

Judgment of Information Quality and Cognitive Authority in the Web

Soo Young Rieh

450 Broadway Street, Redwood City, CA 94063. E-mail: srieh@excitehome.net

In the Web, making judgments of information quality and authority is a difficult task for most users because overall, there is no quality control mechanism. This study examines the problem of the judgment of information quality and cognitive authority by observing people's searching behavior in the Web. Its purpose is to understand the various factors that influence people's judgment of quality and authority in the Web, and the effects of those judgments on selection behaviors. Fifteen scholars from diverse disciplines participated, and data were collected combining verbal protocols during the searches, search logs, and postsearch interviews. It was found that the subjects made two distinct kinds of judgment: predictive judgment, and evaluative judgment. The factors influencing each judgment of quality and authority were identified in terms of characteristics of information objects, characteristics of sources, knowledge, situation, ranking in search output, and general assumption. Implications for Web design that will effectively support people's judgments of quality and authority are also discussed.

Introduction

One of the advantages of searching in the Web is its grant of access to a great amount and a wide variety of information. As a result, however, people need some ways to reduce the large amount of information to select the information that they want. In traditional information retrieval, this problem has long been discussed within the context of "topical relevance"; that is, in terms of whether the topic of the query matches the topic of a document. However, a substantial number of empirical studies (e.g., Barry, 1994; Cool, Belkin, Frieder, & Kantor, 1993; Park, 1993; Schamber, 1991; Spink & Greisdorf, 2001; Wang & Soergel, 1999) have revealed that people use much more diverse criteria than mere topicality to make relevance judgments in the traditional information retrieval environment. This study will take these findings a step further by focusing on two factors that appear consistently across the previous studies: quality and authority. These two factors were chosen be-

cause it is believed that they may be more important relevance criteria than any other criteria identified in the previous studies, especially in a large uncontrolled environment, such as the Web.

The concepts of quality and authority are not new. On the one hand, a number of studies of relevance criteria, particularly in the 1990s, identified various aspects of both concepts including "goodness" (Cool et al.), "usefulness" (Cool et al.), "accuracy/validity" (Barry), "recency" (Barry; Wang, & Soergel), "perceived quality" (Park), "actual quality" (Wang & Soergel), "expected quality" (Wang & Soergel), "authority" (Cool et al.; Wang & Soergel), and "reliability" (Schamber). On the other hand, in recent years, the notions of quality and authority have been discussed with respect to evaluation criteria of Web pages by examining different approaches and implementations. Librarians and researchers in library and information science (e.g., Cooke, 1999; Kjartansdottir & Widenius, 1995; Smith, 1997; Tate & Alexander, 1996), for example, have looked at the issues of quality from the standpoint of bibliographic instructors to develop a guideline or checklist. Researchers in computer science paid attention to the problem of quality and authority with respect to the effectiveness of a search engine, and implemented a way to "filter" information from a huge collection of relevant pages (e.g., Amento, Terveen, & Hill, 2000; Kleinberg, 1999; Price & Hersh, 1999; Zhu & Gauch, 2000). There were a few empirical studies that specifically addressed the issues of information quality in electronic information use environment (Olaisen, 1990), Internet (Klobas, 1995), or lodging Web sites (Jeong, 1998). Recently, Fritch and Cromwell (2001) presented a theoretical model and criteria for ascribing cognitive authority in a networked environment.

In general, although these studies interpreted the notions of quality and authority in various contexts, none of them examined these two concepts specifically from the perspective of information retrieval interactions (e.g., Belkin, 1993; Saracevic, 1997). As a result, the researchers were not able to perceive users as active seekers who look for texts of potential interest, make judgments about information, select information objects, and interpret the information content in

order to understand it. This study, on the other hand, takes an approach of information retrieval interactions in which users are information seekers, judges, and evaluators with respect to their own information problems and situations. In this approach, judgment interactions form a central process between the users and the information in Web pages, and people make judgment of *information quality* and *cognitive authority* in the course of their information-seeking behaviors.

Although this study does not intend to propose a single abstract definition of information quality and cognitive authority, it seems to be necessary to provide an operationalized definition of these concepts. At a conceptual level, quality is defined as “a user criterion which has to do with *excellence* or in some cases *truthfulness* in labeling” (Taylor, 1986, p. 62). Following Wilson’s (1983) definition, cognitive authority refers to influences that a user would recognize as proper because the information therein is thought to be credible and worthy of belief. At an operational level, information quality is identified as the extent to which users think that *the information is useful, good, current, and accurate*. Cognitive authority is operationalized as to the extent to which users think that *they can trust the information*.

Making judgments of quality and authority of information in the Web is a difficult task for most users because there is generally no quality control mechanism for the Web. In the traditional print world, quality is inferred from reviews, refereeing processes, and the reputation of publishing houses (Janes & Rosenfeld, 1996). Therefore, in general, people can judge the quality and authority of printed publications with little difficulty because they have accumulated knowledge and experiences with traditional information resources that make use of conventional indicators of quality (e.g., editorial selection) and authority (e.g., authors, publishers, and document type). On the other hand, anyone can be a publisher of information in the Web by simply uploading documents. No one has to review and approve the content of the information before it is made available to the general public. As a result, users have to make judgments of the wide range of quality and authority of Web information for themselves. To make this problem more difficult, the Web offers a different searching environment for users due to heterogeneous objects, prolific graphics, and diverse organization of information (Fidel et al., 1999; Jasen, Spink, & Saracevic, 2000; Pharo, 1999; Wang, Hawk, & Tenopir, 2000).

By examining these judgments and decisions of information quality and cognitive authority in the Web, this study will address the following research questions: (1) How do people decide which Web site, page, and item to look at? (2) To what extent do judgments of information quality and cognitive authority affect their decision and selection behaviors in the Web? (3) What are the facets of information quality and cognitive authority in Web searching? (4) What are the factors that influence people’s judgments about information quality and cognitive authority?

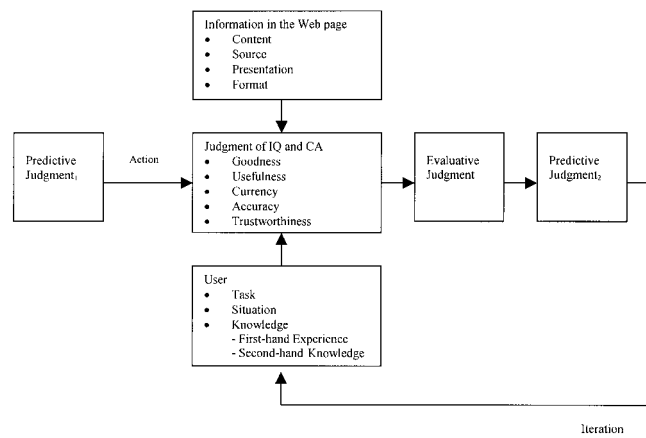


FIG. 1. Model of judgment of information quality and cognitive authority.

Conceptual Framework

To understand people’s judgments of information quality and cognitive authority, this study starts with a conceptual model, as shown in Figure 1. This model suggests that judgment interaction of information quality and cognitive authority can be considered as a central process of information retrieval that is taking place between the user and the information objects in the Web environment. It synthesizes theoretical issues related to the following research areas: (1) judgment and decision making process (Hogarth, 1987; Huber, 1989; Rachlin, 1989); (2) relevance judgment in interactive information retrieval (Barry, 1994; Belkin, 1996; Cool et al., 1993; Park, 1993; Wang & Soergel, 1998); (3) information quality in value-added model (Taylor, 1986); (4) cognitive authority in second-hand knowledge (Wilson, 1983); and (5) characteristics of information objects in the Web pages (Rieh & Belkin, 1998).

Judgment, Decision, and Choice

Research on judgment and decision making suggests a useful framework for understanding the nature of judgment itself in the course of the information retrieval interaction process. According to Rachlin (1989), “a judgment is always a guide for making a decision, which leads to a choice, which then produces an outcome” (p. 43). In other words, the judgment itself is incomplete, and only when related to decisions, choices, and outcomes will it form a complete process. As the judgments and decisions are made internally, the choice is the actual behavior that can be directly observed. In all choice situations, two types of judgments are involved: “predictive judgment” and “evaluative judgment” (Hogarth, 1987). Predictive judgment, according to Hogarth, refers to what people expect to happen, while evaluative judgment denotes the values by which they express preferences. In the model presented in Figure 1, a predictive judgment guides a decision about what kind of action the user is going to take given multiple choices

(alternatives). As a result of this judgment, a new Web page is presented to the user, and when she/he looks at it, an evaluative judgment is made.

Relevance Judgment in Interactive Information Retrieval

In this model presented in Figure 1, users are considered as active seekers of information who engage in a wide variety of interactions during their searches. This notion, overall, is based on Belkin's (1996) information retrieval (IR) interaction model. The key concept of Belkin's model is that IR is most properly considered as a form of information-seeking behavior, in which IR systems support people's interactions with information. Belkin's model attempts explicitly to empower the user in the information-seeking interaction, with other processes and components of IR being seen as providing mechanisms for the appropriate support of such interaction. According to Belkin, these interactions include comprehension, as well as organizing, modifying, creating, disseminating, and using the information. Applying his model to the judgment process of IR, the basic premise of this study is that in all the information-seeking activities, users look for information of potential interest, making judgments of information quality and cognitive authority, and then interpret the information.

