The acquisition of lexical meaning

A plea for naturalism

Some last-minute thoughts

- I'm quite jealous of the speech people
  - For the rather precise formulation of the problems
  - For the relatively clear nature of the data (speech signals)
- Today, a part of language acquisition where goals/issues/methods are less homogenous: learning word meanings

The big picture

- At a certain point in development, children start acquiring mappings between word forms and meanings (≠ referents)
- Whatever other mechanisms are needed (constraints, tracking statistics, social mechanisms), these meanings must be understood by the child as potential communicative content independently of the language

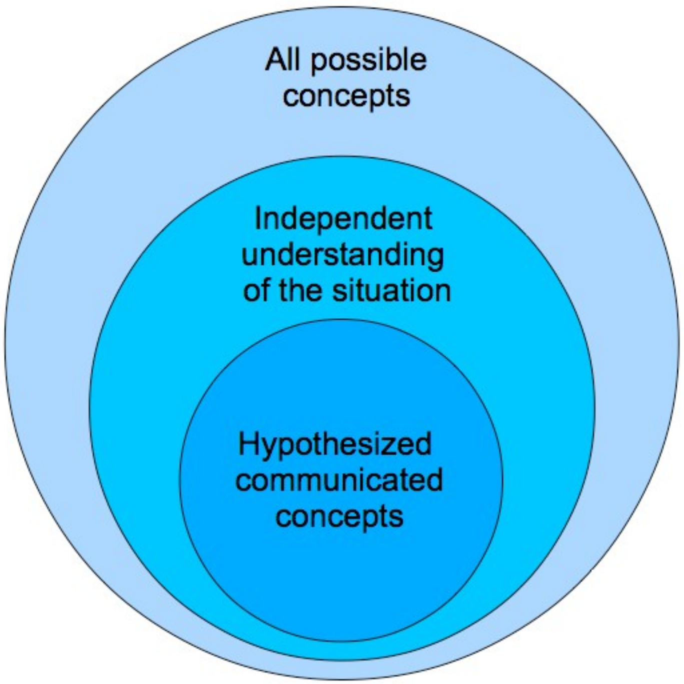
The big picture

- The assumption of independent understanding (cf. Brown 1958, Macnamara 1972, ...)
- Trivially true: otherwise no way in
- But: how does the learner get to an independent understanding of the situation and what is in it?

The big picture

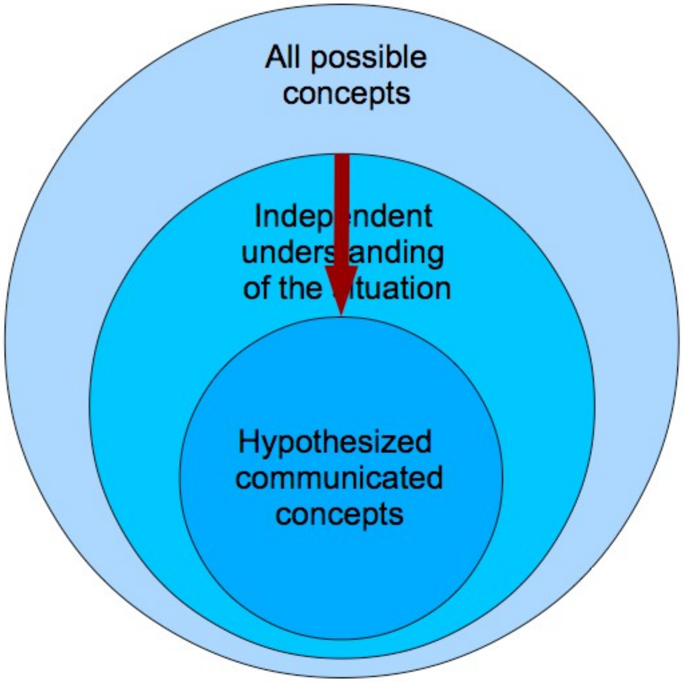
- Note: a different question from how to zoom in on the actually communicated meanings (which has been studied a lot)
- Looking at how to arrive at some independent understanding of the situation is a blind spot in acquisition studies - we know precious little about it
- Insight about this has bearing on the question how to get to the actually communicated meanings and their mappings to words

