CogSysIII Lecture 6: Attention, Memory Organization and Information Presentation

Human Computer Interaction

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last change May 22, 2007

A Short History of Psychology of Thinking

- 1900 - 1910: Würzburger Schule: Narziss Ach, Karl Bühler
  first experiments, Method of Introspection
- 1910 - 1933: Otto Selz, Mannheim: Schema Theory
- 1910 - 1933: Berliner Gestaltpsychologen: Max Wertheimer, Wolfgang Köhler, Karl Duncker
- 1910 - 1950: USA: Behaviorism (Thorndike, Watson, Tolman, Skinner)
- 1956 - 1960: "Cognitive Revolution"

Behaviorism

- stimulus response models
- beginning of experimental psychology
- focus on (reinforcement) learning
- no interest in “internal states”, explanation on a behavioral level

Cognitive Revolution

Precursors

- Information theory (Shannon)
- Beginning of computer science (information processing)
- Chomsky - Skinner debate, “Verbal Behavior”
- Ulrich Neisser, “Cognitive Psychology”

Chomsky Skinner Debate

- Language is
  - productive, (we can generate and understand an infinite number of sentences)
  - systematic, (if we understand “john loves mary” we also understand “mary loves john”)
  - and compositional (meaning of sentence as function of its components and their syntactical relations)
- Competence vs performance

Attention

- How to allow behavior to be controlled by the right information at the right time to the right object in the right order (Styles, 1997)
- Selection of information for reasoning or action
- necessarily: deselection of other information
- selective attention, mostly perceptive selection; e.g., Cocktail party phenomenon
- capacity restrictions: limitation of attention by (multiple) actions

Selective Attention

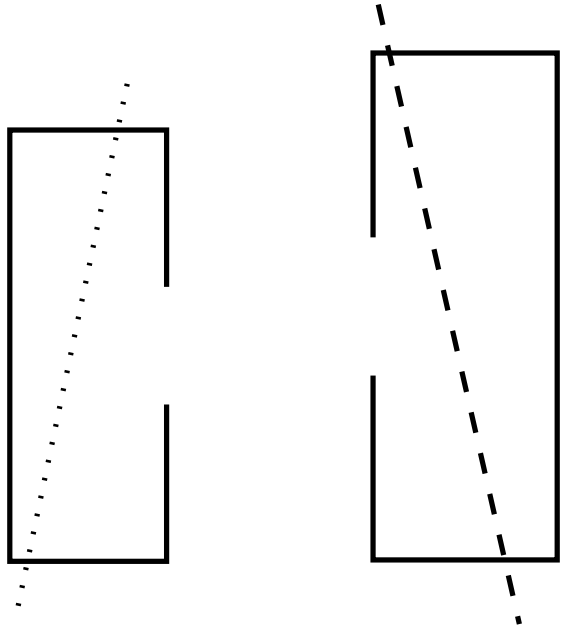
- How can one keep track of one discussion while there are other discussions/music in the background?
- Dichotic hearing experiments:
  - Simultaneous messages on left and right ear, attention focus on one ear using “shadowing” (repeating the message)
  - not able to report the non-attended messages
  - no detection of change in language (e.g. German to English)
  - but: change of male to female voice, introduction of “beeps” get notice

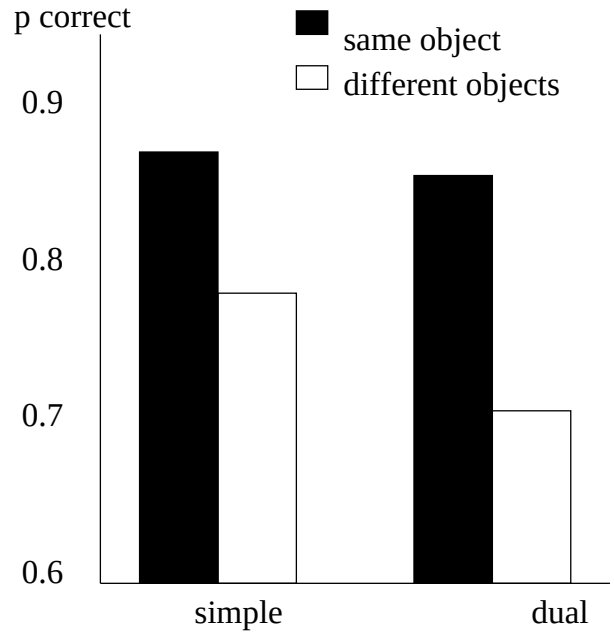
Broadbent's Filter Theory (1958)

