Language Perception and Comprehension

May 5, 2005

Outline

- Reminder: ambiguity and disambiguation
- Recognition of phones
  - Use of phonetic context
  - Use of lexical context
  - Use of visual context
- Lexical Access: recognition of words:
  - Segmentation
  - Use of visual information
  - Word sense disambiguation
- Ambiguity at higher levels

Reminder of Ambiguity (from first day of class)

- Find at least 5 meanings of this sentence:
  - I made her duck

Ambiguity

- Find at least 5 meanings of this sentence:
  - I made her duck
- I cooked waterfowl for her benefit (to eat)
- I cooked waterfowl belonging to her
- I created the (plaster?) duck she owns
- I caused her to quickly lower her head or body
- I waved my magic wand and turned her into undifferentiated waterfowl
- At least one other meaning that's inappropriate for gentle company.

Ambiguity is Pervasive

- I caused her to quickly lower her head or body
  - **Grammar**: "duck" can be a noun (waterfowl) or a verb (move body)

- I cooked waterfowl belonging to her.
  - **Grammar:** "her" can be a possessive ("of her") or dative ("for her") pronoun

- I made the (plaster) duck statue she owns
  - **Meaning:** "make" can mean "create" or "cook"

Ambiguity is Pervasive

- **Grammar**: Make can be:
  - **Transitive: (verb has a noun direct object)**
    - I cooked [waterfowl belonging to her]
  - **Ditransitive: (verb has 2 noun objects)**
    - I made [her] (into) [undifferentiated waterfowl]
  - **Action-transitive (verb has a direct object and another verb)**
    - I caused [her] [to move her body]

Ambiguity is Pervasive

- **Phonetics!**
  - I mate or duck
  - I'm eight or duck
  - Eye maid; her duck
  - Aye mate, her duck
  - I maid her duck
  - I'm aid her duck
  - I mate her duck
  - I'm ate her duck
  - I'm ate or duck
  - I mate or duck

Syntactic Ambiguity

- ## **Grammar:**

  - **"The other day I shot an elephant in my pajamas (what he was doing in pajamas I'll never know)"**

    - Groucho Mark

  - **What's the ambiguity?**

    - **"In my pajamas" can modify "I" or "elephant"**

What we've learned

- **Ambiguity is pervasive**
  - Phonetics
  - Segmentation
  - Word part of speech
  - Word meaning
  - Syntactic properties

How do we deal with ambiguity?

Language processing is fast

- Shadowing task -Marslen-Wilson (1975)
- Some subjects can close-shadow
- Can shadow at latencies of 250-275 ms
- Less 50-75 ms for response execution
  - So ~200 ms to identify a word
  - Before acoustic offset of word!
- Furthermore, shadowers in this time can correct errors in pronunciation or grammar!

What we've learned

- Language perception is very fast

Speech perception

- Words are made up of units called "phones"
- "duck": [d ah k]
- "eat": [iy t]
- "made": [m ey d]
- "her": [h er]
- "I": [ay]
- "symbolic" [s ih m b aa l ih k]
- "systems" [s ih s t em z]
- English has about 50 (some lgs have less, some more)

Phone perception

- People hear sound waves
- How are they able to recognize words in the input?
- Assumption: first they recognize the phones that make up the words
- How does phone perception work?

Phone perception is difficult

- Different people have different accents
- People talk fast or slow
- Many phones sound alike, are hard to tell apart
- Most important issue: **context**

Phones are context-dependent

- http://www.fon.hum.uva.nl/praat/

Phones are context-dependent

Phone	Environment	Example	IPA
[tʰ]	in initial position	*toucan*	[tʰukʰæn]
[t]	after [s] or in reduced syllables	*starfish*	[stɑrfɨʃ]
[ʔ]	word-finally or after vowel before [n]	*kitten*	[kʰɪʔn]
[ʔt]	sometimes word-finally	*cat*	[kʰæʔt]
[ɾ]	between vowels	*buttercup*	[bʌɾɚkʰʌp]
[t̚]	before consonants or word-finally	*fruitcake*	[frut̚kʰeɪk]
[t̪]	before dental consonants ([θ])	*eighth*	[eɪt̪θ]
[]	sometimes word-finally	*past*	[pæs]

