1 # Language I

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3 # Why is Language Important?

- Represents unique form of abstraction in human species
- Language influences perception and memory
- Relevant to the form and manner of information storage
- Relevance to thinking and problem-solving is unquestioned
- Chief means of human communication

4 # Key Terminology

- **Phonology**: (the way sounds function in the language) basic unit = phoneme
  - single speech sound
  - English has about 45; 9 make up half our words
  - dimensions: voiced ("a"); unvoiced ("s"); fricatives ("sh"), plosives ("t"); place of articulation (palate v. lips)
- **Morphology**: (study of the internal structure of words) basic unit = morpheme
  - smallest unit of meaning (words, parts of words, etc.)
  - free (e.g., "old", "the") vs. bound (e.g., "er", "ist")
  - over 100,000 words formed by morpheme combinations
- **Semantics**: (study of meaning)
  - **denotation vs. connotation**
  - **words as economic labels; link between language and concepts**
- **Syntax**: (study of rules that govern combination of morphemes in phrases and sentences; interdependency)
  - **prescriptive vs. descriptive grammar**
  - **"Daddy, what did you bring that book that I don't want to be read to out of up for"?**

5 # Linguistic Relativity

- Whorf (1956)
  - Language determines or influences thinking
- Miller and McNeill (1969)
  - Strong hypothesis
    - Language determines thinking
  - Weak hypothesis
    - Language influences perception
  - Weakest hypothesis
    - Language influences memory

6 # Evidence

- Regional/cultural differences in language
  - Hanuxoo have 92 different names for various types of rice
    - Could be that language evolution enables fine distinctions among types of rice
    - Could be that different environmental conditions influence the things people think about
- Colour categorisation
  - Heider (1972) – color categories are universal – Dani (2 colors) v. American errors similar
  - Failures to replicate (Roberson, Davies, and Davidoff, 2000)

7 Influence of language (English vs. Berinmo) on choice of similar pairs of stimuli by English and Berinmo participants.

Data from Roberson et al. (2000).

8 ## Evaluation

- Harley (2001, p. 87)
  - "There is now a considerable amount of evidence suggesting that linguistic factors can affect cognitive processes. Even colour perception and memory . . . show some influence of language."
- The evidence supports the weak and the weakest versions

9 ## Language Comprehension

10 ## Speech Perception

- Input rapid (≈10 phonemes/sec)
- "Non-invariance" - speech sounds affected by sounds which proceed and follow; also different voices
- Segmentation problem - how to separate sounds in a continuous flow
- Use of prosody
- Definite left-hemisphere advantage

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12 ## Auditory Word Recognition: Basic Processes

- Bottom-up: processing of individual phonemic features
- Top-down: conceptual processing
  - phonemic restoration effect:
    - probably affects response bias, not sensitivity

    "the *eel was on the axle" - hear "wheel"
    "the *eel was on the shoe" - hear "heel"
    "the *eel was on the orange" - hear "peel"

13 ## Theories of Auditory Word Recognition I

- **Motor Theory of Speech Perception (Liberman et al., 1967)**
  - during listening, listeners mimic articulatory movements of speaker and depend on this for recognition
  - Supported by PET studies showing ↑motor activation during speech perception
  - noninvariance is a problem, as is infant data
- **Cohort Theory (Marslen-Wilson & Tyler, 1980)**
  - activation of word cohort as speech signal arrives
  - some activated words eliminated on basis of context; continues until "recognition point" is achieved
  - assumes that lexical, syntactic, and semantic information interact to analyze speech signal; context effects are probably late
    - e.g., "The police indicated that excessive SP--- was a factor in the fatal accident."

14 ## Auditory Word Recognition: Theories II

- **TRACE Model (McClelland, 1991)**
  - three units of levels: features, phonemes, words
  - between-level connections excitatory
  - within-levels inhibitory
  - excitation in the network produces pattern, or "trace" of activation
  - recognized word is that which is highest among candidate words

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16 ## Auditory Word Recognition: Theories III

- **Cognitive Neuropsychological Models**
  - derive from studies of how word recognition fails after brain injury

- make use of “box models” of cognitive processing popular in mainstream cognitive psychology
- basic structural features:
  - **domain-specific systems**
  - **lexicons**

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18 ## Stages in Lexical Processing (Single Word Recognition)

- Contact of the analyzed waveform with the lexicon
  - Spectrographic (LAFS)
  - Motor theory
  - Phonemic theories
- Activation of specific lexical entries
- Selection of appropriate lexical entry from set of activated candidates
- Access to the full information from the lexical entry

