5 Empirische Untersuchungen zum multimedialen Lernen

5.1 Kognitive Modelle multicodalen und multimodalen Lernens

5.2 Gestaltung empirischer Untersuchungen

5.3 Multimedia Principle

5.4 Contiguity Principles: Split-Attention Effect

5.5 Modality Principle

...

Literatur:

Richard E. Mayer: Multimedia Learning, Cambridge University Press 2001

Richard E. Mayer (ed.): The Cambridge Handbook of Multimedia Learning, Cambridge University Press 2005

Teaching and New Media – Historic Perspective

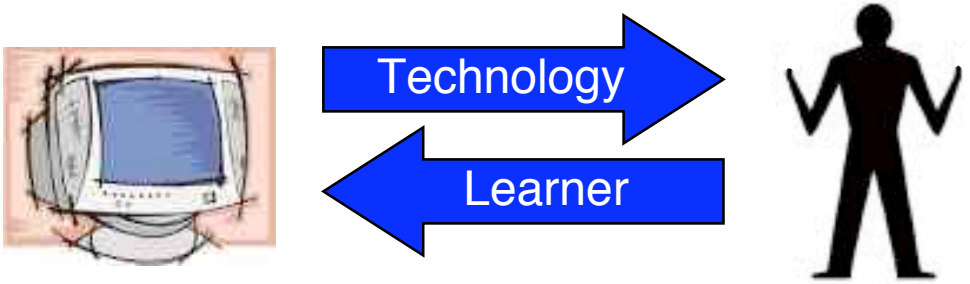
- Edison 1922:

  “The motion picture is destined to revolutionize our educational system, and in a few years it will supplant largely, if not entirely, the use of textbooks”

- William Levenson 1945:

  “A radio receiver will be as common in the classroom as the blackboard”, “Radio instruction will be integrated into our school life”

Two Views of Multimedia Design



- Technology-centered approach:
  - "How can we use multimedia capabilities in designing learning applications?"
  - 100-year history of failure of technology in education:
    - » Motion picture (Edison 1922), radio (Darrow 1932), TV (1950s), computer (PLATO, TICCIT 1970s)
- Learner-centered approach:
  - "How can we enhance learning using multimedia?"
  - Two phases in computer application: *automation* and *augmentation* (Landauer 1995)
  - User-centered approach guided by the capabilities of human cognition
  - Still heavily underdeveloped

Two Metaphors of Multimedia Learning

Information acquisition

- Learner: Passive information receiver
- Teacher: Information provider
- Role of multimedia: Delivery vehicle

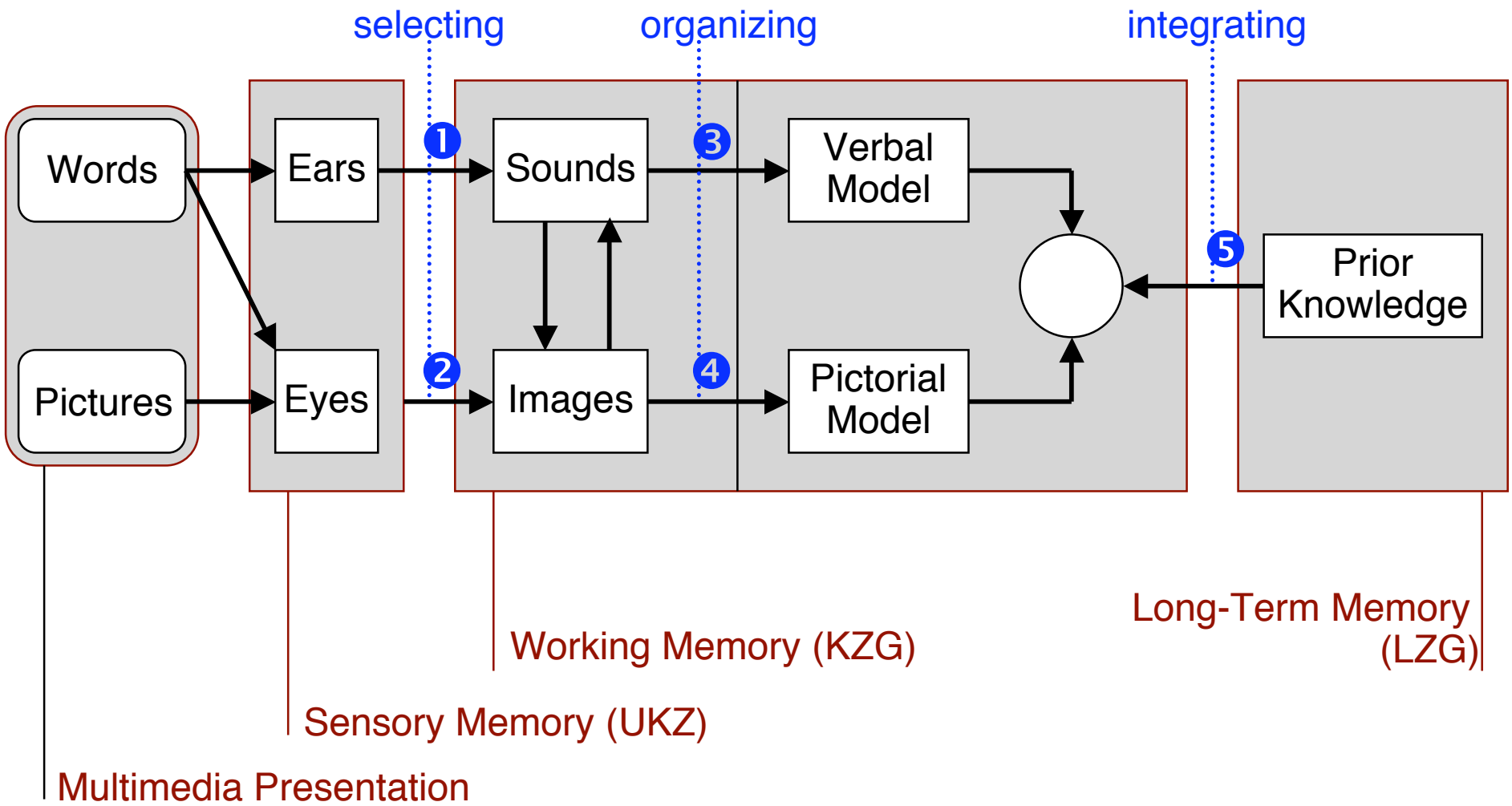
Knowledge construction

- Learner: Active sense maker
- Teacher: Cognitive guide
- Role of multimedia: Provide cognitive guidance

Assumptions for a Cognitive Theory of Multimedia Learning

- Dual channels assumption
  - Separate information processing channels
    - » Visual/pictorial channel
    - » Auditory/verbal channel
  - Sensory *modalities* (eyes/ears): two input channels
  - *Coding* as picture/word: two storage forms
  - Cross-channel representations are possible (e.g. reading, narration)
- Limited capacity assumption
  - Limits for the amount of information that can be processed in each channel at one time
  - Short-term memory: approx. seven chunks
  - Allocation of resources by central memory control processes
- Active processing assumption
  - Learners are active processors, not passive recorders