Warren (1970)

- The state governors met with their respective legislatures convening in the capital city

Warren (1970): Phoneme Restoration Effect

- The state governors met with their respective legislatures convening in the capital city
- The /s/ was deleted in "Legi*latures" and replaced with a cough.
- Warren found participants
  - Heard the word normally
  - Only one participant reported a missing phoneme
  - (But reported the wrong one!)
- Knowledge about likely spoken word can "fill in" missing phoneme information

Warren (1970): Phoneme Restoration Effect

1) The *eel was on the axle.
2) The *eel was on the shoe.
3) The *eel was on the orange.
4) The *eel was on the table.
•   Listeners reported hearing
   1) Wheel
   2) Heel
   3) Peel
   4) Meal

McGurk Effect

Jurafsky   Symbolic Systems 100, Spring 2005

http://www.media.uio.no/personer/arntm/McGurk_english.html

McGurk Effect: an Auditory Illusion

- Visual cues to syllable "ga"
- Auditory cues to syllable "ba"
- Results in perception of "da" or "tha"

What we've learned

- Phone perception relies on knowledge at different levels to solve problem of ambiguous input.
  - Phonetic context
  - Lexical context
  - Visual context

Lexical Access: Detection/Recognition of words

- Segmenting words in speech
- Use of visual information in word search
- Speed of disambiguation process

Lexical Access: segmentation

- Speech doesn't come with spaces in it

    – The stuffy nose can lead to trouble
    – The stuff he knows can lead to trouble

    – Some others I've seen
    – Some mothers I've seen

Word segmentation: experiment

- Shillcock (1990)
- "Cross-modal priming" experiment
  - Based on "lexical decision" (LD) task

Lexical Decision

- Subjects at computer
- 2 buttons, YES and NO
- See strings of letters on screen
- Have to decide "are these a word or not"?
  - DOCTOR - yes
  - DOCPOR - no
  - THINK - yes
  - THIFF - no

Lexical Decision of "FLINK"

http://ibs.derby.ac.uk/~kpat/Israel_cognitive/button1.jpg

Lexical Decision

- Facts about Lexical Decision
  - More frequent words are recognized faster
  - Shorter words are recognized faster
  - Semantic Priming:
    - NURSE
    - DOCTOR

    Faster to recognize DOCTOR than
    - PURSE
    - DOCTOR
  - So something about the meaning of NURSE "primes" the recognition of DOCTOR

Shillcock (1990) Cross-Modal Priming

- Subjects hear a sentence over a headphone.
- At some point in the sentence, subjects see a word on screen and have to do LD
    1) The scientist made a **new discovery** last year.
    2) The scientist made a **novel discovery** last year
- Lexical decision to **NUDIST**
- Subjects were primed in (1) but not in (2)
- Idea: speakers first mis-segmented "new dis" as NUDIST
- But speakers were not aware of having done this

What we've learned

- Word recognition in speech is parallel
- Multiple possible segmentations are considered and rejected subconsciously and quickly

