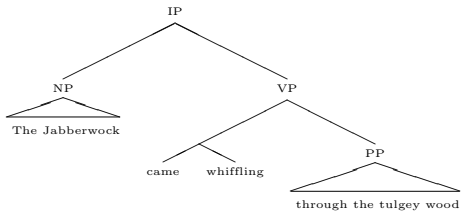
Slide 1

How Do We Understand Language?

And, as in uffish thought he stood,
The Jabberwock, with eyes of flame,
Came whiffling through the tulgey wood,
–Lewis Carroll

(1)



Slide 2

What We Have to Do

1. Parse sounds (or letters) into groups (words, morphemes);
2. Access meanings for words, morphemes;
3. Access syntactic information for words, morphemes;
4. Incorporate these into syntactic structure;
5. Semantic interpretation.

Slide 3

Lexical Access

1. Parse sounds (or letters) into groups (words, morphemes);
2. Access meanings for words, morphemes;
3. Access syntactic information for words, morphemes.

(2) *uffish*
   a. Meaning: ??
   b. Category: Adjective

(3) *Jabberwock*
   a. Meaning: ??
   b. Category: Noun (animate, count)

Slide 4

What Is "Access"?

Common View: It is like looking up an entry in a dictionary.

whiffle, *v.*
1. *intr.* To blow in puffs or slight gusts; hence, to veer or shift about (of the wind; hence, of a ship). Often fig. or in fig. context: To vacillate, to be variable or evasive.
5. *intr.* To make a light whistling sound;
whiffling *ppl.a.* –OED Online

Slide 5

How Might We Investigate Lexical Access?

1. Measure association time
   (a) Tachistoscopic identification
   (b) Naming task
   (c) Eye movements
   (d) **Lexical decision task**
2. Study breakdown in lexical access
   (a) Speech errors
   (b) Tip-of-the-tongue phenomena
   (c) Language impairments (aphasia, dyslexia)
3. Functional brain imaging

Slide 6

Tachistoscopic Identification

- Present a word for very short period of time;
- Subject reports what they saw.
- Can conclude that what they report must have been established within the time of exposure.
- By successively increasing time of exposure, can learn something about mechanisms involved.
- Can present different types of words; differences provide clues to mechanism.

Problem

- No requirement of responding immediately; subject can use later cognitive mechanisms to "sort out" or make guesses about stimulus.

Slide 7

Naming Task

- Present word, subject reads it aloud as quickly as possible.
- Measure time between stimulus and onset of vocalization.
- English pronunciation not consistent, only way to pronounce a word correctly is to access its mental representation.
- Time = lexical access + vocalization

Slide 8

Eye Movements

- Connected text: track movements from one word to the next.

Problem

- Global complexity may play a larger role than access of individual words.

Slide 9

Lexical Decision Task

- Subject sees a sequence of letters and must say as quickly as possible whether it was a real word.
- Stimuli include real words (*horse*) and non-words (*porse*).
- Measure reaction time (and count errors).
- RT to word = lexical access + time to make decision (average about 550 ms).
- Nonwords reacted to slower (search has to fail).
- Can manipulate words and nonwords to investigate mechanisms of access (e.g., nonwords similar to words (*tigar*) vs. dissimilar nonwords (*chistox*)).

Problems

- Measuring access only indirectly (access + decision).

Slide 10

Lexical Decision: Frequency Effects

- People have extensively documented corpus frequency of English words.
- High-frequency words reacted to quicker than low-frequency words.
- Low-frequency words not just rare words that people might not know (*yttrium*), but very familiar words (*puddle*).
- Frequency effect is inverse logarithmic function (RT decreases as log frequency increases).
- Frequency of individual letters plays no role.
- Number of phonologically similar words does play a role (inhibitory).

Slide 11

Lexical Decision: Priming Effects

Repetition Priming

- A word repeated a second time is reacted to faster.
- Recently encountered words still show frequency effects; two effects are separate.

Semantic Priming

- RT to a word (*nurse*) faster if preceded by a semantically related word (*doctor*) compared to unrelated control (*table*).
- Effect is very strong (80ms) and very reliable.

