Lecture 2: Cognitive Psychology Overview I

- Human Information Processing
- “Classic” Memory Theories
- More Recent Memory Theory
- Applications of Theory to Engineering

Information Processing Approach (1)

- Cognitive psychology
  - Distinct from, & reaction to, stimulus-response psychology
  - Psychology of thinking
    - Memory, learning, comprehension, reasoning, attention, skill acquisition, creativity, perception
    - Ordinary activities - rational, intelligent behavior - normal behavior
  - Theoretical approach: models of intervening processes ‘in the head’
    - Describe the ‘black box’ between stimulus and response
- Information Processing Approach
  - Early development in cognitive psychology, dominant
  - View of the human being as a “processor of information”
  - Actively seek information, transform, process, store it, information drives behavior: communication, action, perception, etc.
  - Mind is a symbol manipulation system

Information Processing Approach (2)

- "Revolution" in psychology 1950s-1960s
  - 1950s-1960s: body of empirical research on learning of word lists
    - Difficult and awkward to explain phenomena in stimulus-response terms
    - Series of seminal papers re-interpreted 'verbal learning' experiments into a computer memory metaphor model (note: 60s-70s vintage computers)
    - Lindsay and Norman (1977) Human Information Processing
  - Empirical research extends to areas not conceptualized under the stimulus-response theories
    - Memory
    - Selective attention
    - Etc.

Information Processing Approach (3)

- Intellectual Antecedents (Lachman, Lachman, & Butterfield, 1979)
  - Psychology, Philosophy, Linguistics, Computer Science, Communications Engineering (signal detection theory, information theory), and
  - Engineering Psychology
    - Post WWII Military problems, e.g. aircraft control
    - Human and machine as a operating unit
    - Borrowed concepts from systems theory
    - "Man-machine system" -- Interaction of human and machine
      - Human operator is a transmitter and processor of information, interacting with the machines' displays and controls
    - Engineering Psychology → Cognitive Psychology
      - Concept of human as information transmitter, processor, decision maker
    - Examples ...

Cognitive Concepts from Engineering Psychology

- Aviation and Attention
  - Pilots crashing planes, retracted landing gear instead of braking
    - Brake and landing gear levers identical and next to one-another
  - Pilots must keep eyes on runway when landing
    - Motivation, training did not help
  - Problem of divided attention: concentration on choosing lever reduced attention to task of landing
    - Engineering psychology – required research on attention
    - Not an acceptable concept in stimulus-response psychology
  - Solutions: Different felt shapes to lever handles or place handles apart so they require different arm movements
- Touchtone Dialpad Studies: Reaction Time and Errors
  - Measurement of time and errors in deciding telephone key layout
  - Time to do task and errors becomes important measure of mental processes in information processing approach to psychology


1
ABC 2
DEF 3
GHI 4
JKL 5
MNO 6
PQRS 7
TUV 8
WXYZ 9
*
Oper 0
#

Choice Reaction Time and Mental Processes

- Deininger (1960) – example
  - Engineering psychology introduced idea of measuring time it takes to think and respond
- Choice Reaction Time
- Fitts & Seeger (1953)
  - Stimulus – Response Compatibility
- Back to Cognitive Psychology
  - Sternberg (1966)
    - Memorize digit string
    - Get test digit
    - Was it in or not
    - Respond fast without errors
    - Longer digit string = longer reaction time
    - Yes and no reaction time are the same! = serial search

Memory Theories (1)