Cognitive Model of Multimedia Learning

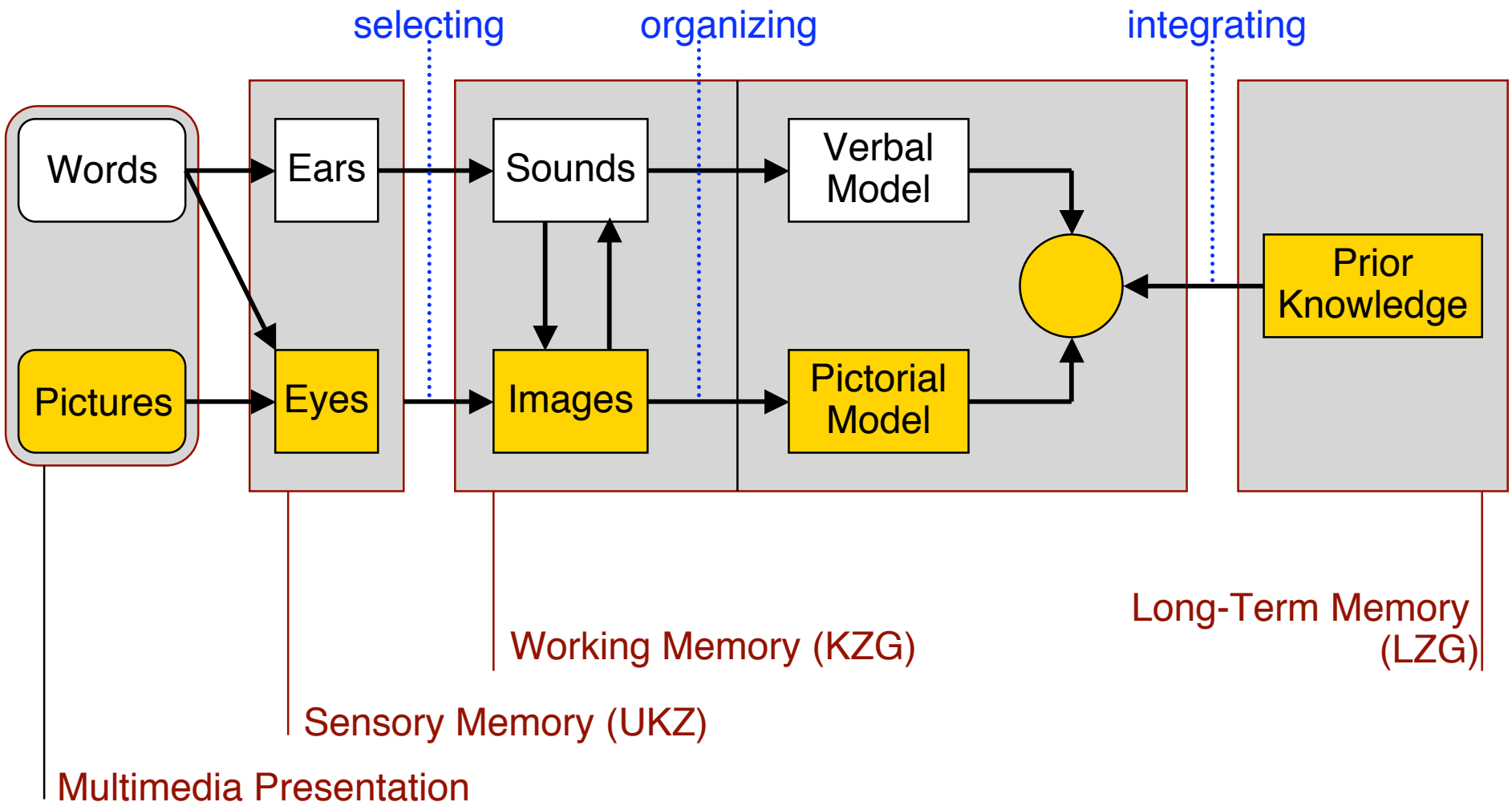


Five Steps of Understanding

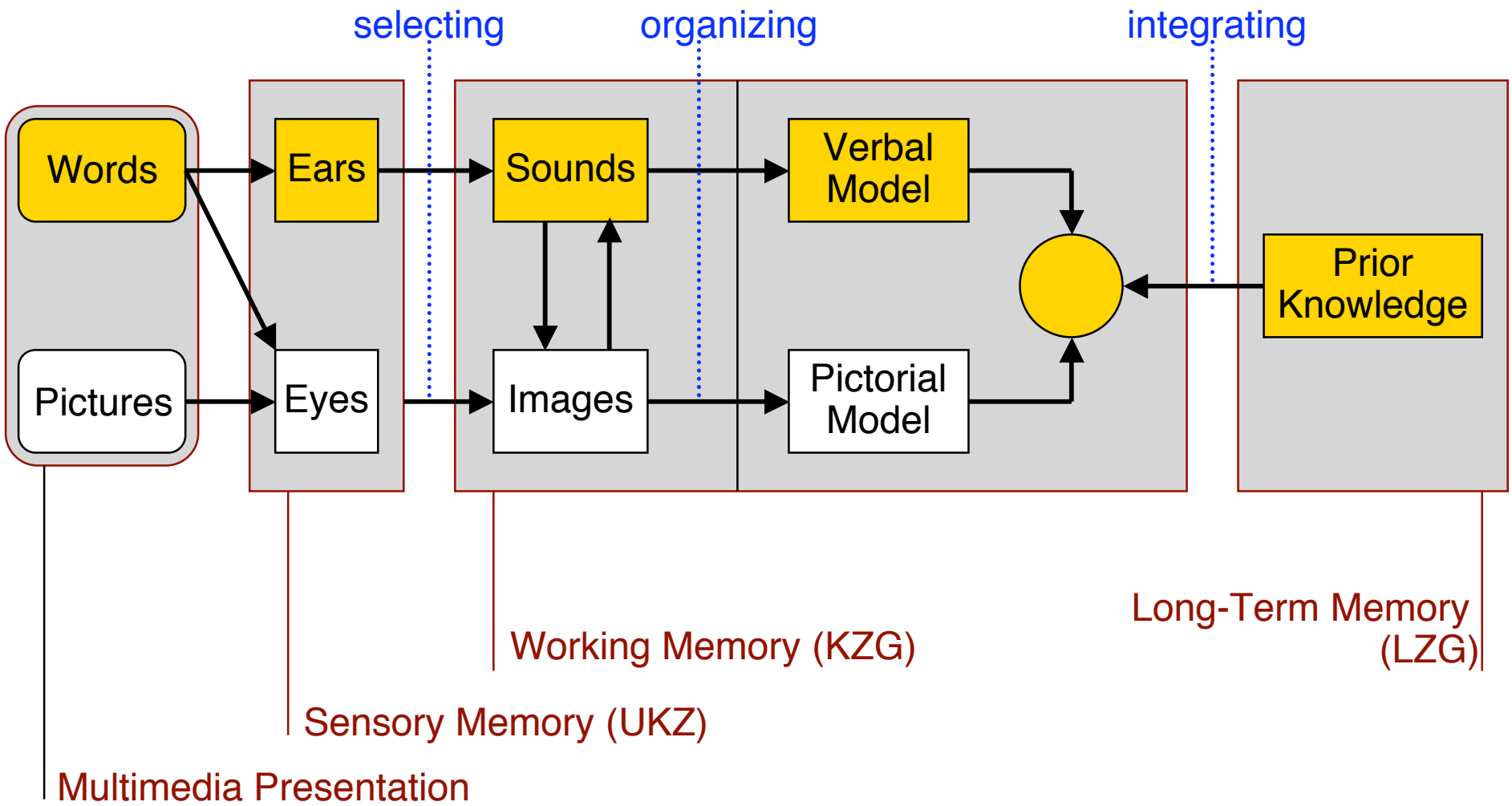
Basic processes, not necessarily in this order (arbitrary moves)

1. Selecting relevant words
   - Paying attention to *some of* the presented words
2. Selecting relevant images
   - Paying attention to *part of* the illustrations and animations presented
3. Organizing selected words
   - Building connections amongst words, e.g. cause-effect chains
4. Organizing selected images
   - Building structures that make sense to the learner, e.g. cause-effect-chains
5. Integrating word-based and image-based representations
   - Making connections between word-bases and image-based representations
   - Most relevant for *multimedia*
   - Extremely demanding process: "sense making"
   - Carried out only segment by segment for larger presentations