Use of visual information in lexical access

Eye tracking example
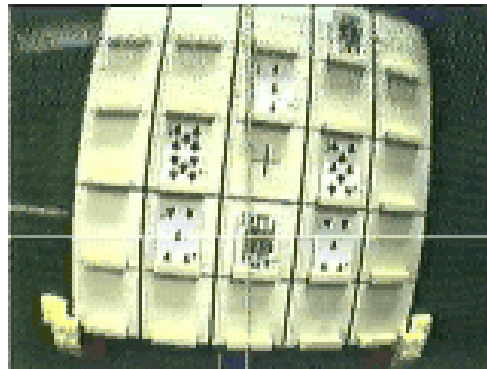
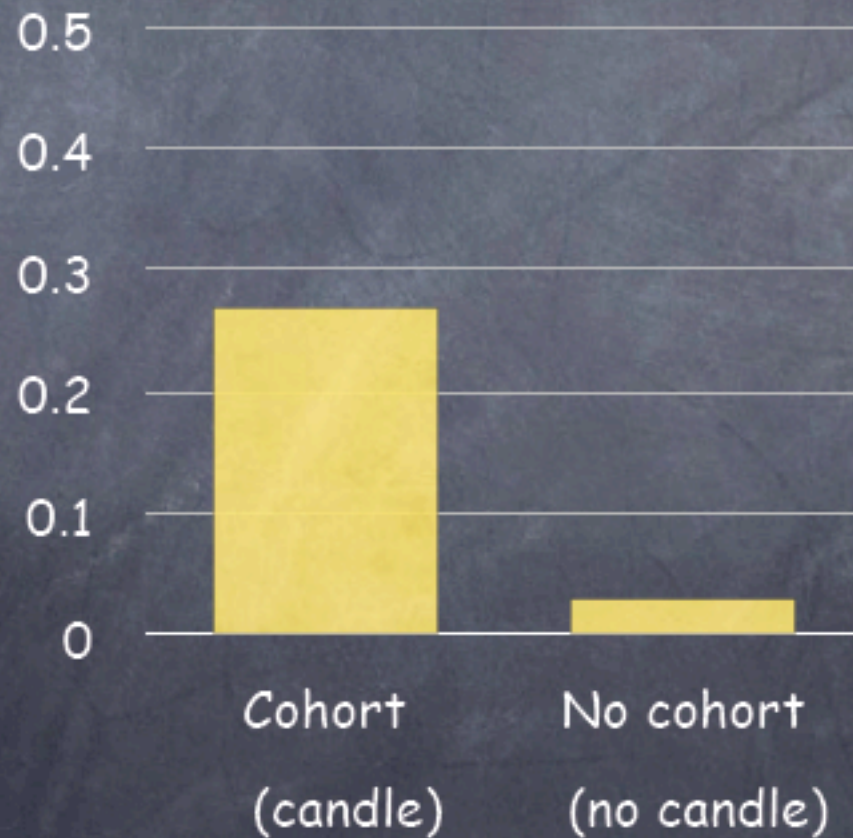# The candle/candy task

"Pick up the candy"

