October 1998

An Exploratory Study of User Searching of the World Wide Web: A Holistic Approach

Carol Tenopir
University of Tennessee - Knoxville, ctenopir@utk.edu

Peiling Wang
University of Tennessee - Knoxville

Elizabeth Layman

David Penniman

Shawn Collins

An Exploratory Study of User Searching of the World Wide Web: A Holistic Approach

Peiling Wang, Carol Tenopir, Elizabeth Layman, David Penniman, Shawn Collins
University of Tennessee, Knoxville
peilingw@utk.edu

Abstract

Presents preliminary results of an exploratory study of users' interaction with Web resources in finding factual information using a holistic approach. The purpose of this study is two-fold: (1) to understand Web users' behaviors and need; (2) to test a methodology for studying users' interaction with the Web. A process-tracing technique, together with tests of cognitive style (Embedded Figure Test), anxiety levels (State-Trait Anxiety Inventory), and self-report computer experience, provided data on how users interact with the Web in the process of finding factual information. Affective state can be affected by Web search results, especially how the person feels about the results. Cognitive styles and time spend on searches seems to be correlated for certain type of questions.

Introduction

Since the advent of the Internet, more and more end-users are directly connected to vast information resources. The World Wide Web (Web) has revolutionized end-user searching for information; users are more than ever aware of their information needs and electronic information resources surrounding them. However, using the Web to find relevant information can be a frustrating and disappointing experience. Web resources are significantly different from traditional sources available in libraries and in online databases because resources are networked, heterogeneous, and in multimedia format. Digital data on the Web are physically stored anywhere in the world and accessible via the Internet. The networked digital information systems no longer have homogeneous collections, nor do they have well-defined boundaries. There is a vast array of formats: text, hypertext, image, sound, video, animation, etc. The organizational schemes and access methods across the Web resources are also diverse. Users are as heterogeneous as resources and the majority of users are perpetual novices with diverse subject background and different levels of information and computer literacy.

Toward Every-Citizen Interfaces: the Nation's Information Infrastructure Steering Committee, National Research Council has published a report drawing from a two-day workshop held in August 1996 to identify research issues and directions in developing interfaces for everyone. Technologies on such interfaces are referred to as every-citizen interfaces (ECIs) (National Research Council, 1997). The report lists the desired characters of ECIs, such as they should be: *easy to understand, easy to learn, error tolerant, flexible and adaptable, appropriate and effective for the task*. Advances in technology are required to implement such interfaces. As the highest-priority, the committee recommends research on understanding the problems and the needs basic to effective human-machine interaction and measuring the effectiveness of technologies when used by humans in problem-solving situations.

To date, there is little reported research on real users' interactions with Web resources (hereafter *user-Web interactions*). This study is designed to observe how users search for factual information on the Web. It focuses on individual differences, which might affect searching. The purpose of this study is two-fold: (1) to understand the process of user-Web interaction; (2) to test a methodology to study Web users. The ultimate goal is to suggest principles for effective Web information retrieval systems and user-Web interfaces.

Relevant Literature

Studies of online searching behavior have been documented for decades. The earliest end-user information retrieval (IR) systems are online public access catalogs (OPACs), which are free and widely available remotely. Researchers have devoted 20 years of efforts to study the searching behaviors of OPAC users. But, Borgman (1996a) argues, "online catalogs continue to be difficult to use, because their design does not incorporate sufficient understanding of searching behavior" (p. 493) and "we need to incorporate more knowledge of searching behavior into the design of these systems" (p. 502). Some results of the studies of OPACs certainly can contribute to the World Wide Web design (Larson et al., 1996).

Earlier studies of information retrieval focused on the systems and technologies, but a growing body of literature indicates the shift of research in this field. More and more studies take user-oriented approaches such as sense-making, cognitive and behavior approaches to investigate the complex nature of user's information behaviors (Bates, 1993a, 1993b, 1996; Belkin, Oddy & Brooks, 1982; Borgmann, et al., 1995; Dervin, 1992; Ellis, 1992; Fidel, 1987; Ingwersen, 1996; Kuhlthau, 1993; Harter, 1992; Marchionini, 1989). Nahl and Tenopir (1996) have demonstrated the importance of the affective and sensorimotor domains for novices in addition to the cognitive elements of online searching.

