

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 26th, 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)

Theoretical Linguistics

Representation and Algorithm

How it is done:

Processes of online comprehension and production

Psycholinguistics

Implementation

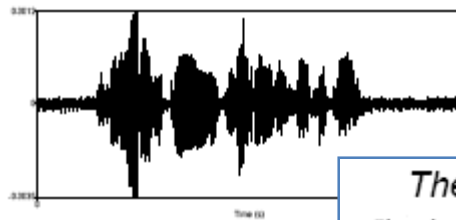
What it is done *with*:

Brain

Neurolinguistics

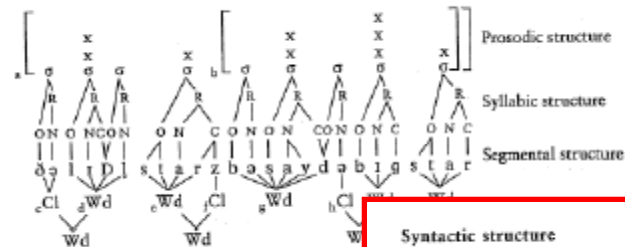
Linguistic representations

The little star is beside the big star
 The little star is beside the big star

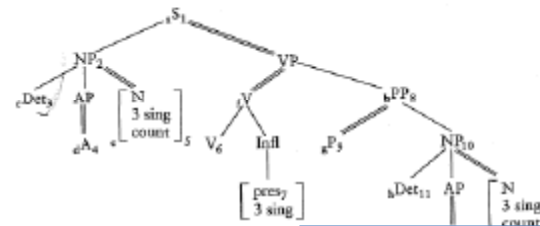


The little star is beside the big star

Phonological structure



Syntactic structure



Semantic/conceptual structure



Spatial structure



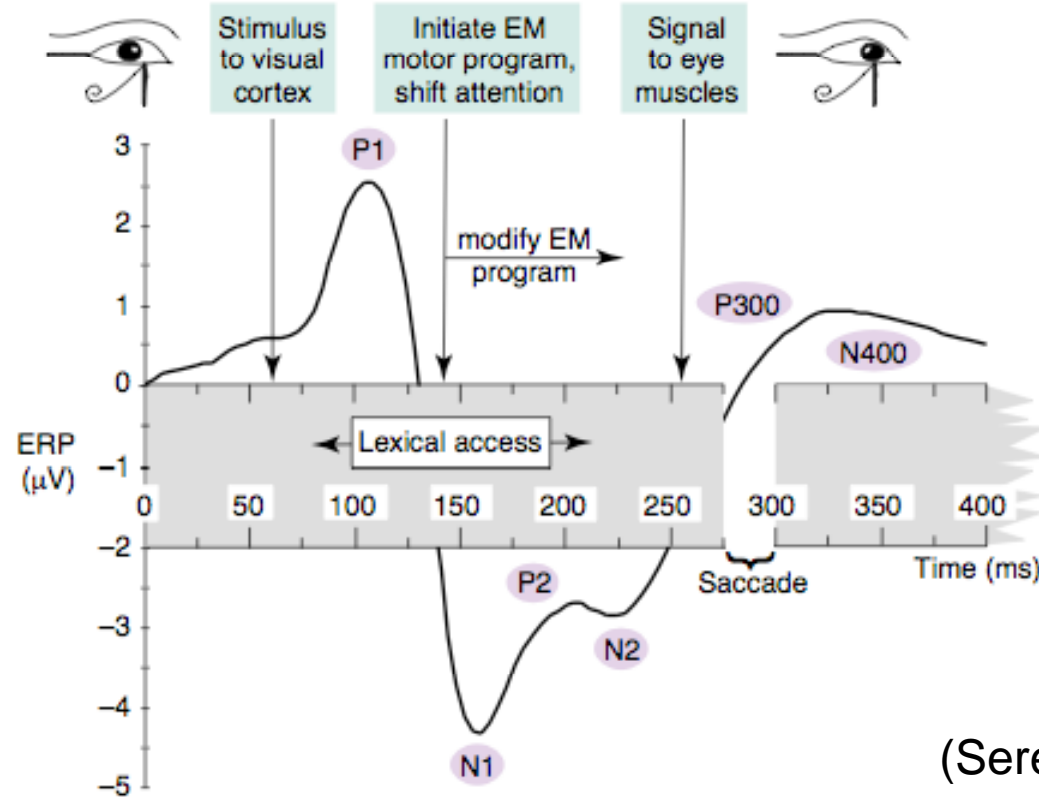
BIG FACT 1: Fast and accurate processing

- 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)

