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Literature examining information judgments and Internet search behaviors notes a number of major research gaps, including how users actually make these judgments outside of experiments or researcher-defined tasks, and how search behavior is impacted by a user’s judgment of online information. Using the medical setting, where doctors face real consequences in applying the information found, we examine how information judgments employed by doctors to mitigate risk impact their cognitive search. Diaries encompassing 444 real clinical information search incidents, combined with semistructured interviews across 35 doctors, were analyzed via thematic analysis. Results show that doctors, though aware of the need for information quality and cognitive authority, rarely make evaluative judgments. This is explained by navigational bias in information searches and via predictive judgments that favor known sites where doctors perceive levels of information quality and cognitive authority. Doctors’ mental models of the Internet sites and Web experience relevant to the task type enable these predictive judgments. These results suggest a model connecting online cognitive search and information judgment literatures. Moreover, this implies a need to understand cognitive search through longitudinal- or learning-based views for repeated search tasks, and adaptations to medical practitioner training and tools for online search.

Introduction

Information search is a process by which a person seeks knowledge about a problem or situation, constituting a major activity by the Internet’s millions of users (Browne, Pitts, & Wetherbe, 2007). The Web is now a primary source of information for many people, driving a critical need to understand how users search or employ search engines (Jansen & Spink, 2006). Extensive literature examines not only behavioral models detailing the different moves or tactics during Internet search but also decision making or strategies described as cognitive search models (Navarro-Prieto, Scaife, & Rogers, 1999; Thatcher, 2006, 2008). The latter examines the cognitive aspects of the moves users employ to optimize their search performance, exploring elements such as expert-novice differences or judgments on when to terminate the search (e.g., Thatcher, 2006, 2008; Cothey, 2002; Jaillet, 2003; Browne et al., 2007). This notion of judgment introduces a second stream of literature, Internet information judgments, where authors note that the use of predictive information judgments impacts decision making in search, based on an anticipation of a page’s value before viewing it (Rieh, 2002; Griffiths & Brophy, 2005).

Cognitive search models rarely explore the impact of predictive judgments. Most studies are based on tasks defined by researchers in experimental settings that are difficult to generalize to professional contexts or real use (Thatcher, 2006; 2008). Scholars have, therefore, called for research into
clinical information retrieval for professional purposes: we pose the following questions concerning doctors’ online search and retrieval (Bennett, Casebeer, Kristofco, & Strasser, 2004). This suggests that the credibility of the online source is a major factor influencing doctors’ information search and retrieval (Bennett, Casebeer, Kristofco, & Strasser, 2004). This suggests that the medical practice is a rich setting in which to examine the impact of information judgments on cognitive search. Therefore, we pose the following questions concerning doctors’ online clinical information retrieval for professional purposes:

RQ1: What characterizes the cognitive search models of practicing medical doctors?
RQ2: What information judgments do doctors apply during online search?
RQ3: How do information judgments impact doctors’ cognitive search models?

We begin by reviewing the literature on Internet search and online information judgments, and then we summarize the relevant research gaps that this study addresses, which includes examining real information retrieval (Rieh, 2002; Thatcher, 2008), how users actually make information judgments (Metzger, 2007), and how search behavior is impacted by them (Rieh, 2002; Browne et al., 2007). The method and the results of each research question are then described in turn. Finally, we discuss the major contributions of this article, which extends previous research by the following: (a) detailing the dominant types of information need, cognitive search strategies, and information judgments used by practicing doctors; (b) suggesting the low applicability of the credibility construct in this context; (c) demonstrating the navigational bias in cognitive search models, a bias that acts on information queries and is driven by doctors’ predictive judgments; (d) describing how the predictive judgments are enabled by users’ mental models of the Internet and search experience relevant to the task; (e) proposing a model to connect information judgment and cognitive search literature; (f) suggesting the difficulty of studying cognitive search as an isolated task in experimental settings, and the need for a longitudinal view of search behavior over time; and (g) providing specific avenues for further research for both information science and medical practitioners in addressing potential needs for Internet search training.

Research Framework

Online Search Behavior

The extensive research into online search behavior demonstrates that Internet search is strongly characterized by a user’s goals and objectives (Jansen, Booth, & Spink, 2008; Rose & Levinson, 2004). Scholars broadly categorize these goals as navigational (to arrive at a URL), informational, and resource based or transactional (to obtain products, services, or other resources). This last category has been a major focus of research, examining Web consumers and online purchases from a marketing perspective (e.g., Rowley, 2000; Ward & Ostrom, 2003; Wu & Rangaswamy, 2003). However, although online shopping is proceeded by information search, it seeks to obtain resources and is influenced by a user’s own previous experience with a physical product or brand (Rowley, 2000). Hence, this is distinct to Rose and Levinson’s (2004) directed information goals that would apply to the professional medical context.

For this reason, our study focuses on general Internet search literature, where action models (Thatcher, 2006, 2008) represent a major stream detailing users’ specific “moves” in search (Marchionini & Schneiderman, 1988). Scholars identify two fundamental starting choices: accessing a general search engine or using a familiar Web site (Choo, Detlor, & Turnbull, 2000; Holscher & Strube, 2000). They also detail specific moves that describe the user’s first guess query, use of Boolean terms, or selection processes from the results returned. The selection process involves assessing the value of results returned and making trade-offs between further iterative text searches and browsing the directories of large sites (Choo et al., 2000; Dennis, Bruza, & McArthur, 2002). Authors examining “moves” also called for studies exploring search at higher levels of abstraction or as strategies and patterns of behaviors (e.g., Byrne, John, Wehrle, & Crow, 1999). Scholars have denoted these as cognitive search models (Navarro-Prieto et al., 1999; Thatcher, 2006, 2008), decision making in search (Browne et al., 2007), and information foraging (e.g., Pirolli, 2007).

Although the effectiveness of online searching relative to other sources has also been examined (e.g. Hodkinson & Kiel, 2003; Sohn, Joun, & Chang, 2002), cognitive search models focus only on online behavior. Researchers observe that in addition to task type, many user characteristics impact decision making or strategy, including expert-novice differences, users’ mental models of the Internet, individual cognitive and learning styles, demographic characteristics, subject matter or domain knowledge, and physical and affective state.

Table 1 shows these major research lines and associated papers, serving as an introduction to key areas of the field, rather than exhaustive review.

Looking more deeply at cognitive search, Thatcher (2006, 2008) identifies 12 different strategy archetypes, which are strongly differentiated by the starting choice of either search engine use or direct familiar site access (see Choo et al. 2000; Holscher & Strube, 2000). Search engine-based strategies include using a generic search engine (“broad first”),
TABLE 1. Research areas in online information retrieval or Internet search.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Example construct or factor examined</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action models or “moves”</td>
<td>Analysis of discrete “moves” that form search behavior (e.g., analytical searching using search terms; browsing by clicking on hypertext; scan-and-select through search engine results; generating queries; examining search results; selecting results; reformulating queries)</td>
<td>Byrne et al., 1999; Choo et al., 2000; Griffiths &amp; Brophy, 2005; Jansen &amp; Spink, 2006; Johnson et al., 2004; Pan et al., 2007; Tauscher &amp; Greenberg, 1997</td>
</tr>
<tr>
<td>Cognitive models (focusing on strategy)</td>
<td>Examining how these “moves” combine into cognitive patterns, e.g., Fidel et al.’s (1999) or Thatcher’s (2000) cognitive search strategy archetypes or Pirolli’s (2007) navigational model based on the Information Foraging Theory</td>
<td>Catledge &amp; Pitkow, 1995; Cothey, 2002; Fidel et al., 1999; Fu &amp; Pirolli, 2007; Navarro-Prieto et al., 1999; Kim, 2001; Pirolli, 2007; Schacter et al., 1998; Thatcher, 2006, 2008; Wang et al., 2000</td>
</tr>
<tr>
<td>Task structure and complexity</td>
<td>Differences in the task complexity resulting in different search patterns (e.g., a migration to Boolean search in highly complex tasks when experiencing navigational disorientation)</td>
<td>Browne et al., 2007; Ford et al., 2005a, 2005b; Navarro-Prieto et al., 1999; Kim &amp; Allen, 2002; Schacter et al., 1998; Thatcher, 2006, 2008</td>
</tr>
<tr>
<td>Expert-novice differences</td>
<td>How Web search experience impacts search behavior, e.g., experts demonstrate more selective and analytical search processes</td>
<td>Browne et al., 2007; Cothey, 2002; Hargittai, 2002; Hodkison &amp; Kiel, 2003; Holscher &amp; Strube, 2000; Lazendorf, 2000; Thatcher, 2006, 2008; Wang et al., 2000</td>
</tr>
<tr>
<td>Mental models (of the Internet)</td>
<td>How mental models of the internet induce behaviors, via simplistic and utilitarian models, or complex structural mental models of the Internet</td>
<td>Cahoon, 1998; Hargittai, 2002; Papastergiou, 2005; Slone, 2002; Wang et al., 2000; Zhang, 2008</td>
</tr>
<tr>
<td>Domain knowledge</td>
<td>How subject matter or domain knowledge influences search strategy (e.g., domain knowledge induces less time with a document from that domain)</td>
<td>Holscher &amp; Strube, 2000; Jailliet, 2004</td>
</tr>
<tr>
<td>Individual characteristics</td>
<td>How cognitive style, learning style, epistemological beliefs, or demographic characteristics produce tendencies to use specific search patterns (Boolean, best match, combined etc.)</td>
<td>Ford et al., 2002, 2005a, 2005b; Hodkison &amp; Kiel, 2003; Jansen, Booth, &amp; Smith, 2008; Kim, 2001; Kim &amp; Allen, 2002; Kyung-Sun &amp; Bryce, 2002; Sohn et al., 2002; Whitmire, 2004</td>
</tr>
<tr>
<td>Physical or affective</td>
<td>How affective or physical state relates to the speed of a search</td>
<td>Wang et al., 2000</td>
</tr>
</tbody>
</table>