The Web is certainly an important new channel for information. Several studies of the users and Web searching focused on search engines, interfaces, and successes (Chu, 1996; Din & Marchionini, 1996; Meghabghab & Meghabghab, 1996; Shneiderman et al., 1997; Pollock and Hockley, 1997; Wang and Pouchard, 1997). Their findings suggested that various Web search engines function differently and users are not very successful in searching for information on the Web: users have difficulties with syntax and semantics of different search engines; more than 30% of the searches result in zero-hit outcomes.

To study user-Web interactions, a closely related field is human-computer interaction (HCI). A workshop sponsored by the National Science Foundation Interactive Systems Program proposed new directions in HCI education and research (Strong, 1994). One of the research priorities identified by the workshop is the need to understand "what people actually do, want to do, and could do with computing systems, ... integrated and communication computing systems" (p. 26). The workshop also pointed out that appropriate methodologies are needed to go beyond current domain-specific studies.

This study attempts to look at some of the issues identified by the UCLA-NSF Social Aspects of Digital Libraries Workshop (Borgman, 1996b). At this workshop, one of three foci for further research is the need for user-centered studies. Some of the identified topics are heterogeneous populations, situated use in a multimedia environment, and information literacy skills needed for digital libraries. Many participants emphasized the needs to explore end-users' information behavior in digital environments and to develop appropriate methods to collect real-world data beyond traditional user-evaluation methods, such as field studies, video, and direct observation. In a comprehensive review, Bishop & Starr (1996) conclude, "we need to understand more about which aspects of searching behavior are universal and which are situation-specific, if we are to design information systems to serve an increasingly heterogeneous user population with increasingly diverse set of information needs" (p. 361). A growing body of research is examining user behavior in interacting with the Internet (and, in particular, the Web) to find information, but this research is still in the early stages (Tenopir, 1998).

The cognitive and holistic approaches to user behaviors require researchers to observe the processes of users' interactions, not merely the outcomes of a process. A process-tracing technique is needed to capture the real process when it happens. An online monitoring method that captures the specific actions an individual takes during a search process is of particular utility in studying users' behavior in interacting with computerized systems. This had been documented by several researchers (Bishop and Starr, 1996; Borgman, Hersh, & Hiller, 1996; Marchionini et al., 1994; Penniman and Dominick, 1980; Rice and Borgman, 1983). Bishop & Starr (1996) also call for integration and extension of traditional methods, and developing new methods to study users in digital environments. They note a number of large-scale digital library projects have incorporated multiple methods, but their work or description of the methods has often been reported and used only internally (p.362). Although computer monitoring data have been collected to study OPAC and IR systems (Borgman et al., 1996; Marchionini et al., 1994; Penniman and Dominick, 1980; Rice, 1990; Rice and Borgman, 1983), we are unable to find reported studies of user-Web interactions using monitoring data at individual users' level beyond site-

tracking. A few studies in progress are capturing Internet users' transaction logs using internally developed proprietary programs. The need to design and develop an appropriate method is of importance in studying the behavior of Web users.

Conceptual Framework and Research Questions

User-Web interaction can be seen as (1) a communication process consisting of a series of transactions between the user and the system; (2) an information-processing and problem-solving process in which the user makes decisions based on the interpretation of information presented to him/her. The assumption is that not all the users will search the Web in the same way, therefore individual differences may result in difficulties in using the Web to find information. This study focused on three factors that might affect users' interaction with the Web: a) computer and search experience; b) cognitive style in terms of an individual's information processing style; and c) affective states in terms of the anxiety level before and after a search.

Computer and information retrieval experience can be measured by a questionnaire about how long and how frequent the users have been using Windows, IR systems, and the Web.

Cognitive style is an individual's characteristic and self-consistent modes of functioning in cognitive activities, such as perception and problem solving. Dimensions of cognitive style can be measured by standard tests; in this study we used the Embedded Figures Test (EFT) individually administered (Witkin, 1971). In the EFT, an individual is asked to locate a previously seen simple figure within a larger complex figure, which embeds the simple figure. The test is scored with average solution time per trial based on solving 12 figures (with a 3-minute limit per trial). The EFT score identifies a person's perceptual tendency by providing a score in terms of field-dependence and field-independence. For relatively field-dependent individuals (those who scored higher in EFT), the Web is expected to be a much more difficult environment.