Traditionally, the judgments of information are discussed within a framework of *relevance judgment* in which people make decisions to accept or reject specific information items based on whether they are relevant or not. A number of studies on relevance criteria (e.g., Barry, 1994; Cool et al., 1993; Park, Cool et al., 1993; Schamber, 1991; Wang & Soergel, 1998) have found that people use much more diverse criteria (e.g., quality, authority, reliability, coverage, depth/scope, novelty) than mere topicality to make judgments of relevance. Bateman (1999) took 40 relevance criteria identified in those previous studies, and found 11 criteria rated as most important by the survey respondents. Her study confirmed the significance of quality and authority in the relevance judgment process by showing that three "constructs," including information quality, information credibility, and information completeness, explained 48% of the respondents' relevance judgment.

Information Quality and Cognitive Authority

Taylor's (1986) definition of quality in his value-added model provides the most general framework for understanding the concept of "information quality." It is based on the assumption that users' judgments to choose particular information objects over others are made by giving *value* to a particular object, but not to others. That is, users are making judgments of value continuously while monitoring a variety of information systems and extracting what seems to be of value. To Taylor, the processes of storage and display on the system side, and choice and use on the user side are throughout based on conscious and unconscious assumptions about the value of information. Taylor identified five

"values" included in quality: accuracy, comprehensiveness, currency, reliability, and validity. Taylor's approach to defining quality indicates that the concept of quality is related to the notion of value as users assess the worth of benefits of interaction results (Saracevic & Kantor, 1997) while engaging in interactions.

Wilson (1983) used the term "cognitive authority" to differentiate it from another kind of authority, "administrative authority," which involves the recognized right of the person who is "in" a certain position. His fundamental assumption in cognitive authority is that people know of the world through two different ways: either based on their first-hand experience, or on what they have learned second hand from others. However, people do not count all "hearsay" as equally reliable; only those who are deemed by the individuals to "know what they are talking about" become cognitive authorities. They are recognized as the authority because they are thought to be credible and worthy of belief. Also, as Wilson points out, cognitive authority is not limited to only individuals; it can be recognized in books, instruments, organizations, and institutions. Among the external tests for recognizing cognitive authority are personal authority (author), institutional authority (publisher), textual type authority (document type), and intrinsic plausibility authority (content of text). Given his concept of cognitive authority, it seems to be clear that cognitive authority is one of the quality control components in information retrieval.

Characteristics of Information Objects in the Web Pages

As a preliminary study, Rieh and Belkin (1998) examined the issues of information quality and cognitive authority in the Web by conducting semistructured interviews with six faculty members and eight doctoral students in 1997. This study found that the users mentioned four different criteria for making judgments of quality with respect to the characteristics of information objects in the Web: source (where a document comes from), content (what is in the document), format (formal characteristics of a document), and presentation (how a document is written/presented). Other criteria included currency (whether a document is up to date); accuracy (whether the information in a document is accurate), and speed of loading (how long it takes to load a document). In conclusion, it was noted that users made comments about the necessity to expend more effort on quality and authority assessment in the Web than in other information systems.

Research Design

Approaches to Research Design

Usually, the first decision that needs to be made in research design is in which setting, laboratory or natural, the data should be collected. The initial methodological approach taken in this study, however, is to identify what types of data need to be collected to answer each research

TABLE 1. Research questions and data collection methods.

| Research question | Data collection method | | |
|---|------------------------|-------------|----------------------|
| | Search logs | Think-aloud | Postsearch interview |
| RQ1: How do people decide which Web site, page, and item to look at? | O | O | # |
| RQ2: To what extent do judgments of information quality and cognitive authority affect their decision and selection behaviors in the Web? | X | O | # |
| RQ3: What are the facets of information quality and cognitive authority in Web searching? | X | # | O |
| RQ4: What are the factors that influence people's judgments about information quality and cognitive authority? | # | # | O |

Note: O: Useful #: Somewhat useful X: Not useful.

question. To understand people's decision-making processes (Research Question 1) and choice behaviors (Research Question 2), it is important to collect concurrent verbal reports as the search proceeds because of possible difficulties in articulating decision processes after the searches are completed. A think-aloud protocol is generally recognized as a major source of concurrent data on subjects' cognitive processes in specific tasks (Ericsson & Simon, 1993). Therefore, this method seems to be the most useful data collection method for answering Research Questions 1 and 2. On the other hand, verbal protocol may not be so useful in identifying the facets of information quality and cognitive authority (Research Question 3) and the factors influencing people's judgments about information quality and cognitive authority (Research Question 4). That is because these two research questions require detailed explanations from users for making judgments of information quality and cognitive authority. Therefore, a postsearch interview (in a laboratory setting) or an open-ended interview (in a natural setting) seems to be the most useful for Research Questions 3 and 4. Although unstructured interviews are often conducted in open-ended ethnographic studies, structured interviews are the more common format in the laboratory setting in which an interviewer asks a series of preestablished questions with limited categories (Fontana & Frey, 1993). Taking into account all these issues, it was determined that a laboratory setting would provide a better environment for data collection than a natural one as a greater number of research questions can be answered in the laboratory setting.

Data Collection

Data were collected from multiple sources, combining search logs, think-aloud protocols during the searches, and postsearch interviews. The principal advantage of this methodology was that it made it possible to collect both concurrent and retrospective verbal data. Table 1 presents the summary of data collection methods for each research question.

Search logs were collected for two purposes. One is to save logs for direct analyses in terms of Web pages that the subjects looked at and actions that they took in the Web. The other is to utilize search logs during postsearch interviews. ScreenCam by Lotus[®] was used to capture PC screen activities and cursor movements, including clicking, scrolling, and typing. The features of ScreenCam allowed the search logs to be played back. These logs included screen activities and cursor movements. This helped the subjects to remember the actions that they took during the searches, as well as enabling the interviewer to pause and play the screen any time so that the subjects could answer the questions in length while the interviewer was holding the screen.

Think-aloud data were collected as the subjects verbalized their thoughts as they performed a task. The think-aloud protocol increases the amount of behavior that can be observed compared to the same subject working under silent conditions. Therefore, think-aloud data made it possible to relate subjects' cognitive processes and experiences to observable behaviors directly.

The postsearch interview was designed to elicit verbal reports by asking specific questions of subjects about their decisions and judgments. Although an established set of questions were used, there was variation in which the response may be probed. The terms "information quality" and "cognitive authority" were never used in the interviews. Instead, operationalized terms were used. For information quality, the questions included the words such as "good," "accurate," "correct," and "useful." Regarding cognitive authority, the questions included the word, "trust."

Sample

This study's participants were 16 scholars recruited at Rutgers University, and included seven faculty members and nine doctoral students. The participants came from diverse disciplinary areas including computer science, chemistry, sociology, linguistics, computer engineering, biomedical engineering, organizational psychology, communication, and library and information science. Scholars

were selected as the sampled population because they are more likely to be concerned with information quality and cognitive authority than other populations. This is due to the fact that their work is, by nature, heavily involved in interacting with information. Scholars find relevant information, assess the quality of the information, and use information in the research process. Therefore, most scholars might feel competent to judge quality and authority based on their own evaluation criteria in the printed environment. However, despite their long tradition of information use in the printed world, scholars can be often novice users of the Web, usually because it is relatively a new information resource environment with different rules and criteria from what they use in the printed collection (Rieh & Belkin, 1998).

Procedures

The experiments took place from December 1998 to June 1999 at the Interaction Lab at the School of Communication, Information, and Library Studies at Rutgers University. This Lab has facilities of video camera installed in the ceiling, a microphone, a PC, and a round desk where the subject can read a consent form, and fill out a questionnaire. The video camera focused on the monitor screen; the face of the subject was not recorded. The PC used was equipped with a 100-MHz processor, 32-MB memory and 5.3-GB hard disk operating under Windows 95, using a 15" color monitor. Two kinds of Web browsers, Netscape 4.0 and Internet Explorer 4.0, were installed on the PC so that the subjects could choose the one with which they were more familiar. ScreenCam was installed on the PC to save the search logs.

Upon arriving at the Lab, the subjects read and signed a Participant Information and Consent Form, and completed a background questionnaire. They then performed four searches based on "generic tasks" that were given to them one at a time. They were allotted 15 minutes to complete each search task, and were instructed to "think-aloud" about what they were doing, and why. The video camera recorded the computer monitor during their searches and captured their "think-aloud" utterances, while ScreenCam logged each step in their search interaction. After completing all four searches, the experimenter sat beside the subject so that they could look at the computer monitor together. For each exact moment of action (e.g., typing in words or a URL in the address bar, following a link of a Web page, or clicking on a button of a Web browser), the experimenter asked the subject why he or she selected a particular Web site, page, or link. Once the screen displayed a new Web page, the experimenter asked a set of questions about the subject's judgment of information in that page. This was continued until the end of the search, and was repeated four times with four different search log files. The entire interview session was recorded both on video and audio tapes for further analysis.

Tasks

The subjects were given "generic tasks," which outlined the kinds of task, but did not restrict the specific information problems. By using generic rather than specific tasks, it was possible to gain some measure of verisimilitude, while maintaining the possibility of comparison across different tasks. The dimensions of quality and authority were embedded in the tasks by using such phrases as "good papers," "useful information," "credible information," and "best price." The tasks were given in a written form, with fields such as research, travel, medicine, and computers. They are as follows:

- (1) For the research project in which you are currently engaged, you would like to find some good papers which are new to you, which you think will be useful (*research task*).
- (2) You are planning for the next conference that you are going to attend, and would like to find useful information about hotels, restaurants, and features of interest in that city (*travel task*).
- (3) A friend of yours has just been diagnosed as having schistosomiasis, and you want to find credible information about the disease itself, and the best methods of treatment (*medicine task*).
- (4) You've decided that you want to buy a new computer to use at home, and now you need to find the best price for it (*computer task*).