The assumption of independent understanding



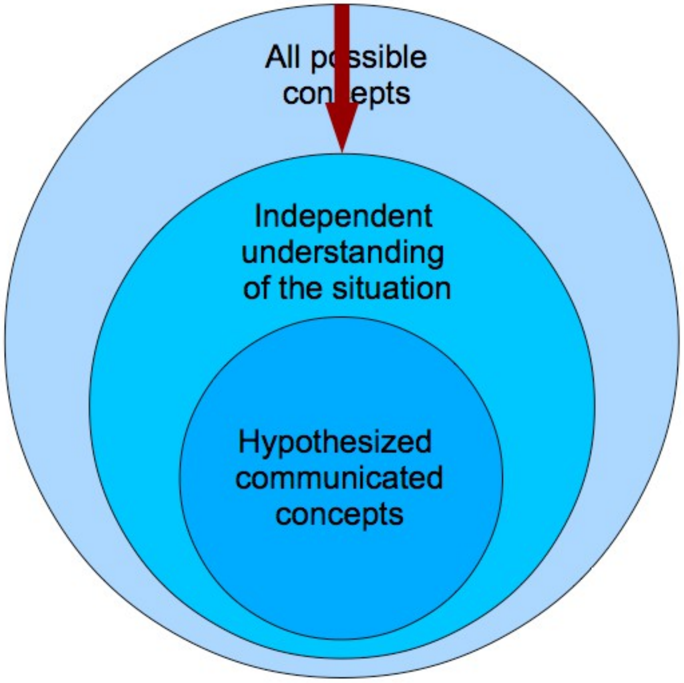
- Let
  - *A* be set of all possible concepts
  - *I* be set of independently understood actual concepts
  - *C* be set of hypothesized communicated concepts
- *C* is a subset of *I*
- *I* is a subset of *A*

The assumption of independent understanding



- Filters for acquiring word meanings:
  - Constraints (Markman 1994)
  - Social inference (Baldwin 1991)
  - Syntactic bootstrapping (Gleitman 1990)
  - Cross-situational learning (Pinker 1989)
- All take *I* and create a subset *C* (sometimes in mapping elements of *I* to linguistic material)
- *I*-to-*C*-mechanisms
- But *I* is presupposed

The assumption of independent understanding



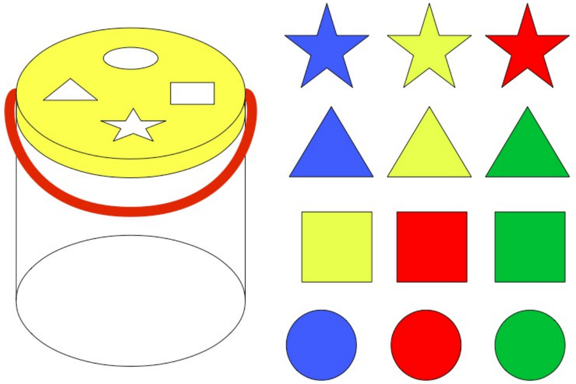
- How to get from *A* to *I*?
- *A*-to-*I*-mechanisms:
  - Perception
  - Understanding (joint) activities
  - Understanding mental states
- Blind spot of linguists
- Understandable: not a linguistic issue
- Only addressed by Gleitman (1990)

The assumption of independent understanding

- But if the assumption is a logical necessity and not even linguistic by itself, why bother researching it?
- Because knowing what is in *I* is crucial for understanding the relative importance of *I*-to-*C* mechanisms.
  - Different *I*s call for different filtering mechanisms
- A plea for naturalism: *A*-to-*I* mechanisms can be investigated on the basis of experiments and models but observational data gives us a naturalistic ground truth.