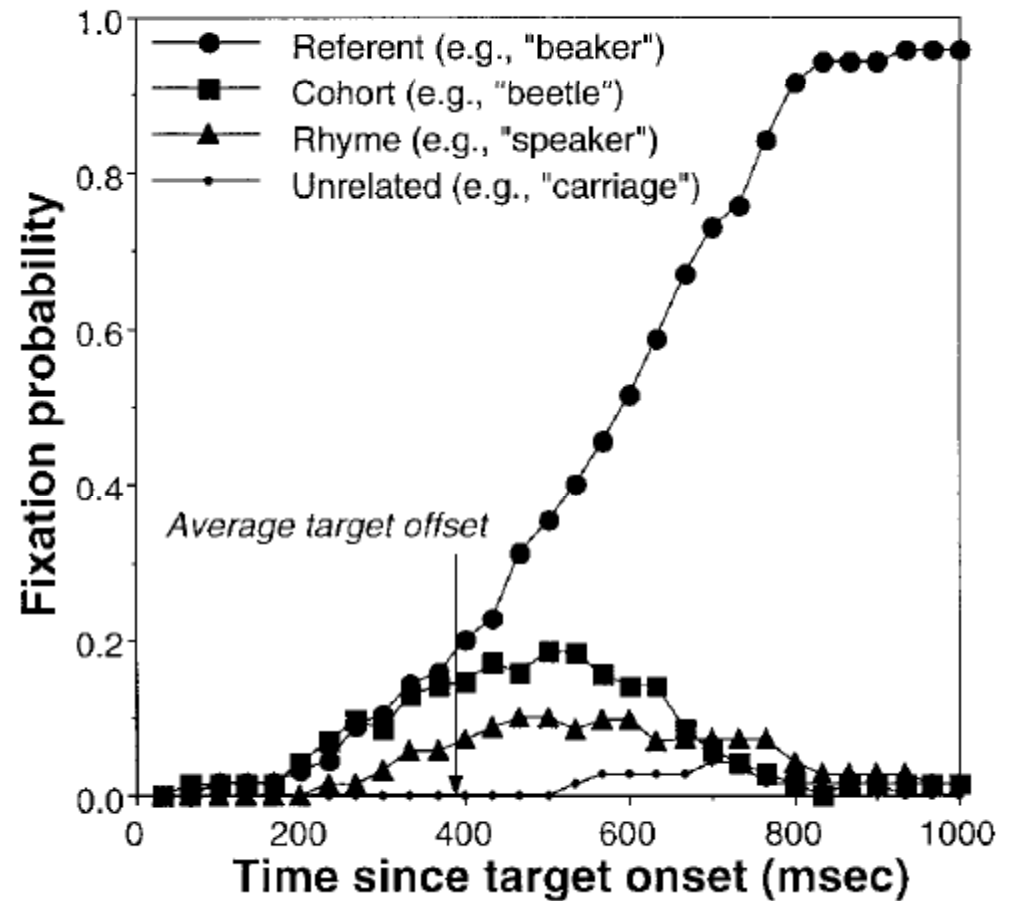
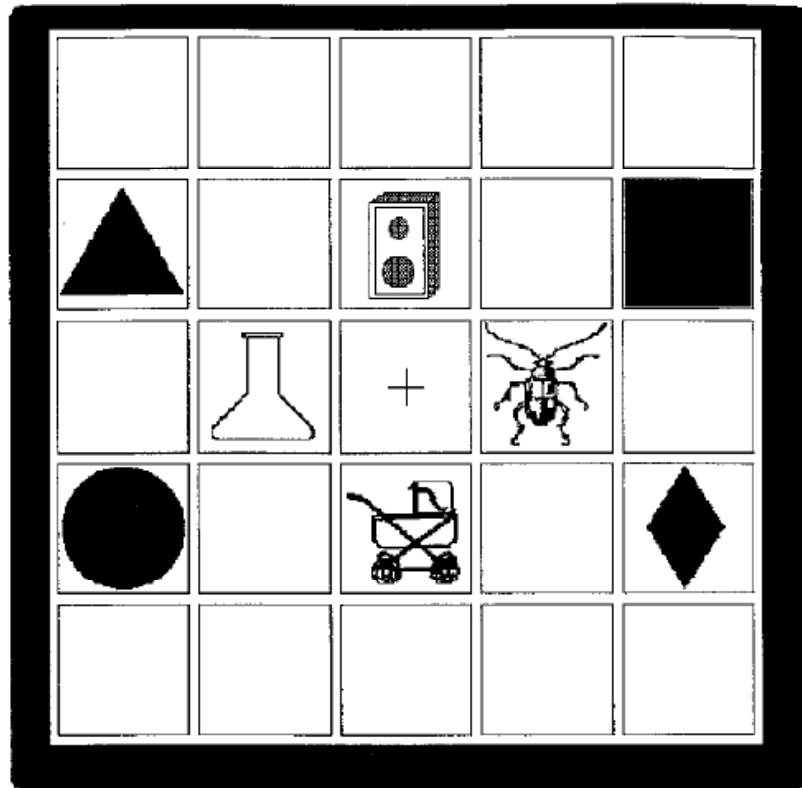
TRENDS in Cognitive Sciences

Figure I. Time line of processing a word in reading. A slightly inflated average fixation time (275 ms) is used to compensate for lack of parafoveal preview. After the saccade from the word, a new fixation begins. On the same time line, an ERP waveform is shown, representing the averaged response to a foveal visual word (average of 40 subjects presented 288 words each). Such waveforms are recorded from an electrode over the left occipito-temporo-parietal region of the scalp [25]. ERP-component nomenclature is a combination of the following: (1) the polarity of the component, positive- or negative-going (P or N, respectively) and (2) either the ordinal number within a given polarity (e.g. 1, 2) or the approximate latency (in ms) of its peak amplitude (e.g. 300, 400). So, for example, the N1 here could also be termed the N150.