Affective states are a person's feelings that might affect one's performance in a task. On the other hand, a person's feeling may also be affected by performing a task. In this study, affective states before and after searching were measured using the State-Trait Anxiety Inventory (STAI), which consists of two forms: S-anxiety and T-anxiety (Spielberger, 1983). T-anxiety indicates an individual's general tendency of feelings; S-anxiety indicates an individual's feelings at that moment. A person's affective states may influence how he/she searches the Web, while self-satisfaction after the search may also change his/her affective states, especially S-anxiety.

One of the major difficulties in studying Web users is the lack of methods for collecting real-world data. Searching Web resources is a highly interactive cognitive process that cannot be understood simply by comparing search outcomes with users' questions. Interview or survey data can only provide a partial picture of the interaction because users may not be aware of or able to recollect what they did during the process. This study is exploratory because there is no ready equipment and technique to observe the users. A process-tracing technique will be designed and tested.

The following research questions are raised:

1. How successful are end-users in searching for information?
2. Do users who have completed library and information core courses perform better?
3. What is the nature of the roles that computer and search experiences, cognitive styles, and affective states play in searching the Web?
4. Are the proposed data collecting techniques appropriate for studying Web users?

Methodology

This study observes user's interaction in a near natural setting. No treatment or control was imposed on the participants. A process-tracing technique was designed to capture search processes and record concurrent

verbalization of thoughts during the search. Standard tests and questionnaires were used to collect data on cognitive domain (computer and search experiences and information processing style) and affective domain (emotional states).

Process-tracing Technique

The proposed method takes advantages of advanced digital technologies to record individual users' processes and behaviors as they interact with the Web for information. Specifically, the transactions with timestamps and cued verbal reports on pausing behavior were recorded (ideally nonverbal language during user-Web interactions should also be captured). To record keystrokes and screen actions, a monitoring program was installed to create a log file. The advantages of using monitoring data are that they are accurate, unobtrusive, longitudinal, transactional, temporal, and can be automatically collected and processed (the computer does the work!). But there are also some disadvantages, such as open to interpretation (although accurate), privacy concerns, and the overwhelming amount of data that can be difficult to manage.

Both retrospective and concurrent verbal reports have been used to study cognitive processes in the last two decades (Ericsson and Simon, 1993). Verbal data reveal human information processing and thoughts that underlie behavior and help to interpret nonverbal activities more accurately. It is understandable that searchers can only verbalize a subset of thoughts occurring during the interaction because some thoughts are difficult to verbalize. If the monitoring data can capture all the actions and moves users make, partial verbalization will provide additional information about their thoughts, which help to reveal users' limitations and problems at specific points during the search.

The equipment was set up to record the following process data: (1) sites visited with time stamp in a transaction log file; (2) continuous screen shots with time stamp on a video tape; (3) verbalization of thoughts recorded on the same video tape.

Participants

Twenty-four graduate students enrolled in a Masters program in information sciences voluntarily participated in this study in September and October 1997. They consist of two groups: (1) fourteen participants are entry-level students who just started the program and are more like general users of the Web; (2) ten participants are advanced-level students or graduates who have completed the core curriculum and are more experienced searchers.

Table 1. Participants' computer and search experience (N=24)

	Computer Use		IR systems Use		WWW Use	
	Months	Times/mon.	Months	Times/mon.	Months	Times/mon.
Mean	41	21.5	51.5	8.8	25.3	15.0
SD	33.8	8.0	34.8	9.6	13.0	11.1
Min.	3	4	2	1	3	1
Max.	132	25	144	25	60	25

Table 2. Participants' cognitive style, and affective state (N=24)

	EFT Score* (seconds)	STAI**	
		S-Anxiety	T-Anxiety
Mean	46.80 &	35.42 #	38.58 #
SD	32.10 &	10.17 #	9.28 #
Min.	16.30	20	24
Max.	172.90	63	63

* EFT: Embedded Figure Test monitored individually; the score is measured by total response time in seconds divided total number of cards.
** STAI: State-Trait Anxiety Inventory by Speilberger, 1983.
& EFT for male: mean 45.80 SD 17.65; for female: mean 47.10 SD 35.31
# S-Anxiety for male: mean 31.60 SD 9.53; for female: 36.42 SD 10.34
T-Anxiety for male: mean 38.80 SD 8.64; for female: 38.53 SD 9.67

Search Questions

Participants were given the following two factual search questions to find information on the Web. They were not guided or assisted on any of the searches.

