Psycholinguistics and sentence processing

LING240: Language and Mind, Summer II 2007
What is psycholinguistics?
A quote from Fromkin et al:

“Psycholinguistics is the area of linguistics that is concerned with linguistic performance – how we use our linguistic competence – in speech (or sign) production and comprehension. The human brain is able not only to acquire and store the mental lexicon and grammar, but also to access that linguistic storehouse to **speak and understand language in real time.** (Emphasis added by me)
FIGURE 9.1 The speech chain. A spoken utterance starts as a message in the speaker's brain/mind. It is put into linguistic form and interpreted as articulation commands, emerging as an acoustic signal. The signal is processed by the listener's ear and sent to the brain/mind, where it is interpreted.
Fig. 4.1  A blueprint of the speaker.
Fig. 5.1 A blueprint of the listener.
A quick observation

Multiple sources of information are used at different points

...and nevertheless, production and comprehension are REALLY FAST!

Fodor (1983) quoting Merrill Garrett:

“What you have to remember about parsing,” Merrill said, “is that basically it’s a reflex.”
Another look

A quote from Fromkin et al:

“Psycholinguistics is the area of linguistics that is concerned with linguistic performance – how we use our linguistic competence – in speech (or sign) production and comprehension. The human brain is able not only to acquire and store the mental lexicon and grammar, but also to access that linguistic storehouse to speak and understand language in real time. (Emphasis added by me)
Standard View

language

specialized algorithm

speaking

grammatical knowledge, competence

recursive characterization of well-formed expressions

understanding

specialized algorithm
Standard View

language

specialized algorithm

speaking

grammatical knowledge, competence

recursive characterization of well-formed expressions

precise but ill-adapted to real-time operation

understanding
Standard View

- language
- specialized algorithm
- recursive characterization of well-formed expressions
- grammatical knowledge, 
  \textit{competence}
- well-adapted to real-time operation but maybe inaccurate
- speaking
- understanding

specialized algorithm
“It has sometimes been argued that linguistic theory must meet the empirical condition that it account for the ease and rapidity of parsing. But parsing does not, in fact, have these properties. [...] In general, it is not the case that language is readily usable or ‘designed for use.”’ (Chomsky & Lasnik, 1993, p. 18)
Alternative View

\[ \text{language} = \text{Grammar} + \text{Resources} \]

- Working memory
- Past experience
- World knowledge
Footnote: Memory matters…

Wh-questions in English

Who did John say Mary thought Bill kissed?
Memory matters…

Wh-questions in English

Who did John say Mary thought Bill kissed t?
Memory matters…

Wh-questions in English

Who did John say Mary thought Bill kissed \( t \) ?

The longer the dependency is, the more taxed your memory resources are
Active dependency completion

Stowe 1986

Self-paced reading: Read sentence word by word, and the reading time for each word is measured

→ When the processing system encounters some difficulties, that will be reflected in slower reading time
My
brother
wanted
to
know
who
Ruth
will
bring
us
home
to
at
Christmas.
Comprehension question
My brother wanted to know

English Filled Gap Effect

Crain & Fodor 1985, Stowe 1986
My brother wanted to know

who

Ruth

Crain & Fodor 1985, Stowe 1986
English Filled Gap Effect

My brother wanted to know

Crain & Fodor 1985, Stowe 1986
English Filled Gap Effect

My brother wanted to know

- who
  - Ruth
    - will
      - bring
        - gap

Crain & Fodor 1985, Stowe 1986
Question

We don’t currently have an answer to the debate, but we could start by asking this question:

How directly is the grammar implicated in speaking and understanding?

Abstract units of language:

phoneme, syllable, phrase, c-command, etc.

Rules and constraints:

island, binding, etc etc.
Fig. 5.1 A blueprint of the listener.

From Cutler & Clifton 2000
Island constraint on wh-movement

Wh-phrases cannot be extracted in certain constructions:

1) *What did [the cop with t ] find the weapon at the crime scene? [Subject NP]

2) *Who did John believe [the claim that Mary kissed t ] ? [Complex NP]

3) *What did the man who bought kissed Mary? [Relative clause]
English Filled Gap Effect again

My brother wanted to know

who

Ruth

will

bring

us

home to at Christmas

Readers slow down upon encountering an NP where a gap was expected, relative to a control structure, in which no gap was expected.

Crain & Fodor 1985, Stowe 1986
Stowe 1986 Experiment 2

• The teacher asked ...

…if [the silly story about Greg’s older brother]…
…what [the silly story about Greg’s older brother]…

…if the team laughed about Greg’s older brother…
…what the team laughed about Greg’s older brother…

• 

<table>
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<th></th>
<th>the</th>
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<th>story</th>
<th>about</th>
<th>Greg’s</th>
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</table>
Stowe 1986 Experiment 2

• The teacher asked …

…if [the silly story about Greg’s older brother]…
…what [the silly story about Greg’s older brother]…

…if the team laughed about Greg’s older brother…
…what the team laughed about Greg’s older brother…

• the  silly  story  about  Greg’s
  if-S  611  677  752  750  798
  wh-S  616  698  760  880  800
  if-V  613  735  754  678  782
  wh-V  608  698  736  755  1063

Island constraint inhibits the active dependency completion!
Binding

- Do constraints on binding restrict the search for antecedents for pronouns/anaphors?

