Our project has investigated the processes of mediated information retrieval (IR) searching during human information-seeking processes to characterize aspects of this process, including information seekers' changing situational contexts; information problems; uncertainty reduction; successive searching, cognitive styles; and cognitive and affective states. The research has involved observational, longitudinal data collection in the United States and the United Kingdom. Three questionnaires were used for pre- and postsearch interviews: reference interview, information-seeker postsearch, and search intermediary postsearch questionnaires. In addition, the Sheffield team employed a fourth set of instruments in a follow-up interview some 2 months after the search. A total of 198 information seekers participated in a mediated on-line search with a professional intermediary using the Dialog Information Service. Each mediated search process was audiotaped and search transaction logs recorded. The findings are presented in four parts. Part I presents the background, theoretical framework, models, and research design used during the research. Part II is devoted to exploring changes in information seekers' uncertainty during the mediated process. Part III provides results related to successive searching. Part IV reports findings related to cognitive styles, individual differences, age and gender. Additional articles that discuss further findings from this complex research project, including: (1) an integrated model of information seeking and searching, (2) assessment of mediated searching, and (3) intermediary information-seeker communication, are in preparation and will be published separately.

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Spink, Wilson, Ford, Foster, and Ellis (2002) propose a theoretical framework for understanding IR interactions within an information-seeking context. The theoretical model depicts a user’s situated actions within IR interactions over time. Time is represented in four categories: (1) interaction time, (2) successive searching time, (3) information-seeking time, and (4) problem-solving time. Successive searching currently receives little, if any, support from present IR interfaces and procedures, or from Web search engines. Largely, IR systems are built following a single search paradigm, i.e., they are designed and operate on the assumption that every search is an unrelated search to any previous or future searches by the user on the same or evolving topic. Some systems (such as Dialog or Lexis/Nexis) support saving searches for successive searching. However, research to improve support features for successive searching is in its formative stage.

Lin and Belkin (2000) propose a multidimensional conceptual model (MISE) for successive searching, including episodes, information-seeking processes, information problem, and problematic situation. Based on work by Schutz and Luckman (1973), they propose reasons for renewal of information-seeking episodes or successive searches, including:

1. **Problem transmutes**: the original information problem is modified and reinitiated the problematic situation.
2. **Problem spawns subproblems**: new concepts emerge that generate new sub-problems. Spink, Greisdorf, and Bateman (1998) point to the role of partially relevant documents in a user’s identification of new concepts related to their information problem.
3. **Problem transits problem**: the original information problem transits into a different problem.
4. **Problem rolls back**: the user is unable to clarify their information problem and the user returns to a previous information-seeking stage.
5. **Problem with answer lost**: a diversion from the original information problem that cannot be resolved.
6. **Problem unanswered**: an interruption in the information-seeking process due to lack of domain knowledge, ill-defined information problem, etc.
7. **Problem cultivated**: process of repeatedly searching to keep up to date in changes in a topic.
8. **Problem envisioned**: an information-seeking process is re-engaged due to external or internal pressures.

Different factors lead to the initiation, sustaining, halting, and reengagement of information-seeking and searching processes. This line of research is significant as it goes beyond the one search approach generally adopted by IR researchers. The one search approach is limited by recent research that shows information seekers with a broader problem at hand often seek information in stages over extended periods and use a variety of information resources. As time progresses, information seekers often search the same or different IR systems for answers to the same or evolving problem at hand. As they learn or progress in their work, or as they clarify a problem and/or question, or as their situational context changes, users come back to various IR systems for further related searches. The process of repeated, related searches over time in relation to a given, possibly evolving, information problem (including changes or shifts in beliefs, cognitive, affective, and/or situational states), is called a successive searching.

The studies reported in this article are part of an ongoing project that seeks to investigate successive searching (Spink, Wilson, Ellis, & Ford, 1998; Spink et al., 2002). The next section of the article provides theoretical background and discusses research in IR interaction, information seeking, and Web studies.

### Related Studies

#### Successive Searching Studies

Recent studies highlight the weakness of research based on the single search approach and the need for studies that classify and categorize successive searching behavior. Studies show many IR system users conduct successive searches when seeking information related to a particular information problem.

#### Early Studies

Some early studies, exploring other issues related to IR systems interaction, noted that users were conducting more than one on-line search on a topic.