search engines with specific attributes (“search engine narrowing down”), and “to-the-point” strategies, where users have knowledge of specific search terms to drive a particular result. In navigating directly to a known site (“known address”), users initiate their search at familiar Web sites. Other strategies named by Thatcher attempt to optimize search through use of mixed approaches and multiple browser windows. In additional to efforts, like Thatcher’s, to categorize search patterns, other authors have attempted to model specific aspects of search or navigation. For instance, Pirolli’s (2007) SNIF-ACT model describes navigational behavior based on the information foraging theory (IFT). Using the perceived relevance or utility of a Web link, called information scent, this model provides an integrated account of the link selections and the timing of when people leave the current Web page (Fu & Pirolli, 2007). Although focused on navigation, this highlights the rarely researched link between search patterns and information judgments.

However, few studies examine this in a professional context or via real information use (Thatcher, 2006, 2008), and so the transferability of this previous research cannot be assumed. Moreover, we cannot simply apply these constructs, as often literature does not arrive at a consensus on their contents. For example, mental models can be described via Zhang’s (2008) interpretation of technical, functional, or process views, distinct to the utilitarian view supported by Papastergiou (2005). Consequently, while seeking to identify the factors identified in previous research, this study looks for them inductively, utilizing their conceptual frame rather than the previous detailed implementations of the construct. Furthermore, for the purpose of constraining the study scope (and presuming the ability to generalize across different contexts), we exclude the aforementioned factors of cognitive style and affective state. Figure 1 provides a simplified representation of this literature, where the arrows indicate an influence on cognitive search strategy.
In the broader literature, quality is often used to denote the concept of credibility (Haddow 2003; Klobas, 1995). However, judgments during online information retrieval differ from other contexts such as traditional media (Danielson, 2005; Sohn et al., 2002). Hence, this article focuses on literature specific to information judgments on the Internet, where scholars identify different judgment criteria that encompass information quality, credibility, and cognitive authority (Rieh & Danielson, 2007). Information quality is a user criterion concerning excellence or truthfulness in labeling, and it includes the attributes of usefulness, goodness, currency, and accuracy (Rieh, 2002). Credibility refers to the believability of some information or its source (Fogg, 1999; Fogg & Tseng, 1999; Metzger, 2007; Wathen & Burkell, 2002), which encompasses accuracy, authority, objectivity, currency, and coverage judgments (Brandt, 1996; Meola, 2004; Metzger, 2007; Metzger, Flanagin, & Zwarun, 2003). Finally, cognitive authority explores users’ relevance judgments, based on Wilson’s (1983) definition of “influence on one’s thoughts that one would recognize as proper” (p. 15). Rieh (2002) examined a series of studies in this last stream (such as Park, 1993; Wang & Soergel, 1998, 1999), proposing its facets as trustworthiness, credibility, reliability, scholarliness, how official it is, and its authority. Most studies can be related to these three higher order constructs based on their self-declared focus. However, these concepts clearly overlap, and many scholars use different definitions and alternative lower order constructs (see Table 2).

In addition, literature also details many judgment methods, including checklist, contextual, external and stopping rule approaches. The most common is the checklist approach, where users scrutinize aspects of the document obtained (e.g., source, author or timestamp) to determine the value of a page (Meola, 2004; Metzger, 2007). However, users rarely fully employ this method, leading authors to propose a contextual approach covering comparison, corroboration, and the promotion of reviewed resources (Meola, 2004). Comparison involves the relative judgment of two similar Web sites and corroboration as the verification of some information contained therein with an alternative source. Promotion of reviewed resources overlaps with literature on rating systems (e.g., Eysenbach, 2000; Eysenbach & Diepgen 1998; Wathen & Burkell, 2002), where the judgment is partly external to the user performing the information retrieval.

In contrast, Browne et al. (2007) suggest users employ stopping rules to terminate search, judging that they have the information to move to the next stage in the problem-solving process (Browne et al., 2007; Browne & Pitts, 2004). Browne details mental lists similar to the checklist containing criteria that must be satisfied. Other rules are possible, such as having representational stability on the information found, stopping when nothing new is learned, gathering information to a certain threshold, or using specific criteria related to the task.

Moreover, authors note that these judgments occur at different times and on different artifacts. For instance, evaluative judgments occur when information is browsed and predictive judgments are made before a page is accessed. The latter is based on a user’s anticipation of a page’s value impacting their search strategy (Griffiths & Brophy, 2005; Rieh, 2002).

All in all, there are many overlapping constructs for exploring users’ information judgments (see Table 2). It is not our objective to propose a single abstract definition, reconcile them, or explain each lower order construct. Rather, we seek an appropriate framework for the applied medical context. Research into use of online health information has mainly focused on patients, and studies suggest a primary focus on information accuracy (Haddow, 2003; Rieh & Danielson, 2007) and cognitive authority (Rieh, 2002). For health information experts, research indicates focus on judgments of source and author (Fogg et al., 2003). However, scholars also note that a wide range of judgments are used for health information (Eysenbach, Powell, Kuss, & Sa, 2002); hence, this approach provides no unified definition of online information judgment constructs. Partial attempts to delineate these constructs made by Rieh (2002) and Metzger (2007) provide a basis for taking information quality to include usefulness, goodness, currency, and accuracy (Rieh, 2002), credibility to encompass accuracy, authority, objectivity, currency, and coverage (Metzger, 2007), and cognitive authority to include trustworthiness, credibility, reliability, scholarliness, how official it is, and its authority (Rieh, 2002). Although there is major overlap between credibility and other the constructs, each is used in an extensive number of studies and cannot be simply discounted, suggesting an inductive approach to this study to determine which is most appropriate. Furthermore, these are considered alongside the distinction of predictive judgments made before a page is seen and evaluative judgments while a page is browsed (Rieh, 2002). These definitions are marked in bold in Table 2 below, alongside certain examples of the alternative variations used.

**Medicine as a Rich Context in Applied Internet Search**

Previous research reveals important gaps that are yet to be addressed: (a) examining how information judgments impact search behavior (Browne et al., 2007; Rieh, 2002); (b) detailing how users actually make these judgments (Metzger, 2007); and (c) supplementing the predominantly used study design of log file analysis, survey analysis, researcher-defined experiments, and academic settings (Hargittai, 2002; Metzger, 2007; Rieh, 2002; Thatcher, 2008). This last observation is supported by our own analysis; of 43 empirical studies described in the Supporting Information, each involves at least one of the researcher-defined experiments, academic contexts, or the use survey and log file methods. These approaches have different advantages, such as the potential large sample sizes possible through log file analysis, or better isolation of variables and detection of cause-and-effect relationships through experimental methods. However, a concentration in experimental approaches...
T A B L E 2. Different criteria with which users judge information on the Internet (those used shown in bold).