(1) This summer, a faculty member at the University of Tennessee, Knoxville submitted a full grant proposal to the National Science Foundation through the FastLane, the agency's new electronic proposal system. It was announced in the Research Good News. Can you find the news for me? [You may use this sheet for scrap paper]

(2) Each year, the U.S. Census Bureau reports on the projections of national population. I am interested in the most current estimate for the population of the United States in 2000. [You may use this sheet for scrap paper]

Procedure

The participants were scheduled to perform the searches at their convenience. After signing a consent form, each searcher followed the same procedure. The searcher:

- filled in pretest questionnaires to measure level of information skills and affective states (State-Anxiety and Trait-Anxiety).
- took an individually administered Embedded Figure Test (EFT) about cognitive styles (12 questions with a 3-minute cut-off time on each).
- was given the first question sheet and asked to find the answer. (The Web browser was set at home state (the university's homepage) and the searcher was reminded to think aloud during the search.)
- filled in two questionnaires when the searcher completed the question (or decided to stop). These questionnaires measured satisfaction of the search result and comments and affective state (State-Anxiety).
- was given the second question sheet and asked to find the answer. (The Web browser was on the page where the first search ended and the searcher was again reminded to think aloud during the search.)
- filled in two questionnaires when the searcher completed the question or decided to stop. These questionnaires measured satisfaction of the search result and comments and affective state (State-Anxiety).

Results

As described in the Methodology section, there are two parts of data collected in this study. The quantitative data describe the search outcomes and the searcher's characteristics in affective, cognitive and computer and search experience domains. The qualitative data describe the search processes and the searchers' thoughts during the interaction. Transcribing the qualitative data requires labor-intensive work, which is still in progress. Therefore, the preliminary results reported here focus on the descriptive features of quantitative variables and their

relationships. Statistical analysis aims at identifying how *search outcome* relates to *affective state*, *cognitive* style, and *computer and information experience*.

How successful were the searchers?

1. Has the searcher found a *correct answer* and how does he/she feel about the result? Table 3 indicates that for question 1 about half of the participants failed to find a correct answer. Three of them gave up after some effort. Of the nine who found an incorrect answer, three of them were very sure they found the right information. For question 2 all participants claimed to have found the correct answer. For those who found the right information (N=22), half of them were highly confident about their search, the other half were moderately confident. The two who found incorrect answers also felt moderately confident about their results.

Table 3. Search results and post-search confidence

Post-search confidence level	Correct answer N=12	Incorrect answer N=9	No answer N=3
Question 1			
High	12	3	
Moderate high		4	
Moderate low		2	
Low			3
Question 2			
Post-search confidence level	Correct answer N=22	Incorrect answer N=2	
4 (high)	11		
3 (moderate high)	11	2	

2. How much *time* was spent on interacting with the system and how many *sites* were visited for each search question? Table 4 indicates that time spent on each question varied among the participants. In general, they spent about 15 minutes for each question, although the deviation for question 1 is much larger than for question 2. The number of sites visited has a similar distribution for questions 1 and 2. The Pearson coefficient is .93 and .89 respectively, indicating a high correlation between the search time and visited sites.

Table 4. Search Time and Sites

	Question 1		Question 2	
	Time (min.)	No. of Sites	Time (min.)	No. of Sites
Mean	14.50	28.13	15.04	29.67
SD	13.77	24.16	9.79	17.46
Range	3, 57	4, 106	3, 39	10, 77

The variables of *time* and *sites* are significantly related for both search questions ($r_1 = .93$; $r_2 = .89$). Therefore, either one will suffice to describe the length of the process.

3. How is the searcher's *affective state* changed after the search? The change of State Anxiety level as a result of performing the Web searches was measured with the same STAI S-Anxiety Form after the search. The value of change is calculated by the formula:

Δ S-Anxiety = Post-search S-Anxiety -- Pre-search S-Anxiety

Note: for question 2,
Pre-search S-Anxiety = Post-search S-Anxiety after question 1

Table 5. Change of State Anxiety Level

	Participants = 24	
	After Q1	After Q2
No change	2	1
Less stressed	13	10
More stressed	9	13
Range of change	-17 to +18	-18 to +13
Mean	-.38	-.33
SD	8.85	6.49

Do the two groups differ significantly?

