



## Full length article

# The role of reading skills in the evaluation of online information gathered from search engine environments



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## ABSTRACT

A critical evaluation of results to find useful information is essential when doing a web search. In this study, we investigated the evaluation skills of secondary school students, based on their behavior in selecting links from a search engine result page (SERP). To clarify the role of reading when evaluating online information, we assessed students' individual reading skills on word, sentence, and text level. Data from 416 15-year-old students participating in a computer based German add-on study to the *Programme for International Student Assessment (PISA)* in 2012 were investigated. Using generalized linear mixed models (GLMMs), it was found that reading skills affected the ability to evaluate online information. These effects were influenced by the distinctiveness of information in relevance and students' navigation to subsequent SERPs or websites. The results are interpreted to show that skilled readers are able to allocate their cognitive resources more efficiently than less skilled readers when evaluating online information. Implications are discussed in terms of underlying cognitive processes when making web search decisions.

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## 1. Introduction

Search engines have become a ubiquitous tool in using the World Wide Web. As a broad information resource, they provide easy access for web users who seek information for any purpose, such as educational, occupational, and private. However, search engines reveal a vast amount of information considerably varying in relevance and quality. A critical evaluation of information in terms of relevance and credibility is crucial, since an incorrect use of information can result in inappropriate decisions and serious consequences (Brand-Gruwel & Stadler, 2011). Secondary school students use search engines quite frequently (e.g., Feierabend, Karg, & Rathgeb, 2013; OECD [Organisation for Economic Co-operation and Development, 2011]), but they often find selecting adequate online information difficult (e.g., Brand-Gruwel, Wopereis, & Walraven, 2009; Lucassen, Muilwijk, Noordzij, & Schraagen, 2013; Walraven, Brand-Gruwel, & Boshuizen, 2008).

Evaluating the appropriateness of information for solving a

search task requires information to be identified and comprehended. Yet, students and even adults differ in their reading proficiency (e.g., Perfetti, 2007; Sabatini, 2015) which raises questions of how reading skills affect their selection of online information. Therefore, the present study seeks to shed light on the role of reading as a conditioning factor of success when evaluating information from search engine result pages (SERPs). We investigated how reading skills on word, sentence, and text level affect students' evaluation of online information and examined if these effects of reading are influenced by the characteristics of SERP links and individual reader behavior. For the characteristics of SERP links, we considered how distinctive links were in terms of their relevance to a search task (i.e., how similar links were in providing relevant information for solving a task at hand). For individual reader behavior, students' navigation to other SERPs and websites connected to SERP links was investigated.

### 1.1. Processing web search information

An information-based web search usually starts by identifying a gap in one's present knowledge (cf. Brand-Gruwel et al., 2009; Gerjets, Kammerer, & Werner, 2011). Web users define a search

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task, formulate a query, and enter it into a chosen search engine, such as Google. A SERP appears that lists several text abstracts with hyperlinks leading to websites of potential interest (i.e., “links”). Search engines offer an initial classification but it is the users who need to decide if the listed information meets the requirements of their search task. Therefore, web users are assumed to use criteria based on information relevance and credibility that affects their processing and efforts in evaluating online information (Flanagin & Metzger, 2007; Hilligoss & Rieh, 2008; Metzger, 2007; Rieh, 2002).

According to dual processing theory (Evans, 2008; Wirth, Böcking, Karnowski, & von Pape, 2007), web users will evaluate SERP information either heuristically or systematically. Systematic processing means web users perform an extensive evaluation of collected information, based on various characteristics (e.g., topic relevance, trustworthiness, completeness; Salmerón, Kammerer, & García-Carrión, 2013). These processes are slow and deliberate, making them cognitively demanding. The mental costs of thorough search might be severe, especially when dealing with the “information flood” provided by search engines (Rieh, Kim, & Markey, 2012). In contrast, heuristic processing means web users only rely on a limited set of information characteristics for evaluating SERP information (e.g., relying on keywords in links, or information that confirms one’s expectations; Metzger, Flanagin, & Medders, 2010). Heuristic processing is fast and automatic and demands fewer cognitive resources to operate (Gigerenzer & Gaissmaier, 2011), but a one-sided consideration of information can lead to insufficient evaluation outcomes (Wirth et al., 2007).