1. Saracevic, Mokros, Su, and Spink (1991) found that 45% academic users in their study had a previous mediated on-line search on the same topic, frequently with the same search intermediary.
2. Huang (1992) found 19 of 44 end-users conducted successive searches.
3. Robertson and Hancock-Beaulieu (1992) identified successive searches by users of the Okapi on-line catalog using identical or closely related search strategies.

These studies, in the early 1990s, identified a phenomenon that had not been explored previously in IR research. The common approach in IR research at this time was to examine only one search conducted by an information seeker.

#### Successive Searching Studies

As the 1990s progressed, accompanied by the development of information-seeking studies and models, specific studies were conducted to investigate successive searching behavior by IR system users and later by Web users.

### IR Systems Interaction

1. Spink (1996) conducted the first specific study of successive searching. She interviewed 200 academic CD-ROM
and Online Public Access Catalog (OPAC) end-users working on a search topic and found an average of two searches per end-user. Many end-users reported conducting successive searches at different stages of their information-seeking process related to a particular information problem.

2. Bateman’s (1998) findings confirmed Spink’s (1996) findings. She investigated the searches over time conducted by 35 end-users and found that 33 (94%) end-users conducted more than one search during their information-seeking process related to a particular information problem with an average of between three to four searches on their topic over time.

3. In 1999, Spink et al. (Spink et al., 1999) studied 47 mediated searches. They found a mean of two searches with successive searches requested by information seekers to extend or expand, or refine the results of previous searches. Most successive searches involved changes in search terms and databases from the previous search. Precision did not necessarily increase over successive searches, and the percentage of partially relevant items decreased significantly after three searches.

Web Searching

(1) In the context of Web searching, Spink, Bateman, and Jansen (1999) found that one-third of respondents to an interactive survey of Excite users were first-time users, conducting their first search of Excite on their current topic; two-thirds reported a pattern of successive searches of between one Excite search on their current topic; many reported more than five Excite searches on their topic; and 38 reported conducting more than 20 searches on their topic. Those who were beginning their information seeking reported mostly single searches.

Modeling the Successive Searching Process

Following the growth in successive searching studies, an NSF funded study by Amanda Spink (Spink et al., 1998), began a deeper exploration of the successive searching process reported in this article. In addition to this study, various researchers began to conduct studies related to modeling successive searching.

(1) Vakkari (2001) asked 11 Finnish users to conduct three searches each over time on their own topic. He found that users problem stages during an information-seeking and searching process are connected to their choice of search term and tactics. As the searches progressed, they were characterized by more and increasingly specific search terms, more tactics and more use of operators. Vakkari (2001) suggest that a user’s relevance criteria depend on their stage of their task performance.

In summary, a growing number of studies have begun to identify the characteristics of successive searches and model the successive searching process in the end-user and mediated search context. Previous studies by Vakkari (2001) imposed a requirement of three searches on study subjects during an information-seeking process. The study discussed below collected data on mediated searches conducted at the request of an information seeker to further explore and model the successive search process.

Research Questions

The research questions we addressed during this study were:

1. How frequently were successive mediated searches requested during an information-seeking process?
2. Why do information seekers request successive mediated searches?
3. What are some characteristics of successive mediated searches related to a particular information problem, for example, changes in search terms, databases?

Such research is the logical next step for research to further model the successive searching process; improve IR and Web system and interface design, and user education.

Research Design

Data Collection

Three search intermediaries were recruited from University of North Texas graduate students at the School of Library and Information Sciences during the semesters from Fall Semester 1998 to Spring Semester 1999. Each intermediary had been trained in the Dialog Information Service. Each intermediary then worked with volunteer information seekers to conduct as many Dialog searches as necessary to assist them to resolve their information problem. Many of the information seekers were students, staff or graduate students.

The data collected during our research included: (1) search transaction logs, (2) numerical data and responses to given questionnaires, (3) texts retrieved and assessed relevance judgments. The research was conducted for 18 months in the United States. Clients were classified by broad discipline, i.e., humanities; “pure” social sciences, such as economics, political science, sociology, etc.; applied social sciences, such as social welfare and social administration; pure science; medicine; and engineering. The numbers of humanities and medical clients were rather small, and the former were incorporated into the pure social sciences group, while the latter were included in the pure science group. This gave four discipline categories.

