Lab 1

• Here are the acceptability judgment tasks!
• Collect data from **three native speakers**
• Enter data in the excel sheet, and email it to me **by Thursday (19th)**
• I’ll send you the group results on Thursday, and then you can write up one-page report (due 26\(^{th}\), next Thursday; more on this in next class)
Sentence processing intro
Using Marr’s levels

Computational theory

What is the problem:
Mediation between “sound” and “meaning”
Different levels (phonology and syntax)

Representation and Algorithm

How it is done:
Processes of online comprehension and production

Implementation

What it is done with:
Brain

Theoretical Linguistics

Psycholinguistics

Neurolinguistics
Linguistic representations

The little star is beside the big star

Phonological structure

Segmental structure

Syllabic structure

Synactic structure

Semantic/conceptual structure

Spatial structure
BIG FACT 1: Fast and accurate processing

- Sentence processing is fast, incremental, and fairly accurate
Measures of Speed

• Measures of speed of processing
  – Eye-tracking
  – Event-Related Potentials (ERPs)
Eye-movements (reading)

(Sereno & Rayner, 2003)
Head-mounted Eye-Tracking
Allopena et al 1998

![Diagram with various symbols and a graph showing fixation probability over time. The graph compares different conditions: Referent (e.g., "beaker"), Cohort (e.g., "beetle"), Rhyme (e.g., "speaker"), and Unrelated (e.g., "carriage").]
Event-Related Potentials (ERPs)

John is laughing.
Event-Related Potentials

- Event-Related Potentials (ERPs) are derived from the electroencephalogram (EEG) by averaging signals that are time-locked to a specific event.

- Scalp voltages provide millisecond-accuracy, promise detailed timing information about syntactic computation, plus information about amplitude and scalp topography.
ERP Sentence Processing

N400

• Developing understanding of N400 is informative

I drink my coffee with cream and sugar
I drink my coffee with cream and socks

• Response to ‘violations’

Kutas & Hillyard (1980)
Morpho-Syntactic violations

Every Monday he mows the lawn.
Every Monday he *mow the lawn.

The plane brought us to paradise.
The plane brought *we to paradise.

(Coulson et al., 1998)

(Slide from Kaan (2001))
Left Anterior Negativity (LAN)

(Slide from Kaan (2001))
Neville et al., 1991

The scientist criticized a proof of the theorem.  
The scientist criticized Max’s proof of the theorem.
The scientist criticized a proof of the theorem.

The scientist criticized Max's proof of the theorem.
How Fast?

• Various types of evidence for processes above the word level within 200-400 msec (conservatively) of the start of a word.

• How are we able to compute so quickly?
Goal of the parser:
Structure generation & selection

• One must generate accurate syntactic structures to arrive at an interpretation

• When there are multiple candidates, one must select the appropriate representation
Basic Parsing Systems

Bottom-up: \( NP \rightarrow \text{Det} \ N \)

Left-corner: \( NP \rightarrow \text{Det} \ N \)

Top-down: \( NP \rightarrow \text{Det} \ N \)

\[
\begin{array}{c}
\text{NP} \\
\text{Det} \\
\text{some} \\
\text{books}
\end{array}
\]
Arnold read some books.
Bottom-up Parsing

NP
| Arnold

Arnold read some books.
Arnold read some books.
Arnold read some books.
Arnold read some books.
Arnold read some books.
Arnold read some books.
Arnold read some books.
Strict bottom-up parsing does not explain incrementality
Basic Parsing Systems

Bottom-up: \[ NP \rightarrow \text{Det} \quad \text{N} \]
Left-corner: \[ NP \rightarrow \text{Det} \quad \text{N} \]
Top-down: \[ NP \rightarrow \text{Det} \quad \text{N} \]

\[
\begin{align*}
\text{NP} & \rightarrow \text{Det} \quad \text{N} \\
\text{Det} & \rightarrow \text{some} \\
\text{N} & \rightarrow \text{books}
\end{align*}
\]
Arnold read some books.
Left-Corner Parsing

Arnold read some books.
Left-Corner Parsing

Arnold read some books.
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Arnold read some books.
Arnold read some books.
Arnold read some books.
Summary: incremental generation

• Interaction of top-down, grammatical knowledge and bottom-up information

• Incremental, predictive structure building (more on this on Thursday)
BIG FACT 2: Ambiguity

• There is MASSIVE AMBIGUITY at any level of language processing (at least temporarily)
• Interest in how people (fail to) resolve such ambiguities
Ambiguity at sentence level

• Global ambiguity
  – The spy saw the cop with the binoculars.

• Temporary ambiguity
  – The defendant examined [by the lawyer...]
  – The scientist knew the solution [was simple...]
  – When Bill left the house [was empty...]
  – The man gave the boy the dog [...bit a cookie]
  – The software manufacturers sell nowadays [...is overpriced]
  – Put the frog on the napkin [...in the box]
The *Garden Path* Theory

- Question: what information is used, and when, to construct syntactic representations?

- Focus is on use of different information sources in resolving *structurally ambiguous* sentences

- Claim (e.g. Frazier, 1987):
  - many different types of information are ultimately used (syntactic, semantic, pragmatic, probabilistic)
  - but syntactic information is used first/fastest
Minimal attachment

• Build a candidate with fewer syntactic nodes

The defendant examined...
  ...the document carefully?
  ...by the lawyer turned out to be innocent.

- Syntax autonomy in ambiguity resolution?
The Garden Path Theory

- Argument #1: Strong contextual biases are ineffective (Ferreira & Clifton, 1986)
  
  John worked as a reporter for a newspaper. He knew a major story was brewing over the mayor scandal. He went to his editors with a tape and some photos because he needed their approval to go ahead with the story. He ran a tape for one of his editors, and he showed some photos to the other.
  
  (a) The editor played the tape agreed the story was big.
  (b) The editor played the tape and agreed the story was big.
  
  The other editor urged John to be cautious.
The Garden Path Theory

- Argument #2: Strong plausibility biases are ineffective (Ferreira & Clifton, 1986)

  (a) The defendant examined by the lawyer turned out to be unreliable.
  (b) The evidence examined by the lawyer turned out to be unreliable.
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<th>Clause type</th>
<th>Example</th>
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<td>The poster that was drawn by the illustrator was used for a magazine cover.</td>
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(Trueswell, Tanenhaus, & Garnsey, 1994)
Fig. 3. Mean first pass reading times in ms (Experiment 2).

By phrase - cost of ambiguity

*Animate*: 128ms

*Inanimate*: 29ms

(Trueswell, Tanenhaus, & Garnsey, 1994)
But...

(Clifton et al., 2003)
Table 2
Mean scores on five dependent measures by condition and region, Experiment 1

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Example sentence: The defendant (evidence)/(who (that) was)/examined/by the lawyer/turned out to be/unreliable ("/") marks indicate region boundaries.)
Discussion

• The ambiguity resolution is a selection process?
  – “fewer nodes” $\rightarrow$ more than one candidate already generated

• Syntax autonomy in generation, but not in selection?
For Thursday

- Read & summarize Altmann & Kamide
- Collect data from 3 native speakers, send me the excel file w/ data

- Erica & sherrod; shannon & faisal – set an appointment w/ me