Cohort absent

	spoon	
candy	+	bottle
	pen	

Cohort Present

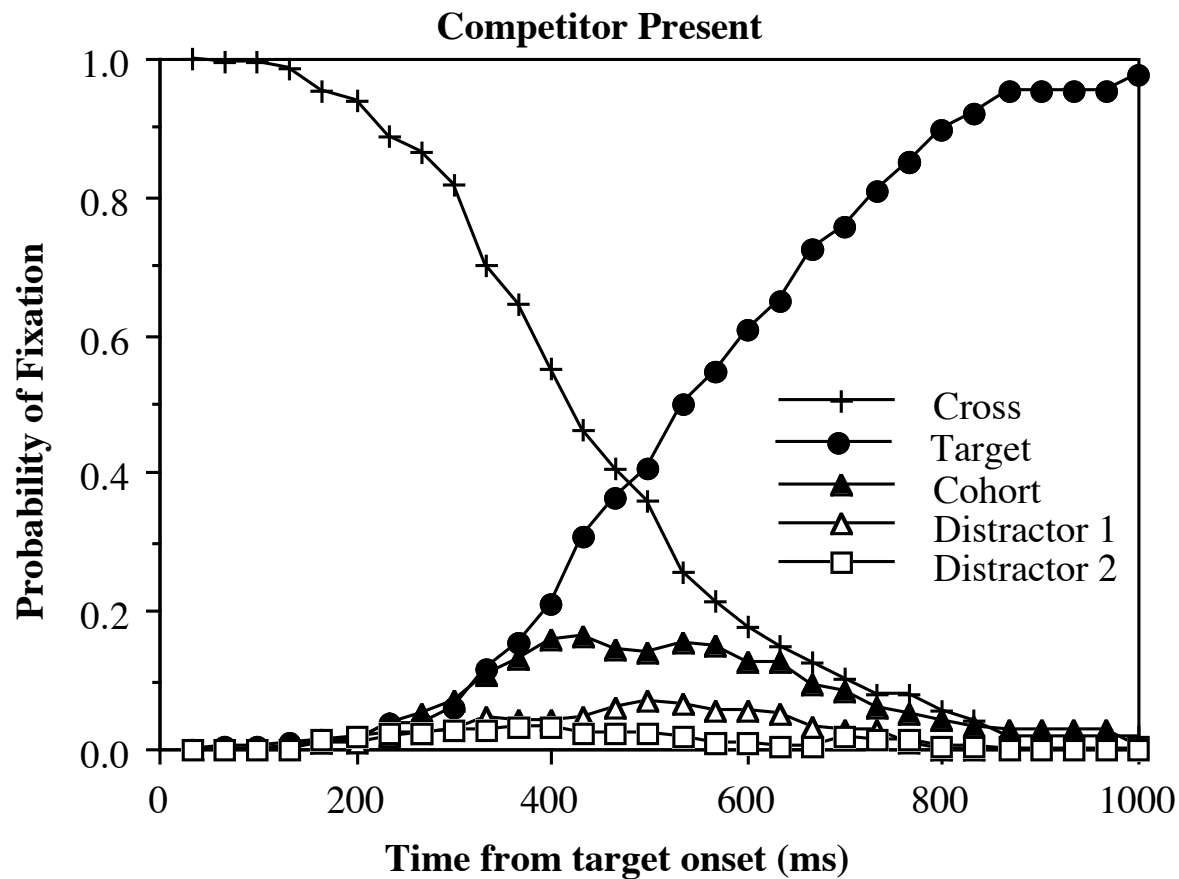|	spoon	
candy	+	candle
	pen	

"Pick up the candy"

Percentage of trials with saccades to distractor

"Pick up the candy"

Tanenhaus et al

Word Recognition

- Word recognition is incremental
  - Before the end of the word is spoken, eye movements are launhced to possible targets
- Millisecond by millisecond, information from the visual environment is used in the process of word recognition.
  - Word recognition is fatser when there are no competitors visible

Word sense disambiguation

- Words can have two meanings
  - "bug"
    - Recording device
    - Insecty thing
- Also called "lexical ambiguity" or "word sense ambiguity"
- How do people resolve lexical ambiguity?

Swinney (1979)

- Rumor has it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other bugs (1) in the corner (2) of his room."

- Immedidately at (1), which sense of the word "bug" is active?

  – Insect

  – Recording device

  – Both

  – Neither

Swinney (1979)

- Rumor has it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other bugs (1) in the corner (2) of his room."
- Cross-Modal Priming
- Test words
  - ANT (appropriate for the context)
  - SPY (not appropriate, but related to the other meaning of bugs)
  - SEW (unrelated control word)

Swinney (1979) Results

- Immediately: facilitation of both
  - ANT (appropriate for the context)
  - SPY (not appropriate, but related to the other meaning of bugs)
- when compared to
  - SEW (unrelated control word)
- By 750 millisec later (other studies showed 200 ms) only find facilitation for ANT
- Idea: parallel activation of all meanings, they compete, by about 200 ms later, only the correct one is still active, it's then available to consciousness

What we've learned

- Word meaning recognition is also parallel
- Lots of contextual information is used (very quickly but perhaps not immediately) to resolve lexical ambiguities

Conversational meaning

- Words mean things
- Consciously we know that
- But even when we're not conscious they still mean things
- Conversational disambiguation

Discourse disambiguation

- We can use sentences in a conversation for different purposes
  - Question
  - Command
  - Statement
  - Agreement
  - Disagreement
- These are called "speech acts"
- Speech act ambiguity:

Conclusion

- Language is highly ambiguous
    - Phone detection (Warren, "stamp")
    - Word segmentation (Shillcock)
    - Word semantics (Swinney)
    - Grammar (duck)
    - Pragmatics (Who's on first)

- Humans resolve by:
    - consider each interpretation of an ambiguity,
    - combine visual, lexical, phonetic knowledge/context to choose most likely meaning,
    - subconsciously

- Current research: what knowledge sources, how learned, how represented, how combined