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Temporal Dynamics of Eye-Tracking and EEG During Reading and Relevance Decisions

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Assessment of text relevance is an important aspect of human–information interaction. For many search sessions it is essential to achieving the task goal. This work investigates text relevance decision dynamics in a question-answering task by direct measurement of eye movement using eye-tracking and brain activity using electroencephalography EEG. The EEG measurements are correlated with the user's goal-directed attention allocation revealed by their eye movements. In a within-subject lab experiment ($N = 24$), participants read short news stories of varied relevance. Eye movement and EEG features were calculated in three epochs of reading each news story (early, middle, final) and for periods where relevant words were read. Perceived relevance classification models were learned for each epoch. The results show reading epochs where relevant words were processed could be distinguished from other epochs. The classification models show increasing divergence in processing relevant vs. irrelevant documents after the initial epoch. This suggests differences in cognitive processes used to assess texts of varied relevance levels and provides evidence for the potential to detect these differences in information search sessions using eye tracking and EEG.

Introduction

Relevance is a central construct for information search and retrieval (IS&R; Borlund, 2003; Hjørland, 2010;

Saracevic, 1975, 2007). We are interested in the human process of making relevance judgments (RJs). Although users can provide some reasons for RJs, the act of judging is opaque. A consequence is poor understanding of the factors affecting RJs (Huang & Soergel, 2013). Understanding RJ cognitive processes is a knowledge gap at the foundations of IS&R. This research seeks to contribute to bridging this gap. We use neurophysiological (NP) instruments to capture psychophysiological signals while a user is making RJs while engaged in information search.

Relevance research is extensive, ranging from theoretical (Hjørland, 2010; Huang & Soergel, 2013; Saracevic, 2007), to behavioral studies (Barry, 1994; Fitzgerald & Galloway, 2001; Taylor, 2012), and to applied and system-oriented evaluation studies (Lesk & Salton, 1968; Ruthven, 2014). RJs have a strong subjective component, yet there is surprisingly little work on internal psychological factors. Theoretical work exists (Wilson & Sperber, 2002), but empirical research addressing RJ cognitive and affective processes is quite recent (Allegretti et al., 2015; Buscher, Dengel, Biedert, & Elst, 2012; Moshfeghi, Pinto, Pollick, & Jose, 2013). Improved understanding of cognitive processes that drive IS&R may eventually allow for causal accounts of user information search behaviors.

Direct elicitation of user RJs poses challenges. Most users will not make the effort to provide explicit relevance feedback (Back & Oppenheim, 2001), and reporting RJs can reflect biases. Inferring relevance implicitly from user actions is attractive (White, Ruthven, & Jose, 2002).