- parallel perceptive encoding
- attended information passes a selective filter
- assumption of limited capacity channel and early selection

Object Based Selection

- Duncan (1984)
- Presentation of two overlapping objects, judgement of one or two attributes in one or both objects



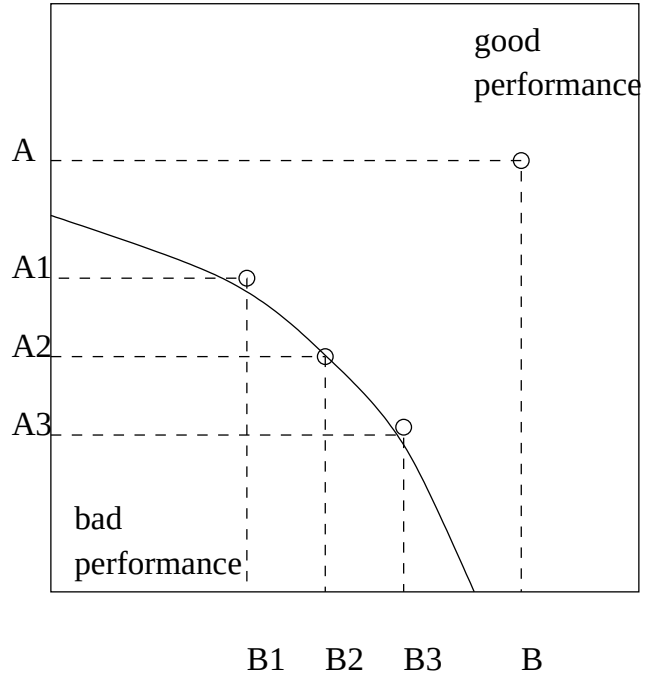


Multiple Task Performance

- Task similarity: shadowing of auditory presented messages, dual task (remember (a) auditory presented words (b) visually presented pictures)
  $\hookrightarrow$ different input channels for different modalities
- Task similarity: copy-typing and shadowing without interference; audio-typing and reading aloud with interference
- Expertise: e.g. expert driver can talk while driving
  People's ability to develop skills in specialized situations is so great that it may never be possible to define general limitations on cognitive capacity. (Spelke et al., 1976)
  alternative explanation: automatization resulting in reduced demands on cognitive capacity (cf. Anzai and Simon)
- Task difficulty

Performance-Operating Characteristic

- Task diagnosis: POC (Wickens, 1992)
- resource vs. data limitation
- If both tasks are resource limited, higher performance in one task results in reduced performance in the other task



Automated Processing

- fast
- no capacity reduction of other tasks
- inevitable – are stimuli triggered, even if the stimulus is not in focus of attention
- no concious control

Example: Stroop Effect

- Stroop (1935), Posner & Snyder (1975)
- Asymetric interference: word activates its “speaking reaction” automatically
- Words are stronger associated with “naming reaction” than colors

