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Implementation intentions during multimedia learning: Using if-then plans to facilitate cognitive processing

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ABSTRACT

To successfully learn from multimedia, learners must actively process text and pictures and integrate their information. Two experiments investigated how to support these cognitive processes by means of implementation intentions. Implementation intentions are "if-then" plans that are assumed to strongly link an opportunity to act (e.g., 'IF I have finished reading a paragraph') with an action that helps to attain a learning goal (e.g., 'THEN I will search for corresponding information in the picture'), so that the action is automatically carried out once the opportunity is encountered. In Experiment 1 ($N = 160$), the number of implementation intentions (1 vs. 3) as well as the type of cognitive process supported by them (text processing, picture processing, text-picture integration, or a combination thereof) were varied. Additionally, a control group learned without implementation intentions. In line with our hypotheses, implementation intentions improved multimedia learning outcomes, especially if they supported a combination of all types of cognitive processes. In Experiment 2 ($N = 42$), this positive effect of the combined implementation intention condition was shown to prevail against a more conservative control group. These findings together indicate that implementation intentions represent an effective means to support learners in effectively processing multimedia instruction.

1. Introduction

Multimedia, that is, a combination of text and pictures, nowadays finds widespread use in textbooks, the Internet, as well as in other formal and informal learning resources. This being the case, research on the benefits of multimedia materials and the cognitive mechanisms underlying their processing has been highly relevant for the past decades. This research has primarily focused on ways of improving learning by optimizing the design of instructional materials (cf. Mayer, 2009). How much learners benefit from multimedia, however, will not only depend on the design of the learning materials but also on how well learners are able to process them effectively (Kombartzky, Plötzner, Schlag, & Metz, 2010).

Studies using eye-tracking to assess learners' information processing during multimedia learning have shown that learners often fail to make best use of the learning materials (e.g., Hannus & Hyönä, 1999; Scheiter & Eitel, 2010). Therefore, the two experiments presented in this paper aimed at investigating how learners can be supported in more effectively processing multimedia instruction. To do so, we applied a concept from motivational/volitional research, namely, implementation intentions. According to Gollwitzer (1999), implementation intentions are 'if-then' plans that strongly link an opportunity to act (e.g., 'IF I have finished reading a paragraph') with an action that will help to attain a learning goal (e.g., 'THEN I will search for corresponding information in the picture'). Their effectiveness for supporting goal achievement relies on the assumption that once a person has internalized the if-then plan, s/he will immediately carry out the action upon encountering the opportunity. In the present studies we used implementations intentions to ensure that learners would apply certain cognitive processes during multimedia learning. In Experiment 1, we investigated what type of cognitive processes or combination thereof should best be supported by implementation intentions to foster multimedia learning. Learners' eye movements served as process measures that could be used to describe the cognitive processes deployed by learners. Experiment 2 aimed at replicating the main finding of Experiment 1 against a more conservative control condition.

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Table 1
Overview over all nine multimedia processes and implementation intentions.

	Multimedia process	Sample literature	Implementation intention
Text processing			
Global text processing	Studying the headlines and titles	(Hyönä et al., 2002)	"If I have opened a new page, then I will carefully study the title first!"
Rehearsal	Rereading the text	(O'Shea et al., 1985; Weinstein & Mayer, 1986)	"If I have finished reading a page, then I will carefully re-read all paragraphs!"*
Organization	Connecting the information in the text across paragraphs	(McNamara et al., 2004; Zwaan & Singer, 2003)	"If I have read a paragraph, then I will search for references to previous paragraphs!"
Picture processing			
Overview/Pictorial scaffold	Studying the picture before reading the text	(Eitel, Scheiter, & Schüler, 2013; Eitel, Scheiter, Schüler, Nyström, et al., 2013; Scheiter & Eitel, 2010)	"If I have opened a new page, then I will carefully study the picture first!"
Selection	Decomposing the picture in relevant elements	(Hegarty & Just, 1993; Hegarty & Sims, 1994)	"If I am looking at a picture, then I will search for its central elements with regard to content!"*
Organization	Putting the relevant picture elements in relation to each other	(Mayer, 2009)	"If I have looked at a picture, then I will put its central elements into context with each other!"
Integration			
Integration text-picture	Connecting the information from a text paragraph with its corresponding picture element	(Mason et al., 2013; Mayer, 2009)	"If I have read a paragraph, then I will search the picture for the contents described therein!"*
Integration picture-text	Connecting a picture element with its corresponding text paragraph	(Mason et al., 2013; Mayer, 2009)	"If I have looked at a picture, then I will search the text for explanations of the examined picture elements!"
Matching of mental models	Verifying one's mental model by means of the picture	(Hegarty, 1992)	"If I want to click to the next page, then I first carefully study the picture to verify my understanding of the text!"

