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A neuroergonomic approach to evaluating mental workload in hypermedia interactions

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ABSTRACT

Neuroergonomics could provide on-line methods for measuring mental effort while the operator interacts with hypermedia. We present an experimental study in which 28 participants interacted with a modified version of an existing Spanish e-commerce website in two searching tasks (Goal oriented shopping and Experiential shopping) that demand different amounts of cognitive resources. Mental workload was evaluated multidimensionally, using subjective rating, an interaction index, and eye-related indices. Eye movements and pupil diameter were recorded. The results showed visual scanning behaviour coincided with subjective test scores and performance data in showing a higher information processing load in Goal oriented shopping. However, pupil diameter was able to detect only the variation in user activation during the interaction task, a finding that replicates previous results on the validity of pupil size as an index of arousal. We conclude that a neuroergonomics approach could be a useful method for detecting variations in operators' attentional states.

Relevance to industry : These results could provide important information for the development of a new attentional screening tool for the prevention of accidents in several application domains.

1. Introduction

To avoid the problems associated with hypermedia interactions (such as a disorientation on navigation or a misunderstanding of the content) while still creating a valid alternative to traditional media, it is necessary to understand and improve search processes. This requires research into how human cognitive systems interact with hypermedia to search for and find information. For example, in the learning domain, previous research has shown that a critical variable that explains learners' navigation behaviour is the reading strategies they used (Salmerón et al., 2006a,b). Results from experiments demonstrated that reading strategies affected the understanding of hypertext contents. Concretely, selecting an effective reading strategy is very important for readers without previous knowledge (Salmerón et al., 2006a,b), because an inadequate strategy leads to incoherent navigation and a poorer understanding of the content. An example of inadequate strategy could be to choose the most interesting link instead of the most semantically related link. Previous research has shown that low-knowledge readers benefit more from a strategy that is semantically coherent with the text. By contrast, readers with more previous knowledge about the domain do not need to follow a semantically coherent strategy to comprehend the text (Salmerón et al., 2005).

To understand the main role that navigation strategies play in interactions with hypertext systems, for example, the Internet, it is necessary to investigate the cognitive factors that determine the choice of search strategy. To know and understand these factors are essential for making progress in developing a predictive model of navigation in hypermedia systems that could allow us to make predictions about performance in the tasks of searching, understanding, and learning. This model should provide recommendations to people designing these systems, such as web page designers and teachers designing hypermedia systems. With this aim, we are conducting research on one factor that has been identified by several authors as a possible determinant in defining and developing specific navigation strategy (e.g. DeStefano and LeFevre, 2007), namely, the mental workload involved when a person is interacting with hypermedia.

Mental workload [MW] is a consequence of the interaction between the characteristics of both the structure of the hypertext system and the human cognitive system, because of navigation

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