<table>
<thead>
<tr>
<th>Higher order construct</th>
<th>Papers/authors</th>
<th>Lower order constructs contributing to higher order construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>Olaisen, 1990</td>
<td>Actual value, completeness, credibility, accessibility, flexibility, form</td>
</tr>
<tr>
<td></td>
<td>Knight &amp; Burn, 2005; Klobus, 1995; Wang &amp; Strong, 1996</td>
<td>Multidimensional construct based on fit for purpose, e.g., intrinsic, representational, accessibility, contextual</td>
</tr>
<tr>
<td></td>
<td>Zeist &amp; Hendriks, 1996</td>
<td>Functionality, reliability, maintainability, portability efficiency, usability</td>
</tr>
<tr>
<td></td>
<td>Kahn, Strong, &amp; Wang, 2002</td>
<td>Product quality (sound and useful), service quality (dependable and useable)</td>
</tr>
<tr>
<td></td>
<td>Haddow 2002; Rich, 2002</td>
<td>Information quality covering usefulness, goodness, currency, and accuracy</td>
</tr>
<tr>
<td></td>
<td>Meola, 2004</td>
<td>Quality (authority, accuracy, objectivity, currency, coverage) assessed by comparison, corroboration and promoted resources</td>
</tr>
<tr>
<td></td>
<td>Tombros, Ruthven, &amp; Jose, 2005</td>
<td>Quality (scope/depth, authority/source, currency, formatting), structure, presentation or physical presentation</td>
</tr>
<tr>
<td>Credibility</td>
<td>Brandt, 1996</td>
<td>Credibility (with reliability, perspective, purpose, and author credentials)</td>
</tr>
<tr>
<td></td>
<td>Johnson &amp; Kaye, 1998</td>
<td>Credibility (with focus on trust)</td>
</tr>
<tr>
<td></td>
<td>Fogg et al, 2001, 2003; Fogg &amp; Tseng, 1999; Wathen &amp; Burkell, 2002</td>
<td>Credibility (with particular focus on trustworthiness and expertise)</td>
</tr>
<tr>
<td></td>
<td>Liu &amp; Huang, 2005</td>
<td>Credibility (presumed, reputed, and surface: author/reputation/affiliation and information accuracy/quality)</td>
</tr>
<tr>
<td></td>
<td>Hong, 2006</td>
<td>Credibility (in terms of expertise, goodwill, trustworthiness, depth, and fairness)</td>
</tr>
<tr>
<td></td>
<td>Metzger, 2007; Metzger, Flanagan, &amp; Zwarun, 2003</td>
<td>Accuracy, authority, objectivity, currency, and coverage (based on the review of the field)</td>
</tr>
<tr>
<td>Cognitive authority</td>
<td>Fritch &amp; Cromwell, 2001</td>
<td>Personal (author), institutional (publisher), textual type (document type), intrinsic plausibility (content of text)</td>
</tr>
<tr>
<td></td>
<td>McKenzie, 2003 (based on Wilson, 1983)</td>
<td>Using Wilson’s definition as “influence on one’s thoughts that one would recognize as proper” (p. 15)</td>
</tr>
</tbody>
</table>

 echoes the concerns for generalizability to other social sciences, where the innocuous consequences for the participant can produce potential behavioral differences compared with real life contexts (see Camerer, 2003).

Hence, doctors’ Internet use provides a rich research setting to supplement these predominantly used methods, as there are stakes or risks for the user in information search. Doctors use the Internet frequently, with a major use and the focus of this study being the search and retrieval of clinical information (Masters, 2008). Use of online resources has been shown to generally improve doctors’ clinical decisions, but occasionally leads to errors in which individuals respond to information supplied by the computer, even when it contradicts their existing knowledge (Westbrook, Coiera, & Gosling, 2005). This risk is inherent in the introduction of any clinical decision support system, where doctors potentially become less vigilant towards errors (Kohli & Piontek, 2007). Hence, despite this potential improvement to clinical care, there is much concern about the possible use of inaccurate online health information, and doctors’ perceptions of source credibility has been identified as a major factor driving its use (Bennett et al., 2004).

In this context, Google is described as a useful diagnostic tool (Johnson, Chen, Eng, Makary, & Fishman, 2008; Sim, Khong & Jiwa, 2008; Tang & Ng, 2006), but its use in medicine has been met with controversy. Authors criticize its effectiveness or downplay Google’s role entirely by suggesting that doctors go directly to preferred or trusted medical sites (De Leo, LeRouge, Ceriani, & Niederman, 2006; Falagas, Pitsouni, Malietzis, & Pappas, 2007; Koenig, 2007; Taubert, 2006). Furthermore, online health information is being impacted by the emergence of Web 2.0, a term that represents both a new philosophy of open participation on the Internet, and a second generation of Web-based tools and communities that provide new information sources (Boulos & Wheeler, 2007; Giustini, 2006; McLean, Richards & Wardman, 2007; Sandars & Haythornthwaite, 2007; Sandars & Schroter, 2007). Web 2.0 has also cultivated further concerns about the quality and credibility of information generated (Hughes, Joshi, & Wareham, 2008), and implicit in the negative reaction to Google and Web 2.0 use is the fear of introducing “inaccurate” information into decision making in health.
Consequently, our study provides an ideal setting to examine how information judgments influence search behavior (see Browne et al., 2007; Griffiths & Brophy, 2005; Rieh, 2002). Few studies examine the detail of doctors’ online information judgments or search behaviors (Podichetty, Booher, Whitfield, & Biscup, 2006). In addition, there are overlapping constructs in studies examining judgments of online information, and only little work connecting cognitive search models and information judgment literature. For this reason, we take an exploratory and mainly inductive approach to this study, as described in the following section.

**Methods**

The sample of 35 volunteer doctors was selected via stratified sampling from a group of 300 that had originally graduated from a major London medical school. This ensured a diverse range of specialties, as information-seeking behaviors are observed to differ among types of medical practice (Bennett, Casebeer, & Kristofco, 2005). The stratification was approximate, given the sample size, using incremental recruiting to fill quotas to ensure multiple participants from each of the 10 most numerous specialties (for detail see National Health Service, Department of Health, England, 2004). In addition, a specific seniority of 2–3 years out of medical school was selected to ensure regular information retrieval on the Internet, as this age group is more comfortable with the Internet (Rettie, 2002) and use it more in medical practice (Masters, 2008). The participants were 57% female, 43% male, and had an average age of 27 years. They were contacted via e-mail, without any specific incentive to participate, and provided the information between April and July 2008.

A multimethod approach was employed after scholars’ recommendations to supplement the commonly used survey or log file methods for investigating behavior in Internet use (Hargittai, 2002). Moreover, literature has highlighted the value of diaries in recording routine or everyday processes (Verbrugge, 1980) and was augmented by the interview-diary method (Easterby-Smith, Thorpe, & Lowe, 2002), which allowed the capture and discussion of real instances of information needs.

An initial test of the diary instrument, not included in final results, was completed with five doctors. This was to address a known issue with diaries; participants often require detailed training sessions to fully understand the protocol (Bolger, Davis, & Rafaeli, 2003). This testing allowed a short training session to be developed (e.g., example diary, introduction by phone). After the evaluation of the diary instrument, participants were invited to complete diaries online during a doctor’s break or at shift end, avoiding interference with the online behavior in observation, but within a short enough time frame such that detailed aspects of use could be documented. Each encompassed a minimum of 5 days at work, and was semistructured around the following topics: (a) the sites that they had used during the day, (b) examples of how and for what purposes they had used the sites, and (c) negative or positive incidents in using the Internet that day (if any). The recording of the diary was on sequential days; hence, if no information retrieval was made, the diary entry remained blank. The researchers were able to monitor the diary completion online, which allowed encouragement to doctors to restart or complete them via phone or e-mail. Two diaries had to be discarded as they did not follow this process (e.g., all the diary was filled in on one day).