Class Exercise: List Learning

- Glanzer and Kunitz (1966): Serial Position Curve
- Elements:
  - Primacy effect
  - Recency effect
- Serial position curve independent of list length
- Intervening task weakens recency effect
- Craik (1970) learn multiple lists
  - Serial position curve after each list recall
  - Final free recall (all lists): no recency effect

horse

window

yesterday

plate

silly

rabbit

sleep

official

sanguine

meeting

sable

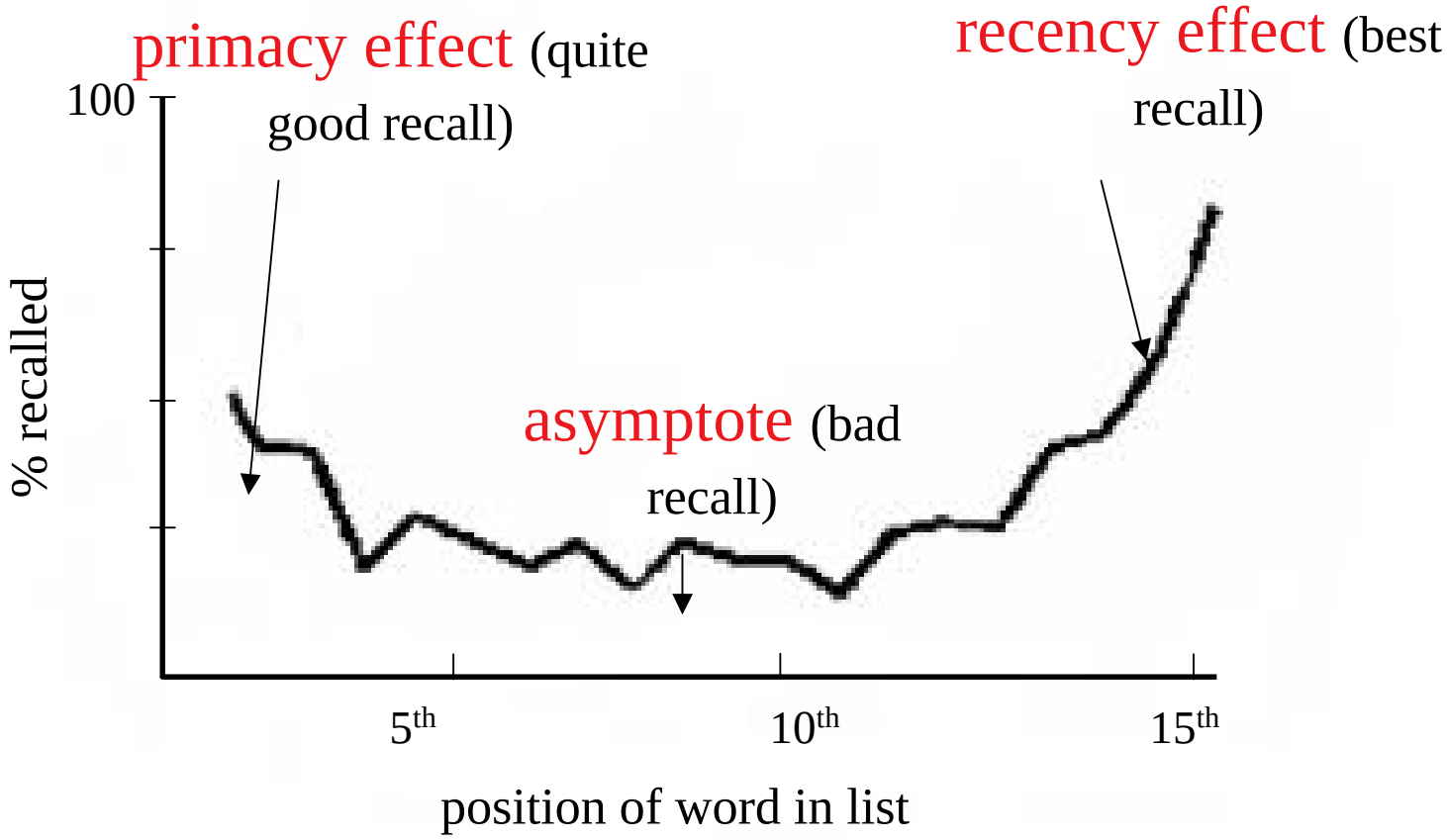
information

portal

rug

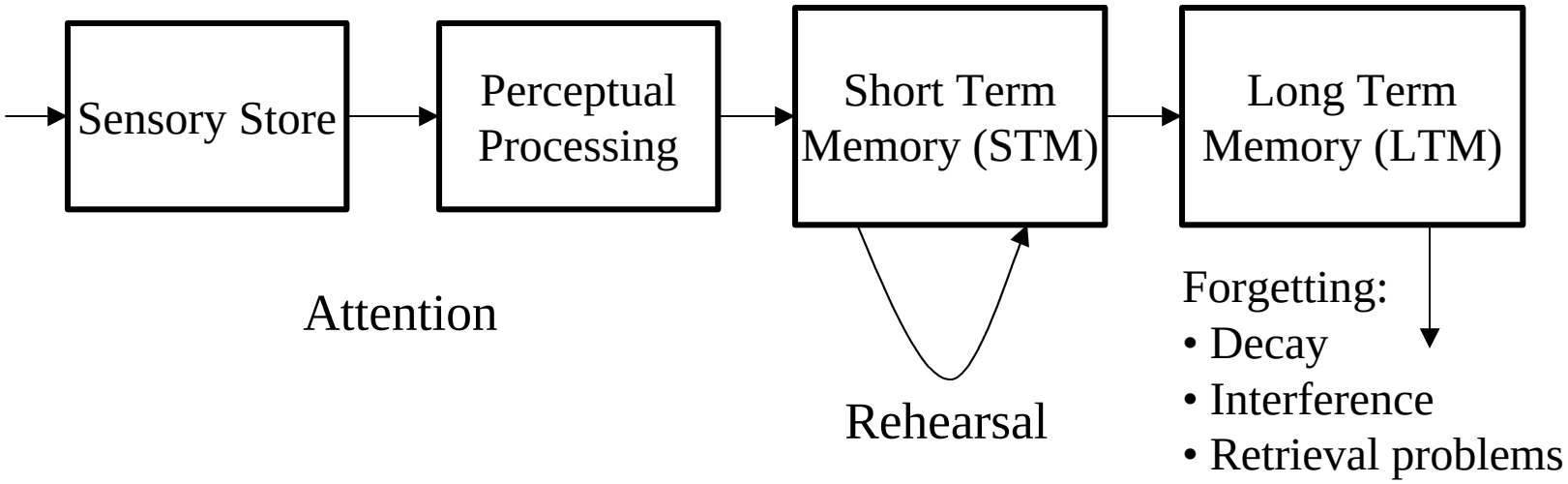
matrix

Serial position curve



Memory Theories (2)

Simple “1970s Vintage” Memory Theory



Memory Theories (3)

- Mutlistore Memory Model - Antecedents
  - William James (1890)
    - Prior to S-R psychology