Data Analysis

The data of one subject (S002) was dropped from the analyses because this subject did not complete all four tasks. For the remaining 15 subjects, the tapes of the interviews and think-aloud comments were transcribed. Then, the search logs were integrated into the transcriptions of think-aloud comments and interviews. The method of content analysis was used to inductively identify and categorize judgments the subjects made during the decision-making and selection processes, along with factors that influenced their judgments. The basic unit of analysis was a Web page viewed by the subjects. The verbal protocol relating to that page from the think-aloud and the interview was segmented into "verbal statements," which could be a sentence, phrase, or single word (Ericsson & Simon, 1993).

Developing Coding Categories

Analysis of the responses stressed the two distinct types of judgment seen in Figure 1: predictive judgment, which is made before the subjects look at a Web page, and evaluative judgment, which occurs while they look at the page. Consequently, the criteria for judgment were also divided into two types, one for each kind of judgment.

Predictive judgment was embedded in questions asked when the subject made a movement from one page to another page. Among these were questions such as: "Can

you tell me why you started here?"; "What was it that made you go to this site?"; "Why did you select this page to look at?"; or "Why did you follow this link (what made you to follow this link)?" Categories of evaluative judgment were embedded in the following interview questions such as "Do you believe that this information is good, accurate, current, or correct?"; "Do you think that this is useful information for your information problem?"; "Can you trust this information?" Identifying categories of criteria for both predictive and evaluative judgments was primarily based on the follow-up questions such as: "If so, why do you think so? If not, why not?" or "If so, what makes you think so? If not, why not?"

Justification of Methodology

The method used in this study is premised on the assumption that the users can identify and discuss the characteristics and features of information objects that influence their judgments of information quality and cognitive authority. The previous studies (e.g., Barry, 1994; Cool et al., 1993; Park, 1993; Schamber, 1991; Wang & Soergel, 1999) demonstrated that users could, in fact, discuss the characteristics that influenced their relevance judgment process. These studies consistently have shown that it is possible to summarize relevance criteria by developing a classification scheme based on the users' own terms. The way of analyzing the data in this study can be justified by a grounded theory approach in which the data is systematically gathered and analyzed and the theory is inductively grounded in data (Strauss & Corbin, 1994).

The reliability issues involve the replicability of the data collection process and the consistency of content analysis. Relying on search logs during the interview, rather than relying on the subject's memory, would provide a basis of the replicability of data collection. The consistency of content analysis came from an intercoder agreement where two independent coders encoded a set of eight searches from two subjects. The intercoder agreement was then computed between the author and the coders respectively by using Holsti's (1969) reliability formula:

$$C. R. = \frac{2M}{N_1 + N_2}$$

In this formula M is the number of coding decisions on which the author and one coder are in agreement, and N_1 and N_2 refer to the number of coding decisions made by the author and the coder, respectively. Reliability measures for the coding of judgment categories in this study reached levels of 0.79 and 0.70, respectively, between the author and the two coders, while those for the coding of criteria categories reached levels of 0.70 and 0.71. Although the reliability measures obtained for coding categories are somewhat low, they are still at an "acceptable" level for drawing conclusions in qualitative studies (Krippendorff, 1980).

Results

The following results have been found based on 1,321 web pages analyzed. The subject profiles, characterization of judgments, and classification of criteria for judgments of information quality and cognitive authority have been reported in the author's other work (Rieh & Belkin, 2000). Therefore, the following sections will focus on addressing the four research questions.

Research Question 1: How Do People Decide Which Web Site, Page, and Item to Look At?

The Web interaction environment permitted a unique situation in which the author could observe people's decision behaviors from a prediction phase to an evaluation phase in a continuous process. The findings of this study support Hogarth's idea of predictive and evaluative judgment in choice behaviors. The results of this study confirm that the subjects do make prediction about the next Web page prior to activating it, and these predictions reflect what the subjects expected to happen and what ultimately led them to action. This is an example of a *predictive judgment*, and it resulted in a new Web page opening, enabling the subjects to then make an *evaluative judgment*, where they express values and preferences about the Web page. When the evaluation of the page did not match their expectations made in the predictive judgment, then the subjects decided to start a new page or go back to a previous one. When the evaluative judgment did meet their predictive judgment, they would decide to use the information or to stay in the page. As noted above, judgment and decision-making in the Web is a continuous process, and this is shown in the study as the users made predictive and evaluative judgments continuously until they complete the searches. The keywords and phrases that appeared often in the subjects' predictive judgments included: "It *would be* a good search engine;" "It *is likely to be* good;" "It *will* give me reliable databases;" "It *sounds like* a generic name." Note that the phrases indicate expectations, anticipations, and predictions regarding the page that the subjects decided to look at. Here are some more specific examples of predictive judgment:

Yeah, I was trying to, the first thing that came to my mind about, what organization would have a Web site that would provide the most accurate information about diseases. And so I figured, well, a medical site would. And the American Medical Association seemed to be the most appropriate place because of what they do and the journals associated with is highly reputable. It seemed like a good place to start for information (Subject Number S008: L322-327 (line number of the interview transcript for each subject).

There's a certain amount of belief that Excite searches are likely to be good but that's in part because I've been told by people who spend more time thinking about Web searches than I do (S013: L293-295).

TABLE 2. Predictive judgment.

| | Research | Travel | Medicine | Computer | Total |
|---------------------|------------|------------|------------|------------|-------------|
| Information quality | 58 (38.9%) | 28 (23.7%) | 31 (30.4%) | 31 (42.5%) | 148 (33.5%) |
| Cognitive authority | 25 (16.8%) | 18 (15.3%) | 23 (22.5%) | 12 (16.4%) | 78 (17.6%) |
| Topical interest | 60 (40.3%) | 60 (50.8%) | 44 (43.1%) | 27 (37.0%) | 191 (43.2%) |
| Aesthetic aspects | — | — | — | — | — |
| Affective aspects | 2 (1.3%) | 7 (5.9%) | 1 (1.0%) | 2 (2.7%) | 12 (2.7%) |
| General expectation | 4 (2.7%) | 5 (4.2%) | 3 (2.9%) | — | 12 (2.7%) |
| Don't know | — | — | — | 1 (1.4%) | 1 (0.2%) |
| Total | 149 (100%) | 118 (100%) | 102 (100%) | 73 (100%) | 442 (100%) |

On the other hand, the keywords and phrases which appeared in the evaluative judgments included: “It *turned out* it wasn’t what I expected;” “I *did* find this article interesting;” “It *looks* scholarly;” “It *seems* to be a kind of authentic organization.” Here, the phrases indicate evaluations of the page based on the information presented within. Here are other, more specific examples of evaluative judgment:

Yes. [I trust the information]. So, it’s in part due to lots of prior experience with this Web site. This particular archive. I have a high degree of confidence in the quality of the information being presented on this archive (S013: L114–117).

Yeah, but I didn’t know enough about it to be able to make a judgment. It just seemed that what they did seem to be very reliably done (S014: L438–439).

I’m guessing that this information is reasonably reliable but I’m also expecting if I go to actually making a reservation at a hotel, then I’m going to double check all the information. So if I decide that I want to use it here, then I’ll write down the telephone number and I’ll call. Then I’ll ask to verify, you know, where they are located and what the room rate is. But, I think, I have enough faith in the information that I’m willing to use it to decide where to call first. (S013: L590–595)

Both predictive and evaluative judgments of Web information were not related to a dichotomous decision whether to accept or reject. Rather, the subjects made multiple-dimensional judgments that took into account areas such as information quality, cognitive authority, and topical interest before a choice was made and actions taken. The response was coded as “information quality” when the subject mentioned that he or she selected a particular information object because it was *good*, *accurate*, *current*, *useful*, or *important*. Cognitive authority was coded as when the subject indicated that a particular object that they choose to be *trustworthy*, *credible*, *reliable*, *scholarly*, *official*, or *authoritative*. And, topical interest was coded when the subject said that the information was going to be interesting because of “what it was about.” The results indicated that there are other facets of judgments that occurred in evaluative judgments to some extent, but rarely in predictive judgments. Those included

affective aspects (e.g., surprised, frustrated, disappointed, get confused, I’d enjoy it), general expectation (e.g., didn’t meet my expectation, It was not what I expected, medium expectation), and aesthetic aspects (e.g., I liked the look, I didn’t like the color, I liked the logo).

Research Question 2: To What Extent Do Judgments of Information Quality and Cognitive Authority Affect Their Decision and Selection Behaviors in the Web?

The results reveal that subjects were indeed concerned about information quality and cognitive authority to a substantial extent when they made decisions about which page to select (predictive judgment) as well as when they made evaluations in the Web page (evaluative judgment). Out of 442 coding instances of predictive judgments, more than half of them (51.1%) were associated with the aspects of quality ($N = 148$, 33.5%) and authority ($N = 78$, 17.6%). In evaluative judgments which accounted for 534 coding instances, the facets of quality ($N = 245$, 45.9%) and authority ($N = 109$, 20.4%) constitute 66.3% of the total responses.

