The Cognitive Theory of Multimedia Learning

Mayer's (2009) Cognitive Theory of Multimedia Learning is an instructional design aiming a linking coherent text and image representations of learning content. This takes into account the possibilities, contexts and limitations of human information processing and memory system to convey information to people in a way that is adapted to their natural way of processing information.

Decisions about how to construct instruction always reflect an underlying concept of how people learn. Multimedia design principles should therefore always be based on available knowledge about how people process information. In this sense, Mayer postulates basic assumptions for his Cognitive Theory of Multimedia Learning that summarise our previous findings on human information processing via perception and memory, as well as learner-centred instructional designs aimed at active knowledge construction (see Chapter 1).

The underlying model of human information processing includes different memory systems, the components of which are based on Paivio's (1986) Dual Coding Theory and Baddeley's (1992) working memory model (see Figure 6.1.). These include sensory memory, working memory and long-term memory, with Mayer also suggesting different processing channels for verbal and visual stimuli, whose processing capacity is limited, as proposed by Chandler and Sweller's (1991) Cognitive Load Theory by.

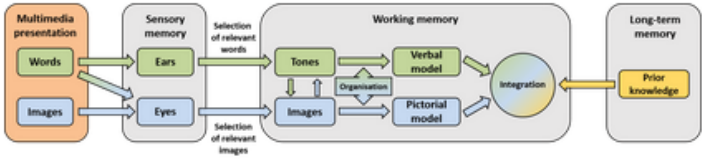

Figure 6.1. *Model for the Cognitive Load Theory of Multimedia Learning. Information processing from left to right: Words and images are perceived and preselected in sensory memory by directing attention. Information perceived as relevant is passed on to the working memory, where mental models are created by organising the individual pieces of stimulus information. These are linked with previous knowledge from the long-term memory and thus integrated as new knowledge into existing knowledge structures.*

Information is perceived in the form of verbal and pictorial stimuli and enters the sensory memory though the eyes and ears. This allows maintaining images and read text as exact visual images in the visual sensory memory for a very short time. Similarly, heard words and other sounds are maintained as exact auditory images for a very short time in the auditory sensory memory. Just as in the multiple memory and working memory models (see Chapter 1, Lessons 3 and 4), a pre-selection of stimulus information is carried out by directing attention, whereby information perceived as relevant is passed on to the working memory and information perceived as irrelevant decays.

The working memory is the centre of information processing. It is the control centre for all relevant information and the component in Mayer's model in which multimedia learning takes place. After the largely unconscious pre-processing of perceived stimuli, it the is task of the working memory to temporarily maintain information and manipulate it in active consciousness. The incoming sensory modalities (i.e., visual and auditory images) from the sensory memory are reorganised for this purpose and further processed into verbal and pictorial models, which now also take into account connections between the two processing channels. For the final knowledge construction, these models are finally combined into an overall impression, which is integrated into new knowledge by linking it with existing prior knowledge from the long-term memory. It can store large amounts of information for a long time, which, however, is not consciously available without prior reactivation. In order to be able to actively reflect on this stored knowledge, it must therefore be transferred back into the working memory.

The Cognitive Theory of Multimedia Learning comprises three basic assumptions:

1. Dual information processing:
Incoming visual and auditory stimulus information is processed though separate channels.

2. Limited processing capacity:
The processing capacity of the channels is limited. Each of the two channels can only maintain a small amount of information at any given time.

3. Active information processing:
Active processing of information is necessary for meaningful knowledge construction. This requires the organisation of incoming information fragments into coherent mental representations and the subsequent integration of mental representations and prior knowledge.

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Figure Supp 1. Exemplary illustration of one page from a lesson in the online course (translated from German).

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Question 1: What is the role of the sensory memory in the classical multi-store model.

- ☐ The pre-selection of relevant stimulus information.
- ☐ The processing of visual stimuli into pictorial models.
- ☐ The repetition of stimulus information.
- ☐ The storage of semantic information.

Question 2: What should be the goals when designing a multimedia presentation to counteract cognitive overload?

- ☐ Promoting irrelevant cognitive processing, managing essential cognitive processing, and minimizing generative cognitive processing.
- ☐ Promoting parallel cognitive processing, managing integrative cognitive processing, and minimizing sensory cognitive processing.
- ☐ Minimizing irrelevant cognitive processing, managing essential cognitive processing, and promoting generative cognitive processing.
- ☐ Minimizing parallel cognitive processing, managing integrative cognitive processing, and promoting sensory cognitive processing.