Procedures

Presearch Interview: in this first interview, a detailed description of the participant’s problem was obtained, together with responses to interview questions and responses to a questionnaire, which covered, for example, problem
stage, Kuhlthau’s stages, feelings about the progress of the work, other information-seeking activities, and uncertainty.

*On-line Search and Postsearch Interview:* during the search, computer logs were kept, together with audiotapes of the interaction between information seeker and the search intermediary. After the search, the participants completed another questionnaire on aspects of the search and, again, on their certainty/uncertainty with regard to different stages of problem resolution. The search intermediary also completed a search assessment instrument.

**Questionnaires**

Three questionnaires were used to record various aspects of context that are connected to context and not record able in transactions: an *information seeker presearch (reference interview) and postsearch, and search intermediary post search*. The aim of the pre- and postsearch questionnaires was to capture the information seeker’s state in a number of areas before and after their search. This allowed the measurement of changes or shifts by information seekers resulting from their search. The questionnaires are described in more detail in Part I of this series.

**Results**

We provide results related to the frequency of successive mediated searches, including the reasons and characteristics of those searches.

**Successive Mediated Search Topics**

Table 1 lists the search topics, search frequency, and reasons for the successive searches conducted for eight information seekers.

Search topics ranged across the physical science, social sciences, humanities, and medical issues.

**Frequency of Successive Mediated Searches**

Table 2 shows the number of mediated searches conducted with each information seeker and the reasons for those searches.

The data in Table 2 shows a total of 18 mediated searches were conducted, including: (a) one in two information seekers requested two searches; (b) one in four information seekers requested three searches; (c) information seekers most frequently requested two searches.

Successive searches were generally spaced over time with some information seekers requesting a second or third mediated search within a week and some within a month. All information seekers requested a second search on their topic, but only two information seekers requested a third search. Information seeker six requested three searches. The second search refined the first search strategy with new search terms and databases. A third search used new terms selected from the second search results to refine the search strategy. A similar situation emerged with information seeker seven.

**Reasons for Successive Mediated Searches**

Many reasons were identified for requesting successive searches. The major reason reported by the intermediaries for conducting successive searches was the information seeker’s need to refine or extend the first search based on their evaluation of the previous search results or due to changes in their information problem—including the need to search different databases or use different search terms to find more information. In some cases, there were multiple reasons for conducting more than one search.

**Refine and Enhance Search Using Results From a Previous Search**

All but one information seeker requested a successive search to refine or enhance the results from the previous search. This may include the use of new search terms.
Information Seeker Requested More Information

In six cases information seekers requested another search to seek more information. This reason was often related to the need to refine or enhance the results from the previous search.

Search Different Databases

In four cases information seekers requested a search using the same or modified search terms on different databases.

Refine the Search—Too Much Data Retrieved in a Previous Search

In three cases the need to refine the next search resulted from too much data retrieved during the first search that was difficult for the information seeker to evaluate.

Refine the Search Due to Increased Problem Complexity Due to Previous Search Results

In two cases the information seeker reported that the results of the previous search increased the complexity of their information problem and necessitated another search.

First Search Only Exploratory

In one case an information seeker reported that they regarded the first search as exploratory, and they wanted a more refined successive search.

In four cases information seekers requested successive mediated searches either to: (a) refine the search to print abstracts, (b) intermediary suggested another search, (c) lost data from previous search, (d) secure more valuable information.

Refining and enhancing previous search results relates to Lin and Belkin’s (2000) process of “problem transmuting” or the modification of an information problem that necessitates a successive search. Further characteristics of successive searches were identified.

Characteristics of Successive Mediated Searches

Some characteristics of the successive mediated searches were investigated, including: information-seeking stage of the information seeker, sources of the search terms, and changes in the search terms and databases searched.

Items Retrieved and Search Cycles

Table 3 provides the number of searches, items retrieved, and search cycles for each mediated successive search.

The mean number of terms used in second searches was significantly higher than for first searches, but higher than third searches. Second searches were characterized by more search items retrieved and more search cycles than first searches. Third searches were the longest in terms of search cycles, but lower items retrieved. First searches were often exploratory and their results were used to identify new search terms and identify new areas and databases. Even though second searches were described as “refining searches,” they were more extensive and interactive in search cycles.

Search Terms

Table 4 provides results related to the search terms used during successive searches.