The remaining completed diaries represented 177 days of recorded online information, and, in general, participants reported that this occurred in the doctor’s work location in a hospital ward or in a clinic, as an individual task, and during or before patient encounters. Within 2 weeks of completing the diary, participants were interviewed for 20–70 minutes (recorded, transcribed, and shared with the participants). The interviews were semistructured and elicited further qualification of the incidents described in the diary, thereby offering a complementary perspective on the same data. Preanalysis of the diaries was not performed, though the interviewer was familiar with its contents. In the interview, doctors were asked to tell stories about a particular incident; hence, the interviews were loosely structured around the critical incident technique, a robust technique to identify the participant’s motivations (Easterby-Smith, Thorpe, & Lowe, 2002).

The extensive qualitative data were examined via thematic analysis (Boyatzis, 1998). Early code development allowed the sample size to be determined, as saturation was seen after only 20 interviews. However, a final sample of 35 was used as recruitment had already exceeded this amount. Two types of coding were initiated: a priori codes identified via the literature review (specifically codes 8–11 in the results were completely a priori) and inductive and open coding to identify themes emerging from the data. These two groups were then reconciled by two researchers through resolution of overlaps and establishing hierarchy in code groups or nodes. This mixed approach was required, as although the applicability of constructs from literature to this context could not be assumed, the extensive research into general Internet search could also not be ignored via an entirely inductive approach. Given that a large number of themes and codes were identified, focus was placed only on those of strong presence, specifically, when observed in over 50% of the sample in individual’s interview and diary. This approach was taken as authors have argued that such measures help ensure robustness of the patterns observed (e.g., Bala & Venkatesh, 2007). Based on this, a final coding template (King, 2004) was applied to the full data set, followed by a measurement of intercoder reliability using the Cohen’s Kappa statistic (see Fleiss & Cohen, 1973). This obtained a value of $k = 0.886$ (standard error = 0.023) across all interview and diary codes based on comparison between two researchers.

**Results**

The results of the diaries revealed 444 search incidents. Hence, doctors were searching for online clinical information an average of 2–3 times a day. No differences were observed...
between types of specialty or groups of related specialties with similar characteristics (e.g., hospital vs. clinic), and all doctors used the Internet and exhibited some of the patterns identified. Doctors used an extensive number of sites (over 50), including some recommended by the NHS, such as PubMed1 (30% of doctors and 8% of all searches incidents). However, they also used many other general-purpose sites, such as Google (79% of doctors or 32% of all incidents), Wikipedia (71% of doctors and 26% of incidents), as well as an array of patient forums or medical-specific wikis. On average, doctors made 12.7 searches (standard deviation = 8.7) using 4.9 separate sites (standard deviation = 2.3) during the week. This latter figure includes only search engines used and the final content site where the participant achieved (or gave up) the information search. We specifically quote this figure as the recording of intermediate sites (those participants had visited during the search, but continued searching) was inconsistent.

In the following sections we describe the results of the coding of both diaries and interviews, relating them to each research question in turn. The coding scheme is fully detailed in Appendix, and includes direct quotes from doctors. During the course of describing the results we will provide IDs of the codes (e.g., ID x) to allow reference to this table where needed.

**RQ1: Characteristics of the Cognitive Search Models of Practicing Medical Doctors**

Doctors had two dominant types of information need or search task: to solve an immediate defined problem (e.g., “the best beta blocker to use for someone with heart failure”) or to get background information on a subject. The former is to advance an immediate task in the clinical context and forms a closed question with a specific answer (ID 1). The latter is an open question driven by the need to be knowledgeable about a subject in front of medical staff or patients, to understand a topic in greater depth, or to later define a specific closed question relating to patient management (ID 2). If it is a background or open question, then the impact on doctors’ immediate decision making is reduced:

To get some background information on something that I’m not really familiar with. . . . It tends not have a big influence on my management plan. (ID 2)

To find out information about something that I did not really know about, but not necessarily to make clinical decisions on how to treat a patient. (ID 2)

Most of the time you don’t want to know a great amount of information. You just want a basic overview about a rare condition. (ID 2)

Doctors’ search models have similar characteristics to those of experts noted in previous studies, spanning three main types: (a) direct access to familiar site (ID 3), (b) using Google as a navigational device or biased search (ID 4), and (c) using Google for normal search (ID 5). The first and third search patterns were previously identified by Thatcher (2008); however, the second is a distinct pattern not clearly noted in previous studies, and might be known as “known address bias” following Thatcher’s specific nomenclature.

This notion of address bias is used to orientate search engine use towards a site that the user believes may have appropriate information on the required subject, and if found in the search engine results, to navigate directly to that page within the preferred site. This was used by 48% of doctors, with two approaches, as 28% of all doctors used specific site names in the informational queries and 41% made preferred selections from results. This is clearly based on previous experience and site use related to the specific task. It also extends Rose’s (2004) notion of navigation goal, which refers to a shortcut to a site in general. Additionally, it differs from Thatcher’s “search engine narrowing down” where bias comes from the attributes of a specific search engine, and here bias originates from anticipated value of the specific final content site that will be used. For example, during query formulation:

I put what I’m looking for, and then I put eMedicine2 and Wikipedia, and I put that through Google [clicked search]. (ID 4)

If there is syndrome that I haven’t heard of, then I would type into Google with the exact phrase. . . . I would select the Web sites that have heard of. (ID 4)

In addition, closed information needs precipitated a direct-to-site or known address strategy. In 37 examples of detailed cases examined, 84% of closed question needs where satisfied by direct-to-site strategies (ID 6a/b).

**RQ2: Information Judgments Doctors Apply During Online Search**

In looking at the criteria doctors apply, the credibility construct is not as useful as information quality or cognitive authority in detailing doctors’ information judgments for two reasons (see ID 8). First, within the construct of cognitive authority, the notion of credibility appears the least important. Second, objectivity and coverage are the only parts of the credibility construct not encapsulated in information quality or cognitive authority; however, these parts of the construct were also not considered important (see Table 2 for definitions). Even so, doctors are using very diverse criteria to judge the value of information, similar to those used by patients, focusing on information quality (usefulness, goodness) and cognitive authority (trustworthiness, authority). All of these important criteria observed are encompassed by Rieh’s (2002) notions of information quality and cognitive authority.

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2www.emedicine.com: Online clinical reference owned by WEBMD, constructed with over 10,000 contributing doctors.
FIG. 2. Level of predictive judgment impact to cognitive search models.

Regarding the method used to make these judgments, different elements of the checklist, the following contextually and externally rated approaches are used:

- **The checklist approach** is dominated by judgments regarding past experience with source/organization or ranking in search engine output, though many other techniques were seen, such as citations of scientific data or other sources (ID 9).
- **The contextual approach** is used, especially the use of promoted resources by hospitals or medical schools, or corroboration of content found. Few doctors compared resources directly (ID 10).
- Finally, the externally rated approach was heavily used, less via official ratings of resources or tools, and mainly due to recommendations by colleagues (ID 11).

In addition, little use of stopping rules was observed, except for the dominant criterion of using information from sites for which the user had a mental model. This said, despite awareness of and the occasional use of these methods, both diary and interview data revealed that doctors rarely made evaluative judgments on information found for two reasons. First, an open or background information need is less directly related to immediate clinical decisions and has lower requirements for information quality or cognitive authority. Second, and more important, doctors rely on predictive judgments to introduce navigational bias into their informational queries, thereby arriving at sites with known information quality or cognitive authority.

**RQ3: How Information Judgments Impact Cognitive Search Strategy**

Doctors used cognitive strategies with navigational bias at various stages search. We will demonstrate this interplay of information judgments and cognitive search using a basic narrative of search as described by Holscher and Strube’s (2000) action model of select/launch search engine, generate/submit query, select document from results, and browsing the document obtained. This discussion follows Figure 2 below, where coding results are “hung” on the action model as a descriptive device. The numbers in brackets denote the code ID relevant to an action step in Holscher and Strube’s representation. Grey boxes have no specific code in this study, but they are included for descriptive completeness. Finally, solid lines indicate the dominant patterns observed in the study, and dashed lines indicate patterns that were either less frequent or not observed at all.

Following the diagram top to bottom, the task initially dictates a specific closed or open information need (ID 1, 2). As noted before, closed information needs often impact a medical decision and require a specific level of quality or authority. As a result, in selecting a Web site or search engine,
the tendency is for closed information needs to precipitate known address strategies of going directly to known sites (ID 6).