One group of participants consists of entry-level students (N=14) who are more like the general users of a university; the other group is advanced-level students (N=10) who had finished core library and information courses with special training in DIALOG searching. It is tempting to hypothesize that the advanced students will perform better than entry-level students in terms of more correct answer, less time (sites), and low anxiety. For question 1, of the 14 entry-level students: 6 found the correct answer (42.9 %), 7 had an incorrect answer (50.0 %), and 1 gave up (7.1 %). In question 1, of the 10 advanced-level students: 6 found the correct answer (60.0 %), 2 had an incorrect answer (20.0 %), and 2 gave up (20.0 %). For question 2 all found answers, but two from the entry-level group had incorrect answers. Their means are not significantly different by t-test, although the advanced students actually spent more time on both questions (Table 6).

Table 6. Comparison of Searching by Participant's Level in the Program

		Question 1		Question 2	
		Time	Change of S-Anxiety	Time	Change of S-Anxiety
Entry-level (N=14)	*Mean*	11.5	-.29	14.7	.21
	SD	8.7	9.62	8.5	7.78
	Rang	3, 35	-17, 18	3, 31	-18, 13
Advanced-level (N=10)	*Mean*	18.7	-.50	15.5	-1.10
	SD	18.5	8.15	11.7	4.38
	Rang	4, 57	-13, 16	4, 39	-8, 5

How are the variables related?

There is not sufficient evidence to conclude that there is a significant difference between entry-level students and advanced-level students in this study. We will therefore treat the sample as a single sample rather than two groups to look at the factors that might affect searching.

Statistical significance of correlation at the .01 level (2-tailed) is found between the following pairs of dependent and independent variables: (1) *time* on *search 1* and *EFT* (r = .56); (2) *time* on *search 1* and *S-Anxiety after search 1* (r = .50); (3) *S-Anxiety* after and before *searches* (r_1 = .63; r_2 = .78). Participants with higher EFT scores seemed to spend more time and get lost in the cyberspace for question number 1, which involved more facets than question number 2. The two participants who spent 43 minutes and 57 minutes in question 1 have an EFT score 61 and 173 respectively.

Significant relationship is not indicated between *search time* and *computer* and *search experience* (including Web search experience).

Discussion and Conclusions

This paper presents the preliminary results of the quantitative part of an exploratory study of users searching of the Web. Further analysis of these quantitative data as well as the qualitative data (still in the process of data transcribing) will be reported in forthcoming papers. The statistical analyses focus on the characteristics of various variables under study. The interpretation of these analyses does not warrant generalized conclusions due to the uncontrolled setting and the relatively small sample. The population we studied was graduate level students in a library and information sciences program. This may be considered a group of early adopters of Web searching or at least people who are motivated to use the Web regularly as required by their future profession. This group will be frequent users for their daily information services and will provide instructions to other users. Studying this user group can, however, provide insights into differences in interacting with Web systems.

In the Conceptual Framework and Research Questions section, we raised several questions. Here, the last question will be addressed first. The methodology has been successfully implemented in the design of this study with a limited budget. It demonstrates the feasibility of collecting data on Web users' searching holistically by capturing processes and thoughts during the interactions. This study obtained rich information on several dimensions of the Web searching. However, due to the financial limit, this study was unable to record the continuous screen shots and concurrent verbalization directly in a digital format. The analysis of data therefore involves laborious transcribing, which can be reduced if they are recorded directly in a computer file rather than on videotapes. This also made collecting data from a larger sample less feasible. Further development of techniques to support this method is important for this line of research.

As the results indicate, searchers in this study seemed to do better in question 2 (more correct answers and higher self-confidence level after search), although they spent about the same amount of time in both searches. The cognitive style, specifically the field-dependence-independence dimension, might affect how an individual searches the Web. The fact that it correlates with search question 1 might indicate that searchers with a field-dependent style have difficulties when a question has more dimensions or requires partitioning a sub-system from the networked space. Partitioning is important in Web searching because many general search engines either failed to index the information at lower levels of a Web site or will return huge postings of URLs. A close look at the questions may provide some insights. The first question can be answered from the homepage of the university where the study was conducted. If the searcher has a conceptualization of partitioning the Web space, he/she would more likely start from the default homepage by either browsing or searching the local search engine. However, many searchers in this study used general search engines such as Yahoo and Excite. Compared with the second question, the first question provided more cues that can be used to evaluate search results. Some of the problems are being unable to decide which facets should be included in the search, missing information on the page, and being satisfied with an answer without checking it against the question. These are the problems similar to those reported for end-users of IR systems.