The mean number of search terms per search (with overlap) did not change significantly between first, second, or third searches. With no overlap, the number of search terms used in second searches was significantly lower than for first searches. Second searches were characterized by more refined search terms within more search cycles and more items retrieved. The mediated search situation is obviously not too different from the end-users search situation in this respect. Vakkari (2001) found that search terms became more specific over end-users successive searches.

Changed Search Terms Over Successive Searches

Table 5 shows how the number of search terms changed over successive searches.
Overall, there was limited overlap in search terms used in first and second searches. About one in five search terms appeared in both searches, reflecting the major search term changes between first and second searches. By the third search, there was no overlap in search terms used from the second search. Information seeker 6 identified a number of terms from the previous results that were used in the third search.

**Sequential Order of Search Terms Use Classified by Source**

Table 6 provides the sequential order of search terms that were classified by source taxonomy developed by Spink and Saracevic (1997):

1. **QS** (Question Statement): terms appearing on the written question statement completed by the information seeker.
2. **UI** (User-Intermediary Interaction): terms resulting from the conversation between the information seeker and search intermediary.
3. **I** (Intermediary): terms suggested by the search intermediary.
4. **TH** (Thesaurus): terms identified in a printed thesaurus.
5. **TRF** (Term Relevance Feedback): terms identified in the retrieved items.

Interestingly, none of the search terms were sourced from the search intermediary. All first searches and most searches included terms largely from the question statement and conversation between the information seeker and search intermediary. Spink and Saracevic (1997) found that most search terms during mediated searching were sourced from these sources. In two searches, a thesaurus was used to identify search terms. In two searches, term relevance feedback was used predominantly during a second and third search. Information seeker 6 identified many terms from the results of the second search that were used during the third search.

Information seekers were the main source of search terms during the successive search process, although intermediaries did contribute search terms in more than 50% of searches. Spink and Saracevic (1997) also found that information seekers were the major and most effective source of search terms during mediated on-line searching. Table 6 shows that most successive searches involved changes in search terms from the initial search.

Interestingly, in nearly one-third of the cases, successive searches involved the use of the same search terms, with no additions and deletions of terms from previous searches. This finding supports previous studies (Robertson & Hancock-Beaulieu, 1992; Spink, 1996) of OPAC end-users who frequently changed their search terms between successive searches. Spink et al. (1999) also found a similar result with end-users conducting successive searches of the Web.

### Search Operators

Table 7 shows how search operators were used across successive mediated searches.

More search operators were used during first searches than later searches. The only exception was the NOT operator that was primarily used during second searches as part of the refining process. The mediated search situation is obviously different from the end-users search situation in this respect. Vakkari (2001) found that search operators were used by end-users later in their later searches. Search intermediaries are distinguished by their training in Boolean searching and seem more likely to use Boolean operators from the initial search.

### Search Commands

Tables 8 and 9 provide a summary of the commands analysis.

During successive mediated searches, the second search was characterized by greater use of more commands and tactics, except for the select command. The mediated search situation is similar to the end-users search situation this
Vakkari (2001) found that more commands and tactics were used by end-users in their later searches.

**Databases**

Table 10 shows the number of successive mediated searches that involved a change in databases.

In six cases the databases used changed over successive searches. Interestingly, the same databases were often repeatedly searched (with either the same or different search terms) over successive searches. Successive searches often included a change in both search terms and databases. From the data we can see that successive searches involved changes, refinements, or extensions from the initial search. How the changes evolved depended upon the nature of the information problem and the information-seeking stages and changes experienced by the information seeker due to the results from previous searches.

**Changes in Information Seeking and Problem Solving**

Questions on the pre- and postsearch questionnaires collected users’ assessments of their information problem stage,

<table>
<thead>
<tr>
<th>User number</th>
<th>Unique in search 1</th>
<th>Unique in search 2</th>
<th>Unique in search 1 and search 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>13</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>17</td>
</tr>
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<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>29</td>
<td>1</td>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>40</td>
<td>20</td>
<td>120</td>
</tr>
</tbody>
</table>

Note: terms with “*” used once by specific user; terms without “*” used more than once by specific user.