Nonetheless, the majority of searches did use a generic search engine, often with bias towards the known sites in the generate/submit query stage by including site names in the search query (ID 4). As noted previously in the known address bias strategy, Google, in particular, was used as a navigation device to access the appropriate part of a specific site quickly. The doctor attempts a match to sites of which they have a mental model. In addition, in selecting the document to be browsed from the returned list, there was inherent bias towards sites of which they had a mental model. Even before formulating the query, the doctors knew that the sites with known quality or cognitive authority will be returned, selecting them in predetermined orders. Although finding new sites is possible, the use of search engines was therefore strongly orientated towards existing trusted sites. For example:

So, you can just Google basic facts . . . more often than not it does come up with sites such as eMedicine or the national library. (ID 4)

If you type in a medical symptom in Google, most of the hits will be medical Web sites and it is quicker than going to them directly. (ID 4)

The doctors’ mental models of various Internet sites allow this target to be selected, and the model contains perspectives on a sites information quality (including utility) and cognitive authority. Hence, this supports the utilitarian view of mental models described by Papastergiou (2005). For example:

I would start with the official government sites first, sites that you know are accredited second, and then work my way down. I have a kind of hierarchy of sites in my head. (ID 12a)

From experience, you tend to do it every day, you find some sites usually provide better clearer information than others, and you learn as you go along. What is reliable or not, you remember. . . . (ID 12a)

In browsing and assessing a certain document, it is likely that the doctor has already resolved issues around information quality and authority, as search is biased towards a site of which they have a mental model. This applies even where the task requires information of increased quality or cognitive authority, as doctors use predictive judgments based on experience of the source to determine if these needs are resolved.

The process of building and using a mental model of sites was employed by most of the sample and was constructed from past experience and the contextual approach prescribed by Meola (2004). In particular, this relied on resources promoted by medical schools or hospitals and recommendations from colleagues. For example:

I was told by colleagues which ones are reliable, and the trusted Web site has useful links. Or, by searching you learn which sites are useful and which aren’t. (ID 13)

It’s through Googling, whatever comes up in the top 5. You use them and can learn to trust them. NICE3 guidelines and Pubmed I picked up at med school. (ID 13)

This experience allows users to create mental models that allow them to make predictive judgments and optimize their search effectiveness, and this explains the bias in cognitive strategies described in research question 1.

On the rare occasions that doctors made evaluative judgments, they performed evaluative information judgments using sites or sections of sites of which they have no mental model. Most often, they use checklist actions or their domain knowledge to corroborate the quality of the information found. For example:

If they are sites I rely on anyway, then a lot of it I won’t [validate] unless it’s a point of specific interest. So, probably about 5–10% of the time I’ll look at references and things. (checklist – ID 11)

Generally when you are looking for something, say, for example, you want details of a particular symptom or disease, I vaguely know what to expect. If it seems sensible we use, which may not be very good practice, but it is something we do all the time. (use of domain knowledge – ID 14)

As stated previously, these evaluative judgments were, in fact, very rare. Moreover, only a few participants actually reported retrieving information from a Web site new to them, despite the fact that over 50 different sites were used in the sample, with the majority of search incidents using a generic search engine (Google). Overall, the search process is highly biased towards sources of known information quality and cognitive authority, although doctors are using cognitive search models, similar to those identified, without these sources of bias, and they use a large number of sites. As such, strategies to the left of Figure 2 become more dominated by these predictive judgments, which are, in turn, enabled through mental models of different sites that contain doctors’ perspectives of information quality (e.g., utility, goodness) and cognitive authority (e.g., trustworthiness) of these sources (see ID 8). Table 3 summarizes the results of each research question and the latent themes or codes that were identified that support this analysis. Themes identified inductively (or redefined in terms of the previous description in literature) are shown in bold italics and are described further in the results discussion of each research question following the table.

Discussion

In this discussion, we highlight the contributions of our analysis, which include: cognitive strategies with navigational bias; the low applicability of the credibility construct; potential explanations for why users rarely make evaluative judgments; the difficulty of studying cognitive search in isolation from information judgments or as a researcher defined task; and emerging theory to connect the large but separate

3www.nice.org.uk: National Institute for Clinical Excellence for the UK’s NHS.
TABLE 3. Key results.

<table>
<thead>
<tr>
<th>RQ</th>
<th>Themes</th>
<th>Description and subthemes</th>
<th>Subtheme ID</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Information need (task type)</td>
<td>Information needs are characterized by two dominant types, <strong>background or open questions</strong> (58% of doctors), and <strong>closed question</strong> with a specific answers (55%).</td>
<td>1, 2</td>
</tr>
</tbody>
</table>
|    | Cognitive search strategy | Three main types of search were observed: (a) using Google as a navigational device or biased search (48%); (b) direct access to familiar site (27%); (c) using Google for normal search (27%)  
- Doctors’ search patterns had similar characteristics to experts in previous studies, and mainly relied on “to-the-point,” “known address search domain,” or “known address” strategies,  
- with (a) being a combination of “to-the-point” and known address” strategies (better described as “Known address bias”). This was composed of two approaches, with 28% of all doctors using specific site names in the informational queries, and 41% making preferred selections from results. | 3, 4, 5 |
| 2  | Criteria for Information judgments | Credibility does not appear to be an important factor in doctors’ information judgments, supporting Rieh’s (2002) view that information quality (usefulness 41%, goodness 31%) and cognitive authority (trustworthiness, 31%, authority, 24%, and reliability 21%) are key. | 8 |
|    | Methods of Information judgment | Although doctors articulated many facets of the approaches on how to judge information (checklist, contextual and the external or rater based), these facets were rarely applied to evaluate content found. | 9, 10, 11 |
| 3  | Predictive judgments, mental models, and search bias | Predictive information judgments were made via a **mental model** of different sites, containing the doctor’s perceptions of their information quality and cognitive authority. | 12 |
|    | Domain knowledge and judgments | **Mental model construction** used a combination of past experience, resources promoted by medical schools, hospitals, or recommendations from colleagues.  
- This approach of using mental models was dominant; its construction and use being early articulated by 83% of the sample. | 13, 14 |

areas of online cognitive search and information judgment literature. We expand on these points in the following sections, discuss their implications for research and practice, and then detail the study’s limitations.

Cognitive Internet Search Adapted for Predictive and Evaluative Judgments

First, the results differ from previous studies into cognitive search strategy by identifying inherent bias at various stages of search. This bias is navigational, orientating users’ searches towards known sites via two mechanisms: (a) performing a normal informational query with the anticipation that these known sites will appear at the top search results, and selecting them with preference; and (b) actually entering specific site names alongside the informational query. Considering the former, scholars speculate that informational queries can often have a navigational component (Tann & Sanderson, 2009). The latter is an additional mechanism to achieve this, but it also relies on users’ mental models of an array of content sites appropriate to the task. The bias towards these sites is enabled by predictive judgments (detailed in Figure 2), which, in turn, primarily rely on information quality and cognitive authority. This extends Thatcher’s (2006, 2008) view, with the identification of new strategy archetypes described as known address bias, denoting the use of search engines for informational queries with bias towards sites of predicted authority and quality. However, since the majority of previous cognitive search studies are completed in the academic environment via experiments with students, lacking significant consequences of the actual use of the information, it is not surprising that previously observed search patterns might differ from those of real needs in the professional context.

Second, we noted the low applicability of the credibility construct among the judgment criteria doctors apply. Most of the concepts associated with credibility (accuracy, authority, objectivity, currency, and coverage) can be explained by the two other well-known, higher order constructs. Although objectivity and coverage within credibility are ideas not incorporated by information quality and cognitive authority, both were considered to be of low importance by the sample. Credibility is a common construct used across a range of studies,

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Although this study concurs with this in the context where information seeking on the Internet is a repeated exercise, it cannot be determined from this study. Hence, this difference is not surprising, and inferences about stopping rule’s role in other types of tasks cannot be made.

In terms of judgment methods, a number of authors have noted that users rarely apply evaluative information judgments (Eysenbach & Kohler, 2002; Meola, 2004; Rieh, 2002). Although this study concurs with this in the context where the information obtained is influencing important decisions, this does not imply the complete absence of any judgment. Doctors are using predictive judgments to resolve needs for information quality or cognitive authority, reducing the cost of searches, because of the time-consuming nature of checklist-type evaluative judgments (Meola, 2004). Additionally, the use of stopping was not directly observed, save for the single criterion of finding information in sites of which users had mental models. Nonetheless, it should be noted that Browne et al.’s (2007) work is based on experimental tasks unfamiliar to the user, as opposed to repeated tasks where users have significant experience and domain knowledge. Hence, this difference is not surprising, and inferences about stopping rule’s role in other types of tasks cannot be determined from this study.

