5 Empirische Untersuchungen zum multimedialen Lernen

5.6 Coherence & Redundancy Principles

5.7 Individual Difference Principles

5.8 Animation and Interactivity Principles

5.9 Navigational Principles

Literatur:

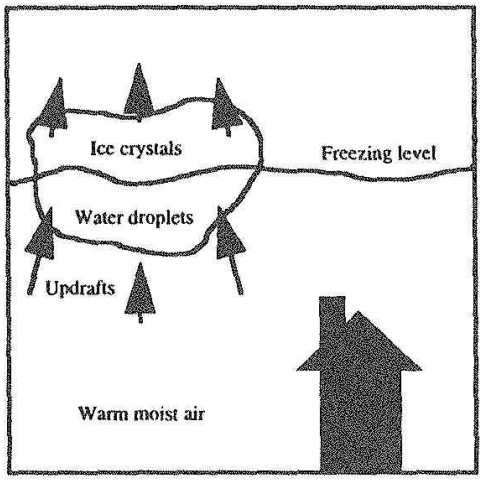
Richard E. Mayer: Multimedia Learning, Cambridge University Press 2001

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

Coherence Principle, Type 1

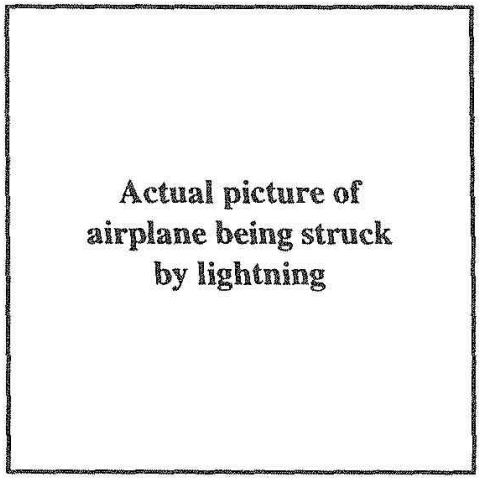
- Students learn better when extraneous material is excluded rather than included.
  - Version 1: Student learning is *hurt* when interesting but irrelevant words and pictures are added to a multimedia presentation
- Harp & Mayer 1998
  - "seductive text", "seductive illustrations":
  - Topically relevant, but conceptually irrelevant
  - Learners regard the extraneous material as entertaining and interesting
  - Cognitive load is increased by extraneous material
- Arguments *pro* addition of seductive details:
  - Arousal theory: students are emotionally aroused and therefore learn better
  - Improvement of information acquisition or of knowledge construction?
- Arguments *contra* addition of seductive details:
  - Dewey (1913): "When things have to be made interesting, it is because interest itself is wanting."
  - Cognitive interest (enjoying to understand) is better than "surface" interest

Example: Interesting but Irrelevant Additions



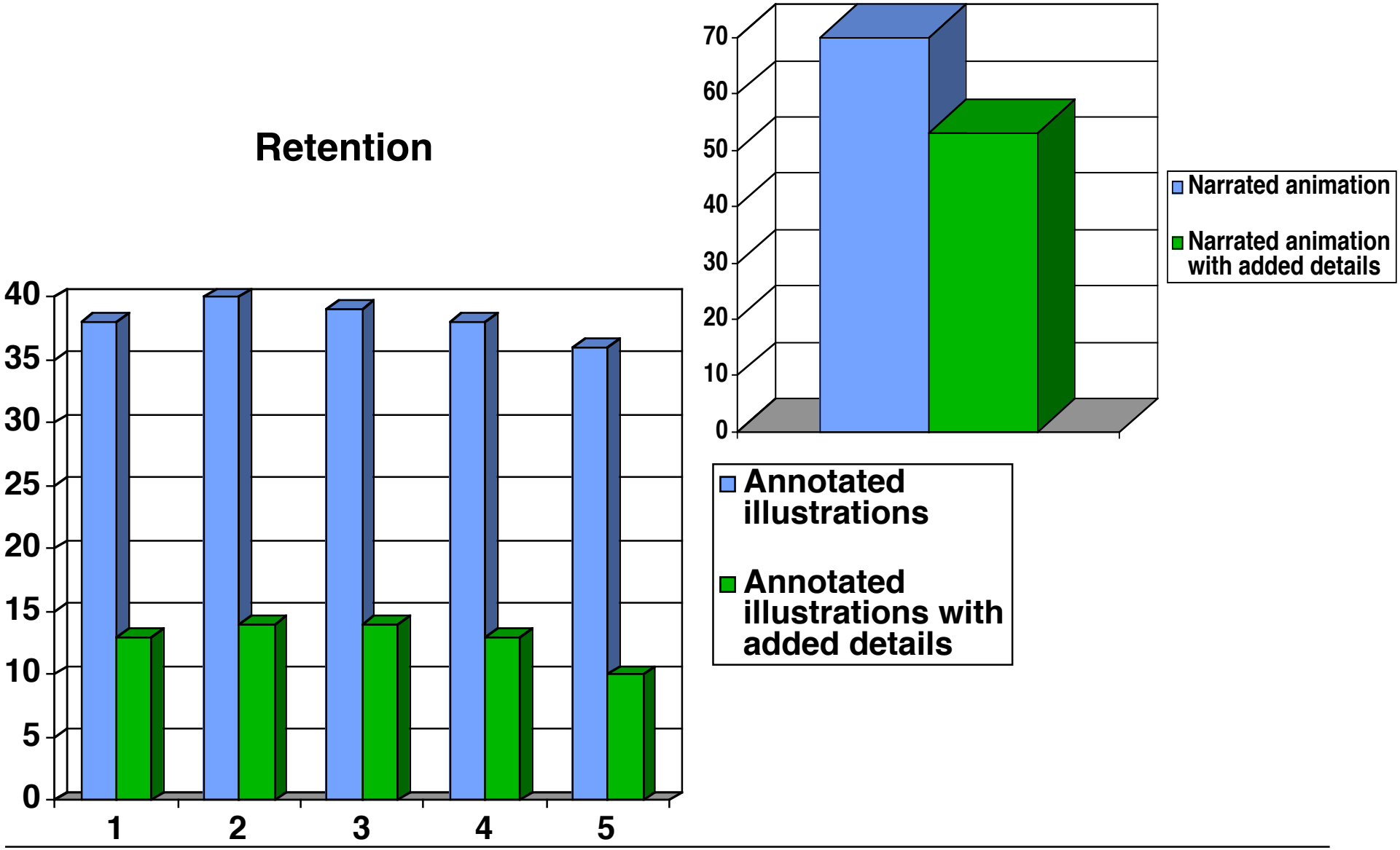
Warm moist air rises, water vapor condenses and forms a cloud.

