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Efficient electronic navigation: A metaphorical question?

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ABSTRACT

Differences in navigation performance have been found for variation in the metaphor used to structure information layout within websites. Our study extends this work by examining three metaphors to clarify further whether differences can be attributed to the metaphor's structure being spatial (versus non-spatial) or because it has greater familiarity. Participants were assigned a website and completed a structurally identical navigation task based on a specific metaphor description. Effects of metaphor were found for total task time, disorientation, and a combined accuracy measure. The house metaphor (spatial/familiar) produced significantly faster task times and more accurately retained metal models than both the town (spatial/unfamiliar) and social (non-spatial/unfamiliar) metaphors. Cognitive style, spatial ability and confidence had mixed and limited influence on the findings. The results suggest that navigation in website environments is facilitated more by the degree of familiarly perceived in the structure of the metaphor, than the spatial or non-spatial nature of the metaphor. This has major implications for the design of hypertext material, especially where the ability to locate information and recall it accurately is important rather than speed per se.

1. Introduction

The way in which individuals represent knowledge directly affects their assimilation, manipulation, and application of that knowledge. It follows that determining and understanding the mental models adopted by users is an essential prerequisite to the design of websites, particularly where efficient navigation is important. A major barrier associated with user interfaces is often described as a 'learning curve', and this barrier can be removed or reduced by allowing users to build on experience from other areas (Blackwell, 2006). The use of metaphors in user interfaces enables users to 'translate' and reuse mental models derived from real-world objects or situations in the virtual world. Up until the early 1980s, metaphor was considered a purely linguistic phenomenon by most scholars; loosely translated from Aristotle as 'calling something by another name' (Cronjé, 2001). Current theories stress that that metaphor is not only to be understood in terms of 'figure of speech' (e.g. Balconi and Tutino, 2007). Rather than a mere interaction between two words, metaphor is the interaction between a source (familiar area of knowledge) and a target domain (unfamiliar area of knowledge or situation), involving the interaction of schemas and concepts (Lakoff and Johnson, 1980; Lakoff, 1993). Following this line of thought, interface metaphors are conceptual models representing the structure, content, and relationships within an information space. Interface metaphors provide a visual meaning of concepts through words and images, and allow users to make new associations and quickly communicate complex ideas (Kuniavsky, 2010). They often suggest a specific 'physical' form or structure and are based on the individual's existing knowledge ('self-constructed models') and/or directions given to the user ('author-provided models') (Marcus, 1998). In interface design, abstract concepts are understood in terms of prototype concrete processes, and 'mapping' between these two domains is a key component of metaphor. This is illustrated by the use of metaphors in graphical user interfaces, where the abstract computer operating system is represented by models and objects from the real world: the symbolic attributes and logic of the source, or the concrete concept (e.g. 'waste basket'), are mapped onto the target, or the abstract concept (e.g. 'delete').

1.1. The benefits of metaphors to navigation

Research on hypertext navigation is based on the idea that there are similarities between navigation in the physical world (real-world navigation) and information seeking in electronic environments, both as a task and as a general activity (Dahlbäck, 2003; Kim and Hirtle, 1995). Studies (e.g. Hammond and Allinson, 1987; Hsu and Boling, 2007; Kim and Hirtle, 1995) have demonstrated the benefit of metaphors within user interfaces to alleviate disorientation (the feeling of being 'lost') and to facilitate navigation (Payne, 2007). It is interesting to note that the term 'navigation' is in itself a metaphor borrowed from seafaring. It was originally applied to hypertext based not on empirical evidence,

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but because a linguistic term was needed to describe the movement between hypertext nodes ('pages'). According to Staggers and Norcio (1993), metaphors serve as the origin of mental models, helping to structure unfamiliar domain. The term mental model is often confused or used interchangeably with other related terms, such as mental imagery and cognitive mapping. Accounts of how mental models develop vary between scholars. The widely used stage model (e.g. Jonassen et al., 1993) proceeds from basic declarative knowledge (knowing that), to structural knowledge (knowing why), to procedural knowledge (knowing how). From a computer professional's point of view, Marcus (2002) describes mental models as 'organisation of data, functions, tasks, roles, jobs, and people in groups at work or play' (p. 48) as they are learned and observed by users. Mental models are incomplete and unstable (Norman, 1983), and evolve through interaction; thus their quality and 'shape' is largely dependent on the individual's characteristics. For this reason, Johnson-Laird (1983) holds that mental models cannot be defined: 'mental models are supposed to be in people's heads, and their exact constitution is an empirical question.' (p. 6). It is, however, important to distinguish mental models from mental images. Mental images can be considered a type of analogue (or quasi-analogue) mental representation. They preserve a lot of the information available in visual images, such as size and distance (Rinck, 2005). It is also necessary to differentiate between mental models and cognitive maps, which refers to a system of spatially and semantically associated information, and the formation declarative knowledge via sensing, encoding, and storing experienced information. This knowledge is then subjected to internal manipulations through, for example, spatial cognition and reasoning (Golledge and Gärling, 2004; Gärling and Golledge, 2000).