Third, we observed the use of mental models of Internet sites, which enables predictive judgments and, in turn, allows navigational bias to be introduced into informational queries. As information seeking on the Internet is a repeated exercise, and the doctors in the sample are making many such information searches every week, they can construct models of different sources. These models were generally articulated at the level of a site or domain and are related to the judgment on criteria noted to be of importance, which included information quality (usefulness, goodness, etc.) and cognitive authority (trustworthiness, authority, reliability, etc.). Various authors have previously identified such mental models (Cahoon, 1998; Hargittai, 2002; Papastergiou, 2005; Wang, Hawk, & Tenopir, 2000; Zhang, 2008), but there is lack of agreement on its exact contents. These results support the utilitarian view of mental models, extended with notions of information quality and cognitive authority that are relative between different sites, a view not strongly identified in previous literature.

It should also be noted that these results are, to a certain extent, a consequence of examining a real-life and extensively repeated search task. Doctors noted that they had learned and adapted strategies, taking into account changing Web search experience and developing mental models of the Internet sites. These models were not entirely fixed as many doctors noted that they had changed over time and with the focus of their professional work. In particular, this suggests that a longitudinal view of Internet search should be examined, where successful previous cognitive strategies (registered in mental models and Internet search experience) dictate planned strategies for the future. Certain researchers have begun to look at this longitudinal view of search (e.g., Cothey, 2002; Zhang, Jansen, & Spink, 2008), but these are limited to action views of search derived from log files rather than exploring behavioral intention. Although we do not propose a detailed model here, further research could consider how cognitive search styles are learned, beyond simple distinctions of expert and novice, by exploring the development Web experience and the construction of mental models. To achieve this, recent attempts to apply learning levels to Internet search could be explored (see Jansen, Booth, & Smith, 2008). This would need to be examined in relation to different types or categories of task, where the task is relatively constant and extensively repeated, to approximate search conditions such as those found in certain professional contexts.

Finally, the results suggest a revised high-level model of cognitive search shown in Figure 3 below. Task type is a dominating factor in determining cognitive strategy (e.g., Thatcher, 2008; Browne et al., 2007); however, a user’s mental model of the Internet also dictates the use of preferred sites, and the user’s Web search experience the execution of certain moves such as specific text queries. Both of these are driven by predictive judgments as users attempt to anticipate moves that will yield improved search results. Because each search task is not exactly identical to the last, the use of predictive judgments may not be sufficient to avoid the need for evaluative judgments. This evaluation may encompass the use of checklists, contextual approaches, or corroboration of content found with their existing domain knowledge. Some of these elements have been suggested in previous literature, such as Marchionini (1995) or other authors listed in Table 1. However, this view differs by connecting concepts from information judgment literature to those in the cognitive search literature.

This difference can also be understood from a practical point of view; cognitive search literature has often been based...
on search with single hypertext or database systems, where users may assume a certain standard level of information quality or cognitive authority in this single source. Additionally, in researcher-defined tasks on the Internet, such judgments may be inconsequential to the user. The advantage of this view is to explain cognitive strategy over a wide range of potential sources now available on the Internet, in which the user has different levels of confidence and certain needs for information quality or cognitive authority. Therefore, these differences concur with certain author’s claims that previous research poorly describes what users actually do (e.g., Metzger, 2007), although their constructs provide a useful frame for analysis.

Implications for Research

Results show that Web experience and mental models, key concepts from cognitive search literature, can be viewed to impact search strategy through key constructs in information judgment literature. This offers a basis to connect the two fields. Further research should examine other possible relationships between these constructs, detail the contents of the two types of judgments in use, and understand how the contents of mental models and Web experience changes over time as individuals gain experience in a certain task category.

In addition, authors working with Technology Acceptance Models (TAM) and user satisfaction also approach users’ information judgments in computer systems (e.g., DeLone & McLean, 1992; McKinney, Kanghyun, & Zahedi, 2005; Wixom & Todd, 2005). For instance, user satisfaction can clearly be delineated by information quality and systems quality (DeLone & McLean, 1992; McKinney et al., 2005), both of which impact attitude and behavioral intention via TAM’s notions of ease of use and usefulness (Davis, 1989; Wixom & Todd, 2005). However, constructs such as cognitive authority are not considered, which can be partly explained by differing units of analysis, meaning these two literature sets are not easily reconciled. Moreover, research in this area has more recently examined Web Acceptance Models (WAM), where constructs such Web experience and experience with a Web site have been shown to have moderating effects on perceived ease of use and usefulness (Castañeda, Muñoz-Leiva, & Luque, 2007). WAM and cognitive search models consider more similar constructs and fundamentally similar real-life phenomena. Thus, WAM’s explanatory power might benefit from examining discrete judgments of distributed information objects across the Internet over time, encompassing such concepts as mental models, mental model construction, and predictive judgments.

Given this, there are a number of priorities and questions for future research. Clearly the exploratory nature of this study invites an empirical and confirmatory test of the results. However, it also suggests a number of other important research avenues, including further focus on real information search (rather than task based experiments), as well as: 1) examining a longitudinal view of mental models’ and predictive judgments’ over time; 2) establishing more detailed contents of the predictive and evaluative judgments at the different stages of search; 3) determining how a range of professional and business contexts, and their specific consequences or risks from using information, drive differences in mental models or predictive judgments, and; 4) work towards an enrichment with WAM via the view of a network of different sites in a user’s mental model.

Implications for Practice

Two major insights are gleaned from this study: the role of generic search engines in medicine and an increasingly sophisticated use of the evolving Internet. First, medical researchers have conflicting views on the role of Google in information search as being a key facilitator (Johnson et al., 2008; Sim et al., 2008), versus having an unimportant role (De Leo et al., 2006). The opposing nature of these views is partly explained by Google’s predominant use for accessing different sites for which doctors have an existing mental model of utility. Consequently, generic search engines play an important role in both determining the availability of content and providing fast access to specific locations in these sites, but also a limited role in guiding doctors to previously unknown sites. Second, this study shows a sophisticated level of Internet customization by doctors, and despite cognitive authority concerns, many are using sites not normally promoted by the medical profession. The prominence of user-generated content or Web 2.0 sites, like eMedicine and Wikipedia, imply that these tools are becoming ingrained into medical practice (Hughes, Joshi, Lemonde, & Warcham, 2009). Despite warnings not to use Wikipedia for medical decision making (Lacovara, 2008), their usefulness, different information needs, and occasional compensatory evaluative judgments mean they play a useful role for doctors. However, the levels of awareness of techniques for information judgment vary between the doctors, and those of lower experience, seeing colleagues use tools like Wikipedia, may attempt their use without the same level of awareness of risk.

This perspective has two main implications for practitioners. First, for medical policy makers, consideration of the risks of the emergence of this behavior must be made. Given the utility of such general-purpose tools, rather than restricting access, further Internet awareness training enabling all doctors to efficiently manage the associated risks could be considered. However, medical students are often taught basic search skills and are introduced to tools such as Pubmed in medical school, and the effectiveness of these types of interventions needs to be better understood (Brettle, 2007). To enable such training to be effective, research needs to consider what constitutes sufficient predictive or evaluative information judgment for patient safety, considering the nature of different information needs derived from the predominant task types and the time constraints of practicing medical professionals.

Second, this customization of search by medical professionals should also be noted by providers of these infrastructure services, from companies providing search engines to
medical librarians. The entrenchment of users’ customized search processes shows the gap between the software available to them and their information needs. The need to personalize Web search has already been identified and explored by research (for example Ma, Pant, & Sheng, 2007; Liu, Yu, & Meng, 2004), and it encompasses techniques such as user profiling and search histories or search categories that modify page rank. However, our results indicate that information needs are driven by task type, which drive certain information quality or cognitive authority needs that doctors satisfy efficiently by building models of sites via experience and corroboration with colleagues, hospitals, or medical schools. Hence, although the current approaches to personalized search may improve its efficiency, further gains could be made by modeling this behavior. To this end, the significant reliance on corroboration to identify levels of information quality and cognitive authority needs suggests further support for certain authors’ claims, such as Pirolli (2007), that improvements in search will need to involve cooperative or participatory Web 2.0 models.