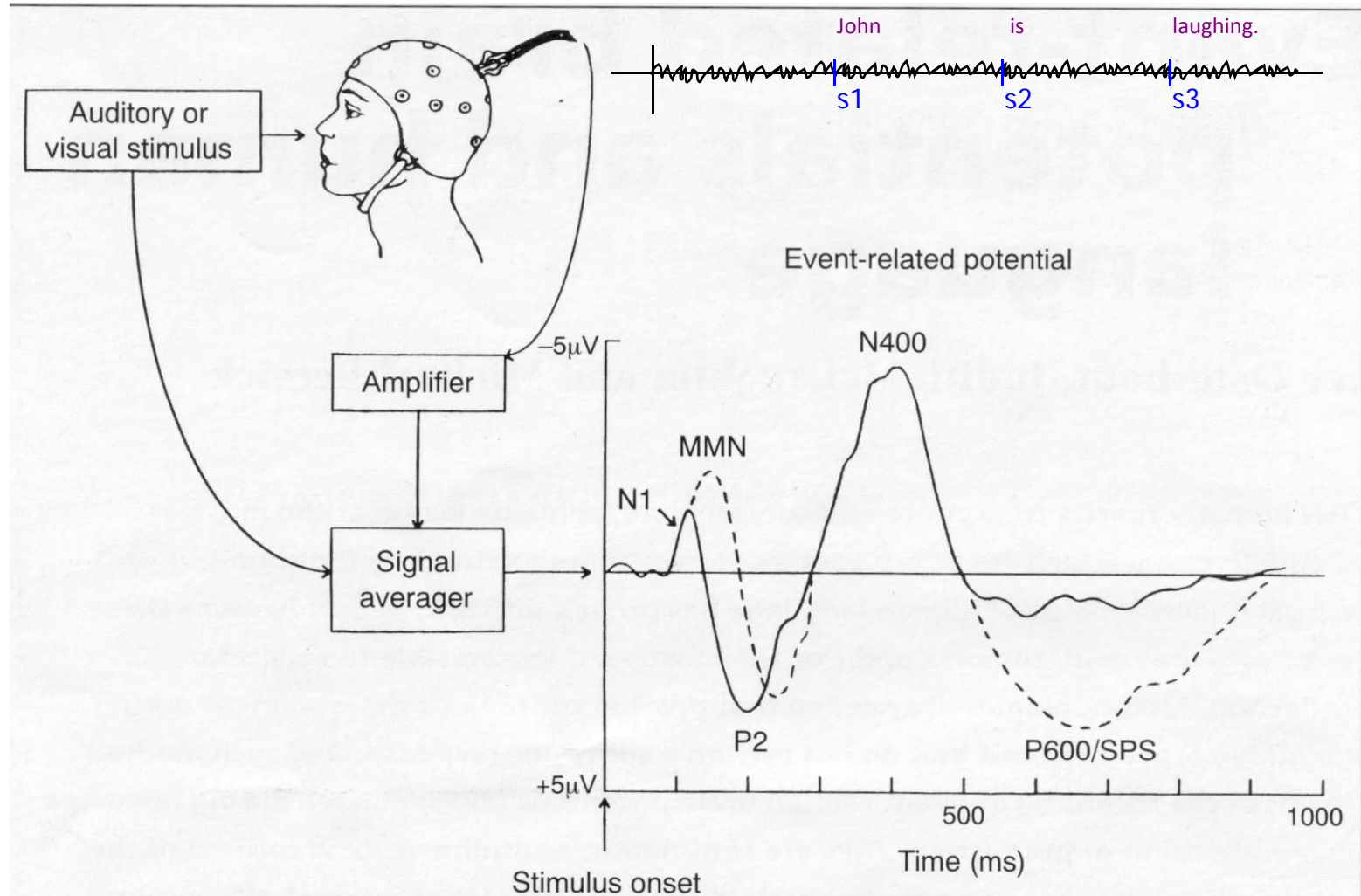
Head-mounted Eye-Tracking



Allopena et al 1998



Event-Related Potentials (ERPs)



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*

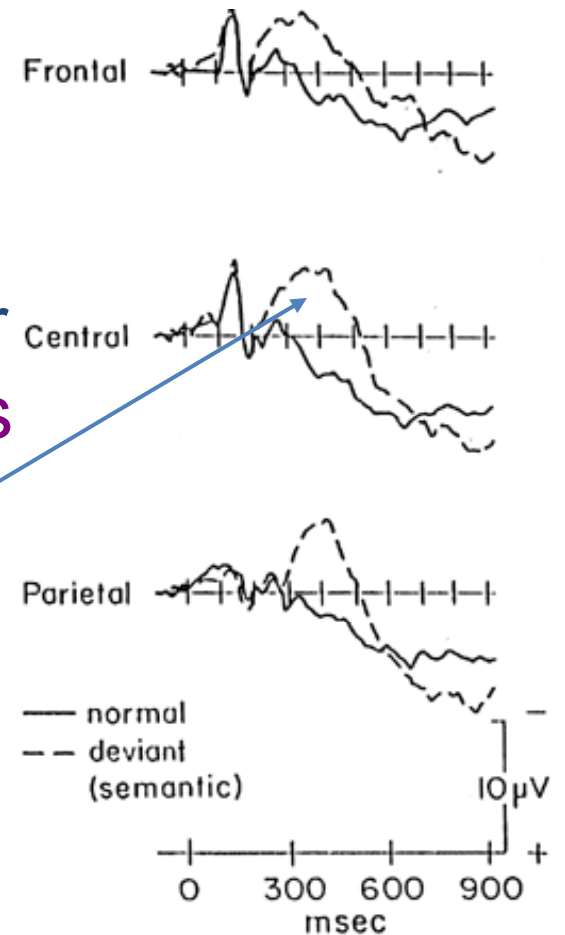
ERP Sentence Processing

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.