- Is there a binding analog of active gap creation? [not relevant for forward anaphora]
  - John thinks Bill is suspicious of him.
  - While he was washing the dishes, John was watching TV.
Binding review

Binding: A binds B when A c-commands and is co-indexed with B.

Principle A

Anaphors must be bound in a local domain.

Principle B

Pronouns must be free in a local domain.

Principle C

R-expressions must be free.
Cross-modal priming
Priming effect in lexical decision

Lexical decision task: Judge real and non-words

doctor – blick $\rightarrow$ 500ms

doctor – janitor $\rightarrow$ 480ms

Doctor – nurse $\rightarrow$ 300ms [facilitation]
Principle B-as-initial-filter

- Nicol (1988), Nicol & Swinney (1989): cross-modal priming study in which subjects had to make a lexical decision to a visually presented word while listening to sentences

  - The **boxer** told the **skier** that the **doctor** for the team would blame **him** for the recent injury.

| punch – facilitation | slope – facilitation | nurse - no effect |
Principle A-as-initial-filter

- Nicol (1988), Nicol & Swinney (1989): cross-modal priming study in which subjects had to make a lexical decision to a visually presented word while listening to sentences

  - The **boxer** told the **skier** that the **doctor** for the team would blame **himself** for the recent injury.

<table>
<thead>
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<th>punch</th>
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<td>slope</td>
<td>no effect</td>
</tr>
<tr>
<td>nurse</td>
<td>facilitation</td>
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</table>
Eye tracking
The teacher wondered what his student pushed the bike into
Sturt 2003

Experiment 1

Accessible-mismatch/Inaccessible-match

Jonathan was pretty worried at the City Hospital. He remembered that the surgeon had pricked herself with a used syringe needle. There should be an investigation soon.

Accessible-mismatch/Inaccessible-mismatch

Jennifer was pretty worried at the City Hospital. She remembered that the surgeon had pricked herself with a used syringe needle. There should be an investigation soon.
Experiment 1

- Early processing: first-pass at reflexive region
Experiment 1

- Later processing: second pass RT at reflexive region
Accessible-mismatch/Inaccessible-match

Jonathan was pretty worried at the City Hospital.
The surgeon \([RC \text{ who treated } Jonathan]\) had pricked herself with a used syringe needle. There should be an investigation soon.

Accessible-mismatch/Inaccessible-match

Jennifer was pretty worried at the City Hospital.
The surgeon \([RC \text{ who treated } Jennifer]\) had pricked herself with a used syringe needle. There should be an investigation soon.
Table 4

First-fixation, first-pass, regression-path and second-pass times for Experiment 2

<table>
<thead>
<tr>
<th></th>
<th>Pre-critical J...pricked</th>
<th>Reflexive himself</th>
<th>Spill-over with a</th>
<th>Pre-final used syringe</th>
<th>Final needle</th>
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<td>251</td>
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<td>137</td>
<td>203</td>
<td>44</td>
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</table>

First-fixation and first-pass times for the reflexive region are calculated using the leftward-shifting procedure described in the data analysis section of Experiment 1. Acc = “accessible,” Inacc = “inaccessible.”
While she was taking classes full-time, Jessica was working two jobs to pay the bills. While she was taking classes full-time, Russell was working two jobs to pay the bills.

Immediate Constraint Application

Self-Paced Reading, Gender Mismatch Paradigm

While she …

While she was taking classes full-time, she was working two jobs to pay the bills.

She …

She was taking classes full-time while she was working two jobs to pay the bills.

PrC

a. Because last semester SHE was taking classes full-time while Kathryn was working two jobs to pay the bills, Erica felt guilty.
b. Because last semester SHE was taking classes full-time while Russell was working two jobs to pay the bills, Erica felt guilty.

noPrC

c. Because last semester while SHE was taking classes full-time Kathryn was working two jobs to pay the bills, Russell never got to see her.
d. Because last semester while SHE was taking classes full-time Russell was working two jobs to pay the bills, Erica promised to work part-time in the future.

Control (cost of adding new person to mental model)
e. Because last semester while Erica was taking classes full-time Russell was working two jobs to pay the bills, she promised to work part-time in the future.
Results

GME at the 2nd NP in non-PrC pair

(Kazanina et al., 2004)
Results

GME at the 2nd NP in non-PrC pair
NO GME at the 2nd NP in PrC pair

(Kazanina et al., 2004)
Summary

We are beginning to see some evidence that grammar is fully used in sentence processing.

But we still need ... more experiments to support the view that sentence processing is fully grammatically constrained.

more theorizing about grammar that can be directly implemented in real time computation.
Further questions

What about production?

What about sound and word processing?

Cross-language variations?

How does the brain perform these linguistic computations?

Implement plausible psycholinguistic models/algorithms in computers?

How do the language processing mechanisms develop in children?

Etc. etc…
You can take undergrad psycholinguistics!

- Offered every fall!
- Get to do some real projects and experiments (most likely)!
- You can learn about attempts to address the questions we didn’t go into!
You can also be a participant!

- Go to the linguistics department website
- Sign up for language experiments, help us make progress in understanding of psycholinguistics, AND get paid!