Going from *A* to *I*

- What can be in *I*?
- Looking at one *A*-to-*I* mechanisms
  - Visual perception
- In a constrained setting: videotaped interaction of mothers and daughters (1;4) playing a game of putting blocks through holes
- Then: mapping to language
- Joint work with Afsaneh Fazly, Aida Nematzadeh and Suzanne Stevenson (CogSci 2013)



Going from *A* to *I*

- Defining *A*: what can the learner represent
  - Object categories and properties like color and shape (block, bucket, red, square)
  - Actions and spatial relations (grab, move, in, on)
  - In predicate-argument formats: grab(mother, (yellow, square, block))
- Obviously, grossly simplifying
  - Universality of conceptualization, focus on basic level, only game-related objects, participants, properties, actions and relations

Experiment

- Experiment: visual perception
- We define *I* as all actions taking place at some moment, and the objects involved.
  - As coded by two coders, in blocks of 3 seconds not hearing the language
  - Assuming all game-related activities are perceived by the child visually
  - In total: 152 minutes of video, 32 dyads
  - Language: Dutch, CDS later transcribed

Experiment

0.00	<nothing happens>
	Een. Nou jij een. ‘one. now you (do) one’
0.03	position(mother, toy, on(toy, floor)) grab(child, b-ye-tr) move(child, b-ye-tr, on(b-ye-tr, floor), near(b-ye-tr, ho-ro)), mismatch(b-ye-tr, ho-ro)
	Nee daar. ‘No there’
0.06	point(mother, ho-tr, child) position(child, b-ye-tr, near(b-ye-tr, ho-ro)) mismatch(b-ye-tr, ho-ro)
	Nee lieverd hier past ie niet. ‘No sweetheart, it won’t fit here’

Experiment

- This gives us insight in what might be in the independent understanding of the situation.
- So: how does it map to language?
- Looking at words that refer to elements of *C*, i.e. things that can be conceptualized:
  - Object labels (*block, table*), properties (*red, round*)
  - Actions (*grab, move*), spatial relations (*in, fit*)
- Two ways: descriptive statistics and a modeling experiment

Experiment

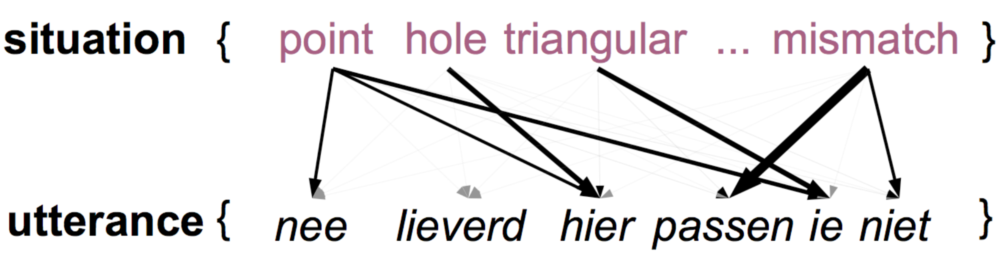
- Descriptive statistics: how often is there an element *m* in *I* that a word *w* in the simultaneous utterance (within 3 second window) refers to?
- And how often is the word *w* present when the element *m* it refers to is in *I*?

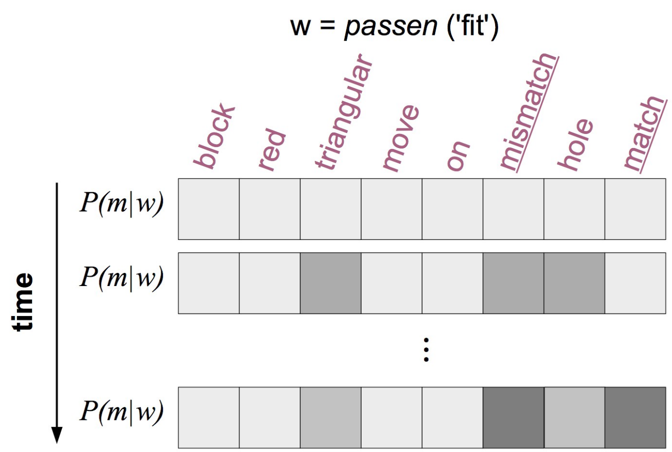
w & *m*	*m* when *w*	*w* when *m*	*w* & *m*	*m* when *w*	*w* when *m*
Pak: grab	0.58	0.01	*Rood*: red	1.00	0.01
Uit: out	0.26	0.18	*Emmer:* bucket	0.38	0.01
Passen: match	0.87	0.06	*In:* in	0.66	0.16

- Already insightful: asymmetry between '*m* when *w*' and '*w* when *m*'. Learner should not expect every element in *I* to be expressed.