Table 2 shows that the facets people relied upon when deciding what information source to look at first is slightly different depending on the task. It was found that subjects were making a judgment of information quality to a greater extent when they were searching on the research task (38.9%) and the computer task (42.5%) than on the travel task (23.7%) and the medicine task (30.4%). They were making a cognitive authority judgment to a greater extent for the medicine task (22.5%) than they did for the other tasks. For the travel task, they expressed more concern for topical interests and their emotional reactions (affective aspects) than quality and authority when compared to the other tasks.

As shown in Table 3, the subjects’ evaluative judgments were concerned more with cognitive authority when the subjects looked for information on the tasks of medicine (25.2%) and computer (23.7%) than those of research (15.6%) and travel (17.3%). The subjects’ higher concerns with authority on the task of medicine are consistent with the findings in predictive judgments presented in Table 2. This could be because of the significance of medical information use and consequences. Another interesting finding is

TABLE 3. Evaluative judgment.

| | Research | Travel | Medicine | Computer | Total |
|---------------------|------------|------------|------------|------------|-------------|
| Information quality | 58 (45.3%) | 84 (51.9%) | 64 (43.5%) | 39 (40.2%) | 245 (45.9%) |
| Cognitive authority | 20 (15.6%) | 29 (17.9%) | 37 (25.2%) | 23 (23.7%) | 109 (20.4%) |
| Topical interest | 18 (14.1%) | 17 (10.5%) | 22 (15.0%) | 14 (14.4%) | 71 (13.3%) |
| Aesthetic aspects | 1 (0.8%) | 5 (3.1%) | 2 (1.4%) | 3 (3.1%) | 11 (2.1%) |
| Affective aspects | 16 (12.5%) | 22 (13.6%) | 16 (10.9%) | 11 (11.3%) | 65 (12.2%) |
| General expectation | 12 (9.4%) | 5 (3.1%) | 4 (2.7%) | 4 (4.1%) | 25 (4.7%) |
| Don't know | 3 (2.3%) | — | 2 (1.4%) | 3 (3.1%) | 8 (1.5%) |
| Total | 128 (100%) | 162 (100%) | 147 (100%) | 97 (100%) | 534 (100%) |

that the subjects were least concerned about the aspects of cognitive authority when they searched on the research task (15.6%). A possible explanation for this result could be found in the types of pages that they selected for the task of research. Almost half ($N = 184$, 45.4%) of the total pages for the research task ($N = 406$) viewed were from index databases (e.g., ERIC, Engineering Index, Periodical Abstracts, SocioFile) or Rutgers Libraries Online Catalogs. Because the subjects were using databases or library systems, they may not be concerned about the authority of information because of the assumption that the information they engaged with was already reviewed and selected by the journal editors, database producers or the librarians.

Although the subjects did not pay much attention to the aspects of cognitive authority on the task of research, they considered judgments of information quality substantially ($N = 58$, 45.3%). This may be because no matter what kinds of system they were using, “goodness” and “usefulness” of information remain important facets in their evaluations. The judgments of information quality were mentioned most frequently ($N = 84$, 51.9%) when the subjects made evaluative judgments for the travel task.

Research Question 3: What Are the Facets of Information Quality and Cognitive Authority in Web Searching?

The content analysis of interview transcripts and think-aloud verbal protocols shows that information quality and cognitive authority are multidimensional concepts for which users expressed their responses in various terms and words. In the evaluation phase, the subjects were asked questions of

quality and authority, and their responses were characterized with the facets of both categories.

Five facets of information quality emerged from the data: goodness, accuracy, currency, usefulness, and importance. It should be noted that all five resulted from grouping and classification of various terms with respect to the concept of information quality. For instance, the terms categorized under “goodness” include: good job, bad, better, excellent, fine, nice, great, best, perfect, wonderful, incredible, cool, the state of art, well kept site, well developed site. “Usefulness” was expressed with these terms: useful, useless, hard to use, informative, helpful, doesn't help, can't understand, it's not going to be of much use, didn't make good use. As seen in Table 4, usefulness ($N = 106$, 43.3%) and goodness ($N = 78$, 31.8%) are the two facets that the subject mentioned most frequently.

The results above also show that the facets of information quality depend on the task. For instance, usefulness is mentioned by the subjects for the tasks of travel and medicine to a greater extent than for those of computer and research. It is interesting to note that the subjects were most concerned with the aspect of accuracy when searching for medical information while they were least concerned with it when looking for good papers. Also, a notable finding is that goodness of information was mentioned less frequently when the subjects interacted with the medical information task than with the other tasks. The results indicate that if subjects found medical information that was *useful* and *accurate*, they would most likely believe that it has values of information quality. Unlike the rest of the tasks, however, the task of medicine did not receive many mentions of

TABLE 4. Facets of information quality.

| Facets | Keywords (direct quote) | Frequency (%) |
|-----------|--|---------------|
| Good | Good job, bad, better, excellent, fine, nice, great, best, perfect, wonderful, incredible, cool, the state of art, well kept site, well developed site | 78 (31.8%) |
| Accurate | Accurate, correct, right, precise | 43 (17.6%) |
| Current | Current, recent, up-to-date, out-of-date, old, timely | 15 (6.1%) |
| Useful | Useful, useless, hard to use, informative, helpful, doesn't help, it's not going to be of much use, didn't make good use | 106 (43.3%) |
| Important | Important | 3 (1.2%) |
| Total | | 245 (100%) |

TABLE 5. Facets of cognitive authority.

| Facets | Keywords (direct quote) | Frequency (%) |
|---------------|---|---------------|
| Trustworthy | I trust it, trustworthy, believe in, confidence that this is true, seems real, faith in the quality | 69 (63.3%) |
| Credible | Credible | 8 (7.3%) |
| Reliable | Reliable, reliably done | 12 (11.0%) |
| Scholarly | Scholarly, academic, professional, biological | 10 (9.2%) |
| Official | Official | 7 (6.4%) |
| Authoritative | Authoritative | 3 (2.8%) |
| Total | | 109 (100%) |

“goodness,” possibly because most of the subjects were not familiar with a medical domain in general, and therefore, had difficulties in judging the goodness of information.

Cognitive authority was characterized as having six facets: trustworthiness, reliability, scholarliness, credibility, officialness, and authoritativeness. Again, note that these are categories classified and labeled under cognitive authority, grouping together similar terms from the subjects. For instance, the subjects expressed their concerns about trustworthiness using these phrases: I trust it, trustworthy, believe in, confidence that this is true, seems real, faith in the quality. They described their concerns about scholarliness with the following words: scholarly, academic, professional, biological.

As seen in Table 5, while trustworthiness of information is the most primary facet (63.3%) in characterizing the concept of cognitive authority across four tasks, it was found that the subjects mentioned it more frequently when searching for information about medicine and computer than about research and travel. Reliability was also popular in these two tasks. Because the author did not run any inferential statistical tests and had rather small number of frequencies, no conclusive arguments should be drawn here.

Research Question 4: What Are the Factors That Influence People’s Judgments About Information Quality and Cognitive Authority?

The results of the content analysis in this study show that the subjects indeed were able to articulate the criteria on which they based their judgments of information. These criteria are the factors that lead people make certain decisions and selections, influencing their judgments. The content analysis of the criteria resulted in six major categories: characteristics of information objects, characteristics of sources, knowledge, situation, ranking in search output, and general assumption. Among them, the characteristics of information objects, characteristics of sources, and knowledge were further characterized with other subcategories.

Based on the results, it seems that the kinds of criteria influencing predictive and evaluative judgments about information quality and cognitive authority were different. While making predictive judgments, the subjects chose a particular Web page expecting quality and authority of information based on their knowledge ($N = 114, 39.6%$) in

terms of system (e.g., system functions and structures) or topic area (e.g., source, experts, and terminology). This selection was often made by going directly to some specific site to which they had been directed by other people (second-hand knowledge) or by their own previous experience (first-hand experience). The subjects also made many of their predictive judgments of quality and authority based on these formal characteristics of sources ($N = 84, 29.2%$). However, when they made their evaluative judgments, knowledge became a less important factor ($N = 47, 13.2%$), giving way to the characteristics of information objects ($N = 188, 52.7%$) such as content, type of information object, and presentation. Interestingly enough, characteristics of source were consistently important criteria for both predictive judgments ($N = 84, 29.2%$) and evaluative judgments ($N = 95, 26.6%$).

Table 6 presents the analysis of criteria for predictive judgment of quality and authority with respect to the tasks. One of the interesting findings here is that the subjects tend to rely on their domain knowledge and system knowledge to a substantial extent across the four tasks to find the information that has the values of quality and authority. For instance, here are what some of the subjects said about their knowledge.