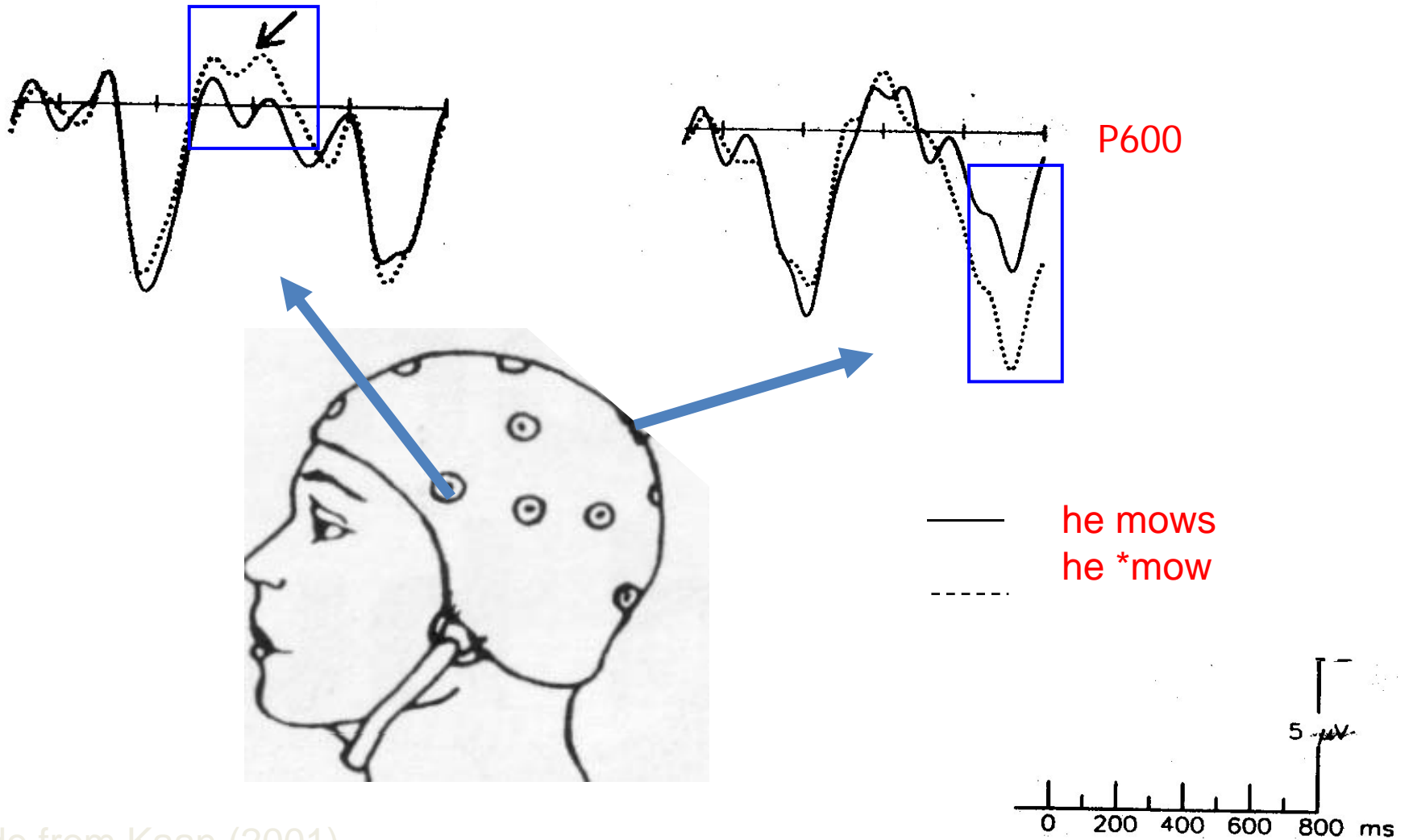
Every Monday he ***mow** the lawn.

The plane brought **us** to paradise.

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

(Coulson et al., 1998)

Left Anterior Negativity (LAN)

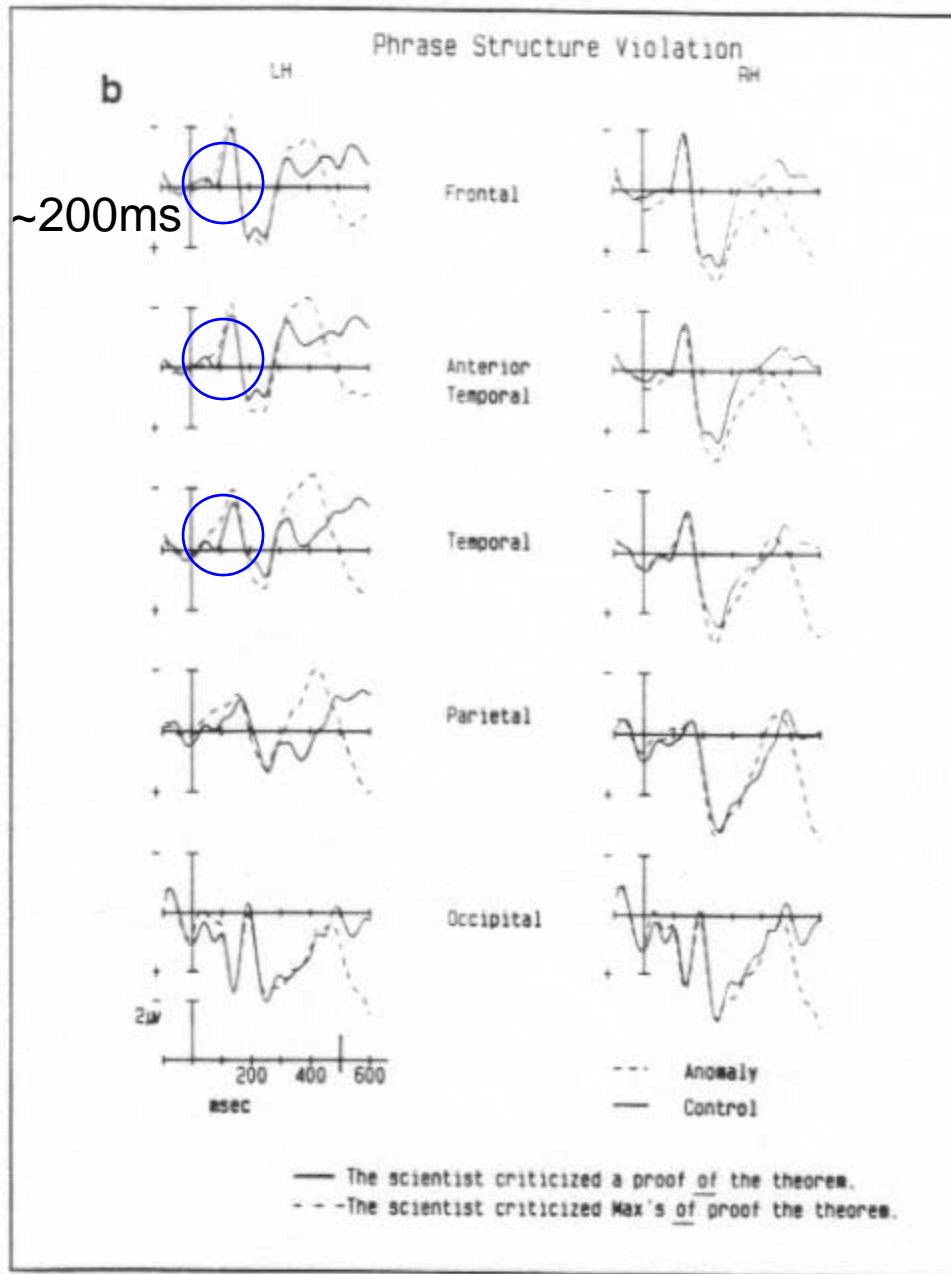


(Slide from Kaan (2001))

Neville et al., 1991

The scientist criticized a proof of the theorem.