The implementation intentions marked with an * were used in the mixed condition (MIX).

1.1. Learning with multimedia

One common and consistent finding in research about learning with text and pictures is that learning with an illustrated text results in better recall and comprehension than learning with text alone (for overviews see Anglin, Vaez, & Cunningham, 2004; Fletcher & Tobias, 2005); this effect is commonly called the 'multimedia effect' (Mayer, 2009). Text-picture combinations are seen as advantageous over plain text because they yield a more comprehensive mental representation, which incorporates the information from both external representations (cf. Cognitive Theory of Multimedia Learning [CTML], Mayer, 2009; Integrated Model of Text and Picture Processing [ITPC], Schnotz, 2005).

Both, CTML and ITPC assume that to arrive at a comprehensive mental representation various stages of cognitive processing are necessary. These processes range from early attentional processes that are closely linked to the input and its representational characteristics (i.e., text and picture processing, respectively), to higher-level cognitive processes relevant to meaning making (i.e., coherence formation, Seufert, 2003; integration, Mayer, 2009). Unfortunately, learners seem to face difficulties in applying these processes, as can be concluded from two lines of research. First, eye-tracking studies have shown that if learners' processing of multimedia materials is unguided, they mainly focus on the text; by spending too little time on information contained in the picture, they consequently fail to come up with a coherent mental representation containing information from both representations (e.g., Hannus & Hyönä, 1999; Scheiter & Eitel, 2010; Schmidt-Weigand, Kohnert, & Glowalla, 2010a; Schmidt-Weigand, Kohnert, & Glowalla, 2010b). Second, there is plenty of research showing that helping learners in applying relevant cognitive processes improves learning, thereby suggesting that learners do not make optimal use of the learning materials on their own (e.g., De Koning, Tabbers, Rikers, & Paas, 2009; Kombartzky et al., 2010; Schlag & Plötzner, 2011; Seufert & Brünken, 2006).

In the following sections, we will first introduce a list of cognitive processes, whose support should prove helpful when learning with multimedia and which were thus in the focus of the intervention that we investigated in the present paper. Second, we will discuss on how to best support learners in applying these processes and introduce our intervention.

1.1.1. Effective processes in learning with multimedia

According to theories of multimedia learning (Mayer, 2009; Schnotz, 2005), effective learning with multimedia comprises cognitive processes related to each of the representational formats individually (*text processes, picture processes*) as well as to connecting information from both representation formats to each other (coherence formation or *integration*, respectively). In the present studies we considered nine cognitive processes that we aimed at supporting with our intervention, whereby always three processes referred to text processing, picture processing, and integration, respectively (Table 1).

1.1.1.1. Text processes. One effective text process is the careful inspection of the text's headings on each page (*global text processing*). According to Sanchez, Lorch, and Lorch (2001) the inclusion of headings in a text leads to an improved memory of the text's contents. Similarly, Hyönä, Lorch, and Kaakinen (2002) found in an eye-tracking study that readers who devoted more time to the topic structure of a text (i.e., headings) produced better summaries of the text in question. Another effective text process is the careful rereading of all paragraphs after the first read-through of each page (*text rehearsal*). In this context, rereading acts as a simple rehearsal strategy (O'Shea, Sindelar, & O'Shea, 1985; Weinstein & Mayer, 1986) but also doubles as a monitoring help to make learners more aware of potential gaps in their understanding (Thiede, Anderson, & Therriault, 2003). Moreover, it could be shown that rereading can act as a compensation for learners with inefficient verbal working memory capacity (Walczyk, Marsiglia, Johns, &