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Text features which enable cognitive strategies during text comprehension

In this special issue on text features which enable cognitive strategies during text comprehension we want to focus on the relationship between (a) text features, such as structure, graphics, visual cues, pictures, headlines, links, etc., (b) cognitive strategies that are triggered or enabled by these features, and (c) the outcomes of processing, often measured by text comprehension and/or some learning or task performance. More simply stated, what evokes the text (structure, etc) in terms of strategies and what are the results?

We will present 5 articles that involve theory-based, mostly cognitive psychological research related to this issue, with implications for practice. All papers concern studies on the area of hypertext – more specifically, studies on the processing of multiple (web-based) texts about the same topic. Reading and comprehending these texts involve both processing the content, and navigating through a structure of hyperlinks that connects the individual information units. Looking for the connectedness or coherence of these information units is an important aspect of hypertext comprehension. Following the links between multiple information sources adds a navigational load to the existing comprehension load (Conklin, 1987; Sanchez & Wiley, 2005). As a network of information units must be represented and manipulated, spatial processing and spatial abilities become critical. It appears that spatial ability is even more important for web navigation than memory (Juvina & Van Oostendorp, 2004).

The first article is by Charlotte van Hooijdonk, Alfons Maes and Nicole van Ummelen, and entitled *'I have been here before' – an investigation into spatial verbalizations in hypertext navigation*. An interesting issue in Web-based reading is whether readers construct spatial representations of the information, and whether they use for the construction of that information space the visual organizing cues, like menus, indexes or spatial maps, which are available in the texts presented on the Internet. Van Hooijdonk et al. explore the usefulness of thinking-aloud protocols as a means of characterizing cognitive tasks involved in executing digital information tasks, such as fact-finding questions. In particular, they used protocol analysis to detect levels of cognitive actions in which hypertext users are involved, i.e. pragmatic, semantic and perceptual/syntactic actions. They further investigated the way in which users use spatial descriptions to conceptualize their actions, and how these spatial descriptions relate to the three levels – pragmatic, semantic, and perceptual/syntactic.

A central question in their study is whether spatial conceptualizations show up in verbalizing low-level actions, such as clicking or typing – or also in planning and monitoring the task. It appeared that spatial expressions were most frequent when users describe actions on the lower, syntactical level. At least, this it the outcome when mainly fact-finding questions are presented. It has to be seen whether the same results are found when

other tasks are given, such as a learning task, or when deep comprehension questions are posed.

The second contribution, *Using graphics to support comprehension of dynamic information in texts*, is by Rick Lowe and Harto Pramono. Text and graphics have long been combined in various ways to provide complementary sources of information. The utility of such combinations can be attributed to the different profiles of strengths and weaknesses that each of these two forms of representation offer to the information designer (Schnotz, Bannert & Seufert, 2002). While there are many circumstances in which text alone or graphics alone would suffice, information designers often exploit the advantages offered by using them jointly. For example, a graphic may be used to resolve potential ambiguities in a text, or to support a more precise interpretation. In recent years, technological advances have driven the development of many new ways of using text and graphics together. Despite this progress, some fundamental questions remain unanswered, questions that should underlie the design of such combinations. A central point in the discussion by Lowe and Pramono is the fact that little is known about the influence of micro-level design factors on the effectiveness with which static and animated graphics support comprehension of *dynamic* information. Selected findings from empirical research are discussed as a basis for suggesting a more principled approach to the design of adjunct graphics, and the potential implications for the design of adjunct graphics are discussed.