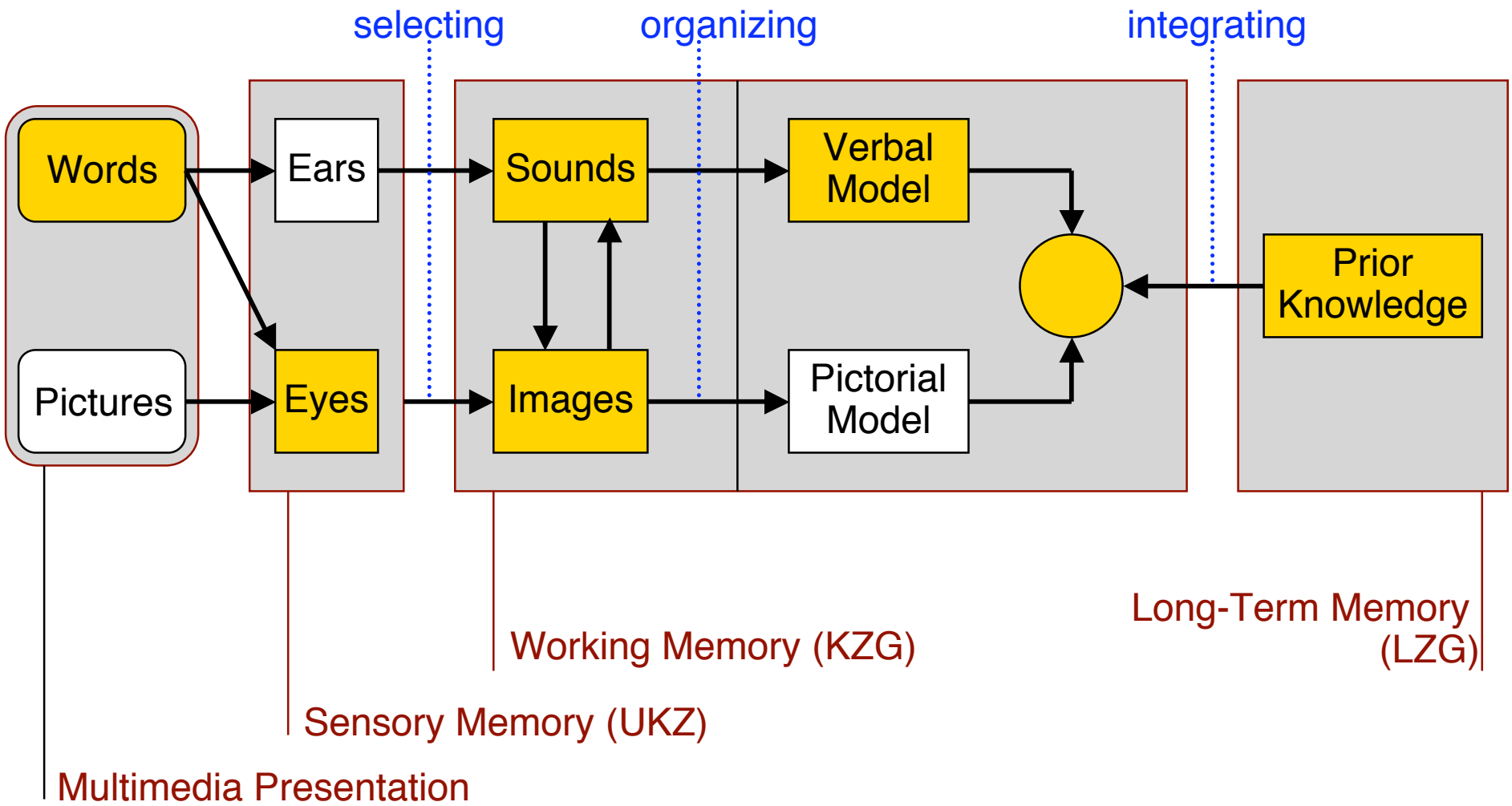
Example: Processing of Pictures



Example: Processing of Spoken Words



Example: Processing of Printed Words



„Multimedia“-Begriff

- "... the multimedia part of the definition reflects the idea that the multimedia instructional message is presented using both words and pictures."

  Mayer 2001, p. 22

- Multi*codalität* als Mindestvoraussetzung
  - Verschiedene Symbolsysteme (Text, Bild)
  - Gleicher Eingabekanal (Visuell)
- Multi*modalität* als zweite Stufe
  - Verschiedene Symbolsysteme (Text, Bild, Musik)
  - Verschiedene Eingabekanäle (Visuell und auditiv)
  - Unterscheidung:
    - » Text als Ton (Alternative zu monomodaler Präsentation)
    - » Nicht-textuelle Ton-Information (Präsentationsform jenseits monomodaler Präsentationen)

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What is Good Research?

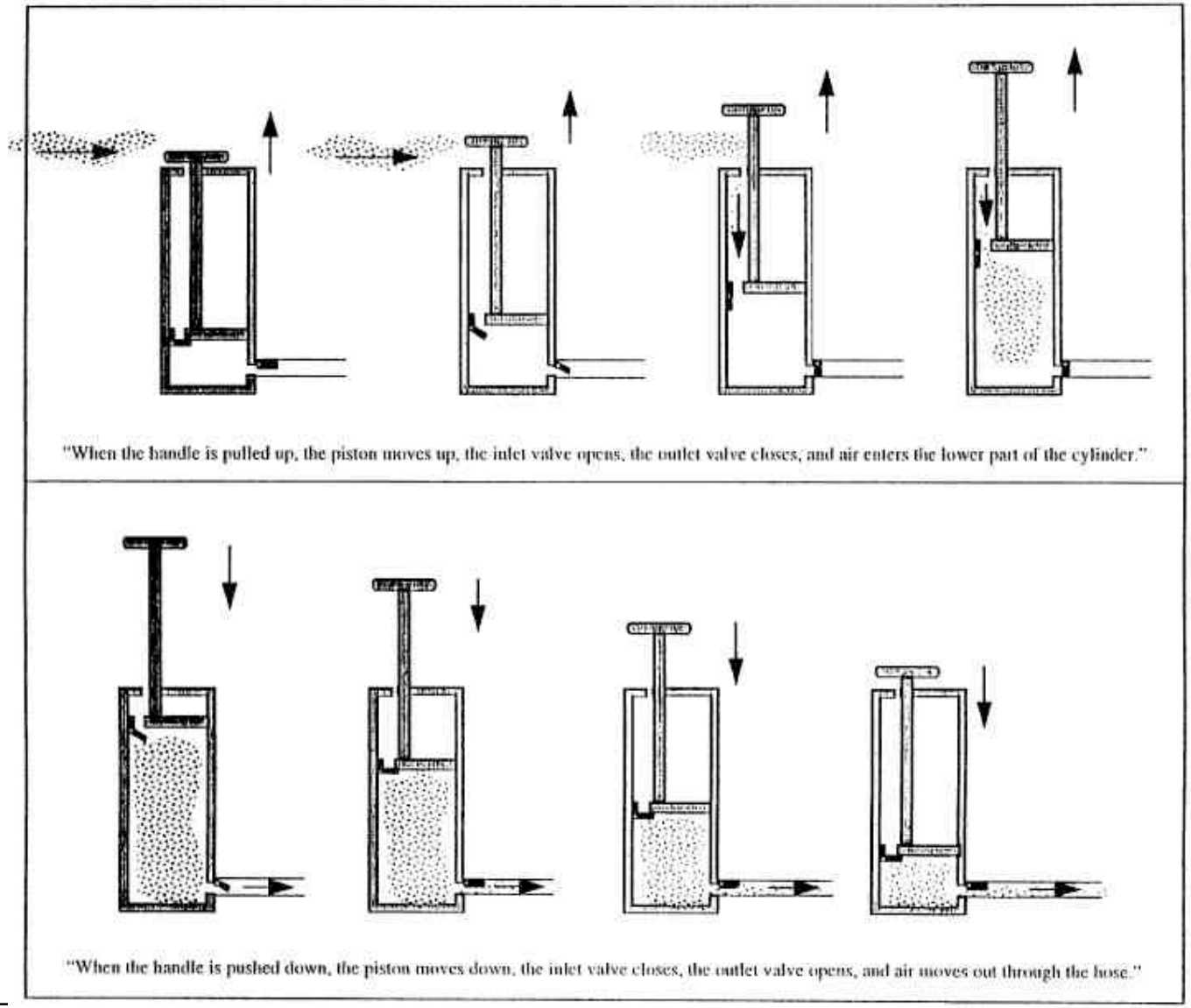
- Informal Studies
  - Observing people as they learn, or ask them about their learning
  - Formative Evaluation: Adapting material according to learner feedback
  - Summative Evaluation: Collecting opinions on positive and negative features
  - *Example*: Lecture evaluation
- Controlled Studies
  - Comparing two groups or more
  - Dependent variables: Measuring the learning effect
  - Independent variables: Composition of groups ideally equivalent except of one specific variable
  - Preferred scientific method
- Clinical studies
  - Comparing the process/outcome on people in real-world contexts
  - Similar to controlled studies, *but influence from abitrary non-named dependent variables is possible!*
  - *Example*: Replacing a traditionally tought course by an e-learning course and comparing the outcomes