Limitations

This study has clear limitations when generalizing to other contexts, notably due to the use of diaries, the sample size and nature, and the naturalistic design of the study. Firstly, although diary methods offer many benefits, especially when compared with traditional survey methods, diary studies must achieve a level of participant commitment and dedication rarely required in other designs. A common issue is the training requirements for participants to follow protocol, and we outlined a number of steps in the method used to mitigate this. There is also potential for reactance, referring to a change in experience or behavior as a result of participation; though, at present, there is little evidence that reactance poses a threat to the validity of diaries (Bolger et al., 2003). Overall, the use of diaries, though very beneficial, meant the study design resulted in a sample size only suitable for exploratory research.

Secondly, the specific sample relates to junior doctors, and there is known differences in online information-seeking behavior based on doctor seniority. However, not only are junior doctors as a population significant in the context of the UK’s NHS (approximately 38,000 junior doctors), but given how quickly online search mechanisms change, their study provides value in examining emergent behaviors in the overall doctor population. Scholars note that such Internet use, led by the junior segment, will become increasingly prevalent in the population as a whole (e.g., Sandars & Schroter, 2007) and is increasingly replacing the use of traditional information sources (Bennett et al., 2004).

Finally, in a study based on a post-event reflection and of naturalistic design, there are possible discrepancies between users’ actual actions and what they report. The use of diaries mitigates this to a certain extent as the users’ perspectives were captured close to the event in question. In addition, naturalistic studies are often contextual and the ability to generalize to cannot be assumed. For instance, clinical information is a specific task type and users are completing a regular or repeated task and have significant Internet experience and domain knowledge relevant to the information search and retrieval.

However, there are many contexts to which the results are potentially transferable. In the health sector as a whole, healthcare professionals such as pharmacists or dentists use the Internet in this manner (McKnight & Peet, 2000). Another major and similar use of the Internet is by patients seeking health information, where many patients regularly search on conditions and acquire significant domain knowledge (Bundorf, Wagner, Singer, & Baker, 2006). Moreover, we would speculate that there are many settings where the characteristics would apply, such as in important but repeated decision making for general users or in extensive use of the Internet for professional purposes by other types of knowledge workers.

Concluding Remarks

This study addresses major gaps in research in three ways by: a multimethod study design that supplements the dominant research methods examining this subject, using the medical context that highlights repeated online information search with stakes or risks for the user (rather than a researcher defined or single inconsequential task), and examining the previously identified but under researched link between cognitive search models and information judgments.

Results indicate that: (a) doctors’ principal type of information needs can be characterized as closed (specific answer) or open (background reading); (b) principal cognitive strategies used are similar to expert strategies identified in previous studies; (c) closed information needs precipitate direct access to specific content Web sites (denoted as known address strategy) rather than generic search engine use; (d) dominant types of information judgments used by doctors relate to information quality and cognitive authority, suggesting the low applicability of the credibility construct; (e) use of evaluative judgments in examining a document are scarce, explained by a reliance on predictive judgments to resolve information quality and cognitive authority needs; (f) predictive judgments are enabled by users’ mental models of Internet sites; and (g) navigational bias is created by predictive judgments during informational queries, suggesting new cognitive search strategy archetypes (described as known address bias) and mixed approach to navigational/information search types.

A model is proposed that demonstrates how the constructs in information judgment literature can describe the influence on search strategy of constructs normally associated with cognitive search literature. This responds to scholars’ calls to examine this link and enable the connection of two large but previously separate fields. The model is potentially transferable to settings where the task is repeated and the use of the information has consequences or potential risks for the user.

Results also suggest that research needs to supplement the dominant research method of examining discrete tasks with
a view of strategies that are built over time on real information needs. Hence, in addition to a confirmatory approach to this study, other opportunities for future research are as follows: (a) examining longitudinal view of how users learn to optimize repeated search tasks, detailing how mental models and predictive judgments change over time; (b) establishing more detailed contents of the predictive and evaluative judgments at the different stages of search; (c) determining how a range of professional and business contexts, and their specific consequence of information use, drive differences in mental models or predictive judgments; and (d) work to towards an enrichment of WAM, considering the Internet as a network of different sites of which users have mental models that drive usage intentions.

References

of the American Society for Information Science and Technology, 52(6), 499–507.


## Appendix

### Detailed Results and Coding scheme (Diary and Interview Data)

<table>
<thead>
<tr>
<th>Area</th>
<th>Code ID</th>
<th>Code</th>
<th>Description</th>
<th>Proportion of doctors/cases observed</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Cognitive search   | 1       | Information seeking for “closed” question          | Specific information or question, i.e., to check – quickly a diagnosis, management options, drug information, or specific fact – for deep or specific information on a particular medical problem | 55%                                | “To look at what different management options might be.”  
“Prescribing guidelines are handy.”  
“Double-check potential differential diagnosis.”  
“The best b blocker to use for someone with heart failure.”  
“Wikipedia search first, like someone came up to me and said my mother has Gaulin’s syndrome, do you think I have it?” |
|                    | 2       | Background information seeking or “open” question   | Get background or overview information on a topic to:  
– ascertain the right questions to ask or  
– appear knowledgeable on a topic                                                                                   | 58%                                | “You can get an overview of a topic that you’re not really familiar with very easily.”  
“You can sound a lot more knowledgeable than you are which is quite nice!”  
“Start with a site with basic information to get myself more knowledge about a subject.” |
|                    | 3       | Direct access to familiar site                     | Going directly to a known site, rather than using a general search engine                                  | 27%                                | “Have their own built in search engine. You go to the Web site and you just add whatever you are looking for.”  
“If I’m not using Google, then I might have gone directly to something like eMedicine and just use key words.”  
“If you type in a medical symptom in Google, then most of the hits will medical Web sites and its quicker than going to them directly.”  
“If there is syndrome that I haven’t heard of, then I would type into Google with the exact phrase. I would select the Web sites that have heard of.”  
“I put what I’m looking for, and then I put eMedicine and Wikipedia, and I put that through Google [clicked search].”  
“Type in the most pertinent phrase and just Google it and take it from there.”  
“But I’m not usually looking for something that rare, so generally I put the name into Google and hope that it will come up with the right thing.” |
|                    | 4       | Google/search engine as a navigational device      | Using Google as a starting point to navigate to sites, as the final sites to be used are known               | 48%                                |                                                                                                   |
|                    | 5       | Google/search engine generic use                   | Using a general search engine without a predetermined site in mind                                           | 27%                                |                                                                                                   |
|                    | 6a      | Direct access for closed question                  | Using direct site access for a task that has a closed (code 1) information need                            | 84%*                               | N/A combinative matching of codes 1 and 3                                                                 |
|                    | 6b      | Direct access for open question                    | Using direct site access for a task that has a closed (code 2) information need                            | 16%*                               | N/A combinative matching of codes 2 and 3                                                                 |
|                    | 7a      | Google/search engine for closed question           | Using a generic search engine for a task that has a closed (code 1) information need                      | 47%**                              | N/A combinative matching of codes 1 and 4/5                                                                 |
|                    | 7b      | Google/Search engine for open question            | Using a generic search engine for a task that has a closed (code 1) information need                      | 53%**                              | N/A combinative matching of codes 2 and 4/5                                                                 |