We mentioned above that looking for coherence is an important reading strategy, particularly in a Web-based environment. Ladislao Salmerón, Walter Kintsch and Jose J. Cañas compare this strategy to a strategy based on interest, that is, selecting those links that lead to information units that are of high interest to the reader. They are the authors of the third contribution, *Coherence or interest as basis for improving hypertext comprehension*. Educational hypertext aims to improve reader's comprehension by providing flexible access to information. However, as mentioned above, this flexibility imposes additional tasks on a reader who is used to gaining information in a linear manner. One of these difficulties is choosing in which order to read the hypertext sections. In their work, Salmerón et al. explore two possible strategies to decide on the reading order in hypertext: a strategy based on coherence, and a strategy based on interest. The results of two laboratory experiments reveal that a reading order that is controlled by looking for semantic coherence improves comprehension for novice readers, more than one based on interest. They further discuss ways to automatically analyze the coherence of reading order by using the Latent Semantic Analysis technique (Landauer, Foltz & Laham, 1998) and how to include it in educational hypertexts in order to enhance comprehension.

In processing content, individual differences are important. A well known factor is the amount of prior knowledge (Kintsch, 1998). In the context of multiple sources, the comprehension criterion which readers set is also important (Elshout-Mohr & Van Daalen-Kapteijns, 2002). Do they want to connect seemingly isolated bits of information, and do they try to construct an integrated understanding of the presented information or not? In this respect, personal epistemological beliefs are relevant. The study *Constructing meaning from multiple information sources as a function of personal epistemology: the role of text-processing strategies* by Ivar Bråten and Helge Strømsø demonstrates this. They examined differences in text-processing strategies between students with naïve as opposed to sophisticated epistemological beliefs, when reading to comprehend multiple texts, that is, different texts about the same topic.

The results of their study showed that the students holding sophisticated epistemological beliefs outperformed the students holding naïve beliefs on text comprehension at the level of the text base as well as with respect to the situation model (Kintsch, 1998).

Students holding sophisticated epistemological beliefs reportedly used elaboration, and to a certain extent also monitoring, more than students holding naïve beliefs. Further analyses revealed that there was no difference between the groups with respect to memorization. Their study demonstrates that students with sophisticated epistemological beliefs are better readers than students with naïve beliefs when the task demands the melding of information from different perspectives. The results are also consistent with the notion that students having sophisticated epistemological beliefs attain this advantage by engaging in more active use of deep-level strategies such as elaboration and monitoring. In terms of educational implications, this research suggests that students working with multiple texts should be given the opportunity to reflect on their epistemological stances and also be taught how they can construct meaning strategically in this complex task environment.

The final contribution, *Enhancing internet experience of visually impaired persons by means of dynamic highlighting and selective reading*, is written by Ion Juvina and Herre van Oostendorp. They propose a process model of web navigation to generate navigation support in the form of goal-specific dynamic highlighting, and they show how these ideas can be used to assist visually impaired readers in using the Internet via screen readers.

As mentioned above, using Web-based documents involves navigation in order for the reader to make sense of different but linked pieces of text. Juvina et al. use performance-oriented tasks with well-defined goals (e.g. 'You need to lose weight. What type of food would you include in your healthy diet?'). In this case comprehension is a means toward attaining the task's goal. It seems natural to highlight goal-relevant information to guide users' selections of relevant items, but the same information sources can be used for a variety of goals, thus what might be relevant for a particular goal is irrelevant for another one, and vice-versa. Therefore, highlighting needs to be goal-specific. Furthermore, triggering a reader's attention toward goal-relevant items should also be synchronized with the reader's progress through task execution. Specific items might become relevant or irrelevant during task execution, depending on what the reader has already done. For illustration, it would not be useful to recommend *starters* when the customer is already eating *dessert*. Consequently, the suggestions have also to be presented dynamically.

Research on cognitive modeling of web navigation emphasizes the importance of 'information scent' (relevance of semantic cues such as menu items, link labels and headings to the reader's goal) (Pirolli & Card, 1999). Juvina and Van Oostendorp have extended this idea with the concept of 'path adequacy', indicating the goal relevance of past selections. Empirical data that support the arguments put forward are presented. Suggestions (highlighted via voice) generated by the cognitive model had a positive effect on navigation behavior and task performance. In the second part of their contribution they present the outline and components of a model that can help visually impaired persons in using the Internet via screen readers. An intelligent agent is designed that is capable of dynamic highlighting and selective reading based on machine learning algorithms and runs synchronized with the cognitive model.

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