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21 ## Reading (Visual Word Comprehension)

- Similar processes likely, but entry into the system is a visual (graphemic), not an acoustic (phonemic) representation
- Transformation from grapemes to phonemes is critical
- Two routes to reading
  - Grapheme-phoneme conversion
  - Lexical (whole word) reading

22 ## How Reading is Studied

- Eye movement recordings
- Reading aloud
- RSVP (rapid serial visual presentation)
- Subject-controlled presentation
- Word-identification techniques
  - lexical decision
  - naming

23 ## Eye-Movement Research

- Emphasizes a “word-recognition” vs. “meaning construction” approach to reading
- Asymmetric perceptual span (3-4 letters to the left of fixation and 15 letters to the right)
- Parafoveal preview allows for skipping words
- Fixations may be affected by context and meaning
  - predictable words receive less fixation
  - “garden path” sentences:
    “The young man turned his back on the rock concert stage and looked across the resort lake. Tomorrow was the annual one-day fishing contest and fishermen would invade the place. Some of the best bass guitarists would come to this spot”
  - derivation of meaning occurs early (parafoveally? instantaneously?)

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25 ## Visual Word Identification

- Rapid (200ms)
- Automatic (e.g., Stroop effect)

- Basic effects:
  - word-letter effect: letters identified better if in words than if alone (e.g., TAKE v. _ _ K _)
  - word-superiority effect: letters identified better when in real word (e.g., TAKE v. PAKE)
  - These effects imply that "word environment" influences recognition

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27 ## Visual Word Identification: Models I

- Serial Letter Model

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- Parallel Letter Model

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- Aoccdrnig to a rscheearch at an Elingsh uinervtisy, it deson't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht frist and lsat ltteer is at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae we do not raed ervey lteetr by it slef but the wrod as a wlohe.

29 ## Visual Word Identification: Models II

- Direct Word Model

- Interactive Activation Model

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32 ## Route 1 (Grapheme–Phoneme Conversion)

- Converting spelling (graphemes) into sound (phonemes)
- Marshall and Newcombe (1973)
  - Surface dyslexia – poor reading of irregular words; strong reliance on Route 1
- McCarthy and Warrington (1984)
  - KT read 100% of nonwords accurately, and 81% of regular words, but was successful with only 41% of irregular words
  - Over 70% of the errors that KT made with irregular words were due to regularisation
- Significant variability in performance, suggesting that this is not a clear dissociation

33 ## Route 2 (Lexicon Plus Semantic System)

- Event sequence
  - Representations of familiar words are stored in an orthographic input lexicon; activation leads to…
  - Meaning is activated by the semantic system and..
  - Sound pattern is generated in the phonological output lexicon
- Beauvois and Dérouesné (1979)
  - Phonological dyslexia – impaired Route 2; use Route 1; 100% real words; 10% nonwords
- Coltheart (1996)
  - *General* phonological impairments, not just problems with phoneme-grapheme conversion

34 Route 3 (Lexicon Only)

- Like Route 2 but the semantic system is bypassed – printed words are pronounced but not understood
- Funnell (1983)
  - Phonological dyslexia with poor ability to make semantic judgments about words
- Coslett (1991)
  - Reasonably good at reading irregular words, but had no understanding of them

35 Deep Dyslexia

- Characteristics
  - Particular problems in reading unfamiliar words
  - An inability to read nonwords
  - Semantic reading errors (e.g., “ship” read as “boat”)
- Damage to the grapheme–phoneme conversion and semantic systems
- Patterson, Vargha-Khadem, and Polkey (1989)
  - Studied left hemispheric removal, producing all of these symtpomes; generated right-hemisphere hypothesis
- Laine et al. (2000) used MEG
  - Activation mainly in the *left* hemisphere

36 Surface Dyslexia and Phonological Dyslexia

- Lesions to the Plaut et al. model simulated performance in surface dyslexia
- Alzheimer’s disease
  - Progressive dementia
- *Deep dyslexia*
  - Plaut and Shallice (1993)
    - Developed the model further
    - Virtually all the main symptoms of deep dyslexia could be simulated

37 Language Comprehension

- Parsing: analysis of syntactical (grammatical) structure of the sentence
- Analysis of literal meaning (semantics)
- Analysis of intended meaning (pragmatics)

38 Parsing

- Four major possibilities:
  - Syntactic analysis generally precedes (and influences) semantic analysis
  - Semantic analysis usually occurs *prior* to syntactic analysis
  - Syntactic and semantic analysis occur at the same time, in parallel
  - Syntax and semantics are very closely associated, and have a hand-in-glove relationship

39 Grammar or Syntax

- Syntax – word order and combination critical to meaning:
  - “He showed her the boys pants.”