The scientist criticized Max's of proof the theorem.



500ms/word

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

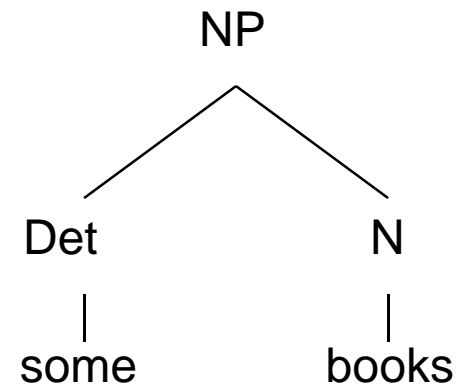
- One must generate accurate syntactic structures to arrive at an interpretation
- When there are multiple candidates, one must select the appropriate representation

Basic Parsing Systems

Bottom-up: NP → Det N ●

Left-corner: NP → Det N
●

Top-down: NP → Det N
●



Bottom-up Parsing

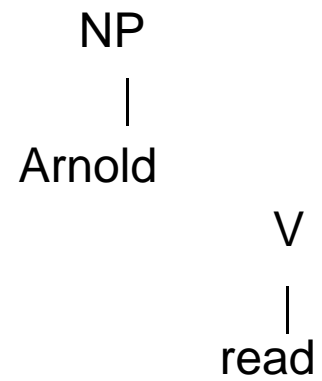
Arnold read some books.

Bottom-up Parsing

NP
|
Arnold

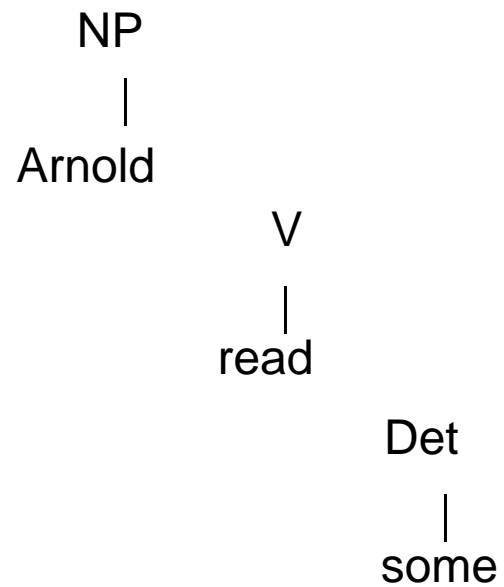
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Bottom-up Parsing



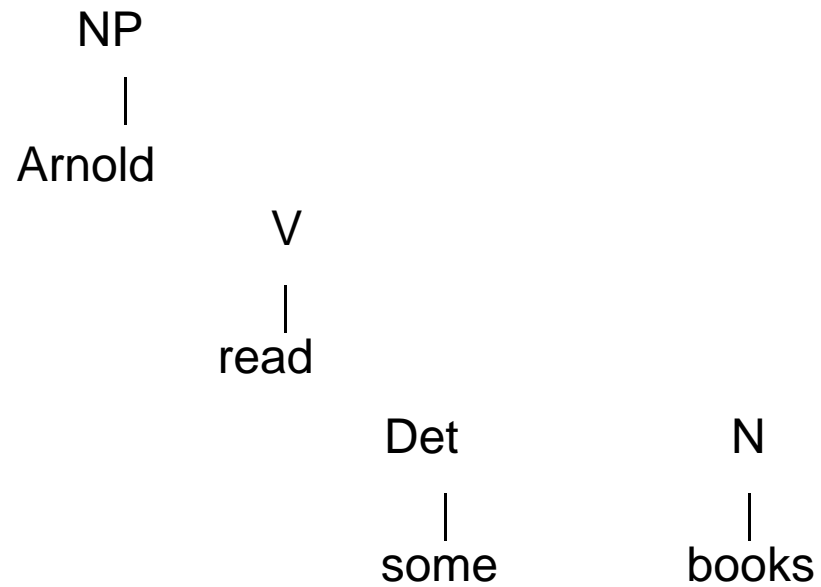
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Bottom-up Parsing



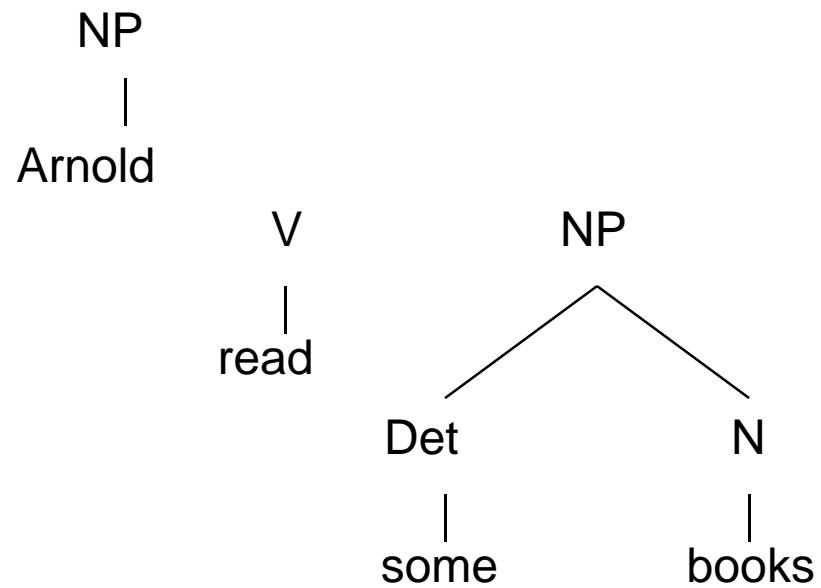
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Bottom-up Parsing