Clark/Mayer 2005

Goals of Multimedia Learning

- Two different effects of learning can be measured:
- *Retention*
  - Remembering
  - Ability to reproduce or recognize presented material
  - Example test: “Write down all you can remember from the passage you just read”
- *Transfer*
  - Understanding
  - Ability to use presented material in new situations
  - Example test: “List some ways to improve the reliability of the device you just read about”

Example: “Multimedia” Instructional Message



Example: Retention and Transfer Tests

- Retention Test:
  - "Please write down an explanation of how a bicycle tire pump works. Pretend that you are writing to someone who does not know much about pumps."
- Transfer Test:
  1. "What could be done to make a pump more reliable – that is, to make sure it would not fail?"
  2. "What could be done to make a pump more effective – that is, to make it move more air more rapidly?"
  3. "Suppose you push down and pull up the handle of a pump several times but no air comes out. What could have gone wrong?"
  4. "Why does air enter a pump? Why does air exit from a pump?"

Mayer's Examples

- Examples used in R. Mayer's experiments
  - "How lightning storms develop"
  - "How brakes work"
  - "How pumps work"
- Various versions ("instructional messages")
  - Text only
  - Text and pictures
    - » Different placement of pictures
    - » Different styles of text
  - Printed text vs. spoken narrative
  - …

Mayer's Seven Principles (2001)

- Multimedia Principle
- Spatial Contiguity Principle
- Temporal Contiguity Principle
- Coherence Principle
- Modality Principle
- Redundancy Principle
- Individual Differences Principle

- In the following, all these principles are covered
  - New structure following Handbook of Multimedia Learning (2005)
    - » Combining some principles (e.g. Split-Attention Effect)
  - Additional principles from other authers

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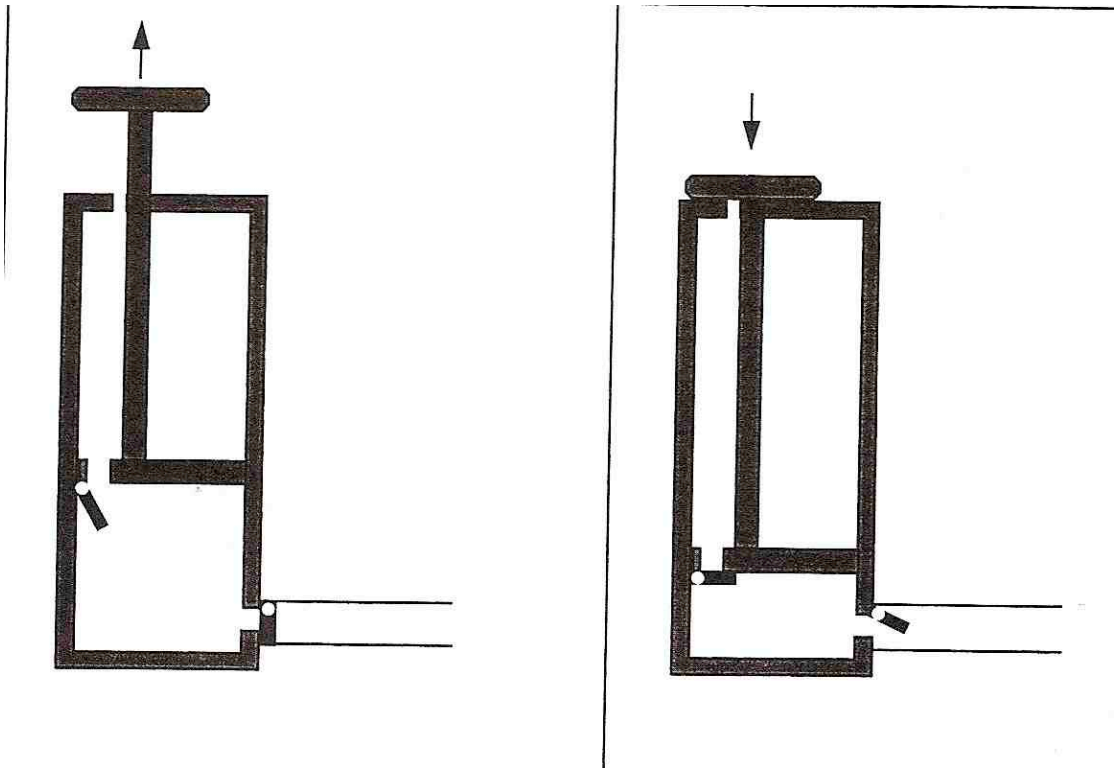
Are Pictures Different from Words?

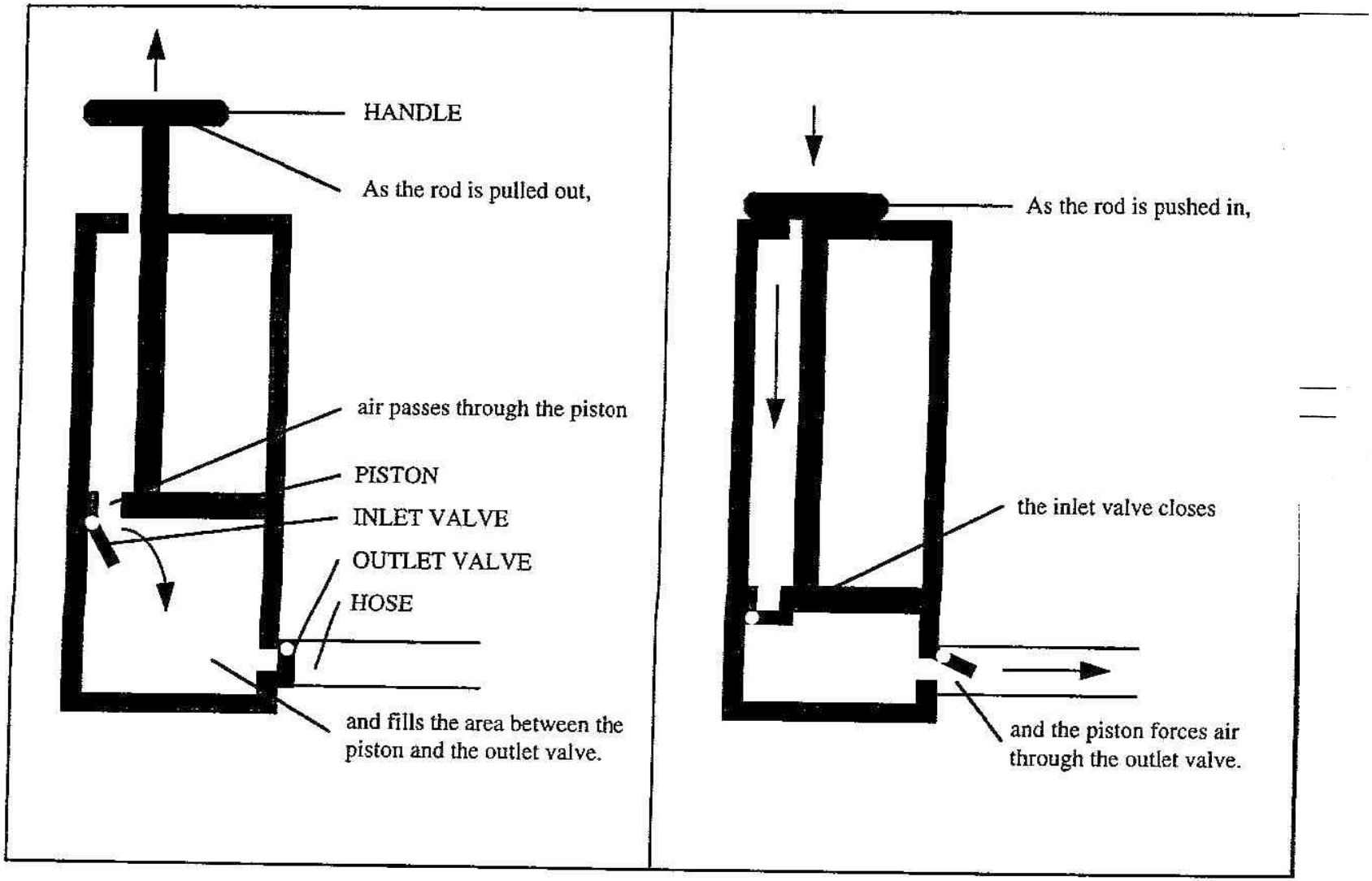
- *Pro* Words:
  - Most common way of presenting information
  - Pictorial presentation conveying the same information is waste of effort
  - Prediction on experiments: Students who receive presentation only in words should perform equivalently to students receiving presentation in words and pictures
- *Pro* Combination of Words and Pictures:
  - Humans have two different channels to process presented material
  - Words and pictures: qualitatively different systems for representing knowledge
    - » Words: abstracted and interpreted presentations
    - » Pictures: "original" mode of knowledge representation for humans
  - Prediction on experiments: Students who receive presentation in words and pictures will perform better than those receiving words only
    - » At least in transfer tests
    - » Possibly even in (word-based) retention tests