Affective states, specifically State Anxiety level, seemed to swing widely before and after the searches (Table 5). A close look at the three searchers who gave up on the first question, reveals that two of them had a higher post-search stress level (increased 7 and 16 points respectively) and one had a lower stress level (decreased 2). The other two who were moderately low in confidence about their answers also had higher post-search stress (increased 6 and 18 respectively). All of these five searchers had lower stress levels after finishing the second search (the decrease ranged from 3 to 18 points), when their self-confidence levels were either high or moderately high. Further analysis of searching process and searchers' verbalization can provide insights into the affective dimension in searching the Web.

The following are tentative conclusions: students who finished core courses (received intensive IR search training) are not necessary more effective or efficient on searching the Web. The searchers who spent more time on the Web seemed to visit more sites rather than reading more at each site (*time* and *sites* are highly correlated). Most searchers seem to accept the first seemingly relevant answer without further checking and verifying. The more field-dependent searchers tend to get lost on the Web while searching on questions that have more facets and require partitioning the Web. Affective state can be affected by Web search results, especially how the person feels about the search results. Further analysis of both sets of data will provide more understanding of our searchers in this study.

Acknowledgement

The authors wish to thank all the participants for their time and participation. The first author wishes to acknowledge the support of the Graduate School, the University of Tennessee Knoxville from its Faculty Development Research Funds.

Bibliography

Bates, M. J., Wilde, D. N., and Siegfried, S. (1993a). An analysis of search terminology used by humanities scholars: The Getty online searching project Report No. 1. *Library Quarterly* 63: 1-39.

Bates, M. J., Wilde, D. N., and Siegfried, S. (1993b). A profile of end-user searching behavior by humanities scholars: The Getty online searching project Report No. 2. *Journal of the American Society for Information Science,* 44: 273-291.

Bates, M. J. (1996). The Getty end-user online searching project in the humanities: Report No. 6: Overview and conclusions. *Colleage & Research Libraries* 57, 514-123.

Belkin, N. J., Oddy, R. N., & Brooks, H. M. (1982). ASK for information retrieval: Part I. Background and theory. *Journal of Documentation, 38*(2), 61-71.

Bishop, A., & Starr, S. L. (1996). Social Informatics of digital library use and infrastructure. In M. E. Williams (editor), *Annual Review Of Information Science And Technology* Vol. 31 (pp. 301-401). Medford, NJ: Information Today.

Borgman, C. L. (1996a). Why are online catalogs still hard to use? *Journal of the American Society for Information Science,* 47(7), 493-503.

Borgman, C. L. (1996b). *Social Aspects of Digital Libraries: A workshop hosted by The Department of Library and Information Science Graduate School of Education & Information Studies (GSE&IS) University of California, Los Angeles, February 16-17, 1996* .
Internet. http://www.gslis.ucla.edu/DL/#papers. Accessed: June 4, 1997.

Borgman, C. L., Hirsh, S. G., & Hiller, J. (1996). Rethinking online monitoring methods for information retrieval systems: From search product to search process. *Journal of the American Society for Information Science, 47*(7), 568-583.

Chu, H., & Rosenthal, M. (1996). Search engines for the World Wide Web: A comparative study and evaluation methodology. *Proceedings of the 59th ASIS Annual Meeting* (pp. 127-135). Medford, NJ: Information Today.

Dervin, B. (1992). From the mind's eye of the user: The sense-making qualitative-quantitative methodology. J. D. Glazier, & R. R. Powell (Editors), *Qualitative Research In Information Management* (pp. 61-84). Englewood, CO: Libraries Unlimited.

Ding, W., & Marchionini, G. (1996). A comparative study of Web search service performance. *Proceedings of the 59th ASIS Annual Meeting* (pp. 136-142). Medford, NJ: Information Today.

Ellis, D. (1992). The physical and cognitive paradigms in information retrieval research. *Journal of Documentation, 48*(1), 45-64.