Assuming limited cognitive resources (as described by DeStefano & LeFevre, 2007), heuristics are of particular importance as they provide mechanisms for reducing the complexity of decision-making (Pan et al., 2007). Metzger et al. (2010) identified from group discussion protocols several social and cognitive heuristics that web users apply when evaluating online information (e.g., interpersonal recommendations, reliance on the reputation, or name recognition of websites). Layout-related cues can be also used for heuristic decision-making (e.g., rank of a link in the hit list; Walraven, Brand-Gruwel, & Boshuizen, 2009). Although minimizing the perceived cognitive costs of web search, heuristics can be insufficient for adequate information selection. Pan et al. (2007) investigated the gaze and click behavior of college students and found different behavioral pattern as the position of links differed. The authors provided their participants with lists of ten links that were either ordered normally (i.e., as derived from Google), normally with the two first links swapped, or the whole list in reverse (i.e., the first ranked link became the 10th, the second ranked link the 9th, and so forth). Participants of the reverse order condition invested more time in checking returned results and websites than participants in the normal and swapped conditions, but inspected the relevant links less often and failed more often to complete search tasks successfully. The displayed position was even a better predictor of link selection than the relevance of the links. Similar results were obtained by Kammerer and Gerjets (2014) who showed that web users relied on the link position to select trustworthy information on a controversial medical issue. Notably, the influence of the position was reduced when a three-by-three grid interface was presented instead of a traditional link list. Participants visually inspected more results before selecting a link in the grid condition, showing that web users can adapt their behavior when heuristic expectations are not met.

## 1.2. The role of reading skills in web search

When evaluating online information, reading is the essential component in receiving and processing written information. While reading, individuals are assumed to actively construct a mental

representation that integrates a text representation of word structures and propositional meaning with one’s general knowledge (Kintsch, 1998; Perfetti & Stafura, 2014; Rouet, 2006). This process is supposed to be semi-hierarchically organized on word, sentence, and text level (e.g., Hamilton, Freed, & Long, 2013; Perfetti & Stafura, 2014; Richter, Isberner, Naumann, & Kutzner, 2012). For experienced readers, basic reading activities on word and sentence level like lexical access and propositional integration occur automatically (Perfetti, 2007; Samuels & Flor, 1997). Controlled processes (e.g., reflection on and evaluation of text) are necessary for deep elaboration of text meaning.

In web search, SERP information is usually fragmented, requiring readers to make selections based on sparse information. Written SERP information is often just skimmed for keywords and phrases (Coiro & Dobler, 2007; Salmerón, Naumann, García, & Fajardo, 2017). Herein, proficient reading skills on word and sentence level might support quick decision-making and heuristic link selection, especially when these skills have become automated (Walczyk, 2000). Nevertheless, controlled reading processes on text level in retrieving meaning and comprehension are indispensable and required to determine which text segments are relevant to a task at hand (McCrudden & Schraw, 2007). If web information is interpreted improperly, web users will come to incorrect conclusions in their evaluations, among other consequences. Rouet, Ros, Goumi, Macedo-Rouet, and Dinet (2011) found, for example, that students matching for exact words selected more irrelevant link titles than students using semantic cues. Using surface cues, such as in word matching might spare cognitive resources, but it is often not an appropriate heuristic strategy for assessing information relevance.

### 1.2.1. The impact of information relevance

According to current models of web navigation (e.g., CoLiDeS+; Juvina & van Oostendorp, 2008), link selection is driven by the semantic similarity—or information scent—between presented information and a pursued search task (Blackmon, 2012). Information scent is assumed to be delivered by semantic and contextual cues in the link. Readers need to interpret and use these sparse cues in digital text environments to determine nuances in information relevance (e.g., Foltz, 1996). Blackmon (2012) found that web users are likely to select an adequate link if its information is semantically close to a search task. However, the selection rate dropped tremendously as semantic similarity of other links increased. Blackmon concluded that links compete for the attentional resources of web users, especially if they are highly similar. This means that instead of trying to create a comprehensive picture of a text situation for a comprehensive assessment of relevance, web users are likely to process only as much information as necessary to come to a (in their opinion) suitable conclusion.

Regarding proficiency in reading, web users might be especially able to select adequate links when the task-specific relevance of information is easy to identify and they are not required to extensively allocate their cognitive resources. For students, when seeking information, for example, about migraines to prepare a talk for biology class, advertisements for new pharmaceuticals would be easier to discard as irrelevant material than scientific articles in medical journals (that are not suitable since they usually address the information needs of experts rather than school students). For this example, a suitable link might lead to an expository text on migraines (e.g., identifiable by giving a definition, or announcing to provide comprehensive information). The SERP links normally share the same keywords (“migraine”), but they also provide further semantic cues (e.g., references to pharmaceuticals and companies, use of technical terms) that readers can use to determine the relevance of the link for a search task. In the case that all

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