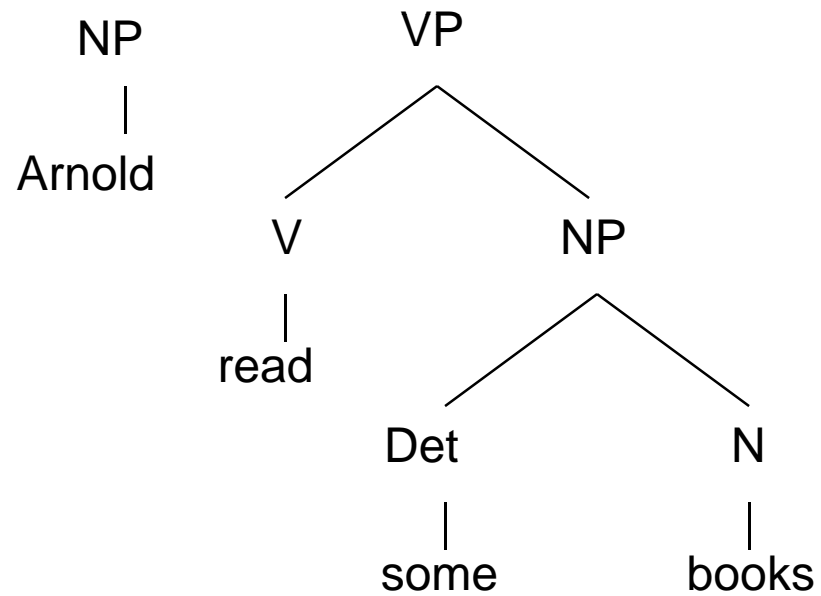
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Bottom-up Parsing



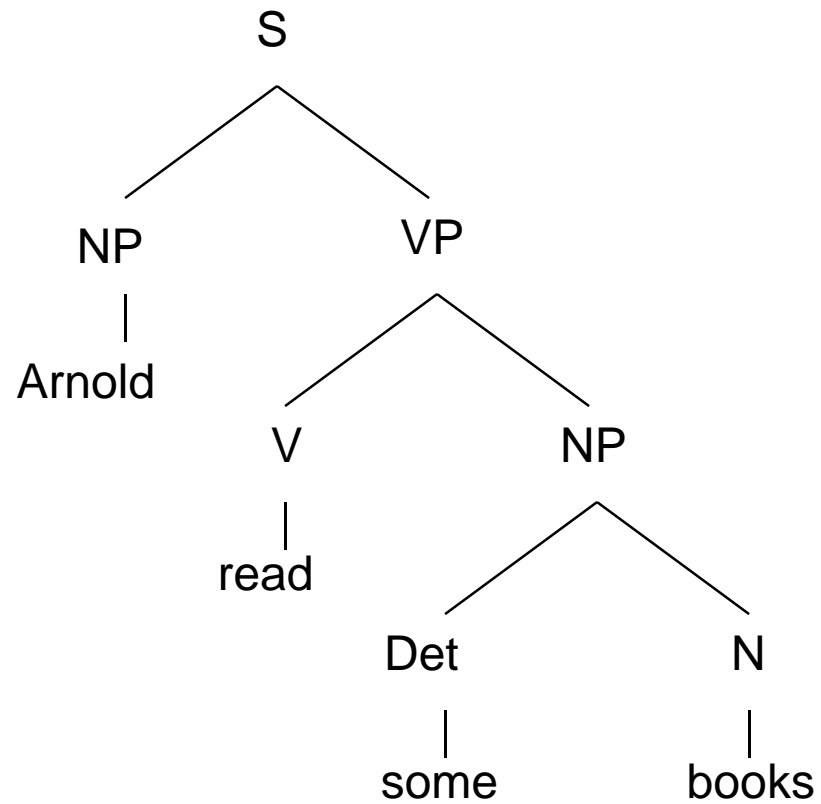
Arnold read some books.

Bottom-up Parsing



Arnold read some books.

Bottom-up Parsing



Arnold read some books.

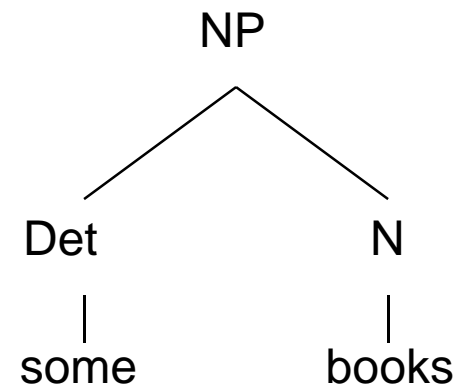
Strict bottom-up parsing does not
explain incrementality

Basic Parsing Systems

Bottom-up: NP → Det N ●

Left-corner: NP → Det N
●

Top-down: NP → Det N
●

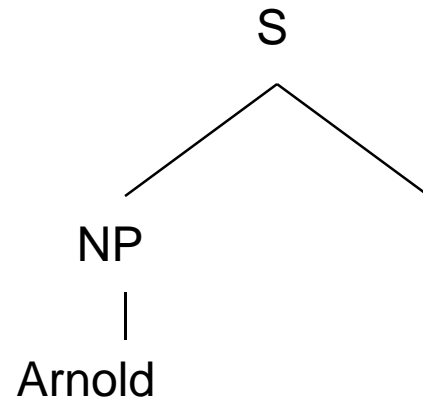


Left-Corner Parsing

NP
|
Arnold

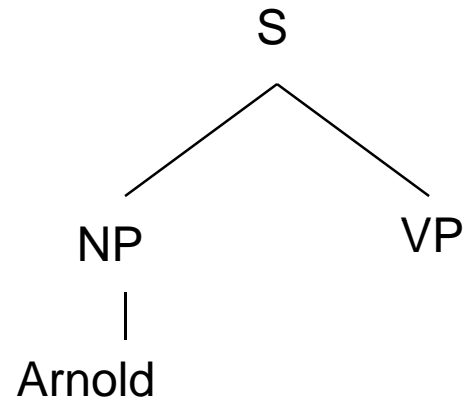
Arnold read some books.