Well, I know the National Library of Medicine, that they are going to have all of the medical databases. I also know that they’re the most prestigious medical resource in the U.S. I know that Medline is one of their services, one of many services I don’t know about. So Medline was a possibility but I also know that the National Library of Medicine is the major place to go. And that Medline would be a possibility under that. And that’s pretty much all that I knew. (S010: L418–423)

I knew that there were a number of healthcare sites and this was the one [Dr. Koop site] that stood up in my mind because I just read about it and because I thought that he was an outstanding surgeon general. So, they picked a very good person . . . He seem to be a very morally correct and right kind of person so I would trust him, in terms of trust, this is the case where I would expect him to not sign on to a site that would be doing things badly. (S016: L397–406)

Just prior experience. I got the sense that it was, that I would get more quote, serious, quote, or sophisticated sources

TABLE 6. Criteria for predictive judgment of quality and authority.

| | Research | Travel | Medicine | Computer | Total |
|--|------------|------------|------------|------------|-------------|
| Characteristics of information objects | 37 (34.9%) | 18 (32.7%) | 17 (23.9%) | 8 (14.3%) | 80 (27.8%) |
| Type of info object | 13 (12.3%) | — | 2 (2.8%) | 1 (1.8%) | 16 (5.6%) |
| Title | 10 (9.4%) | 6 (10.9%) | 11 (15.5%) | 3 (5.4%) | 30 (10.4%) |
| Content | 12 (11.3%) | 8 (14.5%) | 3 (4.2%) | 1 (1.8%) | 24 (8.3%) |
| Organization/structure | 1 (0.9%) | 3 (5.5%) | — | 2 (4.6%) | 6 (2.1%) |
| Presentation | — | — | — | — | — |
| Graphics | — | — | — | 1 (1.8%) | 1 (0.3%) |
| Functionality | 1 (0.9%) | 1 (1.8%) | 1 (1.4%) | — | 3 (1.0%) |
| Characteristics of sources | 24 (22.6%) | 12 (21.8%) | 29 (40.8%) | 19 (33.9%) | 84 (29.2%) |
| URL domain type | 1 (0.9%) | — | 4 (5.6%) | — | 5 (1.7%) |
| Type of source | 4 (3.8%) | 9 (16.4%) | 6 (8.5%) | 1 (1.8%) | 20 (6.9%) |
| Source reputation | 6 (5.7%) | 2 (3.6%) | 13 (18.3%) | 18 (32.1%) | 39 (13.5%) |
| One—collective source | — | 1 (1.8%) | 1 (1.4%) | — | 2 (0.7%) |
| Author/creator credentials | 13 (12.3%) | — | 5 (7.0%) | — | 18 (6.3%) |
| Knowledge | 45 (42.5%) | 24 (43.6%) | 19 (26.8%) | 26 (46.4%) | 114 (39.6%) |
| Domain knowledge | 17 (16.0%) | 7 (12.7%) | 6 (8.5%) | 18 (32.1%) | 48 (16.7%) |
| System knowledge | 28 (26.4%) | 17 (30.9%) | 13 (18.3%) | 8 (14.3%) | 66 (22.9%) |
| Situation | — | 1 (1.8%) | 3 (4.2%) | 2 (3.6%) | 6 (2.1%) |
| Ranking in search output | — | — | 3 (4.2%) | 1 (1.8%) | 4 (1.4%) |
| General assumption | — | — | — | — | — |
| Total | 106 (100%) | 55 (100%) | 71 (100%) | 56 (100%) | 288 (100%) |

from AltaVista. And from Infoseek I would get sort of mid range stuff. And when I was looking for, I just figured Infoseek would be as good as any that, a good search engine for that because travel arrangement and local attractions and restaurants and stuff is what I was looking for. (S005: L87–91)

With respect to the task of research, system knowledge was often related to the reasons why the subjects decided to go to library systems, index databases, or archives in the Web rather than going to general Web portal sites. For instance, S014 decided to search on the “SocioFile” database for the task of research, as he believed that “It just seems much more efficient for people. If you’re looking for research manuals, I wouldn’t use one of those other engines” (S014: L221–222). He added that “[It is] efficient in the sense that these will be organized by journals rather than, I think the data I get are more reliable than I might get from Yahoo, AltaVista or someplace. I’m more familiar with this system” (S014: L224–226). On the other hand, S016 decided to try the “Database Systems and Logic Programming Bibliography” site, which he knew was “a very good Web site in Germany” (S016: Think-aloud).

Among the five judgment criteria related to characteristics of sources, “type of source” and “source reputation” were the ones mentioned for all four tasks. Type of source often appeared in the context of mentioning an organization type from which the information came from, such as “a governmental homepage” (S004), “a company’s Web site” (S001), or “a conference” (S003). The following example demonstrates a general pattern in which the subject selected an information object when he recognized that it was from a “reputable source:”

For this task, I know that I did not trust the information until, I did not completely buy into the information until it

came from the Center for Disease Control, some place that I knew, that was very, very reputable in an area like this. (S008: L381–384)

It was noticed that “author/creator credentials” were the concerns of Web users in this study only when they were looking for research and medical information. For example, when the subjects recognized that a research paper in the Web was written by a scholar (S003), a famous researcher (S006), or an expert (S007), they would select it. Some subjects said that they decided to go to a particular archive or database site because they knew that it was created and maintained by their colleagues. For instance, S013 wanted to try the particular archive because it is established by a professor at the Rutgers Linguistics department. S016 used a database on his field that he knew that a computer science professor in Germany has maintained.

Once users make their predictive judgment and decision, they then take an action by choosing a particular Web page, looking through it and making evaluative judgments. The patterns that emerged here show that overall the subjects’ evaluative judgments were based more on characteristics of information objects and sources, rather than their own knowledge and situational factors. With respect to the characteristics of information objects, they mentioned content, graphics, organization/structure, and type of information object relatively more often than other criteria. Regarding the characteristics of sources, they were concerned about source reputation and type of source to judge the quality and authority of information. For definitions and examples of these criteria, see the author’s previous work (Rieh & Belkin, 2000).

The factors influencing evaluative judgments are different depending on the tasks, as shown in Table 7. In terms of specificity of the content, the subjects wanted to have “de-

TABLE 7. Criteria for evaluative judgment of quality and authority.

| Major categories subcategories | Research | Travel | Medicine | Computer | Total |
|--|------------|------------|------------|------------|-------------|
| Characteristics of information objects | 54 (51.4%) | 67 (63.2%) | 43 (49.4%) | 24 (40.7%) | 188 (52.7%) |
| Type of info object | 11 (10.5%) | 1 (0.9%) | 3 (3.4%) | 1 (1.7%) | 16 (4.5%) |
| Title | 2 (1.9%) | 2 (1.9%) | 1 (1.1%) | — | 5 (1.4%) |
| Content | 31 (29.5%) | 40 (37.7%) | 24 (27.6%) | 13 (22.0%) | 108 (30.3%) |
| Organization/structure | 1 (1.0%) | 7 (6.6%) | 3 (3.4%) | 6 (10.2%) | 17 (4.8%) |
| Presentation | 4 (3.8%) | 2 (1.9%) | 5 (5.7%) | 1 (1.7%) | 12 (3.4%) |
| Graphics | 4 (3.8%) | 13 (12.3%) | 4 (4.6%) | 2 (3.4%) | 23 (6.4%) |
| Functionality | 1 (1.0%) | 2 (1.9%) | 3 (3.4%) | 1 (1.7%) | 7 (2.0%) |
| Characteristics of sources | 30 (28.6%) | 18 (17.0%) | 30 (34.5%) | 17 (28.8%) | 95 (26.6%) |
| URL domain type | 1 (1.0%) | 1 (0.9%) | 1 (1.1%) | — | 3 (0.8%) |
| Type of source | 7 (6.7%) | 10 (9.4%) | 6 (6.9%) | 5 (8.5%) | 28 (7.8%) |
| Source reputation | 10 (9.5%) | 3 (2.8%) | 14 (16.1%) | 9 (15.3%) | 36 (10.1%) |
| One—collective source | 1 (1.0%) | 4 (3.8%) | 2 (2.3%) | 2 (3.4%) | 9 (2.5%) |
| Author/creator credentials | 11 (10.5%) | — | 7 (8.0%) | 1 (1.7%) | 19 (5.3%) |
| Knowledge | 18 (17.1%) | 7 (6.6%) | 9 (10.3%) | 13 (22.0%) | 47 (13.2%) |
| Domain knowledge | 11 (10.5%) | 4 (3.8%) | 9 (10.3%) | 7 (11.9%) | 31 (8.7%) |
| System knowledge | 7 (6.7%) | 3 (2.8%) | — | 6 (10.2%) | 16 (4.5%) |
| Situation | 2 (1.9%) | 4 (3.8%) | 1 (1.1%) | 1 (1.7%) | 8 (2.2%) |
| Ranking in search output | — | — | — | — | — |
| General assumption | 1 (1.0%) | 10 (9.4%) | 4 (4.6%) | 4 (6.8%) | 19 (5.3%) |
| Total | 105 (100%) | 106 (100%) | 87 (100%) | 59 (100%) | 357 (100%) |

tailed” information for the tasks of travel and computer. For the task of medicine, they found that “basic” (S007), “general” (S008, S010), “short introduction” (S016), or “background” (S008) information was sufficient because, as S012 explained, if the information was “too specific and scientific . . . I can’t understand it” (S012: L177).

In addition to content, the subjects expressed their concerns about other characteristics of information objects such as graphics and organization/structure. It is interesting to note that for the tasks of travel and computer, the subjects expressed preferences not only based on detailed information, but also on visual characteristics such as graphics and organization/structures of information. However, graphics and organization/structure received relatively little attention in the tasks of research and medicine. This is reflected in the opposite ways subjects reacted to graphics according to the two sets of tasks. For the tasks of travel and computer, they preferred to have some graphics in the pages and made comments including: “Well, I don’t think I like this page very much. There was no picture of computer” (S008: L240–241). However, for the tasks of research and medicine, the sentiments appeared to the contrary: “They had trick animation. It was a waste of time. So I got frustrated with this one real fast” (S005: L553–554); or “It’s far too busy, cute, lots of pictures, but impossible to find things” (S016: L519–520). These responses suggest that graphics in the Web pages are useful for users only when graphics indeed contain information such as a picture of place and computer.