Words & Pictures & ...

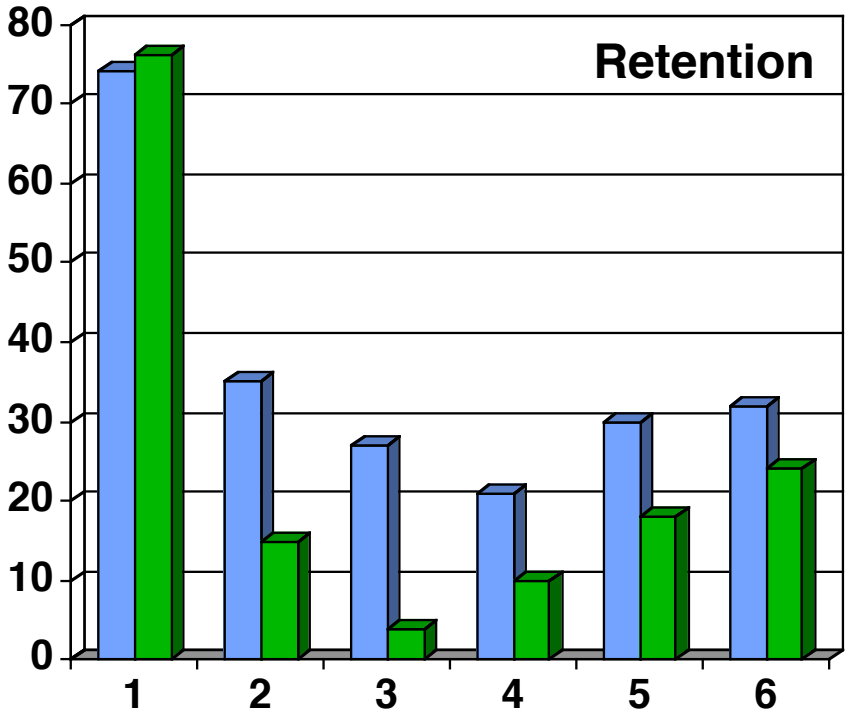
As the rod is pulled out, air passes through the piston and fills the area between the piston and the outlet valve. As the rod is pushed in, the inlet valve closes and the piston forces air through the outlet valve.

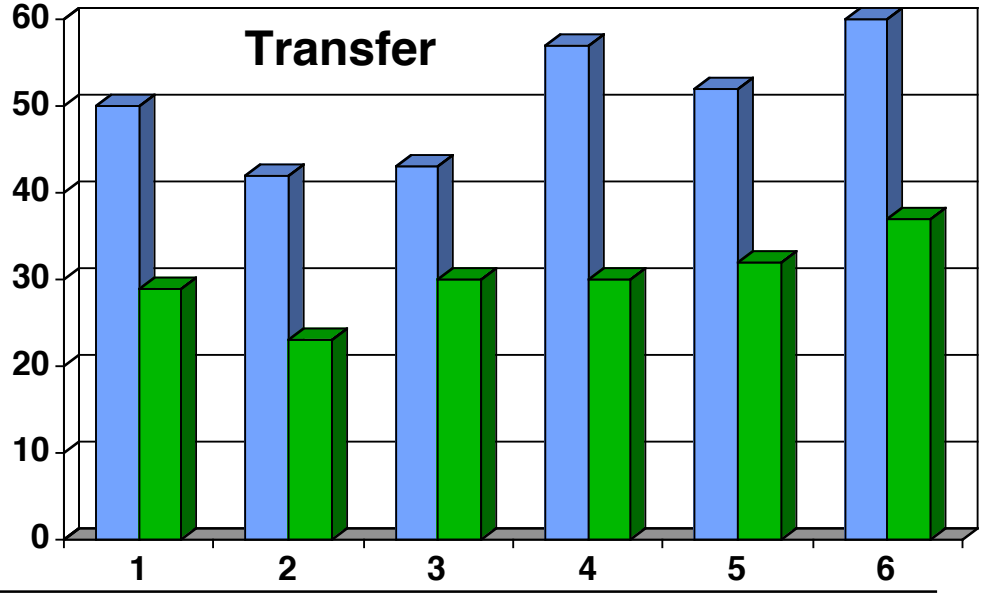


Words & Pictures & Combination



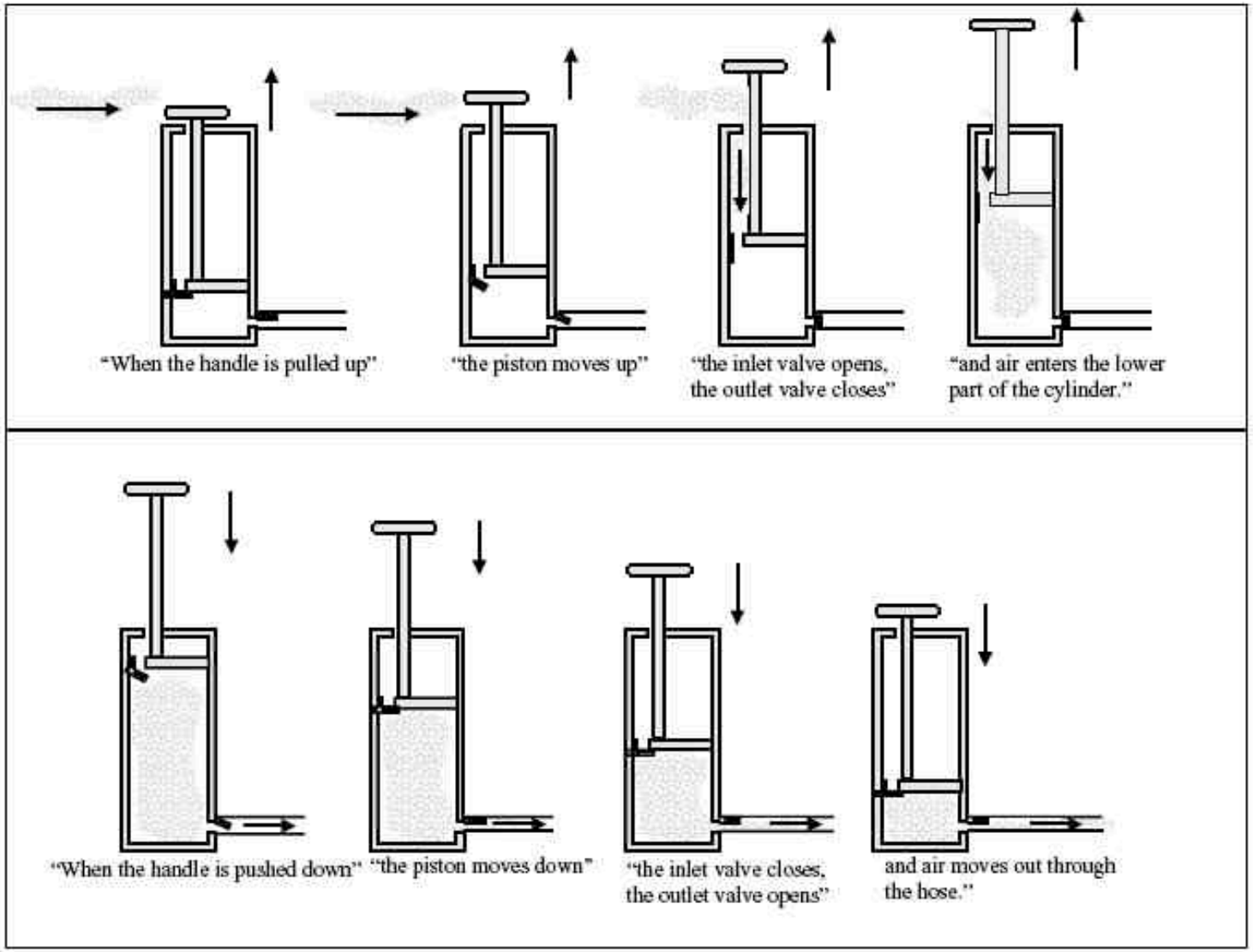
Experimental Results on Multimedia Principle (1)