When the surface of the earth is warm, moist air near the earth's surface becomes heated and rises rapidly, producing an updraft. As the air in these updrafts cools, water vapor condenses into water droplets and forms a cloud. When flying through updrafts, an airplane ride can become bumpy. Metal airplanes conduct lightning very well, but they sustain little damage because the bolt, meeting no resistance, passes right through. The cloud's top extends above the freezing level. At this altitude, the air temperature is well below freezing, so the upper portion of the cloud is composed of tiny ice crystals.

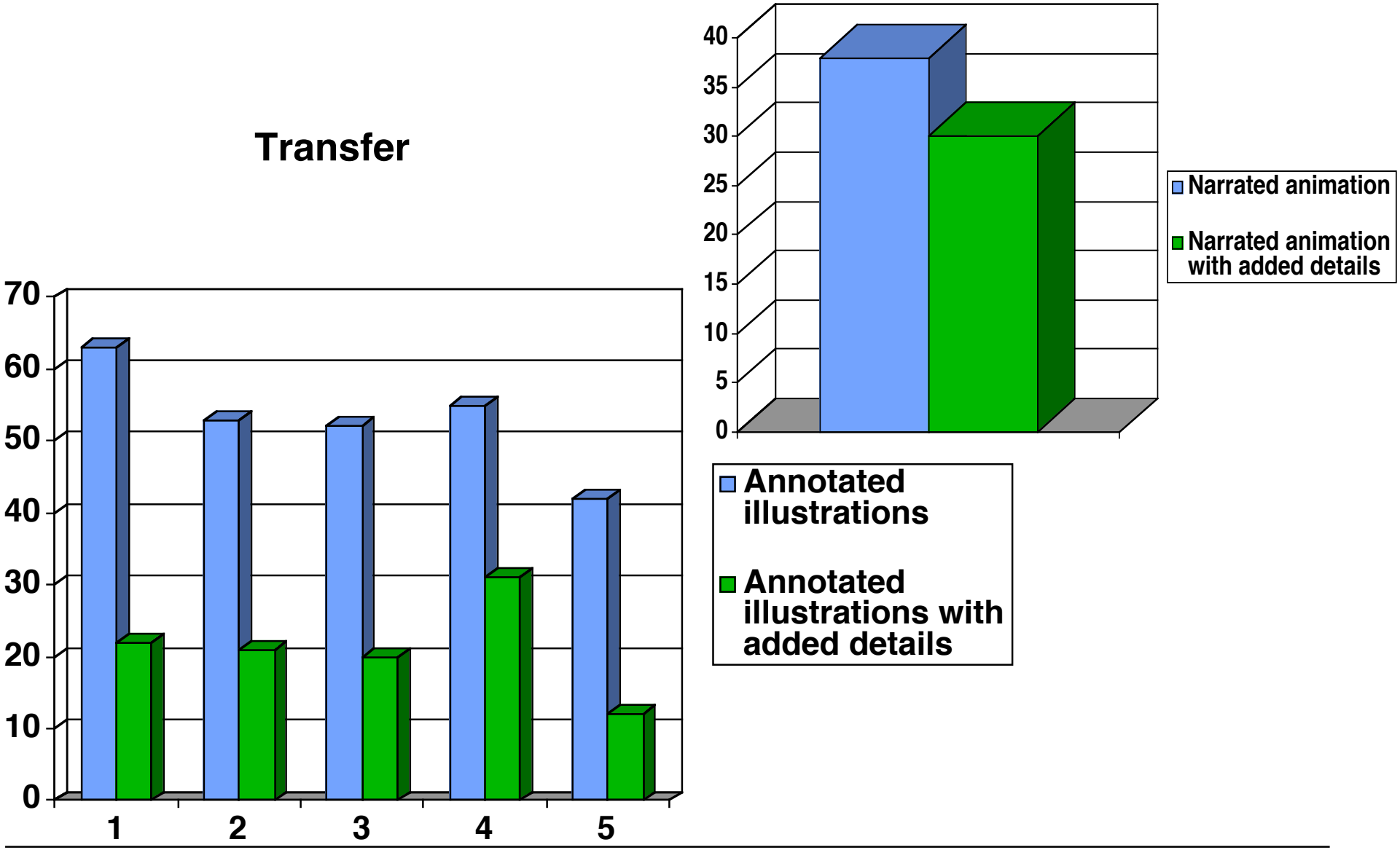


Metal airplanes conduct lightning, but sustain little damage.

Experimental Results on Coherence Principle (1)



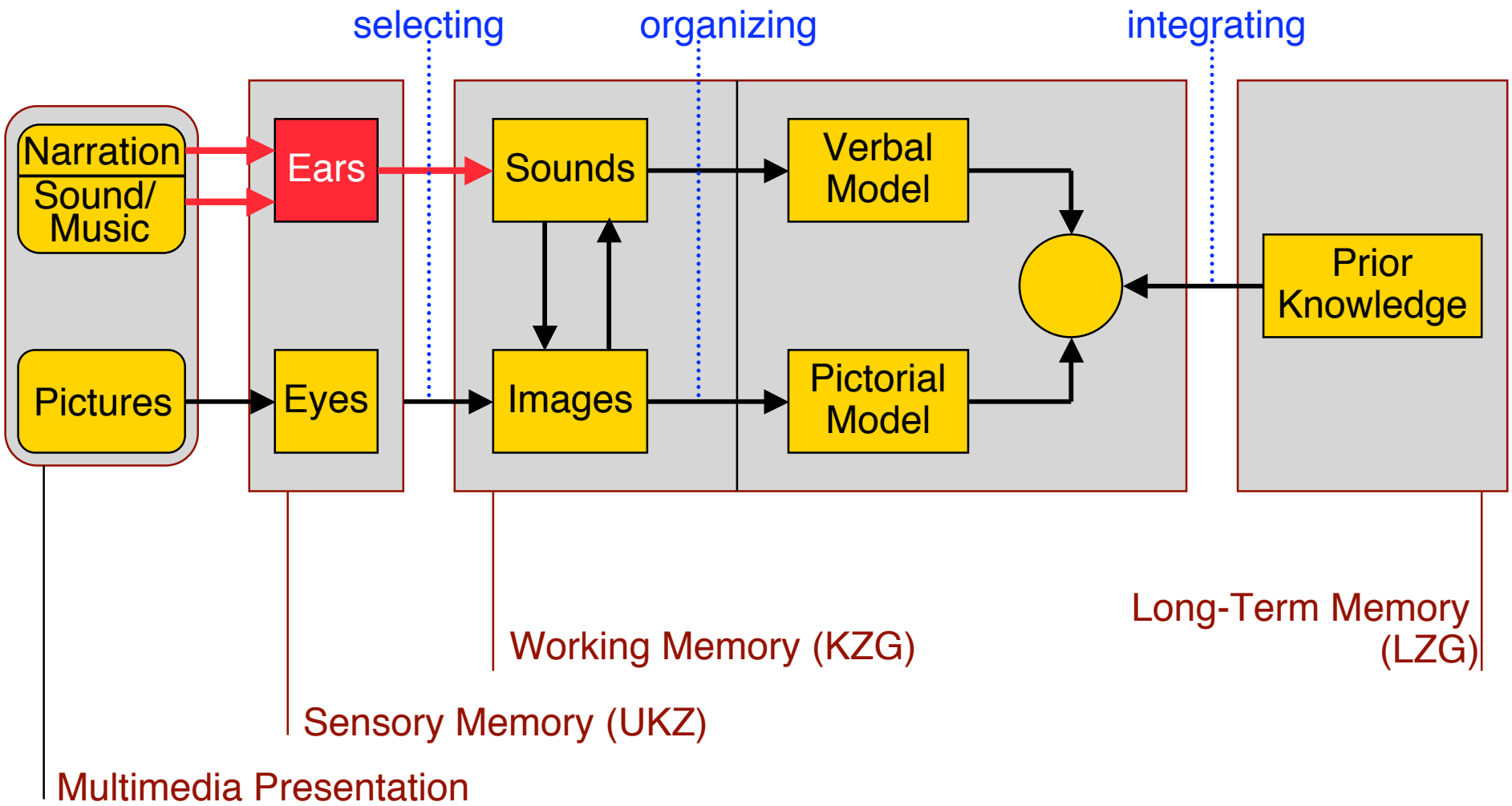
Experimental Results on Coherence Principle (2)