Question 3: Which processing channels are distinguished in dual information processing according to the Cognitive Theory of Multimedia Learning?

- ☐ Auditory-pictorial channel and visual-verbal channel.
- ☐ Auditory-verbal channel and visual-pictorial channel.
- ☐ Attention channel and working memory channel.
- ☐ Channel with limited capacity and channel with unlimited capacity

Question 4: Which multimedia design principle do you apply when emphasizing important information in a presentation to improve clarity?

- ☐ Signaling principle
- ☐ Prior knowledge principle
- ☐ Modality principle
- ☐ Redundancy principle

(…)

Figure Supp 2. Example questions from the exam (translated from German). The exam comprised a total of 30 question questions and the question order was varied.

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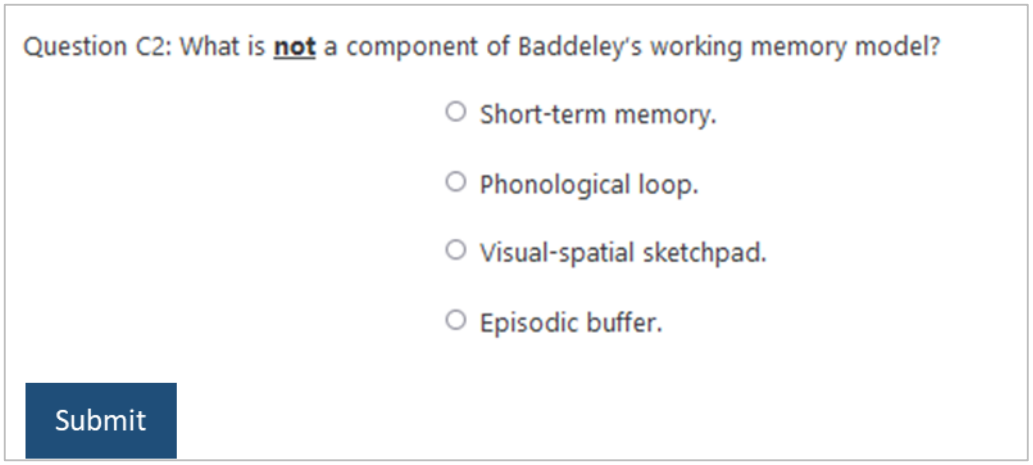

Figure Supp 3a. Illustration of a practice question from the online course (translated from German). Participants received a brief feedback after each practice question that either informed them of a correct answer or, in the case of an incorrect answer, offered them to repeat the relevant content (see Figure Supp 3b).

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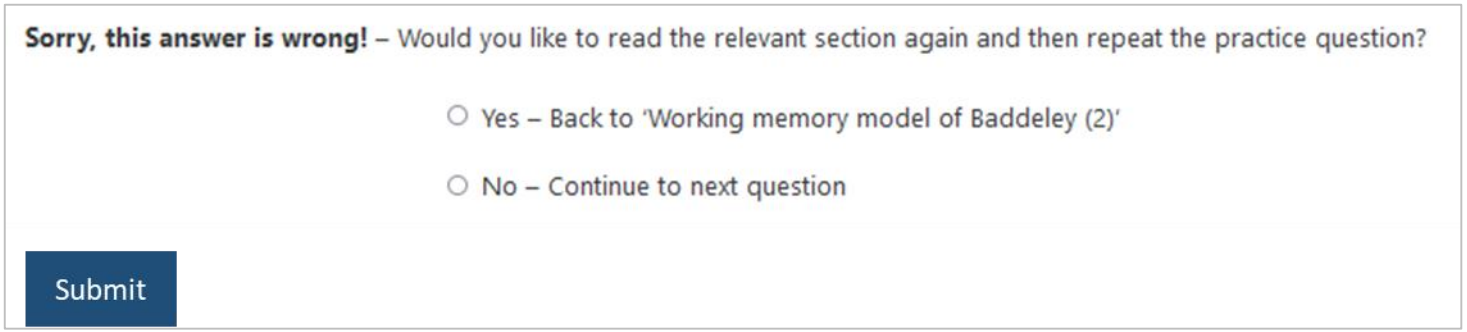

Figure Supp 3b. Illustration of the feedback after giving an incorrect answer to a practice question in the course (translated from German). Participants had the choice to repeat the corresponding content, i.e. the relevant section of the lesson followed by the respective practice question (see Figure Supp 3c), or to continue to the next question without trying again.