Another interesting note is that the type of information object was mostly mentioned in the task of research. When searching for information for their own research, the subjects were concerned with things such as getting “full article” (S007: L500) or “abstracts, they’re from journals”

(S014: L264). They did not believe the information was useful when in the form of “forum” (S001: L76), “announcement” (S005: L601), “Powerpoint slides” (S005: L636), and “huge bibliography” (S006: L669).

The results indicate that the range of evidence people used for ascribing source characteristics are much broader and diverse in the Web than the simple “author name,” “journal name and document type,” “author credentials” of the print environment (Park, 1993; Wang & Soergel, 1999). The subjects in this study remarked characteristics of sources in terms of: URL domain type, type of source, source reputation, one-collective sources (e.g., whether the information is based on a single person’s opinion or that of a group of people).

The following quotes illustrate how the subjects made efforts to recognize quality and authority based on the type of source expressing the preferences “official site” over “profit-site.” At the same time, if the information was from a company that is dedicated to a certain domain area, they would trust the information.

Well, yeah, it’s put out by the, not really the Chamber of Commerce but by the official representative of Charleston . . . Nobody is trying to sell anything particularly here. Now they may not list here some things that actually might be interesting. But all of the major stuff is going to be here because it’s their travel site, their representation to the outside about one of their cities so they would want to put all the good stuff out there. (S010: L519–527)

So I see that this is actually a company that’s primarily dedicated to providing health information on the Web. So it is not just a sideline that they do; it’s actually a company devoted to that. And they work with a number of major information providers. (S013: L729–736)

Another category of criteria used by the subjects extensively was source reputation, as the following comments demonstrate. Note that the subjects mention that they could trust the information when they recognize the name of a source that is well known.

I'm inclined to privilege the Center for Disease Control because it's a big deal. Big name thing. (S005: L438–439)

Probably more so than the other one because I trust, I trust the World Health Organization would distribute accurate, timely, information. (S003: L560–561)

One reason was that it was from Oxford University Press, which is well known and highly thought of. (S014: L387–388)

Regarding the characteristics of sources, they received little attention for the travel task (17.0%), being more important for the other three (ranging from 28.6 to 34.5%). In particular, the subjects for the research task responded that author/creator's credentials ($N = 11$, 10.5%), source reputation ($N = 10$, 9.5%), and type of source ($N = 7$, 6.7%) influenced their evaluative judgments of quality and authority. These three criteria were also mentioned to some extent for the medical task: source reputation ($N = 14$, 16.1%), author/creator credentials ($N = 7$, 8.0%), and type of source ($N = 6$, 6.9%). For the computer task, the subjects hardly paid attention to author/creator credentials, though they were still concerned about source reputation ($N = 9$, 15.3%) and type of source ($N = 5$, 8.5%).

Discussion

Although the previous studies on relevance criteria have been investigated in diverse information interaction contexts including academic (e.g., Barry, 1994; Cool et al., 1993; Park, 1993, Wang & Soergel, 1999), weather-related (Schamber, 1991), and health-related (Nilan, Peek, & Snyder, 1988) situations, this research is the first of its kind in that it examines two judgment factors, information quality and cognitive authority, in the Web environment. The premise of this research was that while searching for information in the Web, people are concerned with the information's quality, authority, and topicality because overall, the Web has no quality control mechanism. In addition, a variety of information resources are becoming available in the Web, and as such, users often encounter decision-making situations where they must choose one information object among multiple alternatives. If there are a number of information resources related to their topical interests, they would want to find "useful" and "good" information, and would be likely to base their actions on the concept of quality and authority.

One of the significant findings of this study is that the Web users do make judgments about information quality and cognitive authority to a great extent when searching for

information. Both of these facets are more diverse than those identified in the previous research (e.g., Klobas, 1995; Merchand, 1990; Taylor, 1986). For example, Taylor defined the values of information quality in five aspects: accuracy, comprehensive, currency, reliability, and validity. Klobas identified four components of information quality: accuracy, authority, currency, and novelty. Marchand's concept of quality included actual value, perceived value, aesthetics, features, meaning over time among others. On the other hand, the results of content analysis in this study identified some facets that were not found in the previous literature including judgment of whether the information is good, useful, important, trustworthy, credible, scholarly, and official.

Considering that the participants in this study were all scholars, it is interesting to note that they perceived the cognitive authority when the information looked "scholarly" (e.g., scholarly, academic, biological, professional). They also gave high authority to academic institutions and government institutions, and low authority to commercial sites. These results corresponds to Olaisen's (1990) findings in which he noticed that bank managers scored the credibility, trustworthiness, reliability, and accessibility of information produced by banks or credit-evaluation companies as quite high when using electronic information. These two results suggest that rules for ascribing authority are based on whether two parties belong to the same, or different reference groups.

This study also examined two distinct kinds of judgments—predictive and evaluative—based on Hogarth's (1987) framework. The methodological approach taken in this study provided a unique situation in which the author was able to observe people's searching behaviors with respect to both of these judgments in a continuous process during the interaction with Web information. The empirical findings indicate that Web users' judgment and decision process correspond to Hogarth's conceptual framework as defined in general judgment situations. The subjects made predictive judgments given multiple alternatives before they opened a new Web page, and once they did, they made an assessment of the information while looking at the Web page. If the Web page was good, useful, or trustworthy in matching their expectation, they continued to use it. If not, they would either go back to the previous page or try a new site. This process seems analogous to traditional IR situations where people make predictions about relevance based on document surrogates, and later make evaluative judgments based on full-text documents. There has been little research examining people's judgment and decision making in these two different stages of information seeking behavior. Wang and Soergel's (1998, 1999) work is one example of such research, as it investigated three stages of document use: selecting, reading, and citing. However, while this study analyzed the continuous process of moving forward and backward in a Web browser, theirs conducted research in distinct time periods, collecting the data for selecting process in 1992 and for reading and citing decision in 1995.

The fundamental findings that differentiate this study from the previous ones on Web information quality (e.g., Cooke, 1999; Kjartansdottir & Widenius, 1995; Smith, 1997; Tate & Alexander, 1996) include ones on making judgment of quality and authority, which was found by this study to be subjective, relative, and situational. Here, usefulness and goodness are the two primary facets of information quality. Usefulness of information is not necessarily determined by objective characteristics of information objects or sources, but by users who ultimately make judgments of usefulness of information. Various terms indicate "goodness" (e.g., good job, better, excellent, fine, great, best, perfect, wonderful, state of the art), but their common theme appears to be denoting something in which the information excels or is superior. In other words, people believe the goodness of information is a result of relative judgments, or comparing the Web page with their general expectations or with another Web page. The results of this study indicate that this is because judgments are not only based on external factors in terms of characteristics of information objects and sources but also on individuals' own knowledge, which leads them to different predictions, expectations, and furthermore different evaluations.

Identifying knowledge as a primary factor in influencing predictive judgment is another significant finding of this study, and one that supports Wilson's (1983) discussions about knowledge and memory with respect to the concept of cognitive authority. Wilson claimed that people don't believe everything they are told, using the terms "first-hand" and "second-hand," showing how people strive for the "first best" in the former. As Wilson says, "finding out by being told differs from finding out by seeing or hearing or living through an experience" (p. 10). The subjects in this study tended to recall the knowledge from their first-hand experience more frequently than their second-hand knowledge. This implies that being told about a Web site is not a complete substitute for a sites being used before. However, Wilson's arguments still stand because the results show that previous experiences taught the subjects something but not everything. The subjects in this study did not depend entirely on experiences that they had; they used their second-hand knowledge to transcend the limits of personal experiences.

Another important finding of this study is that the subjects took account of source characteristics while making both predictive and evaluative judgments of quality and authority. In addition, the results show that the range of evidence that the users employ for ascribing sources is much broader and diverse in the Web than in the print environment. For instance, they believe in the quality and authority of information if it is from a reputable or famous source, and take their cues for making judgments from there. They preferred academic Web sites for the research task, but they gave more credit to governmental Web sites for the medical task. While they wanted to find sites from government or nonprofit organizations rather than commer-

cial sites for the travel task, they preferred to go to the manufacturer sites directly for the computer task.

With respect to the characteristics of source, it is important to note that the Web users' judgments of quality and authority are influenced more by institutional level of source (e.g., source reputation, type of source, and URL domain type) than by the individual level (e.g., author/creator credentials). For all the tasks but the research task, the subjects responded that source reputation and the type of source influenced their judgments of quality and authority to a greater extent than did author/creator credentials. This result is different from that of the relevance criteria identified in the context of traditional information environments. In Barry's (1993) study, for example, her users mentioned authors/editors ($N = 33$) twice as much as they did organization ($N = 15$) with respect to "source traits." This could be because while Web users are concerned with author/creator credentials, such information is not always available to them. Also, it seems that they pay more attention to the institutional level of source than the individual level of source.

