Levels of analysis in the common ground debate

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Outline:

• Common ground debate in psycholinguistics
  - two different approaches to the same question
  - resulting in two opposing answers

• A framework to distinguish between hypotheses
  - levels of analysis for psychological/cognitive processes
  - ways of approaching theoretical resolution

• Applying the framework to common ground:
  - Relevance Theory as a computational level account
  - Requires common ground

• Levels of analysis in evolutionary theory
  - adaptationism as a constraint on psycholinguistic work
  - parallels between cognitive and evolutionary levels of analysis
Common Ground

- Mutual knowledge against which utterances are produced and comprehended

- We know that people tailor their production to their audience (Snow, 1972; Shatz & Gelman, 1973; Bell, 1984; Fussel & Krauss, 1992; Brennan & Clark, 1996)

- In order to do this, speakers/listeners must design/interpret speech according to a particular kind of knowledge called common ground. (Clark & Marshall, 1981; Clark, 1992; 1996) i.e. information that they share and know that they share.
The task of human communication

- Triadic communication as joint action (Clark, 1992; 1996)
The task of human communication

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Common Ground

“I hear they found moles digging in the garden”

“Yes. I hear pest control is coming at noon tomorrow”
Common ground in linguistic communication

TO WHAT EXTENT, IF AT ALL, DO WE INTEGRATE COMMON GROUND IN PROCESSING DURING DISCOURSE?
Common Ground: Egocentric Model

• Communicators as Cognitive Misers (Fiske & Taylor, 1984)

• Communication predicated upon most easily-accessible information, including privileged information (e.g., memory, private knowledge, perceptual instance)

• Optional adjustment stage uses common ground to detect and correct errors. (Keysar, Barr, Balin & Brauner, 2000)

• Tasks of referent-label comprehension most conducive to experimental study…
Common Ground: Egocentric Model

- Keysar, Barr, Balin & Brauner (2000)
  - Competitor delayed target ID
  - Fixation on competitor longer than non-referent
  - ~ 1/4 of the time participants tried to move the competitor
  - … even when competitor was hidden by a paper bag (Keysar et al, 2003)
Common Ground: Egocentric Model

• Private information is foundation against which utterances are produced/comprehended

• “…process of inferring the intended referent based on the speaker’s communicative intentions is not only unsupported, it is in fact unnecessary”. (Shintel & Keysar, 2009, p.64)

• In direct opposition to pragmatics-based account…
Common Ground: Full Constraint Model

• Common ground is the critical foundation upon which all utterances are produced and comprehended

• Therefore constrains all levels of linguistic processing

• “The speaker designs his utterance in such a way that he has good reason to believe that the addressees can readily and uniquely compute what he meant on the basis of the utterance along with the rest of their common ground” - Clark, Shrauder & Buttrick, 1983, p.246

• Approach that complements wider pragmatic and cognitive-pragmatic literature (Clark & Marshall, 1978; 1981) - identifies components necessary in observed communication to achieve successful discourse

• Defines discourse as “joint action”
Common Ground: Full Constraint Model


- First and total fixations restricted domain based on Cook’s situation

- Task-relevant & partner-specific constraints

- Complements work contra Keysar et al; immediate constraint to common ground (Hanna et al, 2003)
Common Ground: Rival accounts

EGOCENTRIC MODEL

Language in use

FULL CONSTRAINT MODEL

Communication as literal meaning

Processing - Cognitive economy

Communication as speaker meaning
Levels of analysis (Marr, 1982)

- Computational (what and why?)
- Algorithmic (how?)
- Physical (what structures implement this?)
Levels of analysis

Language in use

Communication as speaker meaning

FULL CONSTRAINT MODEL

Computational level

Algorithmic level

EGOCENTRIC MODEL

Communication as literal meaning

Processing - Cognitive economy
Levels of analysis

• “An algorithm is likely to be understood more readily by understanding the nature of the problem being solved than by examining the mechanism (and the hardware) in which it is embodied” (Marr (1982), p. 27)

• “The analysis of behavior need not wait until brain scientists have done their part. The behavioral facts will not be changed. Brain scientists may discover other kinds of variables affecting behavior, but they will turn to a behavioral analysis for the clearest account of the effects of these variables” (Skinner, 1989, pp. 18)

• “If you wanted to study the neurology of an ant, let’s say, you begin by asking what does the ant do? [...] You want to find the units of computation.” (Chomsky, recent interview on applying Marr to neuroscience)
Computational constraints

- Top-down approach, reverse engineering
The task of human communication

- Literal meaning and speaker meaning

- Linguistic underdeterminacy
  (Atlas, 2005; Austin, 1955; Carston, 2002; Grice, 1971; Sperber & Wilson, 1995)
Common ground integration

- The signal meaning is underdetermined if the goal is speaker meaning
- Speaker meaning must be reached inferentially
- Utterances must be produced in evidence of one’s own speaker meaning, such that successful interpretation can be reasonably expected
- This cannot be achieved by an algorithmic level that is not constrained by partner-specific mutual knowledge
Common ground integration

• The answer is that we use common ground

• Clark & Marshall (1978) propose copresence heuristics to establish common ground
A fuller picture of the computational level

- Cognitive-pragmatic accounts of communication (Wittgenstein, 1953; Austin, 1962; Sperber & Wilson, 1986; Baron-Cohen, 1988; Tager-Flusberg, 1992; 1993; 1997; Bara, 2010; Reboul et al in press)

- Relevance Theory is computational level analysis of ostensive communication
  - Cognitive Principle (that human cognition is geared to the maximisation of relevance)
  - Communicative Principle (that utterances create expectations of optimal relevance)
Relevance guided comprehension

a) Is devoted to his duty
b) Is willing to follow orders
c) Does not question authority
d) Makes his goals those of his team
e) Is a patriot
f) Earns a soldier’s pay
g) Is a member of the military
Relevance guided comprehension