Stroop Effect

ROT *777*

BLAU

GRÜN

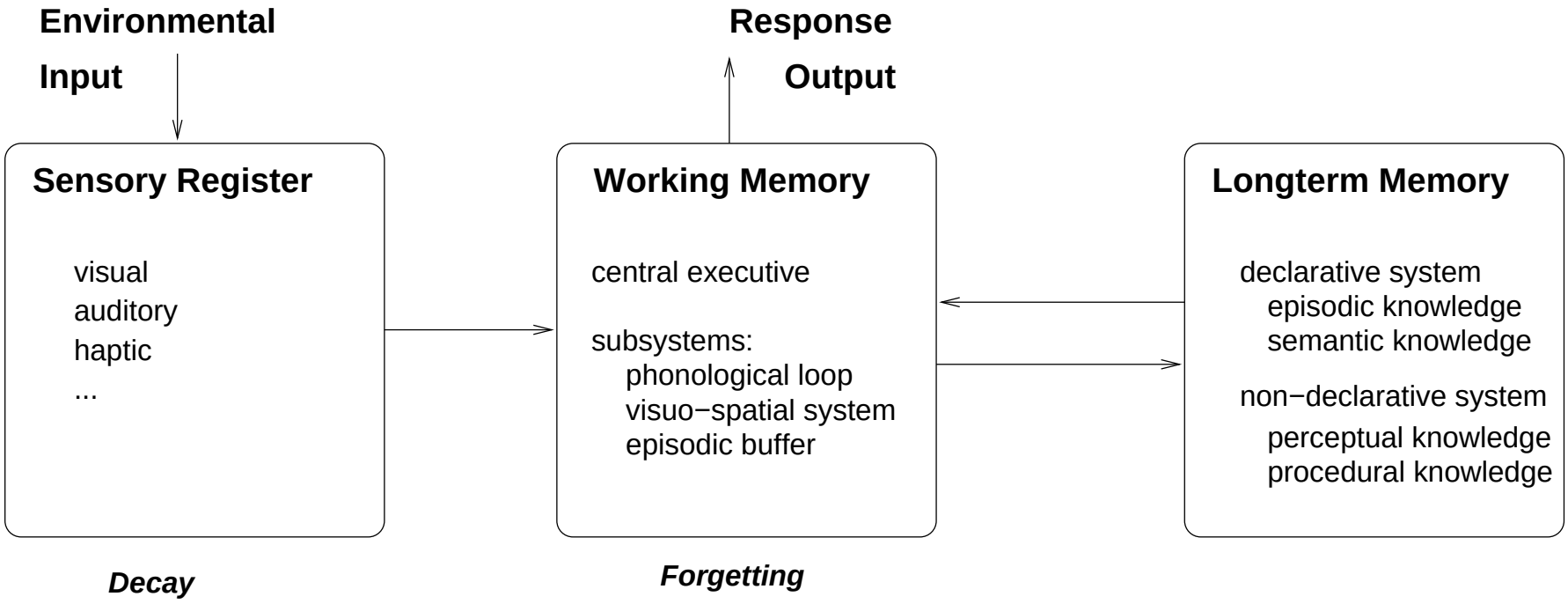
Consequences for Design

(Balzert, Lehrbuch der Software-Technik)

- Make information salient when it needs attending to (color, highlighting, sound, spacing)
- Avoid cluttering (plain interfaces, such as Google, are easier to use)
- Automatization can only be achieved if the same stimulus is always associated with the same reaction (e.g.; OK bottom in a message window can always be activated by pressing return-key)

Human Memory

Modal Memory Model (Atkinson & Shiffrin, 1968)



Sensory Register

- Decay time approximately 1 second
- Virtually unlimited storage capacities
- No information organization (“iconographic memory”)
- Sperling’s span of apprehension experiments
- Purpose: demonstrate the existence of sensory store and determine its properties, many of which can be explained by the existence and nature of the span of apprehension, a limit in the amount of information that can be transferred from sensory store to STM in a given amount of time. It is a function of the rate of transfer of information (which is processed in a serial fashion). Because of the short decay time of sensory store, information not transferred from sensory store to STM during the decay time limit is lost.

