if no referent can be recovered:

Fred is working for her, and so is Jane.
Fred is working for his wife, and so is Jane.

The referent, and not just the meaning, of { her / his wife } must be the same for Fred and Jane; and if Fred has no wife, the reference fails and no CC can be construed.

The assignment of a compositional denotation of the VP depends on the referential success of its constituents. The compositional meaning of an expression could never depend on the referential success of its constituents.

Semantic entries in the lexicon only provide pointers to concepts

Lexicon

\[ \text{work}_{\text{lex}} = \lambda x \text{WORK}(x) \]

Conceptual Representation

\[
\begin{align*}
\text{WORK} & \supseteq \text{WORK}_1 \\
\text{WORK} & \supseteq \text{WORK}_2 \\
\vdots
\end{align*}
\]

\[
\begin{align*}
\forall x (\text{WORK}_1(x) \supset \text{DEVICE}(x) \ldots) \\
\forall x (\text{WORK}_2(x) \supset \text{HUMAN}(x) \ldots) \\
\vdots
\end{align*}
\]

* concept names are completely arbitrary and receive their content only from subsumption relations and axioms in the conceptual representation; see below.
Intermediate summary

I am claiming that all the effects of productive contextual modulation that we looked at:

- modulation of a function by the denotation of a linguistically explicit argument, or of an argument by the denotation of a linguistically explicit functor,
- modulation of a function by an implicit argument,
- modulation of a function by any other form of contextual information

can be modelled by contextual concepts.

But not all in the same way...

Context dependence 1: Indexicality

The simplest case is the case of Kaplan indexicality.

The computation of the content of indexicals (in the narrow sense) rests on the assumption that it is a process of variable saturation. Lexically specified variables are evaluated by the context (speaker, listener, place, time, ...).

The exact same procedure is responsible for the interpretation of functor expressions, such as nearby, enemy, left, fast, which contain a lexically specified variable (location, person, perspective, comparison class, ...) that is evaluated to the current contextual value and may be bound.

In extension of the latter, we may also consider expressions that arguably also contain implicit index variables, albeit perhaps not lexically specified, such as It's raining.

Context dependence 1: Indexicality – shifting and binding

The evidence for implicit variables in any case is in shiftability of the value and bindability of the variable:

1. Shiftability

Even though my utterance of It's raining is by default interpreted as it's raining here and now, the sentence Both Graham and Peter said it was raining.

is plausibly interpreted as Graham having said it was raining in Washington and Peter in Berlin, when the context tells us that Graham was in Washington and Peter in Berlin.

But not all context dependence can be tied to variables....

Context dependence 2: Non-indexical modulation

Variable evaluation as it operates in the interpretation of indexicals is clearly not applicable to lexical items whose characters do not contain variables.

This includes the cases of

- modulation of a function by the denotation of a linguistically explicit argument; e.g., open (book, letter, door, bottle, buffet)
- modulation an argument by the denotation of a linguistically explicit functor, (read, publish, find, start) a novel
- and modulation of a function denotation by other forms of contextual information that is not given by a variable or an explicit functor or argument expression; e.g., the various interpretations of work in replies to different questions.

The first two of these cases:

- modulation of a function by the denotation of a linguistically explicit argument; e.g., open (book, letter, door, bottle, buffet)
- modulation an argument by the denotation of a linguistically explicit functor, (read, publish, find, start) a novel

are straightforward to model in a concept representation, and we shall see how in a moment.

The hard problem is the last case:
### Context dependence 3: "free" contextual modulation

- modulation of a functor denotation by other forms of contextual information that is not given by a variable or an explicit functor or argument expression; e.g., the various interpretations of work in replies to different questions.

The problem here is that:
- there are *arbitrarily many parameters* with respect to which any two actual contexts may differ;
- there can be no criteria for the identity of contexts that are themselves context-independent.
- accordingly "contexts" are no respectable entities and cannot figure as arguments for any respectable function.

"Free" productive contextual modulation is a task for non-monotonic knowledge-based reasoning, but still compositional!

### How are CCs computed?

- Differently for different information structure status

<table>
<thead>
<tr>
<th>Anaphoric expressions</th>
<th>Focal expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>are interpreted with reference to an established discourse representation. There is no modification and (next to) no lexical semantics involved.</td>
<td>are interpreted via their lexical entries, plus contextual modulation.</td>
</tr>
</tbody>
</table>

The lexical entry provides a grossly underspecified lexical concept (a node in the conceptual representation) and modulation operates on conceptual representations.

### Anaphoric vs. focal occurrence

<table>
<thead>
<tr>
<th>Is Fred working?</th>
</tr>
</thead>
<tbody>
<tr>
<td>focal occurrence</td>
</tr>
<tr>
<td>anaphoric occurrence</td>
</tr>
</tbody>
</table>

| 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, in this discourse, 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

*Anaphoric expressions* select their denotation from a small and finite domain: the discourse representation (short term memory).

The information used in their evaluation is structural (incl. salience status) and high-level semantic class information (\(\omega\)-features, subcat), i.e., the mechanisms are those of anaphora resolution.

Typical case are anaphoric pronouns and VP anaphora.

### Computing values for focal expressions

*Focal expressions* are mapped to their values in two steps:

1. The expression selects a *lexical entry*, which contains a pointer to a *lexical concept*.

   --- the semantics strictly ends here ---

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

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

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

### Application to "coercion"

**Argument (Re-)Interpretation**

(1a) Fred began reading a novel.
(1b) Fred began a novel.
Argument (Re-)Interpretation

(1a) Fred began reading a novel.
(1b) Fred began a novel.

A lexical entry for \textit{begin}:

\[ \lambda y \lambda x. \exists s [ \text{BEGINNING}(s) \land \text{AGENT}(x,s) \land \text{EVENT}(y,s) ] \]

\[ \text{[reading a novel]} \sqsubseteq \text{EVENT} \]

But where is the needed \textit{event argument} for

Fred began a novel?

also:

\[ [\text{a novel}] \sqsubseteq \text{EVENT} \]

A lexical entry for \textit{novel}:

\[ \lambda x. \text{NOVEL}(x) \]

not very informative?

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

If we believe that a novel is a longish prose narrative, etc., then this is \textit{not lexical knowledge}, but literary theory;

some polysemous senses of \textit{"novel"}

The various \textit{"polysemous senses"}, i.e., CCs, are generated in the conceptual representation as different \textit{views}:

\textit{Views} provide enriched subordinate concepts of a more abstract concept and inherit attributes from select superconcepts.

The various \textit{NOVEL} concepts are (fairly general) CCs.

They are further enriched by information from:

- subcategorization and predication
- additional discourse and situational information

A sketch for an account for contextual variation in predicate denotation

1. The methodology
   - assumptions of incrementality, immediacy, and multi-modality (to keep closer to processing)
   - compositionality (to account for productivity and learnability), but at the level of denotations
   - computability
2. Some of the features
- Polysemy disappears from the lexicon and is relocated in the conceptual representation.
- No productivity in the lexicon, (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 subcategorization, predication, and (non-monotonic) inference from discourse and utterance context.

References (very incomplete, sorry)