Conclusion

This study addressed the issue of information quality and cognitive authority in a large uncontrolled environment by examining scholars' information seeking behaviors in the Web with respect to their judgments of quality and cognitive authority. The users' decision-making and selection processes were identified given multiple information sources in the Web. During the study, it was noticed that users make extensive efforts to make judgments of information quality and authority. Furthermore, users identified and characterized a number of factors influencing their judgments of information quality and cognitive authority.

Judgment of Information Quality and Cognitive Authority Model Revisited

The results of this study made it possible to extend the original model of information quality and cognitive authority judgments presented in Figure 1 (see Figure 2). It did so on the following aspects: (1) identifying more diverse facets of judgment of information quality (good, accurate, current, useful, and important) and cognitive authority (trustworthy, credible, reliable, scholarly, official, authoritative); (2) separating characteristics of Web information into two categories: characteristics of information objects (type, title, content, organization/structure, presentation, graphics, functionality), and characteristics of sources (URL domain, type, reputation, one-collective, author/creator credentials); (3) differentiating knowledge in terms of system knowledge and domain knowledge; (4) adding new factors influencing judgment of quality and authority such as situation, ranking in search output, and general assumption; and (5) emphasizing the difference in judgment facets and criteria with respect to the types of task.

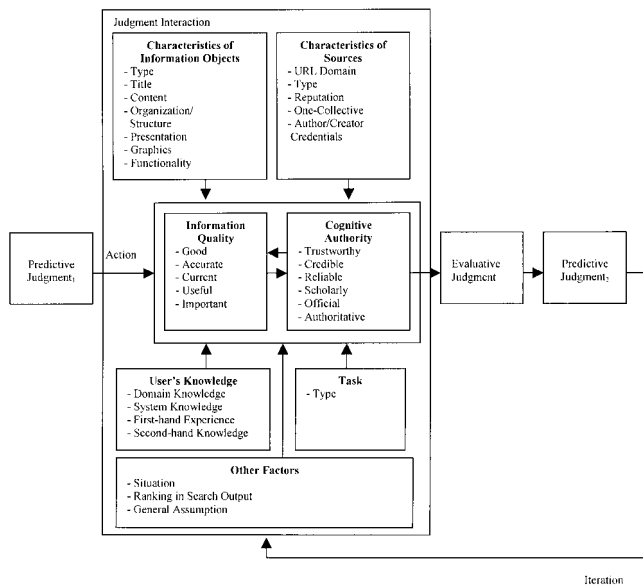


FIG. 2. Revised model of judgment of information quality and cognitive authority.

Theoretical Implications

The findings of this study imply that research on relevance judgment can move forward by examining the relevance criteria with respect to a particular information interaction environment. Although there has been some research on comparing relevance criteria (e.g., Barry & Schamber, 1998; Wang, 1997), little effort has been made thus far into investigating individual relevance criteria focusing on the interaction context that users engage in. This study showed that, as relevance criteria, quality and authority, are important issues for the users when they are interacting with information in the uncontrolled environment such as the Web.

The definition of information quality in general (e.g., Taylor, 1986) and of Web resources in particular (e.g., Cooke, 1999) has been discussed based on theoretical assumptions. This study identified and characterized the facets of information quality based on users' own words, which makes this study different from the previous studies. One contribution that this study makes in the field of information quality is that the findings indicate that the concept of information quality is closely related to cognitive authority in that the users often make judgments of information quality based on authority of sources. The authority of sources, in turn, provides the potential pool in which users can make judgments of information quality.

This study is the first empirical research to examine the concept of cognitive authority defined by Wilson (1983). The results certainly validate Wilson's notion of first-hand experience and second-hand knowledge in making judgments of cognitive authority. There were numerous instances in which the subjects mentioned that they wanted to go to the Web sites they chose because they had already been there before (first-hand experience). The subjects did

not go to the Web sites based on "any" information that they had heard or read (second-hand knowledge). They decided to select certain pages or sites when there was some indication for authority of the source, which could be recognized based on their own experience, other people's recommendations, or something that they heard of. It was also noticed that the subjects often referred to "other people" who seem to serve as "cognitive authorities," such as engineers, friends, colleagues, or a professor group. Some instances were observed in which the subjects said their "cognitive authorities" were newspapers, journal articles, and even television advertisements.

Implications in the field of interactive IR with regard to the methodological approach are also offered in this study. Probably the most significant implication can be found in "generic" tasks used in this study. The tasks were claimed to be generic in the sense that they outlined the kinds of task while not restricting the specific information problems. For example, the subjects were asked to find "some good papers," and they were allowed to choose their own topics related to the research project in which they were engaged. Another example came when the subjects needed to find the best price for a new computer while they could choose a particular model in which they were personally interested. These "generic" tasks worked well for this research by demonstrating various topics that individual subjects chose while not digressing from the tasks given. Another contribution that this study has made to the methodology of interactive IR research is the way that postsearch interviews were conducted. Using search logs during the interview rather than relying on the subject's own memory proved to be useful for both the subjects and the interviewer to understand users' behavior and judgment. This method also provided a basis for the replicability of data collection, and thus increased the reliability of this study.

Practical Implications for Web System Design

The implications for designing Web systems can be discussed with respect to two distinct types of judgment identified in this study: predictive judgment and evaluative judgment. The findings about predictive judgments have a number of implications for developers of Web search engines in terms of improving user interface design and adding new features, while findings for evaluative judgments present some suggestions for designers of Web sites in a way that can enhance users' decisions to use the particular Web page.

To support predictive judgment, this study recommends that Web search engines develop a way to search more effectively for "sources" as well as "information objects." This is based on the finding that the subjects often made decisions to go directly to the sites that they had visited previously (first-hand experience) or about which they had heard from others whom they trust (second-hand knowledge). Google™'s "Search a site" feature is a step towards enabling users to restrict their search to a specific site. For

example, users can use the “admission site:” syntax in the search box to find admission information on Rutgers’ Web site. This feature is certainly on the right track by offering a way to conduct searches associated with a particular Web site. But, the “Search a site” has a limitation as it is based on the assumption that users know the exact URL. In this study, it was observed many users could not remember the exact URLs, and had to locate the site based on the names of organizations. However, some search engines were just not able to locate the particular Web sites that they intended to visit. For instance, S008 typed in “American Medical Association” in the query box, but failed to locate the homepage of AMA in the search results. This is because, as Kleinberg (1999) noticed, the AMA homepage may not use the term “American Medical Association” most often. It suggests that users need to be able to specify their query in terms of characteristics of source, which often serves as the basis for judgments of quality and authority.

Another way to support people’s predictive judgment is to provide a way to search for a particular type of Web site. The results revealed that users expressed their expectations in terms of type of source. For instance, the subjects wanted to go to a “company’s Web site” (S001), “governmental homepage” (S004), “conference site” (S003), “university site” (S013), or a “professor’s personal homepage” (S007). This suggests that it would be helpful if users could specify the kind of site they want when they submit their topical query. Some search engines such as Excite™ (www.excite.com) provide a feature in which users can select a particular domain type (i.e., .com, .org, .gov, .edu, .net, .mil). However, it was found that the users in this study were more concerned about type of source ($N = 20$) than URL domain type ($N = 5$). Northern Light’s (www.northernlight.com) “Limit documents to” feature enables users to limit their search to a personal page, learning materials, question and answers, for sale, and job listings in addition to URL domain type. This is close to what users are expecting to have, but it can be greatly extended covering more comprehensive type of source.

Once users conduct the searches by entering their query, search engines display the top results listing “representations” of information objects. According to the findings of this study, Web users would make their predictive judgments more effectively if they could see more clues that indicate the facets of information quality and cognitive authority. In this study, the subjects expected to find information that is good, useful, accurate, current, and important, as well as trustworthy, reliable, credible, scholarly, official, and authoritative. To recognize those facets in current search engine results, users have to rely on very limited representations available such as title, summary, and URL. Without enough clues, users often had to open one Web page based on guessing rather than decision, and often had to come back to the search results page because their choice was not what they expected. Users would then choose something else, and repeat this behavior until they finally found the page that they had expected. If information ob-

jects and sources on results page were more detailed, users would make better predictive judgments, and they would be less likely to have to return to the search results to open another page. This study confirms this, showing that information about sources at institutional (name or type of source) and individual (author/creator) levels could be very helpful for users who tend to make predictive judgments based on characteristics of sources.

To support the evaluative judgments of Web users, this study suggests that Web designers should present additional and more explicit forms of evidence for information quality and cognitive authority on their pages. The users in this study mentioned that they tend to find such evidence from a number of different characteristics of information objects and sources including content, source reputation, type of source, graphics, and author/creator credentials. However, it was noticed that sometimes users were not able to see what they needed to know because it was either unavailable or it was placed in the bottom of the page. The easiest way of improving the Web design to support such behavior is to place source information or other critical characteristics on the top of the page so that it can be noticed without users having to scroll down.

Future Research

The directions for future research are closely related to the limitations of this study, including the fact that this study did not collect actual comparative data regarding judgments of quality and authority between the print environment and the Web environment. It was presumed that people’s relevance criteria and decision rules accumulated in the traditional information systems may not be directly applicable to the Web. In the future, similar studies should be extended by directly comparing people’s judgments of information quality and authority between the Web environment and the printed environment, focusing on the judgments of information quality and cognitive authority in the different information interaction environments.