Left-Corner Parsing



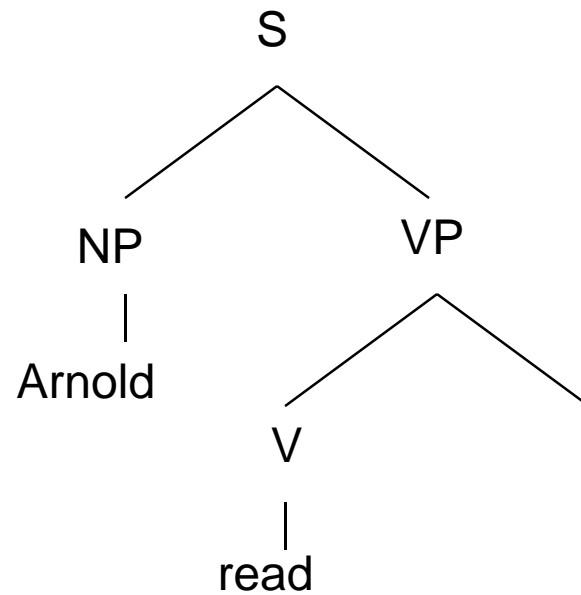
Arnold read some books.

Left-Corner Parsing



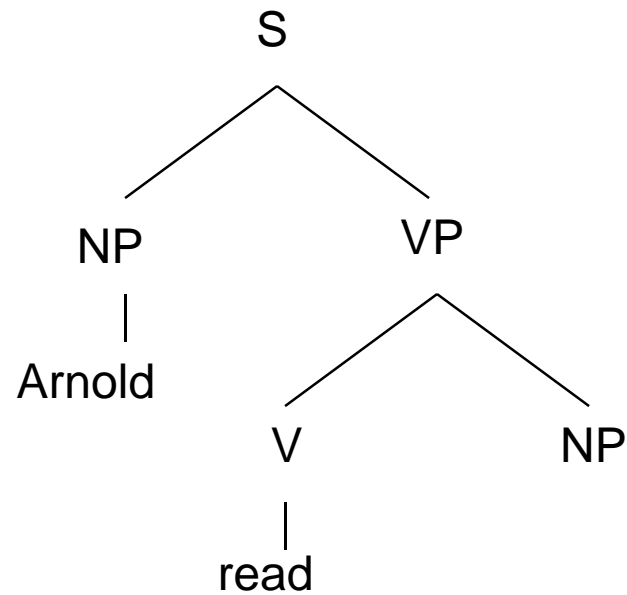
Arnold read some books.

Left-Corner Parsing



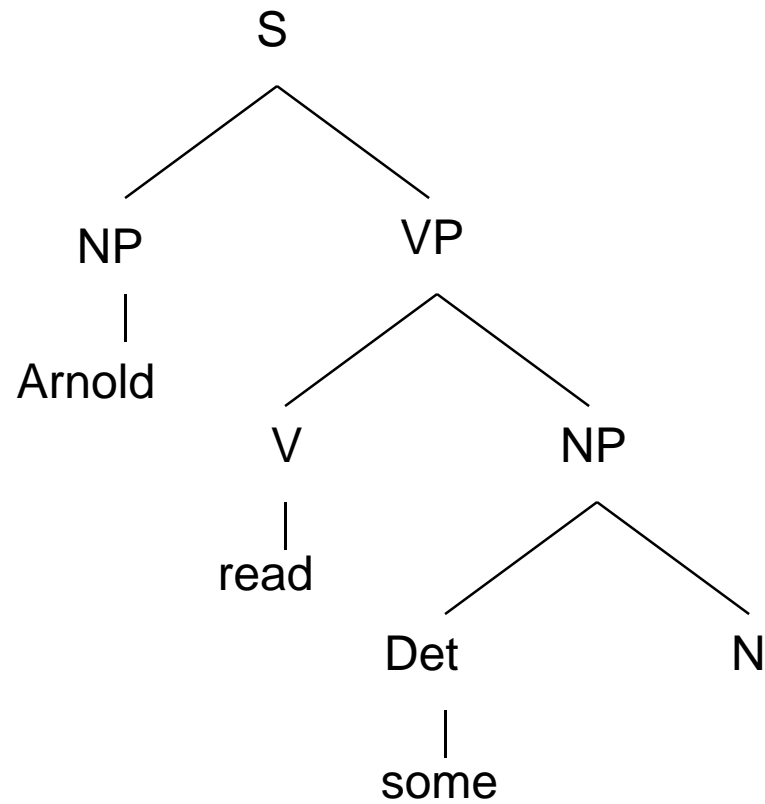
Arnold read some books.

Left-Corner Parsing



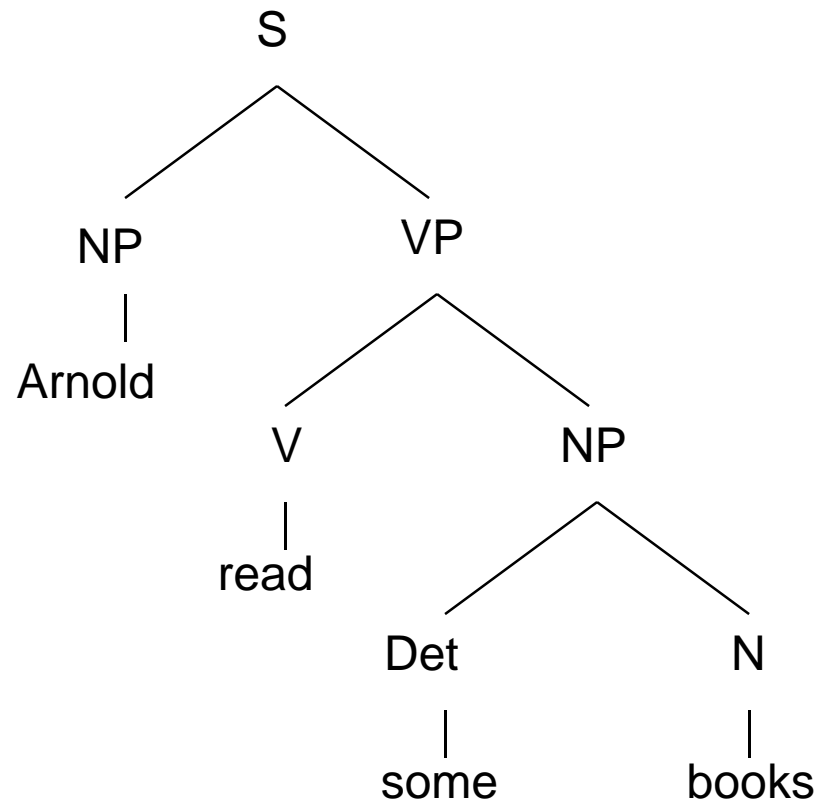
Arnold read some books.