<table>
<thead>
<tr>
<th>User number</th>
<th>Mediated search 1</th>
<th>Mediated search 2</th>
<th>Mediated search 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TH* QS* UI* TH*, TH UI TH* QS*</td>
<td>UI* TH UI, QS* UI QS, QS UI QS*</td>
<td>QS, TH TH* TH, TH TH TH, TH* TH</td>
</tr>
<tr>
<td>2</td>
<td>QS* QS* QS* QS* UI*</td>
<td>QS QS QS QS, QS QS QS UI* UI* UI*, QS QS UI TRF* TRF* TRF* TRF*, UI QS QS UI UI* UI*, QS* UI*, QS UI QS</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>QS* QS* UI* QS* QS* UI*, QS* QS, UI*, QS* QS* QS* QS* UI* QS</td>
<td>QS* QS*, UI*, QS* QS* QS*</td>
<td>QS* QS*, UI*</td>
</tr>
<tr>
<td>4</td>
<td>QS* QS* QS* QS* QS*</td>
<td>QS* QS* QS* QS* UI*</td>
<td>QS* QS* QS* QS*</td>
</tr>
<tr>
<td>5</td>
<td>QS* QS*, QS* QS* QS*, QS*</td>
<td>QS* QS*, QS* UI*</td>
<td>QS* QS* QS*, UI</td>
</tr>
<tr>
<td>6</td>
<td>QS* QS*, QS* QS* QS* SI*</td>
<td>QS* QS* QS* UI*</td>
<td>TRF*, TRF* TRF*, TRF*</td>
</tr>
<tr>
<td>7</td>
<td>QS* QS* QS*</td>
<td>QS* QS* QS*</td>
<td>QS* QS</td>
</tr>
<tr>
<td>8</td>
<td>QS* QS* QS*</td>
<td>QS* QS* QS*</td>
<td>TRF*, TRF* TRF*, TRF*</td>
</tr>
<tr>
<td>Total number</td>
<td>103</td>
<td>87</td>
<td>27</td>
</tr>
</tbody>
</table>

Note: terms with “*” used once by specific user; terms without “*” used more than once by specific user.
work stage, familiarity with their information problem, completeness of retrieval, and satisfaction with results (Table 11).

The data shows that information seekers often experienced shifts in their information-seeking and problem-solving stages during and between successive searches. Some information seekers reported shifting back to a previous stage or “problem rolls back” (Lin & Belkin, 2000), and some reported moving to a more advanced stage. Previous studies (Spink, 1996, 2002; Spink & Wilson, 1999) also show that information seekers experience shifts and changes in their information-seeking and problem-solving processes due to their interactions with IR systems and subsequent changes in their information problems. Different information seekers experienced different changes and reactions to their mediated interaction. For example, Information Seeker 2 experienced no change in their information problem stage as a result of their mediated interaction, being at Stage 3 before and after their first mediated search. They did report a shift in the problem stage as a result of the second mediated search from Stage 3 to Stage 4. Alternatively, Information Seeker 1 did report a one-stage shift from 3 to 2 in their information problem after their first mediated search, and then another shift in their information-seeking stage from 2 to 3. Overall, different users experienced different levels of change between successive mediated searches. After their first mediated search: (a) two information seekers shifted to a later information problem stage, (b) five information seekers stayed in the same information problem stage, (c) one information seeker shifted to a previous information problem stage.

Interestingly, a number of study participants remained in the same information problem stage after their first mediated search—measured before and after they mediated—and felt the mediated interaction had not affected a change. One information seeker shifted to a previous information problem stage. They may have overestimated their information problem stage in the presearch form or felt the interaction gave them information that convinced them they were actually at an earlier problem stage than they thought.

Information seekers also experienced change between the first, second, and often the third search mediated search. For example, Information Seeker 6 shifted from 3 to 2, then stayed in stage 2, and then shifted to stage 3.

As Table 11 shows, different information seekers experienced different levels of change in their work stage on their topic, familiarity with their problem, completeness of the retrieval, and satisfaction with results, due to their mediated interaction.

### Relevance Judgments

Table 12 shows data concerning the relevance of the retrieved items during successive searches.