- "He showed her boys the pants."
- An infinite number of sentences is possible in any language
- Sentences are nevertheless systematic and organised
- Chomsky (1957, 1959)
  - Rules to take account of the productivity and the regularity of language
  - A grammar should be able to generate all the permissible sentences in a given language

40 Syntactic Ambiguity

- "They are flying planes"
  - The grammatical structure is ambiguous
- Global and local levels
- Making use of prosodic cues
  - Stress and intonation (illustrate with above example)
- Allbritton, McKoon, and Ratcliff (1996)
  - Doubts about the use of prosodic cues
- Snedeker and Trueswell (2003)
  - Listeners' interpretation of ambiguous sentences was influenced by prosodic cues even *before* the start of the ambiguous phrase

41 Garden-path Model

- Frazier and Rayner (1982)
  - Only one syntactical structure is initially considered for any sentence
  - Meaning is not involved in the selection of the initial syntactical structure
  - The simplest syntactical structure is chosen, making use of two general principles: minimal attachment and late closure
  - According to the principle of minimal attachment, the grammatical structure producing the fewest nodes is preferred
  - The principle of late closure is that new words encountered in a sentence are attached to the current phrase or clause if grammatically permissible

42 Evidence for the Garden-Path Model

"Put the apple on the towel in the box"

Based on data in Spivey et al. (2002).

43 Constraint-based Theory

- MacDonald et al. (1994) – all relevant information/constraints are available – various possibilities influence comprehension to the extent they are activated
  - Grammatical knowledge constrains possible sentence interpretations
  - The various forms of information associated with any given word are typically not independent of each other
  - A word may be less ambiguous in some ways than in others (e.g., ambiguous for tense but not for grammatical category)
  - The various interpretations permissible according to grammatical rules generally differ considerably in frequency and probability on the basis of past experience

44 Unrestricted Race Model

- Van Gompel, Pickering, and Traxler (2000) – combines aspects of GP and UR models
  - All sources of information are used to identify a syntactic structure, as is assumed by constraint-based models
  - All other possible syntactic structures are ignored unless the favoured syntactic structure is disconfirmed by subsequent information
  - If the initially chosen syntactic structure has to be discarded, there is an extensive process of re-analysis before a different syntactic structure is chosen

45 Evidence for the Unrestricted Race Model

- Data from van Gompel et al. (2001).

46 Inference Drawing

- Rumelhart and Ortony (1977)
  1) Mary heard the ice-cream truck coming
  2) She remembered the pocket money
  3) She rushed into the house
- Logical inferences
  - Depend on the meaning of the words
- Bridging inferences
  - Establish coherence between the current part of the text and the preceding text
- Elaborative inferences
  - Serve to embellish or add details to the text

47 Drawing Inferences in Language Comprehension

- "She took out an apple and ate it."
- Anaphora: "Bob told Bill about **his** serious illness"
  - "his" refers to "Bob"
    - depends on distance between Bob and "his" (probably not)
    - depends on "Bob" as topic of discourse
- Three models:
  - constructivist: full mental model formed
  - minimalist: only limited, constrained, inferences are formed (automatic vs. strategic distinction)
  - search-after-meaning: meaning constructed 'after the fact' in accordance to goals

48 Search-after-Meaning Theory

- Graesser, Singer, and Trabasso (1994)
  - The reader goal assumption
    - The reader constructs a meaning for the text that addresses his/her goals
  - The coherence assumption
    - The reader tries to construct a meaning for the text that is coherent locally and globally
  - The explanation assumption
    - The reader tries to explain the actions, events, and states referred to in the text

49 Minimalist Hypothesis

- McKoon and Ratcliff (1992)
  - Inferences are either automatic or strategic (goal directed)
  - Some automatic inferences establish local coherence; these inferences involve parts of the text in working memory at the same time
  - Other automatic inferences rely on information readily available because it is explicitly stated in the text
  - Strategic inferences are formed in pursuit of the reader's goals; they sometimes serve to produce local coherence

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- The types of inferences normally drawn, together with the predictions from the S-A-M and minimalist perspectives. Adapted from Graesser et al. (1994).

51 Semantic System

- Meaning stored separately from form
- Models of representation in semantics
  - Feature-based models (see categorization)
  - Nondecompositional meaning
- Modality-specific semantic deficits: optic aphasia as an example

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