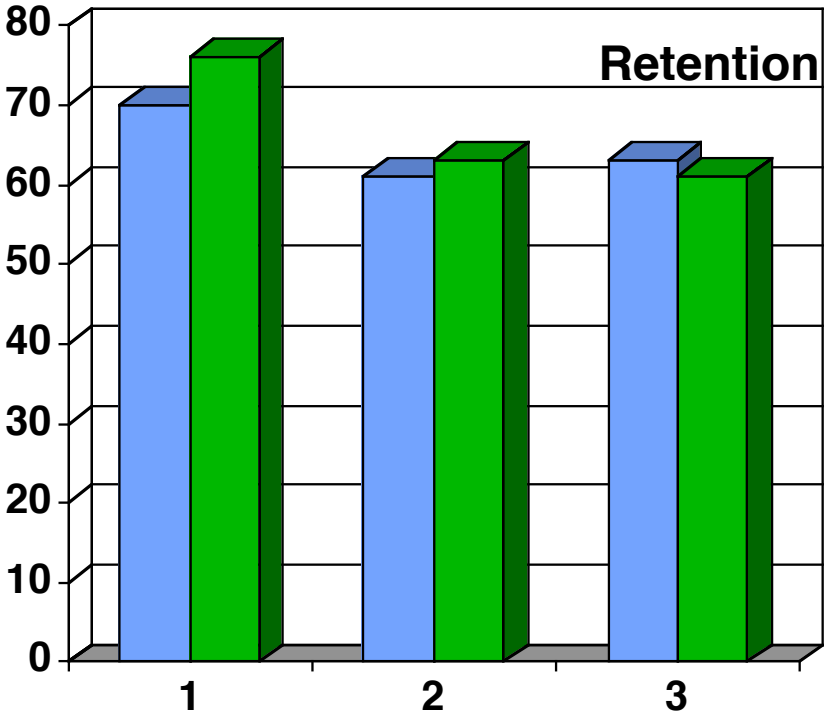


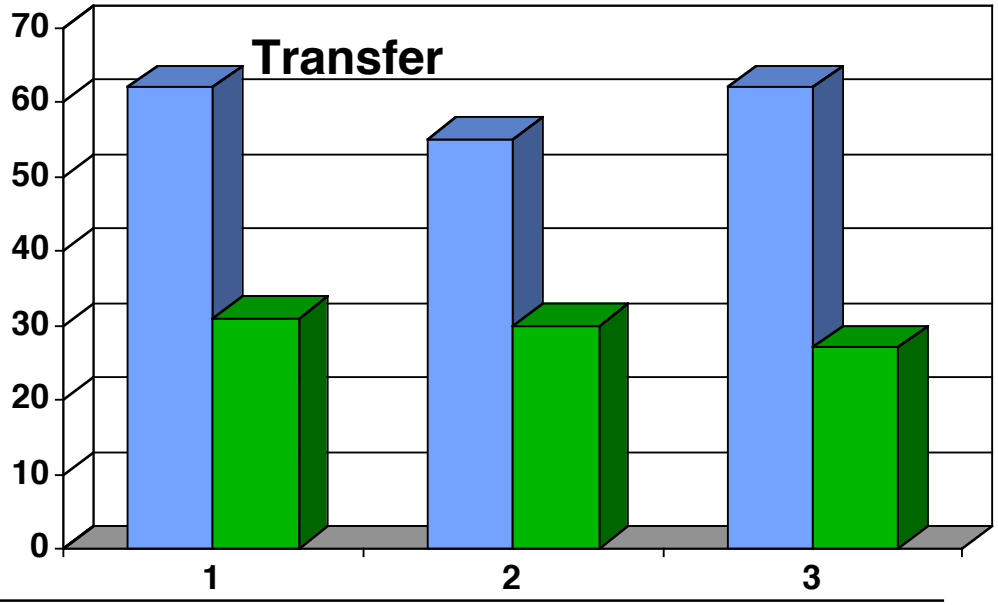
Mayer & Anderson 1991

Narrated Animation



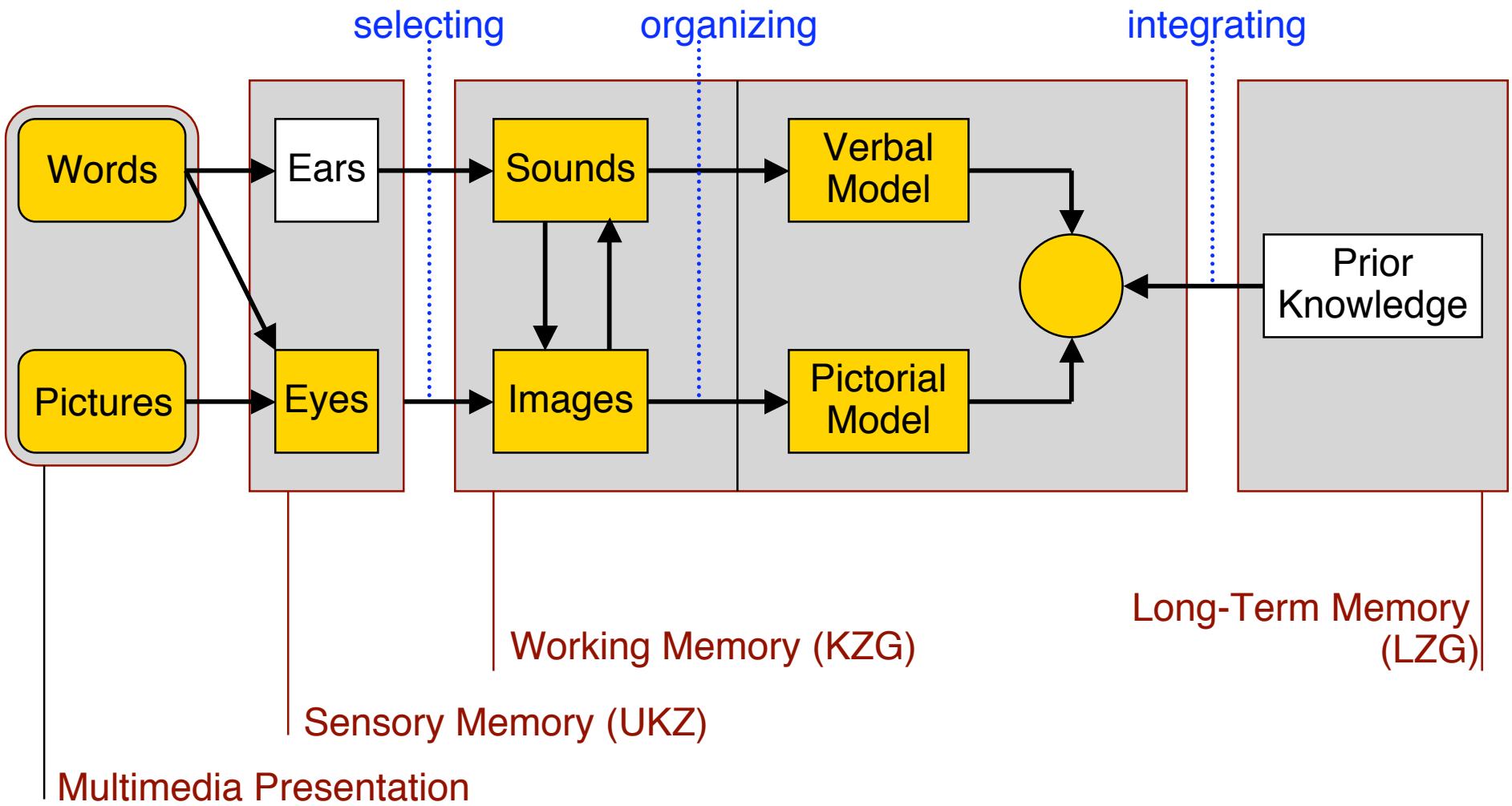
Experimental Results on Multimedia Principle (2)