In this study, scholars were selected as the sampled population because it was thought that they were more likely to be concerned with making judgments of information quality and cognitive authority than any other population as their work is heavily involved in finding and assessing information. Future research needs to expand the generality of the findings of this study by investigating similar research problems in different settings or with different subject groups. We can examine, for instance, how people in business settings make judgments of quality and authority in their work environment. The scholars in this study tend to trust the information from academic institutions and government institutions while giving low authority to commercial sites in general. So it may be interesting to examine whether the two parties belong to the same, or different reference groups. Another way to extend the findings of this study is to investigate the research agenda with high school students or college students who have not acquired the

knowledge and skills to evaluate information sources in the printed environment, and have been exposed to uncontrolled environments such as the Web.

This study attempted to identify the implications for Web design that will effectively support people's judgment of quality and authority, but did not go further than that. Another possible area of research might be to implement some interface features and functionalities identified in this study into a Web system, and evaluate the effectiveness and usability of the new system.

Future research will extend our understanding judgment and decision-making process of information quality and cognitive authority, and that will eventually lead to the design of Web systems that effectively support people's judgment of quality and authority when searching for information.

Acknowledgments

This research was completed while the author was at the School of Communication, Information, and Library Studies, Rutgers University. The author wishes to thank her advisor, Professor Nick Belkin for providing incredible guidance and insight to her research over the years. She is also grateful to her committee members, Professor Tefko Saracevic, Professor Carol Kuhlthau, Dr. Marilyn Tremaine, and Dr. Colleen Cool for their support and encouragement during the various stages of this research.

References

Amento, B., Terveen, L., & Hill, W. (2000). Does "authority" mean quality? Predicting expert quality ratings of Web documents. *Proceedings of the 23rd Annual International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 296–303).

Barry, C.L. (1994). User-defined relevance criteria: An exploratory study. *Journal of the American Society for Information Science*, 45(3), 149–159.

Barry, C., & Schamber, L. (1998). Users' criteria for relevance evaluation: A cross-situational comparison. *Information Processing and Management*, 34(2/3), 219–236.

Bateman, J. (1999). Modeling the importance of end-user relevance criteria. *Proceedings of the 62nd ASIS Annual Meeting* (vol. 36, pp. 396–406).

Belkin, N.J. (1993). Interaction with texts: information retrieval as information seeking behavior. *Information Retrieval '93: Von der Modellierung zur Anwendung*. Proceedings of the First Conference of the Gesellschaft für Informatik Fachgruppe Information Retrieval, Regensburg. Konstanz: Universitätsverlag Konstanz, pp. 55–66.

Belkin, N.J. (1996). Intelligent information retrieval: Whose intelligence? *Proceedings of the Fifth International Symposium for Information Science*, Konstanz: Universitätsverlag Konstanz, pp. 25–31.

Cooke, A. (1999). *Authoritative guide to evaluating information on the Internet*. New York: Neal-Schuman.

Cool, C., Belkin, N.J., Frieder, O., & Kantor, P. (1993). Characteristics of texts affecting relevance judgments. *Proceedings of the 14th National Online Meeting* (pp. 77–84).

Fidel, R., et al. (1999). A visit to the information mall: Web searching behavior of high school students. *Journal of the American Society for Information Science*, 50(1), 24–37.

Fontana, A., & Frey, J.H. (1994). Interviewing: The art of science. In N.K. Denzin, & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 361–376). Thousand Oaks, CA: Sage.

Fritch, J.W., & Cromwell, R.L. (2001). Evaluating Internet resources: Identity, affiliation, and cognitive authority in a networked world. *Journal of the American Society for Information Science and Technology*, 52(6), 499–507.

Hogarth, R.M. (1987). *Judgment and choice: The psychology of decision*, 2nd ed. New York: John Wiley & Sons.

Holsti, O.R. (1969). *Content analysis for the social sciences and humanities*. Reading, MA: Addison-Wesley.

Huber, O. (1989). Information-processing operators in decision making. In H. Montgomery & O. Svenson (Eds.), *Process and structure in human decision making* (pp. 3–21). New York: John Wiley & Sons.

Janes, J.W., & Rosenfeld, L.B. (1996). Networked information retrieval and organization: Issues and questions. *Journal of the American Society for Information Science*, 47(9), 711–715.

Jansen, B.J., Spink, A., & Saracevic, T. (2000). Real life, real users, and real needs: A study and analysis of user queries on the web. *Information Process and Management*, 36, 207–227.

Jeong, M. (1998). *Measurement of information quality on lodging websites: An experimental study with eight hypothetical lodging websites*. Unpublished doctoral dissertation, The Pennsylvania State University.

Kjartansdóttir, A., & Widenius, M. (1995). The quality of business information on the Internet: Evaluation criteria applicable to Internet resources. *Swedish Library Research*, 3–4, 43–50.

Kleinberg, J.M. (1999). Authoritative sources in a hyperlinked environment. *Journal of the Association for Computing Machinery*, 46(5), 604–632.

Klobas, J.E. (1995). Beyond information quality: Fitness for purpose and electronic information resource use. *Journal of Information Science*, 21(2), 95–114.

Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*. Beverly Hills, CA: Sage.

Marchand, D. (1990). Managing information quality. In I. Wormell (Ed.), *Information quality: Definitions and dimensions* (pp. 7–17). Los Angeles: Taylor Graham.

Nilan, M.S., Peek, R.P., & Snyder, H.W. (1988). A methodology for tapping user evaluation behaviors: An explorations of users' strategy, source and information evaluating. *Proceedings of the 51st ASIS Annual Meeting*, 25, 152–159.

Olaisen, J. (1990). Information quality factors and the cognitive authority of electronic information. In I. Wormell (Ed.), *Information quality: Definitions and dimensions* (pp. 99–120). Los Angeles: Taylor Graham.

Park, T.K. (1993). The nature of relevance in information retrieval: An empirical study. *Library Quarterly*, 63(3), 318–351.

Pharo, N. (1999). Web information search strategies: A model for classifying web interaction? In T. Aparac, T. Saracevic, P. Ingwersen, & P. Vakkari (Eds.), *Digital libraries: Interdisciplinary concepts, challenges and opportunities*. Proceedings of the 3rd International Conference on the Conceptions of the Library and Information Science (CoLIS3) (pp. 207–218). Lokve, Croatia: Benja Publishing.

Price, S.L., & Hersh, W.R. (1999). Filtering web pages for quality indicators: An empirical approach to finding high quality consumer health information on the World Wide Web. *Proceedings of the 1999 Annual Symposium of the American Medical Informatics Association* (pp. 911–915).

Rachlin, H. (1989). *Judgment, decision, and choice: A cognitive/behavioral synthesis*. New York: W. J. Freeman and Company.

Rieh, S.Y., & Belkin, N.J. (1998). Understanding judgment of information quality and cognitive authority in the WWW. *Proceedings of the 61st ASIS Annual Meeting* (vol. 35, pp. 279–289).

Rieh, S.Y., & Belkin, N.J. (2000). Interaction on the Web: Scholars' judgment of information quality and cognitive authority. *Proceedings of the 63rd ASIS Annual Meeting* (vol. 37, pp. 25–38).

Saracevic, T. (1997). The stratified model of information retrieval interaction: Extension and applications. *Proceedings of the 60th ASIS Annual Meeting* (vol. 34, pp. 313–327).

- Saracevic, T., & Kantor, P. (1997). Studying the value of library and information services. Part I: Establishing a theoretical framework. *Journal of the American Society for Information Science*, 48(6), 527–542.
- Schamber, L. (1991). Users' criteria for evaluation in a multimedia environment. *Proceedings of the 54th ASIS Annual Meeting* (vol. 28, pp. 126–133).
- Smith, A.G. (1997). Testing the surf: Criteria for evaluating Internet information resources. *The Public-Access Computer Systems Review [On-line]*, 8(3). Available: <http://info.lib.uh.edu/pr/v8/n3/smith8n3.html>.
- Spink, A., & Greisdorf, H. (2001). Regions and levels: Measuring and mapping users' relevance judgments. *Journal of the American Society for Information Science and Technology*, 52(2), 161–173.
- Strauss, A., & Corbin, J. (1994). Grounded theory methodology: An overview. In N.K. Denzin and Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 273–285). Thousand Oaks, CA: Sage.
- Tate, M., & Alexander, J. (1996). Teaching critical evaluation skills for World Wide Web resources. *Computers in Libraries*, 16(10), 49–55.
- Taylor, R.S. (1986). *Value-added processes in information systems*. Norwood, NJ: Ablex Publishing.
- Wang, P. (1997). The design of document retrieval systems for academic users: Implications of studies on users' relevance criteria. *Proceedings of the 60th ASIS Annual Meeting*, 34, 162–173.
- Wang, P., Hawk, W.B., & Tenopir, C. (2000). Users' interaction with World Wide Web resources: An exploratory study using a holistic approach. *Information Processing and Management*, 36, 229–251.
- Wang, P., & Soergel, D. (1998). A cognitive model of document use during a research project. Study I. Document selection. *Journal of the American Society for Information Science*, 49(2), 115–133.
- Wang, P., & Soergel, D. (1999). A cognitive model of document use during a research project. Study II: Decision at the reading and citing stages. *Journal of the American Society for Information Science*, 50(2), 98–114.
- Wilson, P. (1983). *Second-hand knowledge: An inquiry into cognitive authority*. Westport, CT: Greenwood Press.
- Zhu, X., & Gauch, S. (2000). Incorporating quality metrics in centralized/distributed information retrieval on the World Wide Web. *Proceedings of the 23rd Annual International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 288–295).