Cognitive Science

Understanding of

- Human Memory
- Encoding & Retrieval Processes
- Cognitive Processes in Learning
- Mental Models, Schemata
- Theories of Multimedia Learning

Overview

- Sensory Memory
- Short-Term Memory, Working Memory
- Implication for Design of Instructional Technology
Group Discussion

Describe how the properties of sensory and working memory are optimized to fulfill the different functions of the two systems. Use examples to illustrate your points.

—How did Sperling (1960) show that sensory memory is temporarily, rather than visually limited?

Sensory Memory

• Holds information in a relatively raw, unprocessed form for a short time after the physical stimulus is no longer available
• Items remain in sensory memory for about 2 sec.
• Storage capacity of sensory memory is much larger than that of short-term memory
• Information in sensory memory is a fairly accurate representation of the stimulus

Reason/Need

• Constantly and rapidly changing stimuli that bombard your senses
• Need to keep an accurate record of the sensory stimulation for a brief time while we select the most important stimuli for further processing
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Sensory Memory

Components
Visual sensory memory (iconic memory)
• Information lasts about 1/4–1/2 s
Auditory sensory memory (echoic memory)
• Information lasts about 2–4 s
• Long and short auditory storage?

Sensory Memory

Question
How can the concepts of
Selective Attention and Automaticity
be used to improve the design of multimedia
learning environments?

Pattern Recognition
Is thought to be accomplished by
• Template matching
• Prototype model
• Feature analysis
What are the potential problems with each of these methods?
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Information Processing

- Temporary storage of information in thinking and problem solving
- Distinct components: phonological (speech-based) and visuo-spatial
- Capacity is limited to around 7 +/- 2 items, can be extended by means of efficient coding systems (Miller, 1956)

Working Memory

- Span of absolute judgment (capacity to transmit information): about 2.5 bits (6 categories)
- Relationship of number of variables, total capacity, and accuracy for any particular variable

Miller (1956)
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Important Terms

- Chunking
- Rehearsal
- Encoding

Working Memory

Multiple component view of WM

- Central Executive
- Articulatory Loop
- Visuo-Spatial Sketch Pad

Baddeley & Hitch, 1974

Baddeley & Hitch Model

- Central executive
- Articulatory Loop
- Visuo-Spatial sketch pad
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Baddeley & Hitch Model

- Central executive
  - Coordinates information from two slave systems

- Articulatory Loop
  - Phonological store, holds acoustic information for 1-2s
  - Articulatory control process (inner speech)

- Visuo-Spatial sketch pad
  - Processing of Imagery:
    - Patterns
    - Spatial Relations

Cognitive Science Questions

What is the difference between short-term memory and working memory?

What is the relationship between working memory capacity and intelligence?

What is the importance of this component view of working memory for the design of multimedia learning materials?

How can the design of such materials take advantage of the processes described by this model?
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Working Memory

- Capacity of WM described in terms of fixed number of independent patterns (chunks)
- Individual differences in WM capacity as cause for general differences in performance across different tasks

Working Memory

THAT IS THE TRADITIONAL VIEW:
BASIC CAPACITY APPROACH

Challenges to Traditional View
- Memory span of normal adults only weakly correlated with performance in skilled everyday activities such as text comprehension (Daneman & Merikle, 1996)
- Some individuals with brain damage show normal performance on complex tasks such as text comprehension, even when they have severely impaired immediate memory performance (Martin, 1993)
Challenges to Traditional View

- When tasks involving reasoning and comprehension (rather than just recall) are performed, reliable working memory capacity available for storage of information appears to be far below 7, more like 3-4
- => not enough capacity for complex mental processing unless additional activity-specific resources are proposed

New Approach for Working Memory is needed:

Transient-Storage Approach

- Working memory is the transiently activated portion of LTM
- Limits on the number of elements in working memory are not determined by a fixed number but rather by the amount of available activation
- Working memory can sometimes contain over 20 units at one time
- Fast decay reduces amount of information that can be recalled in test
Scenario
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Working Memory

Definition (Baddeley & Logie, 1999)
WM comprises those functional components of cognition that allow humans to comprehend and mentally represent their immediate environment, to retain information about their immediate past experience, to support the acquisition of new knowledge, to solve problems, and to formulate, relate, and act on current goals.

Definition (Miyake & Shah, 1999)
• Mechanisms and processes that are involved in the control, regulation, and active maintenance of task-relevant information in the service of complex cognition.
• Consists of a set of processes and mechanisms and is not a fixed place in the cognitive architecture.
• Involves multiple representational codes and/or different subsystems.
• Contents: mainly activated LTM representations.

Small Group Discussion (10 min.)
Discuss in groups of 3-4
• How do the limitations of WM manifest themselves in the instructional use of multimedia or hypermedia environments?
• Use the BBC Learning Web Site as basis for your discussion.
Small Group Discussion (10 min.)

Discuss in groups of 3-4

• How do the limitations of WM manifest themselves in the instructional use of multimedia or hypermedia environments?
• Use the BBC Learn discussion

Instructional Design

Assess
Needs to Identify Goals

Conduct Instructional Analysis

Analyze Learners and Contexts

Write Performance Objectives

Develop Assessment Instruments

Develop Instruct. Strategies

Develop & Select Instruct. Materials

Design & Conduct Formative Evaluation of Instruction

Design & Conduct Summative Evaluation of Instruction

Revise Instruction

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ISD & Cognitive Science

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Revise Instruction

Cognitive Approach to Media Selection

Cognitive Approach to Interface Design

Design from Emotional Perspective

Multimedia Design Principles

Cognitive Task Analysis