



Investigating gaze behavior during processing of inconsistent text-picture information: Evidence for text-picture integration



Anne Schüler*

Leibniz-Institut für Wissensmedien, Tuebingen, Germany

ARTICLE INFO

Article history:

Received 15 June 2016
Received in revised form
8 March 2017
Accepted 10 March 2017

Keywords:

Multimedia learning
Text-picture integration
Eye tracking
Conflicting information

ABSTRACT

In two experiments, eye tracking was used to investigate whether learners construct a mental representation during learning that integrates information from text and pictures. The experimental groups received inconsistent text-picture information on one or two pages of the learning materials. The control groups received only consistent text-picture information. It was expected that learners of the experimental groups should have difficulties in integrating text-picture information when faced with the inconsistencies. This should be reflected in their gaze behavior. Experiment 1 ($N = 51$) and Experiment 2 ($N = 45$) confirmed that assumption for several eye tracking variables. Regarding learning outcomes, only in Experiment 1 worse performance of the experimental group was observed. Furthermore, Experiment 2 revealed that the majority of learners did not remember the inconsistency between text and picture when asked for it after learning. In sum, the results add to our understanding about the cognitive processes underlying multimedia learning.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

It has often been demonstrated that learners receiving text together with pictures recall and transfer the learning contents better than learners who receive text only (for an overview see Mayer, 2009). This “multimedia effect” has been explained by the assumption that text and pictures are integrated with each other into a coherent mental representation (Mayer, 2009). However, there is only little empirical research investigating the integration process directly. In the current study, I was interested in the question of whether learners construct a coherent mental representation during the learning process that integrates information from both text and pictures or whether they construct two locally coherent representations of the text and the picture respectively, which are not immediately integrated with each other during learning. To my knowledge there is no study regarding multimedia learning investigating this question directly. To answer that question, I applied a paradigm from text comprehension research (see Albrecht & O'Brien, 1993) to learning with multimedia materials. In this paradigm eye tracking is used to analyze whether learners try

to achieve and maintain coherence during processing external representations.

Before I describe the paradigm in more detail, I will briefly summarize the theoretical assumptions as well as initial empirical evidence regarding the integration process.

1.1. Theoretical assumptions regarding the integration process

The Cognitive Theory of Multimedia Learning by Mayer (2009) and the Integrated Model of Text and Picture Comprehension (Schnitz, 2014) explicitly consider the interplay between texts and pictures within their frameworks and try to explain why pictures should aid learning. For example, according to the Cognitive Theory of Multimedia Learning learners select pictorial and verbal information from the external multimedia materials, organize them into single coherent pictorial and verbal mental models and, finally, integrate the pictorial and verbal information with each other into a coherent representation.

According to Mayer (1997) integration refers to the process of building one-to-one correspondences between the verbal and the pictorial mental model. Thus, integration occurs when learners build one-to-one mappings between elements, actions, and causal relations in the verbal and pictorial mental model. For example, to map the verbal description of how a toilet flush works to a picture depicting this process (see Fig. 2 for an example), learners must first

* Leibniz-Institut für Wissensmedien, Schleichstraße 6, 72076 Tuebingen, Germany.

E-mail address: a.schueler@iwm-tuebingen.de.

identify corresponding elements in the text and the picture (e.g., they have to realize that the word “handle” refers to the image of the handle at the top of the toilet, cf. Mayer, 2009). Second, they must map actions described in the text to actions depicted in the picture (e.g., they have to note that the phrase “water continues to flow through the siphon pipe” corresponds to the water flowing through the siphon pipe in the picture, cf. Mayer, 2009). Third, they must map causal relations between actions mentioned in the text and actions depicted in the picture (e.g., they have to realize that the causal relation described in the text “because the lower disk has holes, water from the tank can pass through the holes in the lower disk and around the edges of the upper disk” is the same as the causal relation between these aspects depicted in the picture (cf. Mayer, 2009).

The assumption that learners build coherent mental representations is well in line with assumptions made by text processing research (e.g., Kintsch & van Dijk, 1978). Here, empirical research has shown that during reading, coherent mental representations of the text are constructed (e.g., Albrecht & O'Brien, 1993; Myers, O'Brien, Albrecht, & Mason, 1994; O'Brien & Albrecht, 1992). Whether learners construct coherent mental representations during processing multimedia materials that contain contents conveyed by both text and pictures has, to my knowledge, not been investigated so far.

There is, however, initial evidence that learners try to integrate text and picture information with each other, as outlined in the next paragraph.