Coherence Principle, Type 2

- Students learn better when extraneous material is excluded rather than included.
  - Version 2: Student learning is *hurt* when interesting but irrelevant sounds and music are added to a multimedia presentation
- Harp & Mayer 2000
  - Using a presentation with picture animation and *narrated text*
  - Add gentle background music loop
  - Add environmental sounds (e.g. blowing wind, crackling ice cubes)
- Arguments *pro* extraneous sound additions:
  - Arousal theory (fun, playful elements)
  - Relaxation
- Arguments *contra* extraneous sound additions:
  - Limited capacity in auditory processing channel
  - Extraneous sound competes with narration for processing capacity
- Experimental Results:
  - Clearly better retention & transfer when additional sounds omitted

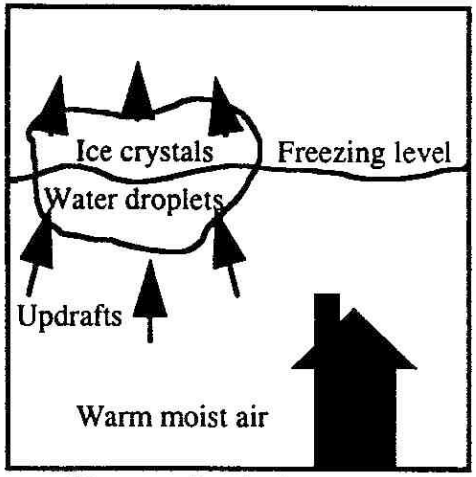
Cognitive Analysis of Coherence Principle Type 2



Coherence Principle, Type 3

- Students learn better when extraneous material is excluded rather than included.
  - Version 3: Student learning is *improved* when unneeded words are *removed* from a multimedia presentation
- Mayer et al. 1996
  - Text passage (approx. 500 words) and captioned illustrations (summaries)
  - Compared with just the captioned illustrations, text omitted
- Arguments *pro* additional textual explanations:
  - Full explanation contains more information than summary
  - Duplicate presentation covers the right version for everybody
- Arguments *contra* additional textual explanations:
  - Summary facilitates active sense making
  - Students have to construct their own knowledge, i.e. their own “full stories”

Example: Text and Summarizing Captions



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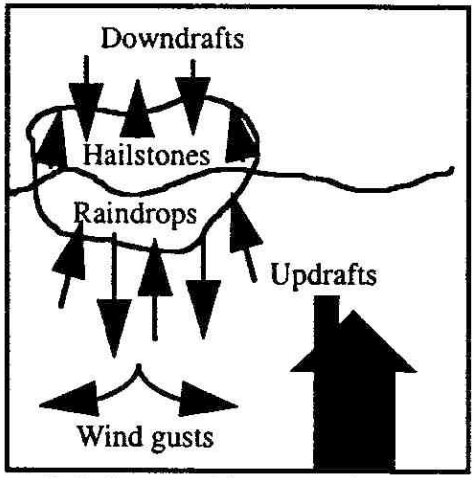
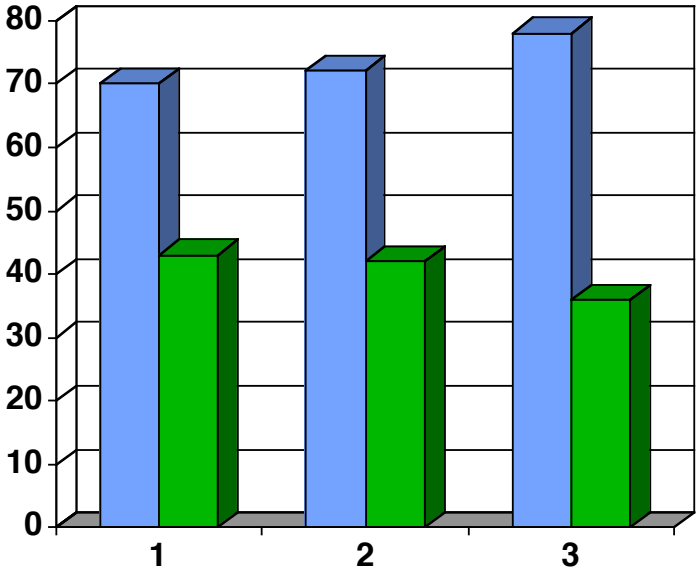


Raindrops and ice crystals drag air downward.