Left-Corner Parsing



Arnold read some books.

Left-Corner Parsing



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.

TABLE 1
EXAMPLE STIMULI FROM EXPERIMENT 1

Verb type	Noun type	Clause type	Example
Ambig.	Animate	Reduced	The defendant examined by the lawyer turned out to be unreliable.
		Unreduced	The defendant that was examined by the lawyer turned out to be unreliable.
	Inanimate	Reduced	The evidence examined by the lawyer turned out to be unreliable.
		Unreduced	The evidence that was examined by the lawyer turned out to be unreliable.
Unambig.	Inanimate	Reduced	The poster drawn by the illustrator was used for a magazine cover.
		Unreduced	The poster that was drawn by the illustrator was used for a magazine cover.

(Trueswell, Tanenhaus, & Garnsey, 1994)

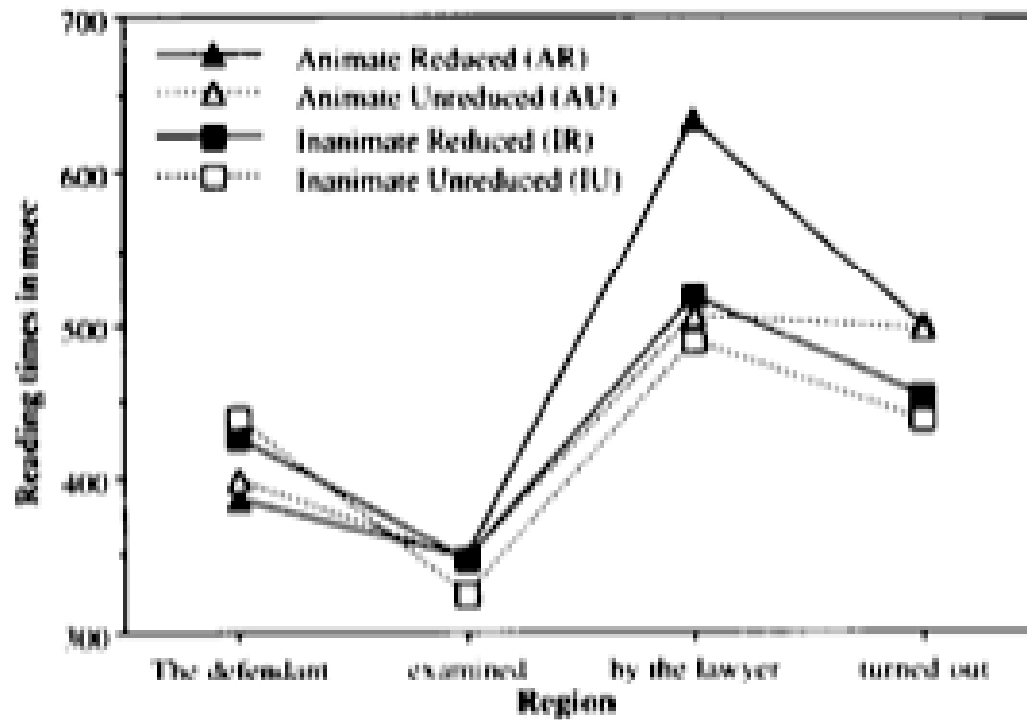


FIG. 3. Mean first pass reading times in ms (Experiment 2).

By phrase - cost of ambiguity

Animates: 128ms

Inanimates: 29ms

(Trueswell, Tanenhaus, & Garnsey, 1994)

But...

(Clifton et al., 2003)

Table 2

Mean scores on five dependent measures by condition and region, Experiment 1

	Region											
	Preview						No preview					
	1	2	3	4	5	6	1	2	3	4	5	6
<i>First fixation time</i>												
Animate ambiguous	—	—	253	246	257	252	—	—	268	253	269	243
Animate control	—	220	247	235	239	268	—	211	239	241	254	245
Inanimate ambiguous	—	—	253	214	242	247	—	—	252	258	238	254
Inanimate control	—	232	234	226	247	250	—	224	235	250	244	246
<i>First pass time</i>												
Animate ambiguous	—	—	295	553	497	447	—	—	336	541	470	449
Animate control	—	297	297	458	482	490	—	280	302	504	482	468
Inanimate ambiguous	—	—	305	469	445	445	—	—	316	509	462	452
Inanimate control	—	313	269	427	483	431	—	298	315	486	430	411
<i>Second pass time</i>												
Animate ambiguous	84	—	106	118	76	1	74	—	165	91	112	3
Animate control	45	98	105	82	102	3	83	109	105	108	99	11
Inanimate ambiguous	44	—	45	44	74	2	68	—	91	27	56	0
Inanimate control	48	95	35	59	72	8	31	55	46	48	82	11
<i>Regression path duration</i>												
Animate ambiguous	—	—	342	651	645	753	—	—	373	763	600	796
Animate control	—	327	376	590	591	878	322	—	387	688	595	833
Inanimate ambiguous	—	—	366	540	509	682	—	—	411	663	498	670
Inanimate control	—	356	377	478	533	672	—	328	369	559	513	628
<i>Regressions out</i>												
Animate ambiguous	—	—	6	12	12	22	—	—	6	23	6	26
Animate control	—	3	16	11	10	25	—	8	15	20	6	30
Inanimate ambiguous	—	—	6	5	7	25	—	—	11	18	3	27
Inanimate control	—	6	20	4	4	15	—	4	14	10	9	30

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” → 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