Mayer & Anderson 1991

Easing Integration of Mental Images



History of Multimedia Principle

- Constructivist approaches, e.g. Ulric Neisser, 1967:
  - Seeing, hearing and remembering are acts of construction
- Allan Paivio, 1986:
  - Coding of words and images are separate independent processes
  - Additive & complementary
- Mayer et al 1991:
  - Cognitive load on constructive process can be reduced by multicodality
    - » Connecting verbal and pictorial images: demanding process
- Nevertheless:
  - Under some conditions adding pictures is harmful …

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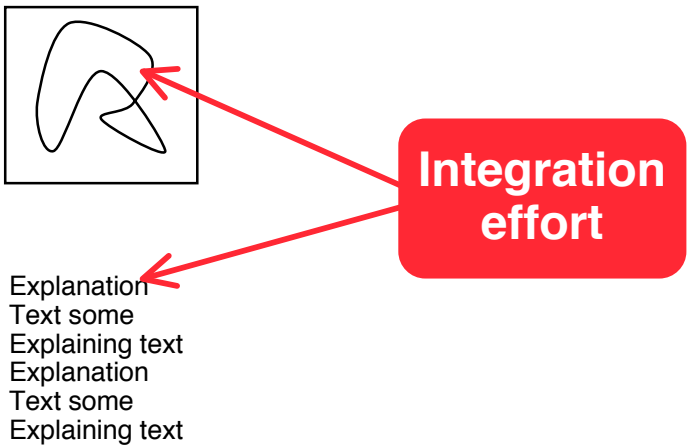
P. Ayres, J. Sweller: The Split-Attention Principle in Multimedia Learning, Cambridge Handbook Ch. 8

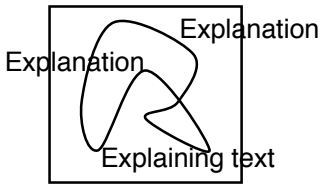
Instructional Split-Attention

- Tarmizi, Sweller 1988:
  - Proven strategies for presenting worked geometry examples fail in some experiments
    - » No increase in learner performance
  - Dependence on the format of the presentation !