Eventually, the water droplets and ice crystals in the cloud become too large to be suspended by updrafts. As raindrops and ice crystals fall through the cloud, they drag some of the air from the cloud downward, producing downdrafts. The rising and falling air currents within the cloud may cause hailstones to form. When downdrafts strike the ground, they spread out in all directions, producing gusts of cool wind people feel just before the start of the rain.

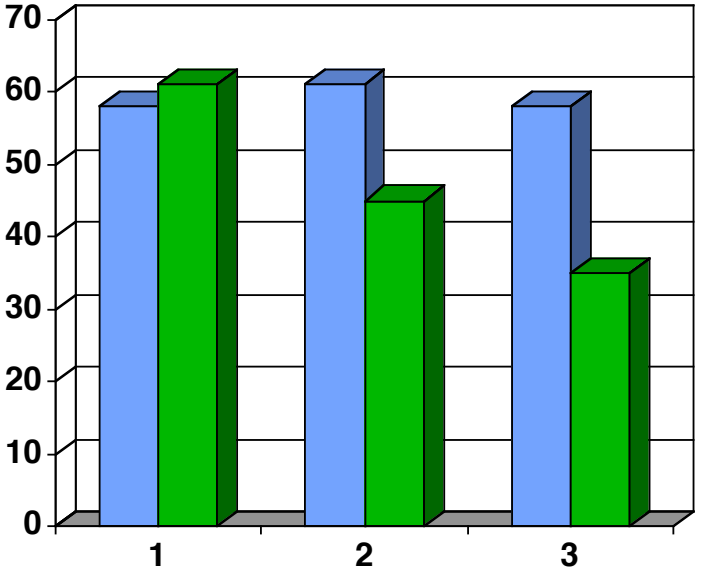
Experimental Results on Coherence Principle (3)



Retention

- Annotated illustrations
- Annotated illustrations with added text

"… shows that the coherence effect sizes are consistent and moderate, with a median of .70, and students who received the summary version … generated a median of 28% more creative solutions than did students who received the full version." (Mayer 2001, p.131)



Transfer

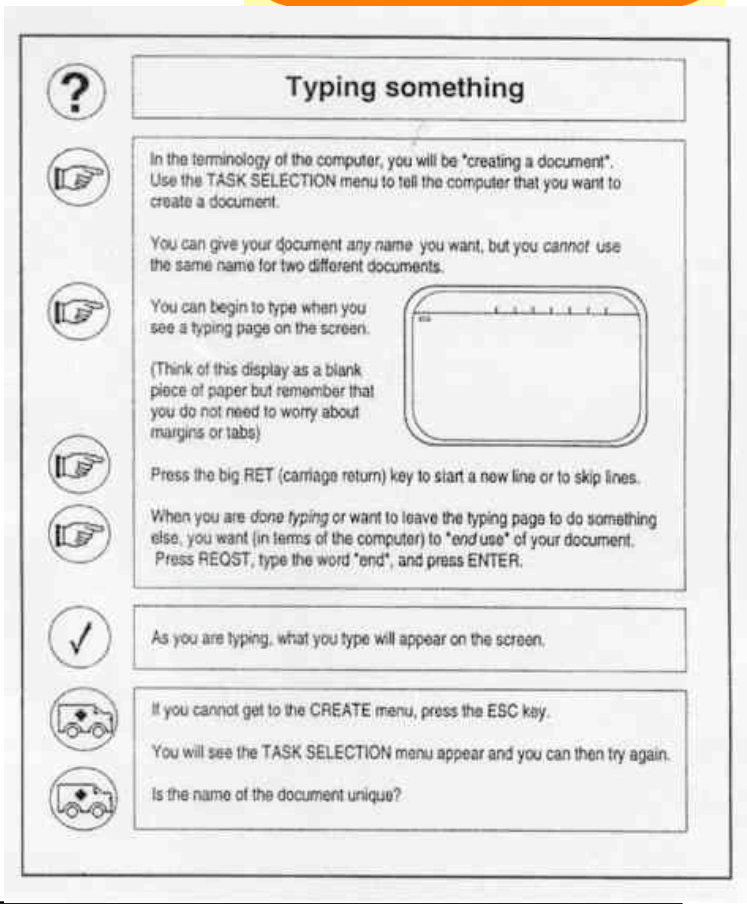
- Annotated illustrations
- Annotated illustrations with added text

Redundancy Principle

- Formulation of the Redundancy Principle in Mayer (2001):
  - Students learn better from animation and narration than from animation, narration, and text
  - Very similar to Coherence Principle Type 3
- Redundancy principle in Multimedia Learning according to Sweller (2005):
  - More general:
    - » "Redundant material interferes with rather than facilitates learning."
    - » "Redundancy effect occurs when additional information presented to learners results in learning decrements..."
  - Variant (1):
    - » Identical information presented in two or more different forms or media
  - Variant (2): (= Coherence Principle of Mayer, 2001)
    - » Additional information is presented within the given forms and media in an attempt to enhance or elaborate information

