ABSTRACT

A large number of studies focus on the development and evaluation of navigational aids in a digital environment. Although results are far from unequivocal, there is fair evidence for the beneficial effect of global structural aids, such as site maps. Less clear is how exactly these navigation aids help digital users: do they promote a semantic or task oriented representation of the information space, do they help users to keep track of their ongoing task or do they simply help users to locate information in virtual space? If we want to answer these questions, more knowledge is needed about how each of these representational levels contributes to the success of digital information tasks. As a first step of this research agenda, we investigated the proportion and the nature of each of these levels in thinking/working aloud protocols of users executing or monitoring digital information tasks. The protocols were collected by using different elicitation methods, which enables us to compare these methods in their ability to disclose the interaction between spatial, semantic and pragmatic representation levels in executing digital tasks.

SUMMARY

Introduction

When using hypertext, we have to navigate through a large amount of information. From its very beginning, hypertext is closely associated with way finding in physical space. Elm & Woods characterize the task of hypertext users as solving a triple navigation problem: where am I, where to go and how to go there (Elm & Woods, 1985). Likewise, Conklin associates hypertext use with two well-known cognitive problems, disorientation and cognitive overhead (Conklin, 1987).

Over the past decades, a large number of navigational aids have been developed to help users orient themselves in a digital environment. Although the studies are far from consistent in their results, most of them find beneficial effects of maps in terms of navigation efficiency, (durable) recall or appreciation. But even if these results are conclusive, they do not explain how exactly these navigational aids help users: do they promote the comprehension of the information structure? Do they enable users to set, monitor, and reach their goals more efficiently? Or do they 'simply' support spatial-perceptual processes involved in hypertext use (locating information, mentally replaying the navigating path, transforming information into a spatial arrangement etc). In our research project, we aim at a better understanding of the cognitive functions involved in web navigation. In particular, we focus on the role of spatial and perceptual processes involved. As a first step, we conducted a thinking aloud study with users of digital information to explore the presence, the proportion, and the nature of information associated with three relevant representation levels, i.e. the semantic, pragmatic, and spatial level. The protocols were collected by using different elicitation methods, which enables us to compare these methods in their ability to disclose the interaction between semantic, pragmatic and spatial representation levels in executing digital tasks.

Theoretical position

The cognitive tasks users carry out on web sites are complex. As an assumption, one can distinguish between low-level (perceptual) and higher-level (conceptual) task components. Users have to coordinate their actions with the mouse and keyboard. They have to perceive the different information modalities on the screen. They have to decide on their navigation path, and they have to understand the information on the web sites, not only in semantic terms, but also pragmatically, in view of their tasks and goals. In sum, using hypertext is a

task with motional, perceptual, spatial, semantic, and pragmatic aspects. One may assume that the higher-level cognitive tasks (understanding and applying information) are affected by low-level tasks (way finding, locating, hand-eye coordination etc). This may suggest that the low level perceptual tasks are crucial in the ultimate success of hypertext user. The idea of dependency of high and low level tasks is comparable to Clark's notion of 'action ladder', applicable to human conversational interaction (Clark, 1996). Clark defines four hierarchically organized levels of language use. These levels must be coordinated successfully to establish common ground. Failures on lower levels results in failures on higher levels (i.e. Clark's principle of upward causality).

If we apply this idea to hypertext use, one may assume that the quality of semantic and pragmatic processes depends on the quality of low-level spatial and perceptual processes. The cognitive importance of perception and space is supported by a number of observations: the widespread use of spatial language and metaphors in talking about digital tasks, the reliance on sophisticated spatial and graphical cues in presenting information in hypertext and the association of information tasks with practical actions within the communicative situation (e.g. coordinating keyboard, mouse and screen; understanding the spatial organization of the screen).

If we assume spatial information to be relevant, the question is how to represent and investigate the cognitive functions of spatial information in executing digital tasks?

Much research has been done in the field of geography, psychology and spatial cognition on how users represent spatial information in the physical world. When people are operating in a spatial environment, they need to know the location (distance – direction) and the attributes (size, color, shape) of the environment (Downs & Stea, 1973). Shum applied the spatial terms distance and direction to hypertext (Shum, 1990). Each hypertext node has a certain distance, which - according to Shum - can be quantified in absolute terms as the number of nodes a user has to visit, or in relative terms as the cognitive distance. Cognitive distance is related to aspects like system response time, ease of returning to the previous node, the number of link traversals/mouse clicks involved. According to Shum, direction is a difficult concept to capture in hypertext. He defines it as going forwards and backwards, but does not explain why. In any case, Shum shows that is possible to define a digital environment as a spatial phenomenon. However, he did not investigate whether and how users make use of these spatial notions in performing digital tasks.

Research on spatial information has also been done in the field of information design. According to Dillon, McKnight & Richardson, users often claim that they experience a sense

of knowing where an item of information occurred in a body of text (Dillon, McKnight, & Richardson, 1993). Dillon conducted two experiments to test the readers' ability to impose structure on randomly presented paragraphs of text (Dillon, 1994). The results of these experiments indicated that the readers had little difficulty to piece the paragraphs together. The readers seemed to have knowledge of the structure of an academic journal, which was independent of its semantic content. However, an academic journal always has a well-defined functional information structure, which is often absent in hypertext.

Likewise, Rothkopf observed an effect of knowledge of location (Rothkopf, 1971). His experiment showed that people could remember the location of the information even if they were not asked to remember it. So, it seems that users remember apparently useless spatial information, which raises the question whether and how this location knowledge functions in a digital environment.

Finally, Boechler makes clear how promising it is to study spatial perception in hyperspace and she offers a number of methodological tools as well as interesting questions which are waiting to be investigated (Boechler, 2001).

Exploratory investigation

As a first step towards more understanding of the function of spatial processing, we executed an exploratory study with hypertext users. We asked different users to perform different tasks which were all intended to elicit verbal protocols, i.e. thinking aloud (expert and novice), co-discovery (between experts and novices), commenting and evaluating the behaviour of other users, instructing how to find digital information). In these protocols, we particularly analysed spatial language: the proportion of spatial language, the way in which space is used to tackle problems, the different levels of spatial language (physical space on the screen, metaphoric space etc). That way, we wanted to know the extent to which users (novices, experts) fall back to space in conceptualizing their task. Furthermore, we wanted to compare several methods of eliciting verbal protocols. Finally, we asked participants to perform tasks afterwards (i.e. estimating the distance and direction between two screen captures, recall tasks, structure drawing tasks). This enabled us to relate protocols to post hoc task performance.

We expected that novices, more so than experts would verbalize low-level actions. The experts were expected to have automatized their lower-level actions. We also expected that the novices would experience difficulties in forming a mental representation of the digital environment, whereas the experts would be able to form a cognitive map of the environment.

Seven subjects participated in the experiment, three novices and four experts. After a practice task, participants were presented to a Dutch medical website (www.medicinfo.nl). They were asked, either individually, or in an expert or novice duo, to answer two fact-finding questions and two explorative questions. While executing these searching tasks they were stimulated to verbalize every action they were planning.

After that, participants were shown the replay of the navigation process of another user in the same website, and they were asked to comment on it. Next, they were asked to write down and draw the information structure of the website. Finally, they received four screenshots of the website; they had to estimate the distance between the screens and the direction between them.

The first results showed that the experts were able to form an abstract representation of the information structure of the web site. The novices could only remember the spatial layout of the homepage.

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