An analysis of the data in Table 12 shows the:

1. Successive searches may not necessarily lead to a decrease in the mean number of items retrieved per search as the number of successive searches increases.
2. Successive searching may not necessarily lead to greater precision as the number of successive searches increases.
3. Successive searches may provide greater information problem clarity for the client, as evidenced by the decline in the percentage of partially relevant items after second searches. Information seekers moved towards more dichotomous relevance judgments over successive searches. Spink et al. (1999) found a similar result in their study of relevance judgments during mediated suc-

<table>
<thead>
<tr>
<th>Operator/ Number of search operators (%)</th>
<th>Mean number of search operators for each cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>First mediated searches</td>
<td>63 (57.3%)</td>
</tr>
<tr>
<td>Second mediated searches</td>
<td>45 (40.9%)</td>
</tr>
<tr>
<td>Third mediated searches</td>
<td>2 (1.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of search command</th>
<th>Searches (No.)</th>
<th>No.</th>
<th>%</th>
<th>Mean/search</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>8</td>
<td>241</td>
<td>58.0</td>
<td>30.1</td>
<td>11–69</td>
</tr>
<tr>
<td>Type</td>
<td>7</td>
<td>96</td>
<td>23.1</td>
<td>13.7</td>
<td>5–37</td>
</tr>
<tr>
<td>Change database</td>
<td>8</td>
<td>39</td>
<td>9.3</td>
<td>4.9</td>
<td>2–11</td>
</tr>
<tr>
<td>Display sets</td>
<td>3</td>
<td>23</td>
<td>5.5</td>
<td>7.7</td>
<td>1–12</td>
</tr>
<tr>
<td>Duplicate detection</td>
<td>6</td>
<td>17</td>
<td>4.1</td>
<td>2.8</td>
<td>1–5</td>
</tr>
<tr>
<td>Total</td>
<td>416</td>
<td>100</td>
<td></td>
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</tr>
</tbody>
</table>
cessive searching. Previous research by Spink et al. (1998) also found that: (1) partially relevant items decreased over end-user successive searches, and (2) partially relevant items were significantly linked to changes in the information seeker’s understanding of their information problem over successive searches. Vakkari (2001) found that partially relevant items increased over end-user successive searches. There is a need for further studies with larger sample sizes to examine these issues.

Discussion

The results of the study reported in this article extend previous research by identifying additional characteristics of successive mediated searches. On average, information seekers requested two searches, and some information seekers requested three mediated searches. Successive searches often involve a refinement or extension of previous searches, with new databases searched or search terms changed, as the information seekers’ understanding and evaluation of results evolved over time from one successive search to the next. Some successive searches involved no change in databases.

We found that the precision obtained over successive searches did not appear to increase as searches are conducted related to the information seeker’s information problem. Also, the substantial reduction of items judged partially relevant after the third search confirmed previous studies by Spink et al. (1998, 1999). As information seekers refine the focus of their information problem through successive searches, they develop a clearer understanding of what is relevant and what is not relevant in relation to their information problem toward more dichotomous relevance judgments. Spink et al. (1998) found a positive correlation relationship between partially relevant items and changes in information seekers’ information problems during the early stages of their information-seeking process.

Many people search IR systems or Web resources repeatedly in relation to the same or evolving problem at hand. Successive searching is a common practice. The successive search phenomenon is receiving more research attention. Searching involves many kinds of changes in the information seekers’ information-seeking process and understanding of their information problem.

The next section of the article discusses an information-seeking approach to successive searching.

An Information-Seeking Approach to Successive Searching

Findings from previous studies of successive searching and the current study provide an information seeking-based approach to successive searching (Fig. 1).

The research continues the process of characterizing the successive searching process, by examining mediated suc-
cessive searching. This research also highlights the need to further explore the relationship between interactive IR and information-seeking research, and relevance judgments. An information-seeking approach to understanding successive searching is emerging within the context of contemporary, user-oriented theory of information seeking. The approach falls within the alternative view articulated by Dervin and Nilan (1986), who posit information as a subjective phenomenon constructed by human beings within a sense-making process. Within this view, an individual through internal cognitive processes continuously constructs meaning. As (Schamber et. al., 1990) suggest within the alternative paradigm, “because meaning is seen as constantly constructed by the individual, appropriate models for information behavior are complex, contextual and dynamic” (p. 769). An approach to successive searching within the context of appropriate models of dynamic information-seeking behavior may provide a basis for new insights into successive searching.