History of the Redundancy Principle

- Miller (1937)
  - Word "cow" spoken and read
  - Word "cow" spoken, read and picture shown
  - Reading test was always better for teaching *without* pictures!
- Frequent replications of the effect...
- Reder, Anderson (1980-82):
  - Full text of textbook chapters (geography, linguistics, economy etc.)
  - Summaries of the text (20% length)
  - "To our surprise, all … experiments indicated that subjects learn information better when they read an abridged or summarized version of the original text than when they read the original chapter."
- Carroll et al. (1990):
  - "The minimal manual"



Typing something

In the terminology of the computer, you will be "creating a document". Use the TASK SELECTION menu to tell the computer that you want to create a document.

You can give your document *any* name you want, but you *cannot* use the same name for two different documents.

You can begin to type when you see a typing page on the screen.

(Think of this display as a blank piece of paper but remember that you do not need to worry about margins or tabs)

Press the big RET (carriage return) key to start a new line or to skip lines.

When you are *done typing* or want to leave the typing page to do something else, you want (in terms of the computer) to "*end* use" of your document. Press REQST, type the word "end", and press ENTER.

As you are typing, what you type will appear on the screen.

If you cannot get to the CREATE menu, press the ESC key.

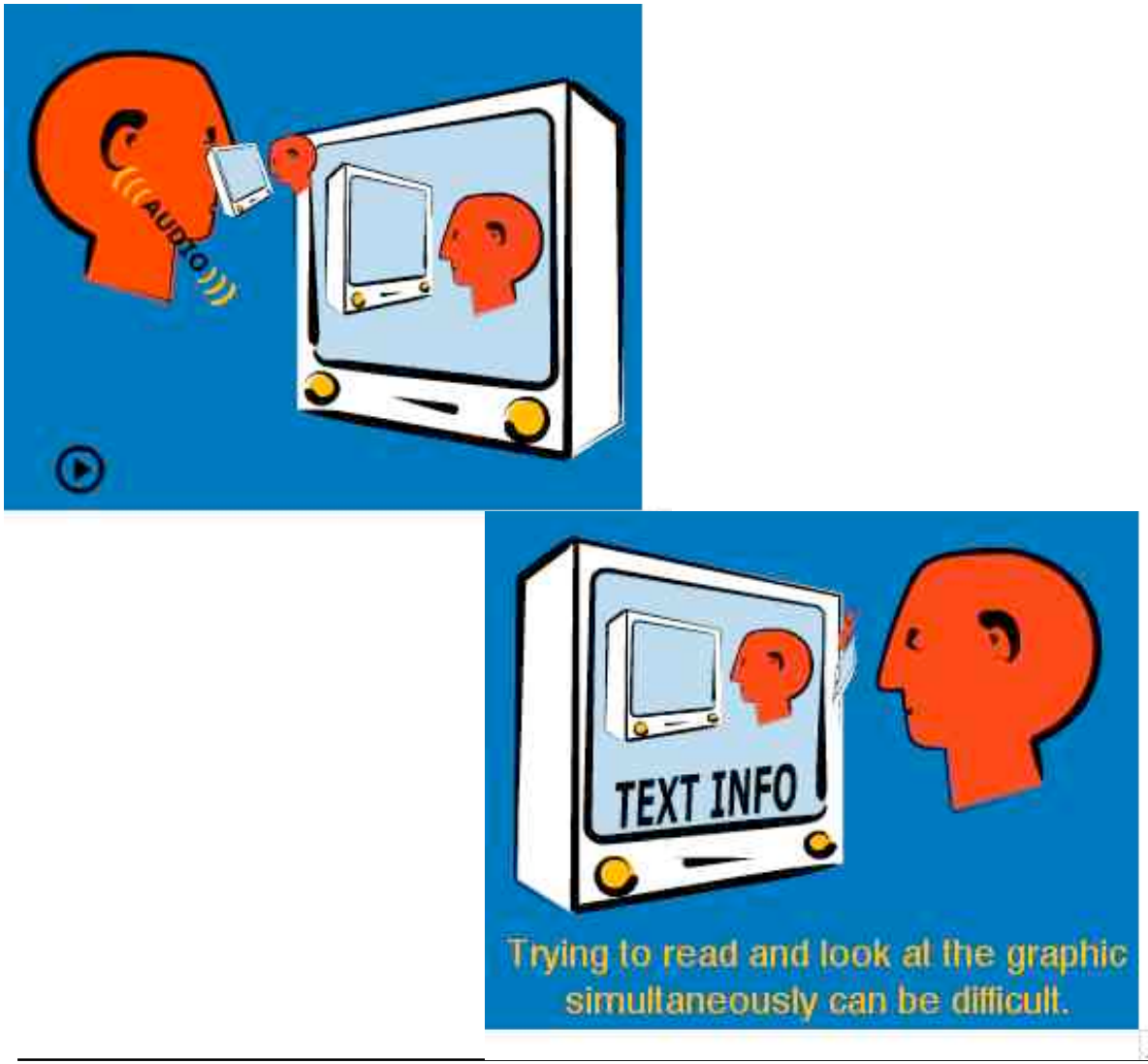
You will see the TASK SELECTION menu appear and you can then try again.