(Continued)
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<tr>
<th>Area</th>
<th>Code ID</th>
<th>Code</th>
<th>Description</th>
<th>Proportion of doctors/cases observed</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information judgments</td>
<td>8</td>
<td>Good</td>
<td>Good job, fine, great, best, wonderful, state of the art, breadth, depth, comprehensive, beyond</td>
<td>31%</td>
<td>“I’d first probably Google it. Now I’d go to the up-to-date Web site; it’s more comprehensive and gives you a list of papers etc.”</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“It gives systematic information that you use in clinical practice which I think is quite good.”</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td>Accurate</td>
<td>Accurate, correct, right, precise, valid</td>
<td>21%</td>
<td>“With Wikipedia, it is not monitored as it is written by the public, but despite this it tends to be relatively accurate.”</td>
</tr>
<tr>
<td>Currency</td>
<td></td>
<td>Current</td>
<td>Current, up to date, out of date, old, timely</td>
<td>21%</td>
<td>“You need to question the level of trust of the information, what I mean is that the information up-to-date?”</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>“It is different because on the ward you may have the first or second edition, online you got the latest edition.”</td>
</tr>
<tr>
<td>Usefulness</td>
<td></td>
<td>Useful</td>
<td>Useful, useless, hard to use, informative, helpful, can’t understand, not of much use, flexibility, user friendly, rubbish, too much information</td>
<td>41%</td>
<td>“GPnotebook® – I’ve used it several times in the past and I’ve found it useful.”</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>“I’ll just Google a condition and I’ll end up with a random site, but that’s not very useful.”</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>“You need to question the level of trust of the information, what I mean is that the information up-to-date?”</td>
</tr>
<tr>
<td>Importance</td>
<td></td>
<td>Important</td>
<td>Important, critical, relevant</td>
<td>3%</td>
<td>“and most the time they’re up to date and relevant”</td>
</tr>
<tr>
<td>Authority</td>
<td></td>
<td>Authoritative</td>
<td>Authoritative, the standard, renowned, reputation</td>
<td>24%</td>
<td>“Sometimes I do look on a couple of different sites that are reasonably reputable . . .”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“If it is from someone famous in the field, you are more likely to pay attention. If there is no author there or you do not know who put it there, then you are less likely to give it any credit.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“which is not accredited by any means.”</td>
</tr>
<tr>
<td>Objective</td>
<td></td>
<td>Objective</td>
<td>Objective, Independence, bias</td>
<td>3%</td>
<td>“If you’re using sites like Wikipedia, you don’t always know who has tampered with it, and you have to make sure that you’re not getting things that are kind of biased.”</td>
</tr>
<tr>
<td>Coverage</td>
<td></td>
<td>Comprehensiveness, depth</td>
<td>3%</td>
<td>“From past experience gives you quite comprehensive information.”</td>
<td></td>
</tr>
<tr>
<td>Trustworthy</td>
<td></td>
<td>Trust, count on, bias, face value, pinch of salt</td>
<td>31%</td>
<td>“I would trust it. It is written by doctors and generally reliable.”</td>
<td></td>
</tr>
<tr>
<td>Credible</td>
<td></td>
<td>Credible, accredited, verified</td>
<td>7%</td>
<td>“That a lot of the sources are unverified, and we should be looking at evidence-based and peer-reviewed material.”</td>
<td></td>
</tr>
<tr>
<td>Reliable</td>
<td></td>
<td>Reliable</td>
<td>21%</td>
<td>“The information is not reliable, such as Wikipedia.”</td>
<td></td>
</tr>
<tr>
<td>Scholarly</td>
<td></td>
<td>Academic, scientific, studies, cited, journals</td>
<td>14%</td>
<td>“There are various guides that you know are reliable, from word of mouth sites like NICE and BNF® are accredited and evidence based. Things like Pubmed too.”</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>“They are very scientifically written; the stuff in there is very robust.”</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>“Do not always know if this is the truth or true scientific information.”</td>
</tr>
<tr>
<td>Official</td>
<td></td>
<td>Official</td>
<td>7%</td>
<td>“I would only take it from a valid or official Web site such as a university Web site or similar.”</td>
<td></td>
</tr>
<tr>
<td>Judgment approach</td>
<td>Checklist approaches</td>
<td>Past experience with source/organization (reputation)</td>
<td>21%</td>
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<tr>
<td></td>
<td></td>
<td>Ranking in search engine output</td>
<td>21%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Citations to scientific data or references</td>
<td>14%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Source citations</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sponsorship by of external links to reputable organizations</td>
<td>10%</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Plausibility of arguments</td>
<td>10%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Certifications, seals, trusted accreditations</td>
<td>7%</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Author identification</td>
<td>3%</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Professional, attractive, and consistent page design, including graphics, logos, color schemes</td>
<td>3%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Comprehensiveness of information provided</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>External judgment</td>
<td>External judgment, recommendation, word of mouth, told</td>
<td>34%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Contextual</td>
<td>Promoted resource</td>
<td>28%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Corroboration</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12a</td>
<td>Using mental model for biased navigation</td>
<td>Using mental model of sites to drive navigation (via predictive judgments of information found)</td>
<td>63%</td>
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</tr>
</tbody>
</table>

"I must have stumbled upon eMedicine when I was at medical school and realized it was a good site and continued using it."

"I found out about eMedicine from Google. It was coming up in searches and I was finding that that site seemed just to have useful information each time I had selected it via Google."

"Looking at the references and pulling up the journals that the information has come from."

"Well, I tend to check the sources, where it’s coming from."

"I would only take it from a valid or official Web site such as a university Web site or similar, or even a drug companies Web site."

"I would also determine if it sounds plausible."

"It’s got somebody or rather its got governance over it, so you trust it."

"If it is from someone famous in the field, you are more likely to pay attention. If there is no author there or you do not know who put it there, then you are less likely to give it any credit."

"This tends to depend on what they look like."

"eMedicine from past experience gives you quite comprehensive information."

"See what other people are using. My medical friends tell me what’s the best thing to use. I rely on what people have recommended to me."

"[I picked the sites up by] word of mouth, no ads or e-mails. Word of mouth, really."

"You get introduced to site by senior people that you respect and that use them; they tell you to use them."

"The royal college. I think I was e-mailed by the person who was running the training and they sent the link to me and told me to go on to it."

"If something that I didn’t expect it to say, then I would probably look up another, and try and cross check what it is saying."

"Normally look at 2–3 Web sites really. I’ll verify it with the people I’m working with."

"I would start with the official government sites first, sites that you now are accredited second, and then work my way down. I have a kind of hierarchy of sites in my head."

"I’ve got really fast at using it as I know where to go, depending on what I need and how important it is . . . and also how much time I have. I have developed a kind of model that works."

"You can choose source because I have experience from using it before. You know what other people say about the reliability of this sites."

(Continued)
<table>
<thead>
<tr>
<th>Area</th>
<th>Code 1</th>
<th>Code 2</th>
<th>Description</th>
<th>Proportion of doctors/cases observed</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>12b</td>
<td>Using mental model for information judgment</td>
<td>55%</td>
<td>Avoiding an extensive evaluative information judgment by relying on preexisting model of information accuracy/cognitive authority</td>
<td>55%</td>
<td>“The whole Wikipedia user-created method of creating Web sites produces some pretty reliable information for less important facts.”</td>
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<tr>
<td></td>
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<td>“Something like eMedicine I would trust it. It’s written by doctors and generally reliable enough to trust it.”</td>
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<td></td>
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<td>“Like NICE guidelines is something that has been rigorously worked out. You wouldn’t check it. It’s something that you would trust.”</td>
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<td></td>
<td>“If it’s quite a respected site, like GPnotebook, I wouldn’t cross check it. It was something quick.”</td>
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<tr>
<td></td>
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<td></td>
<td></td>
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<td>“This whole Wikipedia user-created method of creating Web sites produces some pretty reliable information for less important facts.”</td>
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<td>“Something like eMedicine I would trust it. It’s written by doctors and generally reliable enough to trust it.”</td>
</tr>
<tr>
<td>13</td>
<td>Building a mental model</td>
<td>83%</td>
<td>Defining credibility for a specific site and adding it to the list/model</td>
<td>83%</td>
<td>“I must have stumbled upon eMedicine when I was at medical school and realized it was a good site and continued using it.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“I was told by colleagues which ones are reliable, and which ones are not. ‘It’s through Googling, whatever comes up in the top 5. You use them and can learn to trust them.’”</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>“NICE guidelines and PubMed are useful.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“Generally when you’re looking for something, say, for example, you want details of a particular symptom or disease. I vaguely know what to expect. If it seems sensible, we use if, which may not be very good practice, but it’s something we do all the time.”</td>
</tr>
<tr>
<td>14</td>
<td>Evaluative judgment with domain knowledge</td>
<td>31%</td>
<td>Domain knowledge used for evaluative judgments</td>
<td>31%</td>
<td>“Generally when you’re looking for something, say, for example, you want details of a particular symptom or disease. I vaguely know what to expect. If it seems sensible, we use it, which may not be very good practice, but it’s something we do all the time.”</td>
</tr>
</tbody>
</table>

* 17 Cases/Incidents. ** 63 Cases/Incidents (Out of 100 cases analyzed from diaries). 

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