From this viewpoint, successive searches are considered in relation to a user’s information-seeking process. This approach suggests that the relevance of the retrieved items to a user’s information-seeking process may be measurable as to its effect on the movement of a user through their information-seeking process (Spink et al., 1998). Within this framework, relevance has two dynamic processes: judgment and effect. Relevance at its most basic level can be understood as an “effect.” Relevance must be seen in relation to something else—as relevance is an abstract concept that does not exist independently of its role in judgment and effect. Within this approach, relevance (and relevance judgment) is considered a fundamental property of an IR interaction and the feedback process between user and source, through which a user constructs information (Spink et al., 1998). Therefore, relevance may be understood as an impetus to movement or an effect on or within the movement in a user’s IR interaction and their information-seeking process, and thus an impetus to successive searches.

A user’s information problem will be molded by the information he or she does or does not find, by how he or she defines relevance and how that definition is applied in making relevance judgments. Users able to: (1) clearly define their information-seeking stage or state, (2) understand the characteristics of the information-seeking stages, (3) define how their interaction with an IR system or information affects their relevance judgments, and (4) understand how their relevance judgments affect their information problem, may be better to identify the information they

TABLE 11. Information-seeking and problem-solving stages of the successive mediated search information seekers.

<table>
<thead>
<tr>
<th>Information seeker number</th>
<th>Problem stage (pre &amp; post search)</th>
<th>Familiarity with problem (pre &amp; post search)</th>
<th>Current work stage (pre &amp; post search)</th>
<th>Completeness of retrieval (postsearch)</th>
<th>Satisfaction with results (postsearch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Search 1</td>
<td>3 2 -1</td>
<td>40 52 +12</td>
<td>1 1 +1</td>
<td>22 72</td>
<td></td>
</tr>
<tr>
<td>1—Search 2</td>
<td>2 3 +1</td>
<td>73 46 -27</td>
<td>1 4 +3</td>
<td>41 72</td>
<td></td>
</tr>
<tr>
<td>2—Search 1</td>
<td>3 3 0</td>
<td>74 74 0</td>
<td>6 6 0</td>
<td>47 60</td>
<td></td>
</tr>
<tr>
<td>2—Search 2</td>
<td>3 4 +1</td>
<td>74 72 -2</td>
<td>6 6 0</td>
<td>59 64</td>
<td></td>
</tr>
<tr>
<td>3—Search 1</td>
<td>3 4 +1</td>
<td>73 77 +4</td>
<td>6 1 -5</td>
<td>38 45</td>
<td></td>
</tr>
<tr>
<td>3—Search 2</td>
<td>3 2 -1</td>
<td>78 74 -4</td>
<td>6 6 0</td>
<td>42 41</td>
<td></td>
</tr>
<tr>
<td>4—Search 1</td>
<td>2 2 0</td>
<td>79 75 -4</td>
<td>6 5 -1</td>
<td>38 39</td>
<td></td>
</tr>
<tr>
<td>4—Search 2</td>
<td>3 3 0</td>
<td>76 76 0</td>
<td>6 6 0</td>
<td>75 74</td>
<td></td>
</tr>
<tr>
<td>5—Search 1</td>
<td>3 3 0</td>
<td>72 74 +2</td>
<td>1 3 +2</td>
<td>71 77</td>
<td></td>
</tr>
<tr>
<td>5—Search 2</td>
<td>3 3 0</td>
<td>51 62 +11</td>
<td>6 5 -1</td>
<td>63 69</td>
<td></td>
</tr>
<tr>
<td>6—Search 1</td>
<td>2 2 0</td>
<td>57 50 -7</td>
<td>1 4 +3</td>
<td>64 74</td>
<td></td>
</tr>
<tr>
<td>6—Search 2</td>
<td>3 3 0</td>
<td>74 61 -13</td>
<td>6 5 -1</td>
<td>74 80</td>
<td></td>
</tr>
<tr>
<td>6—Search 3</td>
<td>3 3 0</td>
<td>71 61 -10</td>
<td>5 5 0</td>
<td>73 80</td>
<td></td>
</tr>
<tr>
<td>7—Search 1</td>
<td>3 2 -1</td>
<td>45 74 +29</td>
<td>4 3 -1</td>
<td>54 22</td>
<td></td>
</tr>
<tr>
<td>7—Search 2</td>
<td>2 2 0</td>
<td>59 63 +4</td>
<td>3 3 0</td>
<td>65 63</td>
<td></td>
</tr>
<tr>
<td>7—Search 3</td>
<td>3 3 0</td>
<td>64 72 +8</td>
<td>4 4 0</td>
<td>72 68</td>
<td></td>
</tr>
<tr>
<td>8—Search 1</td>
<td>2 2 0</td>
<td>24 45 +21</td>
<td>5 5 0</td>
<td>64 75</td>
<td></td>
</tr>
<tr>
<td>8—Search 2</td>
<td>3 3 0</td>
<td>28 67 +39</td>
<td>1 6 +5</td>
<td>75 80</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 12. Relevance judgments over successive mediated searches with eight information seekers.