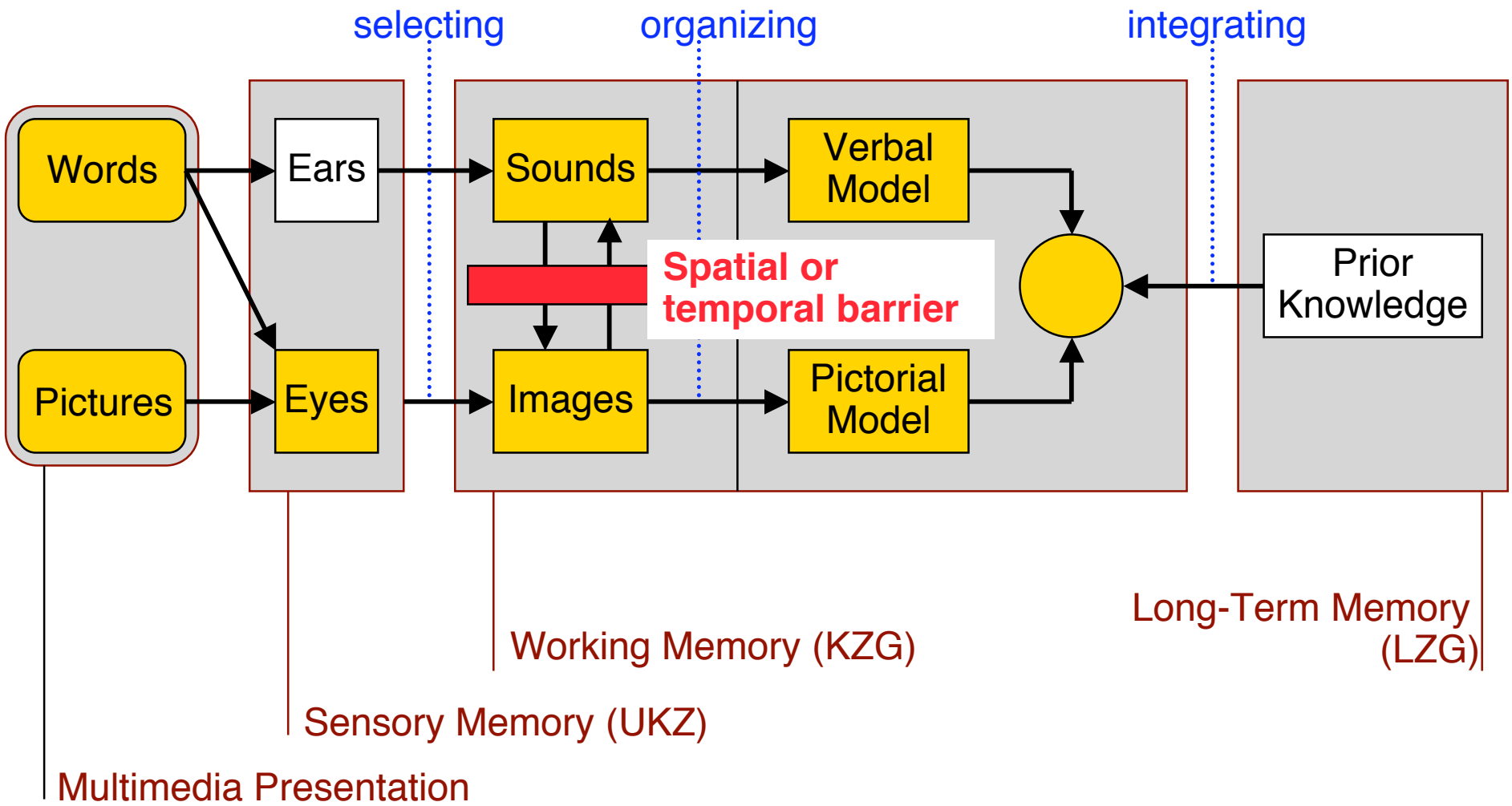
Split presentation



Integrated presentation

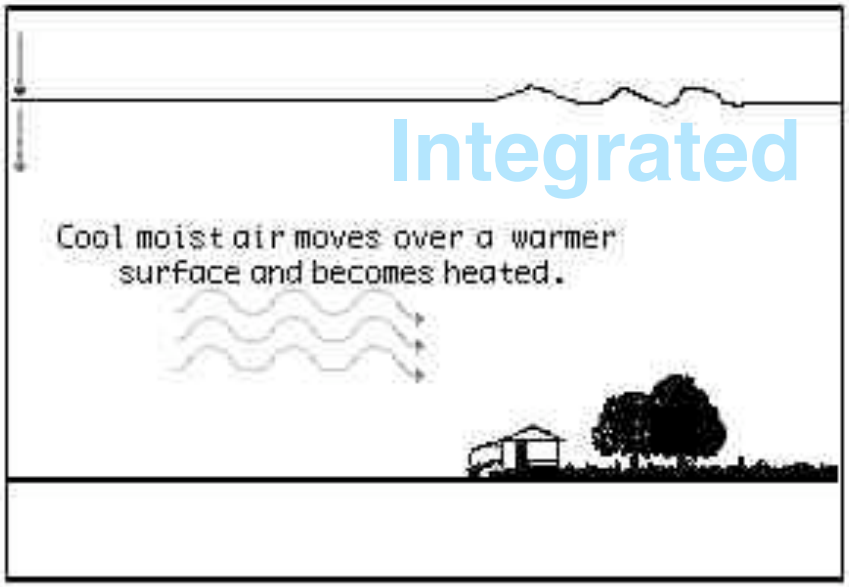


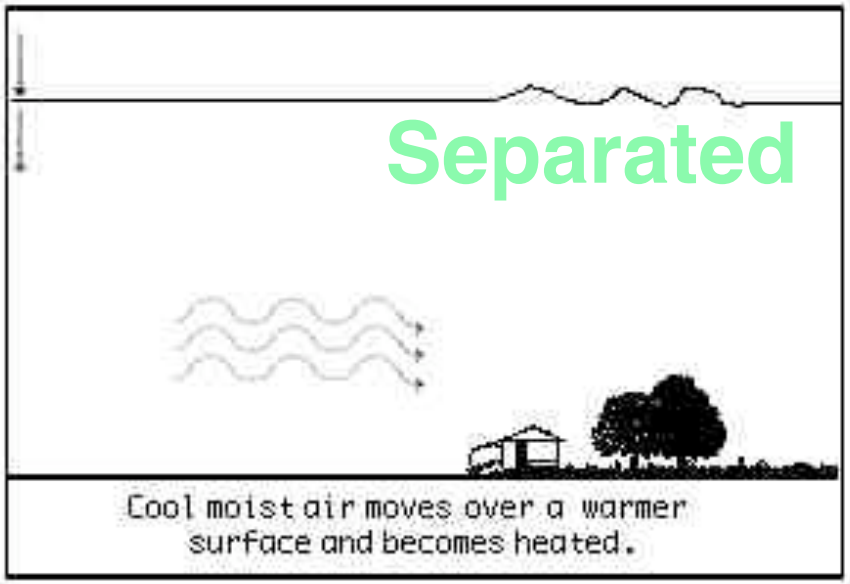
Making Integration of Mental Images Difficult



Spatial Contiguity Principle

- Students learn better when corresponding words and pictures are presented near each other than far from each other on the page or screen.
- Mayer et al. 1989 – 1995
- Comparison of
  - "integrated" text/animation
  - "separated" text & animation
- Retention and transfer results consistently better for integrated presentation





Temporal Contiguity Principle

- Students learn better when corresponding words and pictures are presented simultaneously rather than successively.
- Mayer et al. 1991– 1999
- Experiment:
  - 16-sentences narration followed by a pictorial animation vs.
  - Animation in parallel with narration
- Results:
  - Retention: Parallel version only slightly superior (3 out of 5)
    - » Sequential version =
      Better preparation for purely verbal reproduction of information?
  - Transfer: Parallel version consistently and significantly superior
- Variation:
  - 16 small segments of narration followed by small step of animation
    - » Effect almost equivalent to parallel presentation

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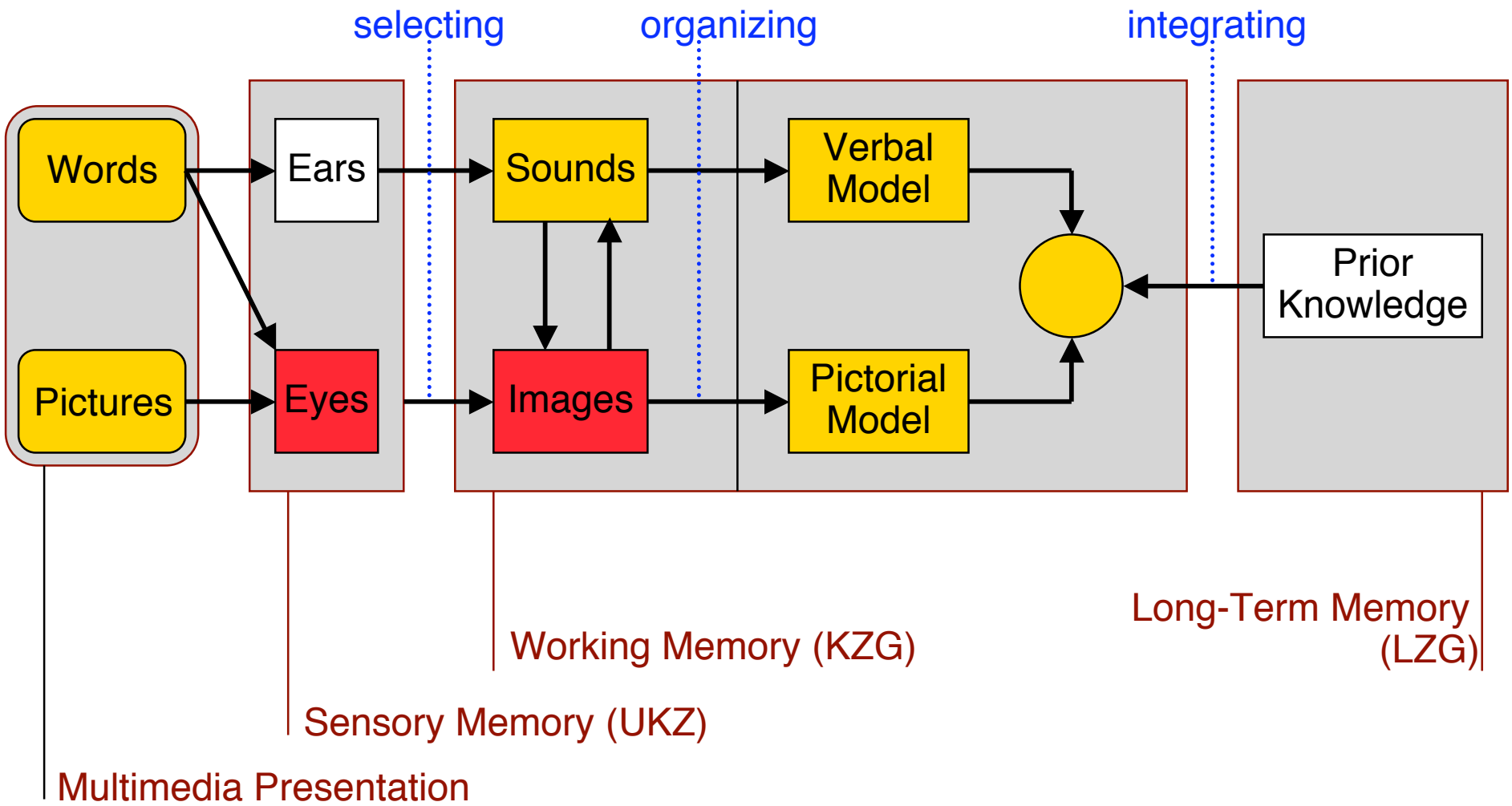
Modality Principle

- Students learn better from animation and narration than from animation and on-screen text.
  - Students learn better when words in a multimedia message are presented as spoken text rather than printed text.
- Mayer et al. 1998 – 2001
- Experiment:
  - Animation accompanied with text
    - » As on-screen (separated) text, small segments, vs.
    - » As audio narration
- Results:
  - Consistent and clear superiority for narration, in retention and transfer

Cognitive Overload by Monomodal Presentation



Less Cognitive Load by Multimodal Presentation