The understanding that users have of an information space, their mental model, affects their ability to navigate through it quickly and efficiently (Hirtle, 2006), and becoming lost or disoriented is often associated with difficulties in forming mental models (Gwizdka and Spence, 2007). The relationship between user and interface is in this context not a unidirectional one. On one hand, the mental model of the user can direct the navigation; on the other hand, an interface can affect the mental model held by the user (He et al., 2008). Thus, an interface that reflects the structure of the system will aid the user in navigating that structure. An interface that is poorly organised and does not make relationships clear can cause disorientation. Losing the sense of location within a hypertext environment can cause users to become frustrated, lose interest, and experience a measurable decline in efficiency (Ahuja and Webster, 2001).

1.2. Related work

A decade ago, Boechler (2001) stated that there has been little examination of the use and nature of conceptual metaphors in the minds of computer users. Whilst a recent literature search suggests this comment is still relevant, a qualification based on research focus needs to be made here. The tendency within the field has moved from reporting performance and/or preference for metaphor versus no metaphor (e.g. Kim and Hirtle, 1995), to one metaphor or another (e.g. Padovani and Lansdale, 2003), and more recently to single versus multiple/composite metaphors (e.g. Hsu and Boling, 2007). However, most of these examine simple symbols and author-provided analogies relating directly to the format of the material presented, in particular those based on the office construct (e.g. with 'desktops', 'filing cabinets', and 'folders'). Although numerous websites exist reproducing familiar locations and objects, there appears to be a lack of empirical research in the area that examines metaphors based on more general or expansive themes (but with structures familiar to the user); for example, virtual classrooms and online shops designed to resemble real-world shops. Furthermore, there is little research focusing on the underlying cognitive principles (e.g. spatial properties and familiarity) that make a metaphor effective or not.

Researchers have expressed concerns regarding the source–target mapping, in that a metaphor can never cover the whole domain of its referent (Averbukh et al., 2007). However, rather than being associated necessarily with the specific nature of the information or its presentation, these types of metaphors are developed from repeated encounters with the target domain, providing a generic and frequently implicit framework for interaction. Metaphors like these are based on perceptual patterns that emerge during sensorimotor activity as we manipulate objects, seeking spatial and temporal orientation (Gibbs et al., 2004). This related to what in Lakoff and Johnson's (1980) original framework is known as embodied cognition.

Cronjé (2001) provides a qualitative evaluation of a classroom metaphor used within a virtual learning environment for students enrolled on a master's degree in computer-assisted education. The virtual classroom contained features taken from real classrooms, such as blackboards, cupboards and workstations. Student reactions to, and interaction with, the metaphorical objects were similar to those of students in conventional physical environments, e.g. scribbling on the blackboard and putting your feet on the desk. A case study by Prasolova-Førland (2008) designed to elicit design guidelines for an 'ideal' virtual campus supports Cronjé's findings. She found a preference among students for a virtual environment with features similar to that of a real campus. For example, unrealistic features such as the ability to 'fly' were deemed unnecessary and disruptive. The overall impression was that the users preferred environments where there was 'a proper correspondence between the place and associated tools and facilities' (p. 191).

Examples of research that provide some insight into this type of conceptual metaphors are studies by Lee (2007) and Hsu (2006). Lee compared learning from a home page construction course where the instructional material was presented either using a standard hyperlink interface, or a visual metaphorical interface (similar overall structure but based on a student dormitory building). Participants' computing experience and knowledge of the topic were controlled as far as practicable. The metaphor-based information led to higher structural knowledge and lower feelings of disorientation. Hsu developed an interface using a mailing system as an explicit metaphor (with secondary level metaphors such as address and package) and compared this with no metaphor interface in an Internet Protocol learning test. The provision of the metaphor did not enhance learning in any of the three tests conducted (including delayed testing); nor was there a difference for the mental models created to reflect the structure and connections within the information presented.

Padovani and Lansdale (2003) compared performance on a search task in two structurally identical hypermedia environments embedded in two different metaphors: a house and a social network. Part of the aim of this study was to examine the effect of the spatial properties of metaphor source domains, specifically whether a spatial metaphor would lead to improved performance. The house metaphor was based on an environment adhering to Euclidean principles of geometry, and thus considered 'spatial'; the social metaphor was based on an environment based not on geometry, but on interpersonal relationships, and was considered 'non-spatial'. Task completion was significantly faster and more efficient (navigation efficiency being number of steps relevant to number of retrieved targets) and participants reported feeling lower levels of disorientation for the spatial metaphor. The spatial metaphor was based on the layout of a house where prior general knowledge of the structure could be assumed, and thus considered familiar; whereas the non-spatial metaphor was based on a social