<table>
<thead>
<tr>
<th>No. of mediated searches</th>
<th>No. of information seekers</th>
<th>Total items retrieved</th>
<th>Mean no. items retrieved per search</th>
<th>No. of relevant items</th>
<th>No. of partially relevant items</th>
<th>No. of not relevant items</th>
<th>Mean precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>First mediated searches</td>
<td>8 (100%)</td>
<td>1540 (36.6%)</td>
<td>192.5</td>
<td>723 (32.3%)</td>
<td>487 (53.9%)</td>
<td>330 (29.2%)</td>
<td>47%</td>
</tr>
<tr>
<td>Second mediated searches</td>
<td>8 (100%)</td>
<td>2504 (59.5%)</td>
<td>313</td>
<td>1447 (64.6%)</td>
<td>392 (43.4%)</td>
<td>665 (58.8%)</td>
<td>59%</td>
</tr>
<tr>
<td>Third mediated searches</td>
<td>2 (25%)</td>
<td>161 (3.8%)</td>
<td>80.5</td>
<td>67 (2.9%)</td>
<td>25 (2.7%)</td>
<td>136 (12%)</td>
<td>42%</td>
</tr>
<tr>
<td>Total</td>
<td>4205 (100%)</td>
<td>2237 (100%)</td>
<td>904 (100%)</td>
<td>1131 (100%)</td>
<td>49.3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
need to resolve their problem. They may also be better able to find the focus for their information problem that helps them most easily resolve their information needs over successive searches. When a user does or does not select a particular piece of information, he or she has made a decision that influences the rest of the information process. That decision will take the user down a particular path to resolving or not resolving their information problem. Users may backtrack and traverse the same path again, and it appears that some users do just that (Spink, 1996, in press; Spink et al., 1999).

The emerging information-seeking approach understands relevance as an effect that causes shifts or changes the user’s information-seeking process, including successive searches. Users themselves may be able to measure a shift or move in their information-seeking process and thus better understand this process and the characteristics of the information that can help them through an information-seeking process. Such an approach looks beyond user satisfaction to a more multidimensional dynamic approach to evaluation of the interaction of untested relevance elements, including the user and the IR system. The next challenge for evaluation testing and experimentation research in IR is to develop evaluation approaches that incorporate models of human information behavior processes within this framework.

Implications

The findings from this study have implications for the design of IR systems, the development of interactive IR models, and the training and searching practice of end-users and search intermediaries. For most people with information problems, seeking information and interacting with IR systems during an information-seeking process, is not a one-search episode. Komlodi (2000) is working on the design of IR systems that support user’s understanding of their search history with features that allow users to store search strategies and results for further use or modification. Theoretically, most interactive IR models and studies of IR system use should take account of the reality that users not only iterate their queries, but also their searches over time. The integration of interactive IR models with human information behavior models is presented in Spink (1999), and can be extended by adding successive searching processes.

In practice, information seekers and intermediaries should be trained to understand that many information problems are not resolved with one IR system search. The picture is more complex. On average, information seekers may need to conduct more than one search or possibly two to three searches during their information-seeking process—just to provide focus and clarity to their information needs. Modifications to information seeker and intermediary training will be required to account for the reality of this need.

Conclusion and Further Research

This study highlights many issues that need further research in successive searching. We need to examine more characteristics and processes associated with successive searching. Does the stage of an information-seeking process that the seeker has reached, or the time elapsed, have an impact on the number of successive searches undertaken? Further research is also required to examine the factors more deeply that compare and characterize information problems that satisfy the user with a single search as opposed to those information problems that lead to successive searches. Currently, most IR systems and interfaces do not greatly assist users during successive search episodes.

References