Sperling Experiment

- First experiment: tachistoscopical presentation of arrays of 12 letters (3 rows of 4 letters each)
- Subjects typically stated that they saw all 12 letters, but could only report 3 or 4 of them before the memory trace faded.
- Second experiment, subjects were told that, after seeing the array, they would hear a musical tone (pitched high, medium, or low) telling them which row of the array to report, and the time lapse between the presentation of the array and the onset of the tone was varied as the independent variable.
- With immediate onset (0 sec. delay), subjects can typically report all 4 letters of the indicated row, but with a delayed onset of 1 sec., recall worsens to about 1-2 letters

Working Memory

- Earlier “Short term memory”, sometimes thought as synonym, working memory emphasises the active, task-based nature of the store
- Storage time: 20-30 seconds, information can be held in STM by rehearsing it
- Limited storage capacity, "bottleneck" in the memory process (Miller, 7 plus/minus 2 chunks)
- Acoustical or visual organization

Long Term Memory

- In the absence of neurological disease or injury, memories in LTM are essentially permanent
- LTM has essentially or virtually unlimited storage capacity
- Semantical/chronological organization

Primacy/Recency Effect

- Murdock, B. B., Jr. (1962): Serial position effect in free recall
- Subjects are presented with a list of words, read out loud to them at a constant rate, and asked to try to remember as many of the words as they can. Recall of the words need not be in order, but is unconstrained (hence "free" recall).
- In general, words at the beginning and at the end of the list are more likely to be recalled than words in the middle; the first of these phenomena is called the primacy effect and the latter the recency effect.

Primacy/Recency cont.

- Modification of basic procedure (Glanzer & Cunitz,1966)
- Suggests that the primacy effect is an LTM effect (due to the fact that early words get more rehearsal time and thus have a higher probability of reaching LTM in the first place), while the recency effect is a STM effect (due to the fact that the last few words on the list are still in STM at the time of recall).
- modify the procedure to eliminate one (but not the other) of these effects:
  - The primacy effect can be minimized (if not reduced altogether) by increasing the rate at which the words on the list are read to the subject,
  - The recency effect can be eliminated by introducing a time delay (with an accompanying distractor task to prevent ongoing maintenance rehearsal) between the end of the list and the onset of the recall process.

Interference and Forgetting

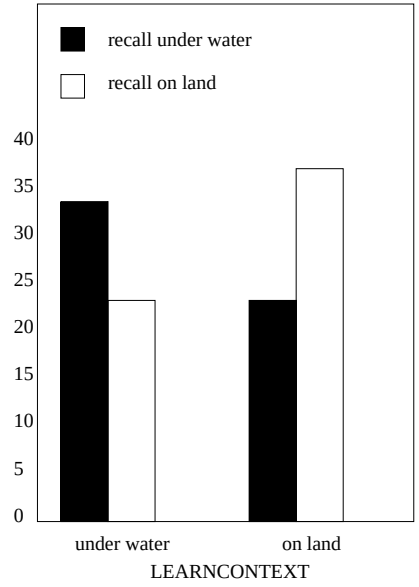
- Interference theory assumes that the ability to remember can be disrupted by what we have previously learned or by future learning.
- Interference by previous memories is proactive interference.
- Interference by later learning is retroactive interference.
- Underwood and Postman (1960) showed that interference is:
  - Maximal when two different responses have been associated with the same stimulus.
  - Intermediate when two similar responses have been associated with the same stimulus.
  - Minimal when two different stimuli are involved.

Experimental Design

	Early	Late	Test	Situation
Experimental Group	A–D	A – B	A–B	Proactive
Control Group	C–D	A–B	A–B	Interference
Experimental Group	A–B	A – D	A–B	Retroactive
Control Group	A–B	C–D	A–B	Interference

Some LTM Effects

- Recognition is usually easier than recall
- Forgetting in LTM is usually attributed to bad retrieval cues and/or bad memory organization
- Context-effects
  Godden & Baddley (1975): learning of word lists under water or outside of wate



Implications for Design

(Balzert, Lehrbuch der Software-Technik)

- Using GUIs (instead of an input prompt) facilitates work: recognition instead of recall
- Do not use Miller's Magical Number Seven principle for recognition problems
- File management systems should allow for recall and recognition (Apple's Sherlock allows to constrain the number of files by giving partial names or phrases)
- Avoid to much memory load
- Group activities together which form a meaningful category
- ...