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Expectations and memory in link search

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Abstract

Strategies in searching a link from a web page can rely either on expectations of prototypical locations or on memories of earlier visits to the page. What is the nature of these expectations, how are locations of web objects remembered, and how do the expectations and memories control search? These questions were investigated in an experiment where, in the experimental group, nine experienced users searched links. To obtain information about expectations, users' eye movements were recorded. Memory for locations of web objects was tested immediately afterwards. In the control group, nine matched users had to guess the locations of web objects without seeing the page. Eye-movement data and control group's guesses both indicated a robust expectation of links residing on the left side of the page. Only the location of task-relevant web objects could be recollected, indicating that deep processing is required for memories to become consciously accessible. A comparison between the experimental group and the control group revealed that what was represented in memory was not an individual link's location but the approximate locations of link panels. We argue that practice-related decreases in reaction time were caused by semantic priming. Roles for the different types of memory in link search are discussed.
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1. Introduction

The groundbreaking idea in hyperlinking was to embed links directly into text where they could be easily found in their semantic context during reading (Bush, 1945; Engelbart, 1963; Nelson, 1965). Because World Wide Web sites typically consist of a collection of several loosely related documents and services, designers have had to come across additional ways to tie the multiple pages of a site together. Most often, this involves presenting links to internal pages in a panel located on the side of the main content. This static interface is here called *the navigational framework*. A quick glimpse at current web sites shows that navigational frameworks vary considerably from site to site. This inconsistency is problematic, because the user has to deal with each navigational framework individually. In fact, there is evidence that WWW users often get frustrated in trying to search information. Several user satisfaction surveys have indicated that normal users have troubles in finding information in 40–70% of the time from on-line shops (for an overview, see Usability Net, 2003). Even experienced users face problems about 30% of the time. Striking figures like these provide a real challenge for designers and HCI researchers.

One common approach to study information search behavior is to compare different layouts by task completion times or user opinions. An option to this kind of *brute force* approach is to study the mental processes involved in finding information from a page. If designers would understand the psychology of users (Carroll, 1991; Card, Moran, & Newell, 1983; Czerwinski & Larson, 2002; Faulkner, 1998; Olson & Olson, 2003), they could describe, explain, and predict user behavior in novel situations in a way not accounted by the brute force approach. The present study conforms to this strategy, since our purpose is to examine how the human *memory* can either support or fail to support users in web navigation. Our analysis begins from the simple observation that in order to navigate, users need to *select* among many candidate links presented on a page. It is thus critical to understand *how* the incorrect links are avoided and the correct one selected. Previous research in link search has mainly focused on the roles of attention and perception (e.g., Oulasvirta, 2004), whereas the roles of prior knowledge and memory are less well understood (cf. Ehret, 2002).

Our starting point is the widely accepted fact that memory consists of several functionally separate subsystems (e.g., Schacter & Tulving, 1994; Squire, 1992). In this paper we distinguish on one hand between explicit and implicit memories (Graf & Schacter, 1985; Schacter, 1987) and on the other hand between memories and expectations. Even before we see a particular web page, we have *expectations* about the probable locations of links, based on previous experiences with web pages. Users can have *implicit expectations* that are inaccessible to consciousness and consciously accessible, *explicit expectations*. Both types of expectations may have an effect on link search behavior. Whereas expectations are a type of *prior* knowledge or skills, memories are here conceived as representations or skills of the posteriori type: they are about the individual page we have seen. *Implicit memory* (memory without the conscious awareness of the original event that caused it) for a particular page we have seen can help in directing attention to the target more efficiently. In addition,

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