Slide 12

Lexical Decision: Priming Cont.

Sentence Context

- Present incomplete sentence: *It is important to brush your teeth every —*.
- Present DAY; decision faster than to YEAR.

Slide 13

Access vs. Postaccess

Do these effects on decision times affect *lexical access*, or some postaccess process (such as decision)?

- In decision, various factors might speed up decision without speeding up lexical access (e.g., noticing that all the real words start with B but none of the nonwords do).
- In the *naming task*, knowledge like this does not help: knowing a word starts with B tells you nothing about how to pronounce it; only accessing that word does.
- Naming: semantic priming effects but no sentence context effects.
- Sentence context effect: easier to reach a decision if word fits context, because only real words can fit a context.

Slide 14

More General Issue

1. Autonomy (Modularity) of Lexical Processing: do other cognitive processes affect lexical access?
   - Sentence context effect suggests yes;
   - But naming task finding suggests that effect is on postaccess decision, not on access.
   - In addition, ambiguous words prime words related to both meanings, even in sentence contexts that disambiguate. *The waiter poured the port into the glasses.* WINE SHIP

Slide 15

More General Issue (Cont.)

2. Feedback in Access: Is it necessary?
   - Effects like semantic priming indicate that lexical information can influence access.
   - However, this does not require feedback from lexical level to phoneme/letter level; see Race and Lexical Search Theory below.
   - Some data suggest more direct effect of lexical information on phoneme/letter identification.
   - Lexical effects only show that lexical information influences response (e.g., decision), not access itself.

Slide 16

Models of Lexical Access

1. Lexical Search Theory—*Serial Comparison*
2. Word-Detector Circuits (Activation Models)—*Parallel Comparison*
   (a) Logogen (Morton 1969)
   (b) Cohort (Marslen-Wilson and Welsh 1978)
   (c) TRACE (McClelland and Elman 1986)
   (d) Race (Cutler and Norris 1979)
   (e) SHORTLIST (Norris 1994)
   (f) Merge (Norris, McQueen, and Cutler 2000)

Slide 17

Lexical Search Theory

Serial search

- Lexical entry: datafile specifying all linguistic information.
- Lexical access = comparing letter pattern of stimulus with orthographic specification of each lexical entry in turn until exact match found.
- Variation in access time explained by the way datafiles are stored and the way search proceeds.
- Search is *frequency-ordered*: search most frequent datafiles first.

Slide 18

Lexical Search Theory: Access

- Three different access files:
  1. Orthographic access file (reading)
  2. Phonological access file (listening)
  3. Semantic access file (production)
- Each file points to actual lexical entries and has an *access code*:
  1. Orthographic: first three letters
  2. Phonological: initial sounds?
  3. Semantic: general semantic category
- Lexical Access = going to right access file and comparing stimulus with access codes.

Slide 19

Lexical Search Theory: Access

- Reading:
  1. go to orthographic file, match first three letters;
  2. compare to all lexical entries matching first three letters in order of frequency;
  3. match found, then do postaccess check.
- Nonword: have to go through entire set of lexical entries and not find a match.

Slide 20

Lexical Search Theory: Explanations

- Logarithmic Frequency effect: frequency-ordered search.
  1. Entries are *ranked* by frequency; function relating them is logarithmic.
  2. Function relating rank to access time is linear.
  3. Therefore function relating frequency to access time must be logarithmic.
- Nonwords take longer: exhaustive search.
- Semantic priming: activate a semantic access file too; get facilitation by searching both files.
- Repetition priming: problem. Suggestion: Not lexical access, but memory trace which facilitates decision. Evidence: repetition effect depends on context.

Slide 21

Activation Models

Parallel search

- Excitatory effects and inhibitory effects
- Units activated by stimulus
- Frequency effect: change strength of activation or lower threshold for activation
- When reach a certain activation level a word is selected
- If activation never reached default mechanism shuts it off (nonword)

Slide 22

Evidence for Activation: Competitors

Various inhibitory as well as facilitatory effects have been found which suggest that *competitors* are activated at the same time as the correct match to the stimulus.