Is the name of the document unique?

Examples of Redundancy Effect

- Bobis, Sweller, Cooper (1993):
  - Paper-folding for elementary school children
  - Diagrams superior to diagrams plus explaining text
- Sweller, Chandler (1994, 1996):
  - Usage of computers in learning is sometimes *redundant*
  - Acts of interacting with the computer interfere with the actual learning activities
  - Comparing
    - » manual-based learning
    - » learning with manual and computer access
  - Learners without computer access perform better in tests!
    - » Physically working with the machine irrelevant for conceptual learning
    - » Machine handling and man-machine interface creates high additional cognitive load

Multimedia Redundancy Effect



- Audio narration plus video animation
  - Balanced combination
  - Load distributed between auditory and visual channels
- Audio narrration plus video animation plus on-screen text
  - Animation and text compete for the visual channel
  - Overall effect ***worse*** than for a subset of the presentation forms

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Redundancy & Expertise Reversal Effect

- Expertise reversal
  - Instructional technique is effective for dealing with novices
  - Becomes less effective when dealing with experts
- Example:
  - Learning from worked examples vs. abstract descriptions
- Redundancy effect in expertise reversal:
  - Novices: Some explanatory material is essential
  - Experts: The same material becomes redundant!

Individual Differences Principle

- Mayer (2001):
  - Design effects are stronger for low-knowledge learners than for high-knowledge learners
  - Design effects are stronger for high-spatial learners than for low-spatial learners
- Good instructional message:
  - Contiguous
  - Coherent
  - Modality efficient
  - Non-redundant
- Who benefits most from good design?

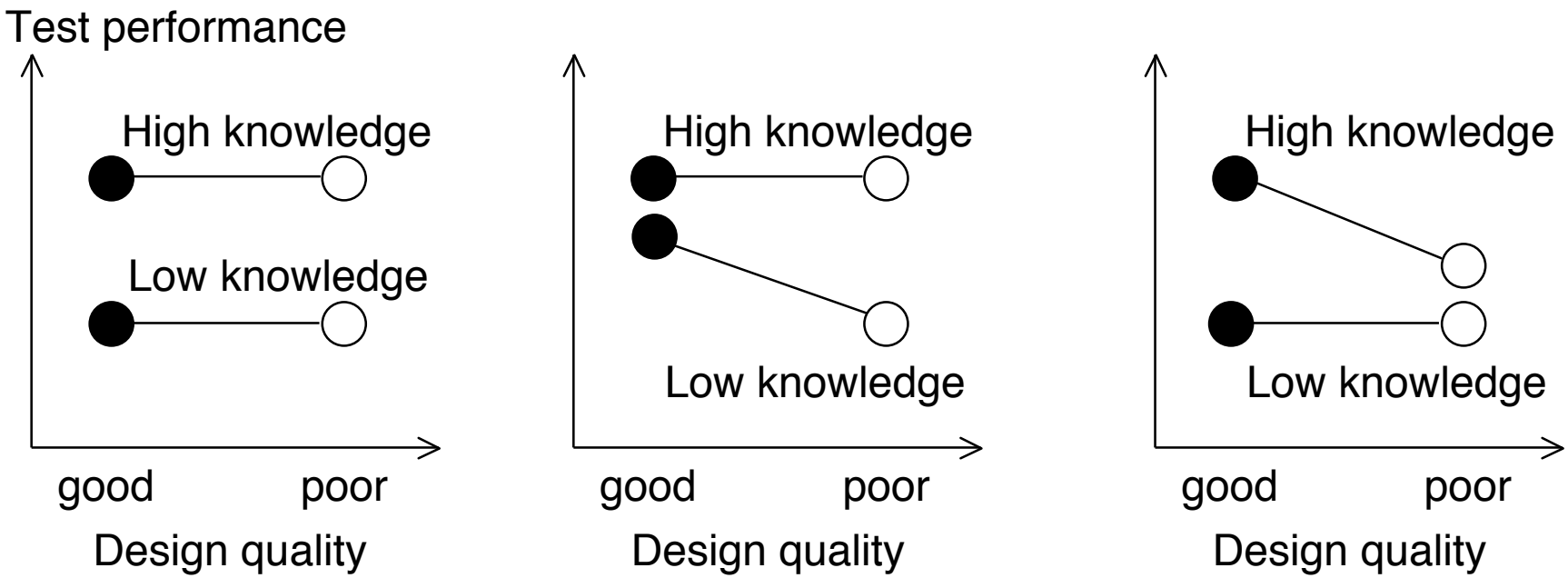
Example: Meteorology Questionnaire

- I regularly read the weather maps in a newspaper (yes/no)
- I know what a cold front is (yes/no)
- I can distinguish between cumulus and nimbus clouds (yes/no)
- I know what low pressure is (yes/no)
- I can explain what makes wind blow (yes/no)
- I know what these symbols mean:

Overall level of meteorology expertise (1 – 5): ?