    - Primary memory = what's in consciousness now
    - Secondary memory = what's permanent in our head
  - Resemblance to 1970s computer architecture
    - Not coincidental
    - Core memory
    - Winchester disk, magnetic tape storage

Memory Theories (4)

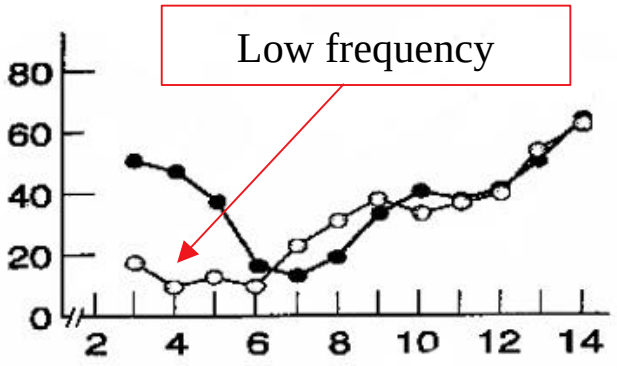
- Multistore Memory Concepts
  - Sensory Memory
    - Veridical sensory-level representation
    - Rapid loss due to decay, quick transfer to STM
  - Short Term Memory
    - Verbal based representation
    - Items must be rehearsed to stay in memory
    - Limited store: Magic number 7 plus/minus 2 (Miller, 1956)
  - Long Term Memory
    - Retrieval strategies are the most important factor in getting information out of LTM
    - Memories can be forgotten simply because they can't be retrieved