Cohort (Marslen-Wilson and Welsh 1978)

- Sound/letter activates all entries beginning with it (the *cohort*): S– → *sad,psychology,steak,staple...*
- Next sound/letter causes inconsistent words to drop out of cohort: ST– → *steak,staple*
- **Evidence:** Large number of similar words inhibits lexical access.

Slide 23

TRACE (McClelland and Elman 1986)

(Model of spoken word recognition; visual counterpart is Interactive Activation Model of Rumelhart and McClelland 1982.)

- Levels of units:
  1. Features ([+voice],[+nasal])
  2. Phonemes (/d/,/n/)
  3. Lexical entries
- Activation spreads from features to phonemes to words.
- Feedback from word layer to phoneme layer.
- Feedback loop: phonemes in words reach threshold activation faster than nonwords.

Slide 24

TRACE: Explanations

- Frequency effect: connections between frequently occurring units are weighted higher.
- Repetition priming: when activated, weights temporarily changed before returning to normal.
- Semantic priming: at the word level words activate semantically related words.

Slide 25

Race (Cutler and Norris 1979)

- Two routes to identification:
  1. Prelexical analysis of input (features/phonemes)
  2. Information can be read from lexical entry
- First one to an output wins.
- No feedback; two routes operate autonomously

Slide 26

Evidence Favoring Race

- Conceptual: feedback could not possibly improve identification, unless it could somehow improve *perception* at previous levels.
- Race: should be able to shift attention between two routes. Evidence: lexical effects variable depending on context.
  1. Lexical effects reduced when all monosyllabic words are presented: monotonous input reduces lexical attention.
  2. Lexical effects only emerge with a lexical task, e.g. lexical decision or noun vs. verb; disappear with e.g. length judgement.
- Race: Lexical effects only facilitatory (due to race). No evidence for inhibitory effects.

Conclusion: No feedback necessary

Slide 27

Some Remaining Issues

1. Is the initial part of the word more important than the rest in access?
   - Various inhibitory and facilitatory effects suggest yes.
   - E.g., nonwords containing words:
     FOOTMILGE *takes longer to reject than* THRIMNADE
     TOASTPULL *no added inhibition*
     TROWBREAK *does not take longer than* THRIMNADE
   - Makes sense if search initially confined just to first syllable.

Slide 28

Some Issues (Cont.)

2. Morphological decomposition
   - Are prefixes stripped off when performing search (or in storage)?
     reconsider, remark, return, reprise, remove...
   - Evidence suggests yes, e.g. nonwords that are words with prefixes removed:
     VIVE, JUVENATE take longer to reject than LISH (*relish*) and PERTOIRE (*repertoire*)
   - Additionally, "pseudoprefixed" words like RELISH and REPERTOIRE take longer to recognize.
3. Reading: is access mediated by phonological recoding?
   - Evidence is mixed; evidence for it might be due to backup strategy that affects decision and not access.

References

Slide 29

References

Cutler, Anne, and Dennis Norris (1979), "Monitoring Sentence Comprehension." In W. E. Cooper and E. C. T. Walker, eds., *Sentence Processing: Psycholinguistic Studies Presented to Merrill Garrett*, x: Erlbaum, pp. xx–yy.

Marslen-Wilson, W. D., and A. Welsh (1978), "Processing Interactions During Word Recognition in Continuous Speech." *Cognition* 10: 29–63.

McClelland, J. L., and J. L. Elman (1986), "The TRACE Model of Speech Perception." *Cognitive Psychology* 18: 1–86.

Morton, J. (1969), "Interaction of Information in Word Recognition." *Psychological Review* 76: 165–178.

Slide 30

Norris, Dennis (1994), "Shortlist: A Connectionist Model of Continuous Speech Recognition." *Cognition* 52: 189–234.

Norris, Dennis, James M. McQueen, and Anne Cutler (2000), "Merging Information in Speech Recognition: Feedback is Never Necessary." *Behavioral and Brain Sciences* 23: 299–370.

Rumelhart, D., and J. McClelland (1982), "An Interactive Activation Model of Context Effects in Letter Perception: Part 2. The Contextual Enhancement Effect and Some Tests and Extensions of the Model." *Psychological Review* 89: 60–94.