How does common ground help to guide the order in which interpretations are considered?
Common ground in relevance guided comprehension

What does speaker A know here?

a) Speaker B just said “John’s a soldier”
b) she’s in a conversation about whether John is suited to be their employee
c) Speaker B knows that she knows (b)

Precisely because of their copresent information, “John is devoted to his duty/the team” is considered before “John is a member of the military”.
Common ground in relevance guided comprehension

If, however, (b) is changed...

a) Speaker B just said “John’s a soldier”

b) she’s in a conversation about what John does for a living

c) Speaker B knows that she knows (b)

Precisely because of their copresent information, “John is a member of the military” is considered before “John is devoted to his duty”
Relevance guided comprehension


You work for a travel agency, and the company advises the rule that those travelling to East Africa must be vaccinated against cholera. You must check this.

Did clients obey the rule that “if one travels to East Africa, then that person must be vaccinated against cholera”? 
Relevance guided comprehension


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Rule: If P then Q

- P: Ethiopia, Yes
- Not-P: Canada
- Q: Vaccinated
- Not-Q: Not Vaccinated
Relevance guided comprehension


You work for a travel agency, and the rule that those travelling to East Africa must be vaccinated against cholera is no longer in force. The company may have mistakenly advised clients of this rule.

Did clients obey the rule that “if one travels to East Africa, then that person must be vaccinated against cholera”? 

<table>
<thead>
<tr>
<th>P</th>
<th>Not-P</th>
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<tr>
<td>Ethiopia</td>
<td>Canada</td>
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<table>
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<tr>
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<td>Vaccinated</td>
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**Rule:** If P then Q

- **P:** If travelling to East Africa
  - **Ethiopia:** Yes
  - **Canada:** No

- **Q:** Must be vaccinated against cholera
  - **Vaccinated:** Yes
  - **Not Vaccinated:** No
Relevance guided comprehension


- Different logical interpretation (was the rule broken/was the rule followed) of the same logical problem

- Uniquely predicted by relevance guided reasoning

- Parallel with guided interpretations in discourse, where common ground is a parameter that determines the order in which possibilities are considered
Recap:

• Functions at the computational level constrain our expectations at the algorithmic level:
  • Common ground integration must enable the task of establishing underdetermined speaker meaning
  • Algorithmic-centric ‘cognitive miser’ accounts of cheap linguistic processing cannot address this task
  • Cognitive-pragmatic approach is also computational, and congruent with a Full Constraint Model of common ground
  • This account provides top-down constraint on algorithmic mechanisms
  • Generates uniquely testable predictions
  • Congruent with wider psycholinguistics literature on asymmetries in production (costlier) and comprehension (cheaper)
  • May even be reconcilable with the appearance of fast, seemingly ‘egocentric’ comprehension
Adaptationist considerations

• Psycholinguists invoke adaptationism whenever they make a functional claim (Tooby & Cosmides, 1990)

• Consilience with evolutionary theory is certainly desirable…
  “If current theory of language is truly incompatible with the neo-Darwinian theory of evolution, one could hardly blame someone for concluding that it is not the theory of evolution that must be questioned, but the theory of language” (Pinker & Bloom, 1990)

• To establish how an adaptation works, finding out what it is doing (and why) makes predictions about the necessary components.
The application of ‘adaptive heuristics’

- Egocentric model may lend itself to “adaptive heuristic” account of language processing:
- Communicators as Cognitive Misers (Fiske & Taylor, 1984)

- Primary constraint: processing costs

- Adaptive heuristics (Gigerenzer, 1999) follow similar principles, ostensibly lend support from evolutionary theory:

- Ball-catching heuristic:
The application of ‘adaptive heuristics’

- Clark & Marshall’s Copresence Heuristics also make use of this notion:
  - physical copresence
  - linguistic copresence
  - cultural copresence

- Mutual Knowledge is never really attainable (Schiffer, 1972)

- Copresence intended as “short-cuts” to common ground; if we satisfy copresence criteria, we can reasonably behave as though we have established Mutual Knowledge

- How do we determine which use of heuristics is evolutionarily sound?
Evolutionary levels of analysis

Tinbergen’s ‘four questions’ (1963):

**Ultimate** What and why?
- Function: To find food and avoid danger.
- Phylogeny: The vertebrate eye initially developed with a blind spot, but the lack of adaptive intermediate forms prevented the loss of the blind spot.

**Proximate** How?
- Causation: The lens of the eye focuses light on the retina
- Ontogeny: Neurons need the stimulation of light to wire the eye to the brain within a critical period

This looks familiar…
Which heuristics are adaptive?

- Applying an adaptive heuristics approach requires that we characterise the task being solved.
- **Communication is not a trait**: it is not an individual performance.

The question (as it pertains to communication) is not: How do we decode linguistic meaning cheaply?

Rather:
How do we establish common ground cheaply?
Summary

- Functions at the computational level constrain our expectations at the algorithmic level
- Common ground integration must enable the task of establishing underdetermined speaker meaning
- Algorithmic-centric ‘cognitive miser’ accounts of cheap linguistic processing cannot address this task

- Functions at the ultimate level constrain our expectations at the proximate level
- Language use is an adaptation to the task of triadic communication - i.e. joint action, where task is establishing underdetermined speaker meaning
- Adaptive heuristics must be applied to the problem of dynamic coordination that occurs between organisms, rather than individual decoding
- Common ground is part of other computational level, cognitive pragmatic accounts that can generate testable predictions
References

References

• Tooby & Cosmides (1990) - Toward an adaptationist psycholinguistics Behavioural and Brain Sciences 13(4), 760-761.