Reading Research

• Processes involved in reading
  – Orthography (the spelling of words)
  – Phonology (the sound of words)
  – Word meaning
  – Syntax
  – Higher-level discourse integration
• Research methods
  – Lexical decision task
  – Naming task
  – Recording eye movements during reading

Phonological Processes

• How much do phonological processes contribute to (silent) reading?
• The strong phonological model (Frost, 1998)
  – Phonological coding will occur even when it impairs performance
  – Some phonological coding occurs rapidly when a word is presented visually
Evidence

- Tzelgov et al. (1996)
  - Stroop effect
    - Participants engaged in phonological coding of the nonwords even though it was disadvantageous

Evaluation

- Many tasks have been shown to involve phonological processing
- But in some studies, phonological processing was limited or absent
- The strong phonological model is probably too strong
  - The involvement of phonological processing in reading depends on the nature of the stimulus material, the nature of the task, and the reading ability of the participants

Lexical Decision

Decide as quickly as possible whether letter string forms a word or not

- Nurse
- Butter
- Sky
- Mufag
- Lion
- Tiger
- Maip
- Mave
- XXXX
- Clown
- Table
- Chair
- Elephant
- Gojey
- Doctor
- Nurse

Demo at: http://www.essex.ac.uk/psychology/exp/experiments/lexical.html
Typical results...

- Semantically related pairs – e.g. Lion-Tiger, Doctor-Nurse have faster “yes” responses than Nurse-Butter or XXXX-Clown

→ The semantic priming effect
  (Meyer and Schvaneveldt, 1971)

Why does priming effect occur?

- Possibilities:
  1) **Automatic activation** of related words
  2) **Expectation** to see related words (controlled attentional process)

- Neely (1977)
  – Measured contribution of these two factors
  – Two priming conditions:
    • The category name is followed by a member of a different, but expected, category (e.g., Bird–Window)
    • The category name is followed by a member of the same, but unexpected, category (e.g., Bird–Magpie)

The time course of inhibitory and facilitatory effects of priming as a function of whether or not the target word was related semantically to the prime, and of whether or not the target word belonged to the expected category.

Neely (1977)
Neely's results:

- Related primes facilitated lexical decision time at short SOA's but inhibited it at long SOA's, in the "expect shift condition."
- Short SOA's produce rapid “automatic priming” whereas the expectation of a shift is a controlled attentional process that requires more time to build up.
- Generally, semantic priming shows how word identification is affected by context.

The word superiority effect

(Reicher, 1969)

Discriminating between letters is easier in the context of a word than as letters alone or in the context of a nonword string.

[Diagram showing discrimination between letters in word and nonword contexts]

DEMO:
http://psiexp.ss.uci.edu/research/teachingP140C/demos/demo_wordsuperiorityeffect.ppt

- Word superiority effect suggests that information at the word level might affect interpretation at the letter level.
- Interactive activation theory: connectionist model for how different information processing levels interact.
- Levels interact
  - bottom up: how letters combine to form words
  - top-down: how words affect detectability of letters.
Brief Review: Artificial Neural Networks

Output to other neurons

“Computational unit”

Input from other neurons

How an artificial neuron works

unit $i$

$w_{ij}$

$\sum (\text{net input}) \rightarrow \text{transformation} \rightarrow a_i$ (activation)

unit $i$

Network Structure

• Many possible architectures, determined by:
  – # layers
  – Connectivity

• Feedforward and recurrent connections
The Interactive Activation Model

- Three levels: feature, letter, and word level
- Nodes represent features, letters, and words; each has an activation level
- Connections between nodes are excitatory or inhibitory
- Activation flows from feature to letter to word level and back to letter level

(McClelland & Rumelhart, 1981)

The Interactive Activation Model

- PDP: parallel distributed processing
- Bottom-up:
  - feature to word level
- Top-down:
  - word back to letter level
- Model predicts Word superiority effect because of top-down processing

(McClelland & Rumelhart, 1981)

Predictions of the IA model – stimulus is “WORK”

- At word level, evidence for “WORK” accumulates over time
- Small initial increase for “WORD”
Predictions of the IA model – stimulus is “WORK”

• At letter level, evidence for “K” accumulates over time – boost from word level
• “D” is never activated because of inhibitory influence from feature level

For a demo of the IA model, see:


Evaluation

• An interesting example of how a connectionist model can be applied to visual word recognition

• It accounts for
  – The word superiority effect
  – The pseudoword superiority effect
  – The size of the word superiority effect is unaffected by word frequency, which is counter to predictions of the model
Dual-route Cascaded Model

Route 1
- Converting spelling (graphemes) into sound (phonemes): sublexical route
- **Surface dyslexia**
  - Marshall and Newcombe (1973)
  - McCarthy and Warrington (1984)
  - KT read 100% of non-words 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 regularization

Route 2
- Representations of familiar words are stored in an orthographic input lexicon
- Meaning is activated
- Sound pattern is generated in the phonological output lexicon
- **Phonological dyslexia**
  - Beauvois and Dérouesné (1979)
  - Coltheart (1996)
  - General phonological impairments
Route 3: Lexicon Only

- Like Route 2 but the semantic system is bypassed
- Phonological dyslexia
- Funnell (1983)
- Patient WT: reasonably good at reading irregular words, but had no understanding of them

Video Demo of Dyslexia

- [http://psych.rice.edu/mmtbn/](http://psych.rice.edu/mmtbn/)