Experiment

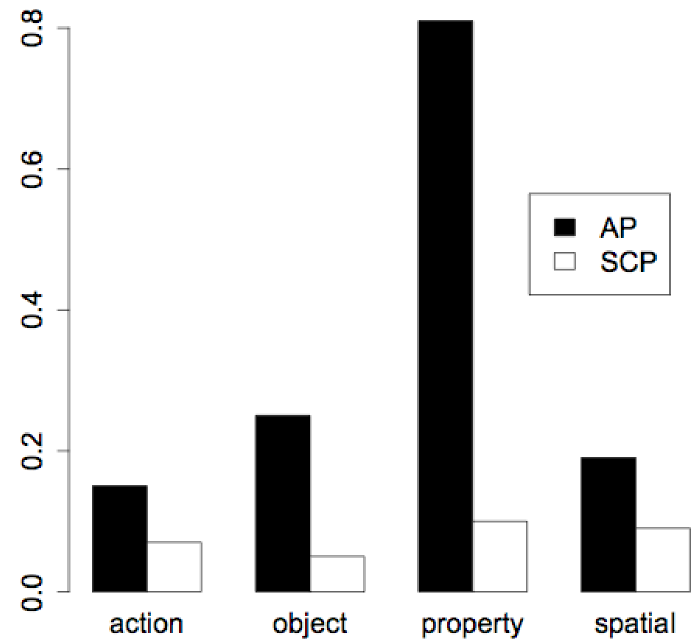
- Computational model: how strong does the association between each word and its meaning get
- Fazly, Alishahi & Stevenson's (2010) model
- Tracking cross-situational co-occurrence between words and elements of a situation
  - Where the situation is the set *I* in the 3-second window within which the utterance falls.
  - In total 2492 utterances





Experiment

- Looking at four (meaning-defined) classes of words
  - Actions, spatial relations, object categories, properties
- For every word, looking at the ranking (AP) of and probability mass (SCP) assigned to the correct meaning
- SCP: overall low
- AP: good for property labels, increasingly bad for object categories, spatial relations and actions



Experiment

- Key insights:
  - *I* sometimes lacks the communicated concept and many concepts are in *I* but not verbalized
  - This varies from word to word
  - In modeling: this dilutes the probability distributions and gives a low reliability for making mappings (esp. for some words)
  - This should guide our research into the mechanisms used for acquiring word-meaning mappings (*I*-to-*C* mechanisms)

Implications for experimental work

- The fact that subjects can use certain mechanisms in certain situations, doesn't mean they actually use it in lexical meaning acquisition
- This interpretive step diminishes if we approximate the parameters of the actual situations more closely in experiments.
- Experimental work can shed further light on
  - The nature & content of *I* and *A*-to-*I* mechanisms
  - Which *I*-to-*C* mechanisms are relevant in the context of actual *I*s

Implications for modeling work

- Similar points & recommendations hold here
- On top: computational modeling can help work out the intricacies of going from *A* to *I*, from *I* to *C* and from *C* to language on the basis of naturalistic data.

Final thoughts

- Obviously, there's much more to be said about the *A*-to-*I* mechanisms.
  - Culture-dependent ways of constructing reality (assuming *A* is universal and *I* contains culture-specific ways of conceptualizing reality)
  - Maturation of types of *A* that are available (physical > intentional > embedded intentional)
- Study of acquisition of meaning needs to take a more holistic scope and naturalistic vantage point to understand the mechanisms involved
  - alongside, not instead of an analytical, teasing-apart approach

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- Thanks to the audience and organizers of this workshop!

Experiment 2

- Experiment 2: understanding plans & goals
- Builds on the visual perception experiment:
  - Chains of events directed to a certain object lead to a certain spatial end-state of the object
  - E.g.: grab(mother,block) -> move(mother,block,on(floor),near(hole) -> letgo(mother,block) -> in(block,bucket)
  - Infer the goal from the chain (at every moment)
- Adds referents where they are lacking
- But doesn't help build stronger associations