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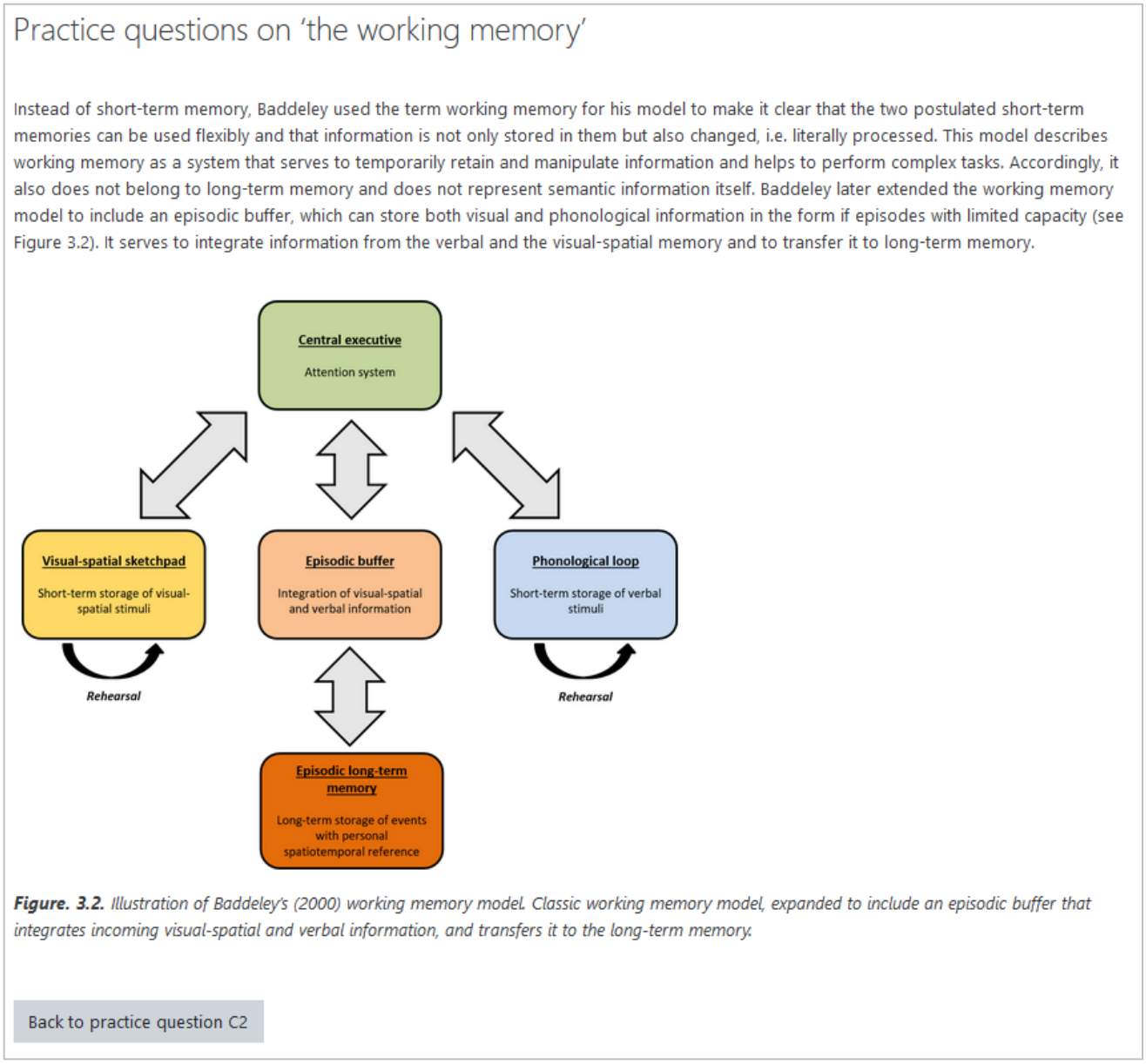

Figure Supp 3c. Illustration of a section from the online course (translated from German). If participants chose to repeat the lesson content to a practice question after giving a false answer, the relevant section from the lesson referring to the practice question was shown again. Afterwards, the participants could try the respective practice question again (see Figure Supp 3a for an example).

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Table Supp 1. Intercorrelations of study variables (N = 106)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Time-management knowledge		.49*	.46*	.29*	.31*	.33*	.28*
(2)	Effort-regulation knowledge			.53*	.33*	.30*	.31*	.28*
(3)	Help-seeking knowledge				.33*	.22*	.22*	.16
(4)	Time-Management use					.15	.38*	.41*
(5)	Effort-regulation use						.32*	.36*
(6)	Help-seeking use							.50*
(7)	Academic performance							

Note. *$p < .05$

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