Fidel, R. (1987). What is missing in research about online searching behavior? *Canadian Journal of Information Science*, 12(3/4), 54-61.

Harter, S. P. (1992). Psychological relevance and information science. *Journal of the American Society for Information Science, 43*(9), 602-615.

Ingwersen, P. (1996). Cognitive perspectives of information retrieval interaction: Elements of a cognitive IR theory. *Journal of Documentation, 52*(1), 3-50.

Kuhlthau, C. C. (1993) *Seeking Meaning: A Process Approach to Library and Information Services.* Norwood, NJ: Ablex.

Larson, R. R., McDonough, J., O'Leary, P., Kuntz, L., & Moon, R. (1996). Cheshire II: Designing a next-generation online catalog. *Journal of the American Society for Information Science, 47*(7), 555-567.

National Research Council. (1996). *More Than Screen Deep: Toward Every-Citizen Interfaces to the Nation's Information Infrastructure.* Toward an Every-Citizen Interface to the Nation's Information Interface Infrastructure Steering Committee, Computer Science and Telecommunications Board, Commission on Physical Sciences, Mathematics, and Applications, National Research Council. URL: http://www.nap.edu/readingroom/books/screen/. Accessed on December 19, 1997.

Marchionini, G. (1989). Information-seeking strategies of novices using a full-text electronic encyclopedia. *Journal of the American Society for Information Science, 40*(1), 54-66.

Marchionini, G., Barlow, D., & Hill, L. L. (1994). Extending retrieval strategies to networked environments: Old ways, new ways, and a critical look at WAIS. *Journal of the American Society for Information Science, 45*(8), 561-564.

Meghabghab, D. B., & Meghabghab, G. V. (1996). Information retrieval in Cyberspace. *Proceedings of the American Society for Information Science Mid-Year Meeting* (pp. 224-237). Medford, NJ: Information Today.

Nahl, D. and Tenopir, C. (1996). "Affective and Cognitive Searching Behavior of Novice End-Users of a Full-Text Database," *Journal of the American Society for Information Science* 47: 276-286.

Penniman, W. D., & Dominick, W. D. (1980). Monitoring and evaluation of on-line information system usage. *Information Processing & Management, 16*(1), 17-35.

Pollock, A., & Hockley, A. (1997). What's wrong with Internet searching. *D-Lib Magazine, 3*, 1-5. Internet. http://www.dlib.org/march97/ bt/03pollock.html. Accessed on June 14, 1997.

Rice, R. E. (1990). Computer-mediated communication system network data: Theoretical concerns and empirical examples. *International Journal of Man-Machine Studies, 32*(6), 627-647.

Rice, R. E., & Borgman, C. L. (1983). The use of computer-monitored data in information science and communication research. *Journal of the American Society for Information Science, 34*(4), 247-256.

Shneiderman, B., Byrd, D., & Croft, W. B. (1997). Clarifying search: A user-interface framework for text searches. *D-Lib Magazine,* (1), 1-18. Internet. http://www.dlib.org/dlib/january97/ retrieval/01shneiderman.html. Accessed on June 14, 1997.

Spielberger, C. D. (1983). State-Trait Anxiety Inventory (Form Y). Palo Alto, CA: Mind Garden.

Strong, G. W. (1994). *A report: New directions in human-computer interaction education, research, and practice.* Sponsored by: National Science Foundation Interactive Systems Program, National Science Foundation Applications of Advanced Technology Program and Advanced Research Projects Agency Software and Intelligent Systems Technology Office. Van House, N. A., Butler, M. H., Ogle, V., &

Schiff, L. (1996). User-centered iterative design for digital libraries. *D-Lib Magazine,* (2), 1-7. Internet. http://www.dlib.org/dlib/february96/ 02vanhouse.html. Accessed on June 14, 1997.

Tenopir, C., guest editor. (1998). "Perspectives on...Internet Issues," *Journal of the American Society for Information Science* 49: forthcoming.

Wang, P., & Pouchard, L. (1997) End-user searching of Web resources: Problems and implications. *Proceedings of the 8th ASIS SIG/CR Workshop, November 2, 1996, Washington, D.C.*

Witkin, H. A. and et al. (1971). *A Manual for the Embedded Figures Tests.* Palo Alto, CA: Consulting Psychologists Press.