Evaluation: 1 per positive answer plus level points
Score below 6: low-knowledge learner
Score 7 or more: high-knowledge learner

How does prior knowledge influence learning?



Theory A:
Knowledge main effect
Independent of design

Theory B:
Knowledge as
compensator

Theory C:
Knowledge as
enhancer

Experimental results: Tend to support theory B.

Role of Learner's Spatial Ability

- Spatial ability = ability to generate, maintain and manipulate mental visual elements
  - Classical measurements exist (E.g. paper folding, contour rotation)
- Does improved design of multimedia presentations affect learners differently, depending on their spatial ability?
  - Spatial ability as an *enhancer* for well-designed instructions?
  - Spatial ability as a *compensator* for dealing with ill-designed instructions?
- Experimental results:
  - Tend to support "enhancement theory"
  - Spatial ability leads to better benefits from good design

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What is Animation?

- "the process of generating a series of frames containing an object or objects so that each frame appears as an alteration of the previous frame in order to show motion" (Baek/ Layne 1988)
- "a series of varying images presented dynamically according to user action in ways that help the user to perceive a continuous change over time and develop a more appropriate mental model of the task" (Gonzalez 1996)
- Separate interaction and animation:
  - Sequence of frames creating impression of motion (possibly without interaction)
  - User control (interaction)
  - Two types of user control (interaction):
    - » Control over pace and direction of frame succession (VCR-like control)
    - » Capability to act on objects appearing within frame

Experiments on Animations in Learning

- Rieber et al 1989:
  - Animated lesson for Newton's laws of motion does *not* lead to better comprehension for elementary school children
- Byrne, Catrambone, Stasko 1999:
  - Benefits of using animation are equivalent to the benefits of prompting learners to make predictions
- Hegarty et al. 2002:
  - Students studying animation with oral commentary do *not* perform better than those who study equivalent static graphics with written text
  - In both cases, performance was significantly improved by prediction questions
- Possible explanations:
  - Continuous animations miss clear phase pictures
  - Animations may be helpful for learners with low ability to mentally simulate the processes

Experiments on Learner Control in Animations

- Learners in control of the pace of animation:
  - Makes material more enjoyable
  - Leads to significant better results in deep learning
    - » Even with low levels of control (e.g. next scene)
- Interaction & Segmentation
  - Structuring the animation into segments (phases)
  - Start/stop of animation under user control
  - Preliminary results (Mayer/Chandler 2001):
    - » Better results than for users without control
    - » Not very helpful for novice learners (overload by control task)

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Orientation in Printed Learning Media

- *Signaling (local content guidance)*
  - Clear structure, visually effective
  - Meaningful headings (for all paragraphs)
  - Distinguishing between types of information chunks
- Clear empirical evidence for effectiveness of signaling
- *Global content guidance*
  - E.g. table of content, concept map, flowchart
- Little empirical studies
  - Efficient searchers spend a lot of time on outline to decide *what* to read in detail

Navigation in Hypermedia Documents

- Disorientation of hypertext users (missing structure)
  - Wright 1991, Chen&Rada 1996, …
- Embedded vs. explicit linking
  - Empirical evidence in favour of embedding
    - » Koved/Shneiderman 1986
    - » Bernard/Hull/Drake:
      Comparing embedded links, page-bottom links, top-left links, left-margin links. Clear preference for embedded links (worst: page-bottom links)
- Breadth/depth Trade-Off
  - Low depth gives an impression of simple structure ("shallowness")
  - 16 x 32 or 32 x 16 item menu structure preferred over 8 x 8 x 8 structure (Larson, Czerwinsky 1998)
- Semantic grouping can be proven to be effective
  - e.g. Snowberry et al. 1983

Site Map Principle

- Site Map:
  - Bird's eye view of content of a group of related hypertext nodes
  - Multiple site maps are possible (e.g. dynamic views, audience-dependent)
- Empirical research:
  - Site maps clearly effective against disorientation (e.g. Chen, Rada 1996)
  - Effect on learning doubtful
    - » E.g. Wenger/Payne 1994: no effect on learning of sitemap presence
  - Low-knowledge learners benefit from hierarchical site maps
    - » Potelle/Rouet 2003
  - Structured site maps are very helpful for the task of summarizing the presented information later
    - » Dee-Lukas/Larkin 1995
- Theoretical explanation:
  - Macrostructures in long-term memory (construction-aggregation model)

Example of a Structured Site Map