Memory Theories (5)

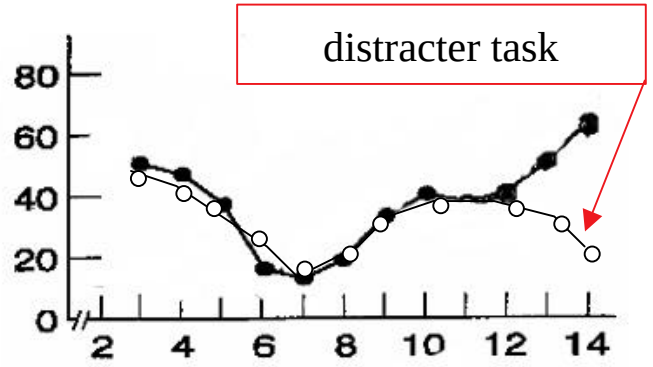
- Evidence
  - Dissociate effects on each part of curve
    - Different characteristics of each “sotrage system”
    - Many list learning experiments from old S-R psychology
    - New memory interpretation – unified explanation – more parsimony
  - Primary Effect changed by
    - Word frequency
      - Rare words cause less primacy
    - IQ
      - Lover IQ, smaller primacy effect
  - Recency Effect changed by
    - Distracter task lowers recall of last items in list
    - Time delay – longer delay makes lover recall

Memory Theories (6)

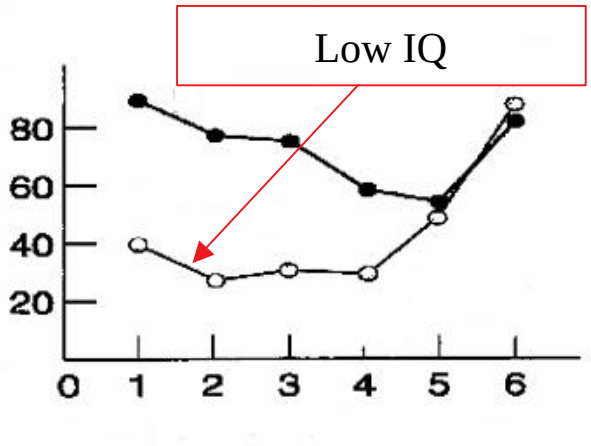
Word frequency



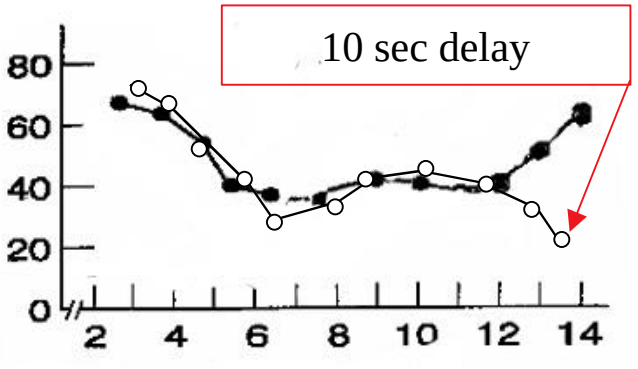
distraction



IQ



delay



Applications of Memory Theories (1)

- (Mis)Application to HCI
  - Short Term Memory and Magic Number 7 plus/minus 2
    - Shneiderman (1st ed text): Menus and memory
    - Has been applied to
      - Place only 7 items on a menu bar
      - Place only 7 items on a pull-down menu
      - Have only 7 bulleted items in a list
      - Never have more than 7 radio buttons or check boxes in a unit
      - Place on seven tabs on top of a website
    - What is wrong with this?

- How much is memory involved?
- Memory Theory has moved on since 1956
  - Working memory: more than just rehearsal area
  - Seven +/- 2 may be wrong: May different estimates, empirical data now in disagreement, may depend upon type of task and material