1.2. Empirical evidence regarding the integration process

Evidence that text and pictures are integrated with each other into a coherent mental representation comes from an experimental study conducted by Schüler, Arndt, and Scheiter (2015). The authors used a modified memory paradigm introduced by Gentner and Loftus (1979) to investigate text-picture integration. Here, students were asked to recognize different versions of sentences and pictures studied earlier. These versions differed in the specificity of objects that were mentioned and depicted in the sentences and pictures, respectively. That is, one version of sentences and pictures referred to a category of objects comprising multiple exemplars, for instance, a tower, whereas the other version referred to a particular exemplar of this category, for instance, a lighthouse as a specific type of tower. Four experimental conditions were constructed by crossing less-specific and specific sentences with less-specific and specific pictures. For sentence recognition, the results of the posttest showed that participants more often falsely recognized specific versions of the sentences when they had been presented with less specific sentences together with specific pictures in the learning phase. Thus, for example, learners falsely recognized the sentence “the lighthouse is on the island” when they had been presented during learning with the sentence “the tower is on the island” paired with a specific picture showing a lighthouse on an island. Thus, participants integrated information regarding the specific exemplars extracted from the picture (e.g., lighthouse) with the more categorical information extracted from the sentence (e.g., tower) into one mental model, leading them to falsely “recognize” the specific version of the sentence. For picture recognition, results of the posttest showed the same effect (i.e., false recognition of specific pictures when participants had been presented with less-specific pictures crossed with specific sentences), but only after a one-week delay (Arndt, Schüler, & Scheiter, 2015). The authors explained this latter finding with the idea that for immediate testing learners relied on a superficial representation of the picture, whereas for delayed testing they relied on the mental model. In sum, the studies conducted by Schüler and colleagues speak in

favor of the assumption that learners construct coherent mental models that contain information from text and pictures. However, what remains unclear from these studies are the cognitive processes associated with this integration process.

Here, eye tracking can give insights. Concerning the integration process, look-foms and text-picture transitions have been determined as indicators. Look-foms describe the duration (fixation times) for inspecting the picture while re-reading the text (i.e., look-foms text to picture) and the duration (fixation times) for re-reading the text while re-inspecting the picture (i.e., look-foms picture to text; see Mason, Pluchino, & Tornatora, 2013, 2015). Text-picture transitions refer to the number of saccades between text and pictures.

For example, Mason, Tornatora, and Pluchino (2013) found that learners who make a high number of transitions between text and pictures, longer look-foms text to picture fixation times, and longer look-foms picture to text fixation times also had better learning outcomes. Similarly, Johnson and Mayer (2012) demonstrated that learners of a successful learning condition had a higher number of transitions between text and pictures (for similar results, see also Hannus & Hyönä, 1999; Mason, Pluchino, & Tornatora, 2015; Mason, Pluchino, et al., 2013; O'Keefe, Letourneau, Homer, Schwartz, & Plass, 2014). On the other hand, in a study conducted by Scheiter and Eitel (2015) the more successful learning group did not show more transitions between text and pictures. Similarly, Arndt et al. (2015) found no relationship between number of transitions and integration performance. A possible explanation for this finding is that learners constructed a coherent representation of text and pictures based on their memory representations (Scheiter & Eitel, 2015; see also; Bauhoff, Huff, & Schwan, 2012). Thus, when reading the text learners retrieved the picture information from memory and integrated the two kinds of information with each other into a coherent mental representation, without switching their gaze between text and pictures. In line with this assumption, Mason, Tornatora et al. (2013) showed that successful learning was associated with longer fixations on text and pictures, indicating that integration might not only occur when switching between text and pictures, but also during processing of one of these individual external representations. In sum, although gaze behavior might give some insights into the cognitive processes that happen during learning, contradictory results have been observed for integrative eye movement behavior as a measure of cognitive integrative processing. Thus, the observed gaze behavior in the reported studies cannot be traced back unambiguously to the integration process.

One explanation for the observed contradictions might lie in the fact that attending to relevant information is a necessary, but not a sufficient prerequisite for learning. Thus, a learner who switches between text and pictures might only pick up information from text and pictures individually without integrating them immediately into a coherent mental representation. Accordingly, the perceptual processes observed via eye tracking should be considered separately from the cognitive processes related to learning outcome (see de Koning, Tabbers, Rikers, & Paas, 2010). To connect perceptual and cognitive processes more tightly, it would be helpful to predict precisely at which point in time more cognitive integration processes would be expected if learners were to try to construct a coherent mental representation during the learning process. In text comprehension research a paradigm has been used which allows for making clear predictions about when cognitive integration of contents should become observable in gaze behavior. The aim of the present study was to extend prior multimedia research on the integration process by adapting this paradigm to multimedia learning settings.

Download English Version:

<https://daneshyari.com/en/article/4940267>

Download Persian Version:

<https://daneshyari.com/article/4940267>

[Daneshyari.com](https://daneshyari.com)