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What contributes to the split-attention effect? The role of text segmentation, picture labelling, and spatial proximity

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Abstract

In the split-attention effect spatial proximity is frequently considered to be pivotal. The transition from a spatially separated to a spatially integrated format not only involves changes in spatial proximity, but commonly necessitates text segmentation and picture labelling as well. In an experimental study, we investigated the influence of spatial proximity, text segmentation, and picture labelling on learning performance. A total of 165 students, divided into five groups, participated in the study. Four of the groups learned from spatially separated texts and pictures in a 2 × 2 design with the factors text segmentation (continuous vs. segmented text) and picture labelling (unlabelled vs. labelled picture). The fifth group learned from a spatially integrated text and picture. Retention and comprehension of the learning material were assessed. Students' working memory capacity and spatial ability were also assessed. The results replicated the split-attention effect with respect to retention only. This effect is attributed mainly to text segmentation and only partially to picture labelling. Spatial integration, however, did not enhance learning.

Keywords: Learning from text; Learning from pictures; Multimedia; Split-attention; Text segmentation; Picture labelling

1. Introduction

A well-known phenomenon in multimedia learning, that is, learning from multiple sources of information, is the so-called "split-attention effect" (Chandler & Sweller, 1991, 1992; Ginns, 2006; Kalyuga, Chander, & Sweller, 1999; Kester, Kirschner, & van Merriënboer, 2005; Owens & Sweller, 2008; Sweller & Chandler, 1994). When each source of information is essential for understanding the represented subject matter, learning improves when multiple sources of information are presented in a spatially and temporally integrated rather than separated format. Cognitive load theory (CLT) provides an explanation for the split-attention effect (Sweller, 2005). Emphasizing the limitations of working memory capacity, CLT states that the overall cognitive load on working memory results from three additive sources (Sweller, van Merriënboer, & Paas, 1998). Specifically, (a) from intrinsic cognitive load, which is due to the complexity of the information to be processed, (b) from extraneous cognitive load, which is caused by the design of the information presentation, and (c) from germane cognitive load, which is related to effortful learning processes. Given a certain intrinsic cognitive load, an increase in extraneous cognitive load implies a decrease in the working memory capacity available for germane cognitive load.

If an instructional text and picture are presented in a spatially separated format, learners are required to split their attention between the two sources of information. This requires them to repeatedly search for information in both the text statements and the elements in the picture, as well as for mappings between text statements and picture elements, in order to understand the subject matter. These processes increase extraneous cognitive load, thereby leaving less working memory capacity for learning processes such as schema acquisition. Learning is consequently impeded. In contrast, if an instructional text and picture are presented in a spatially integrated format, there is less need for the learners to split their attention between the two sources of information.

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Such a design keeps extraneous cognitive load low and leaves more working memory capacity for germane cognitive load. Learning is thus facilitated.

The split-attention design principle has been proposed on the basis of empirical findings as well as CLT (Ayres & Sweller, 2005). It states that multiple sources of information should be presented in such a way that learners do not need to split their attention between them. In the case of an instructional text and picture, both sources of information should be presented in a spatially integrated format rather than a spatially separated format. Within the theory of multimedia learning, Mayer (2001) proposed a similar design principle: the spatial contiguity principle (see also Clark & Mayer, 2008; Mayer, 2005b).

As Chandler and Sweller (1992) have already pointed out, the transition from a spatially separated format to a spatially integrated format often involves more than just a change in spatial proximity. For instance, in order to integrate an instructional text into a picture, the text needs to be segmented. Subsequently, the segments have to be positioned close to those elements in the picture to which they refer; this, in turn, labels the elements in the picture. Conversely, an instructional text can be segmented and a picture can be labelled without spatially integrating them. This raises the question: What is it, precisely, that contributes to the split-attention effect? Is it the segmentation of the text? Is it the labelling of the picture? Could it be a combination of both, that is, how the relation between text segments and picture elements is made explicit? Or is spatial proximity pivotal?

In previous studies, it has been demonstrated that the segmentation of learning material facilitates learning (for overviews see Clark & Mayer, 2008; Mayer, 2005a). Various researchers have shown that the segmentation of text, in particular, is beneficial to improving text recall as well as text comprehension (Gaddy, van den Broek, & Sung, 2001; Glynn, Britton, & Tillman, 1985; Hartley, 1986; Meyer, 1975; Weiss, 1983). It is commonly assumed that the structure of the text assists in guiding the learners' attention during reading. Text segments provide information about which text elements form meaningful units and help learners to identify and attend such units, thereby facilitating a deeper processing of the information presented.

The labelling of pictures can be regarded as a signalling technique. A lot of researchers have demonstrated that the use of signalling techniques in learning material improves learning (for overviews see Clark & Mayer, 2008; Mayer, 2005b). For instance, Mautone and Mayer (2007) investigated how signalling techniques, such as highlighting, improve graph comprehension. Jamet, Gavota, and Quaireau (2008) showed that the signalling technique of colouring facilitates learning from multimedia material. As in the case of the segmentation of learning material, it is commonly assumed that signals guide the learners' attention and make relations between different pieces of information more salient. Signalling helps learners in identifying, attending, and organising important information.

The combination of text segmentation and picture labelling makes the associations between text and picture even more explicit to the learners (cf. Erhel & Jamet, 2006). Therefore, it could well be that learning from segmented texts and labelled pictures which are spatially separated is as successful as learning from those which are spatially integrated. On the basis of analytical comparisons of various presentation formats, Martin-Michiellot and Mendelsohn (2000) have already proposed that the distinction between spatially separated and spatially integrated formats might not correspond to a dichotomy, but rather to more fine-grained differences.

In what follows, an experimental study is presented in which the effects of text segmentation, picture labelling, and the combination of both were investigated. Furthermore, learning from spatially separated texts and pictures was compared to learning from a spatially integrated text and picture. A discussion of the theoretical as well as the practical implications of the findings of the study is given at the end.

1.1. The present study

Five groups of students learning from an instructional text and picture were investigated. The groups were formed by combining two factors: (a) text segmentation (continuous text vs. segmented text) and (b) picture labelling (unlabelled picture vs. labelled picture). Each group received the text and picture in a spatially separated format. Thus, the groups were students who received (a) continuous text and unlabelled picture (Group CONT + UNLAB), (b) continuous text and labelled picture (Group CONT + LAB), (c) segmented text and unlabelled picture (Group SEG + UNLAB), and (d) segmented text and labelled picture (Group SEG + LAB); the fifth group received the text and picture in a spatially integrated format (Group INT). Students were tested on retention and comprehension in a posttest as well as on their spatial ability, their working memory capacity, and their prior knowledge on the topic to be learnt.

1.1.1. Hypotheses

The continuous text and unlabelled picture requires learners to repeatedly search for both the statements in the text and the elements in the picture, as well as for mappings between them, in order to understand the subject matter. According to CLT, such processes enhance extraneous cognitive load and leave less working memory capacity available for learning processes to take place. In contrast, if the text and picture are presented in a spatially integrated format, there is less need for the learners to split their attention between the two sources of information. It was, therefore, expected (Hypothesis 1) the split-attention effect to be replicated, that is, the students who received the text and picture in a spatially integrated format (Group INT) should learn more successfully than the students who received the continuous text and unlabelled picture (Group CONT + UNLAB).

Text segmentation facilitates the identification of meaningful units in the text (Gaddy et al., 2001; Glynn et al., 1985; Hartley, 1986; Meyer, 1975; Weiss, 1983), whereas picture labelling draws the learners' attention to relevant elements in the picture (Erhel & Jamet, 2006; Mautone & Mayer, 2007).