COVER SHEET

ELICITATION BEHAVIOR DURING ONLINE SEARCHING: TOWARDS A GRAMMAR OF INTERACTIVE INFORMATION RETRIEVAL

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ABSTRACT

What elicitations or requests for information do search intermediaries make of users with information requests during an information retrieval (IR) interaction -- including prior to and during an IR interaction -- and for what purpose? These issues were investigated during a study of elicitations during 40 mediated IR interactions. A total of 1557 search intermediary elicitations were identified within 15 purpose categories. The elicitation purposes of search intermediaries included requests for information on search terms and strategies, database selection, search procedures, system's outputs and relevance of retrieved items, and users' knowledge and previous information-seeking. These findings are compared with results from a study of end-user questions (Nahl & Tenopir, 1996) and a study of user elicitations of search intermediaries (Wu, 1993). Implications of the findings for the development of a dialogue-based model of IR interaction based on a grammar of IR interaction framework and the design of IR systems are also discussed.

INTRODUCTION

The aim of the study reported in this paper is to contribute to the development of a dialogue-based model of information retrieval (IR) interaction based on a grammar of IR interaction through the analysis of the elicitation purposes of search intermediaries during mediated IR. Such user modeling research is of growing importance to the development of more effective IR systems (Daniels, 1986) and interactive IR models proposed by Ingwersen (1996), Belkin, Cool, Stein and Theil (1995), and Saracevic (1996) that attempt to identify the relationship between important elements and processes within user-IR system interaction. Elicitations, or requests for information by a user, have been identified as an important element within a dialogue based approach to modeling user - IR system interactions.

Belkin (1984) suggested the utility of a dialogue-based model of information retrieval (IR) with the interaction between a user and IR system as a central process. Ingwersen's (1996) Cognitive Model of IR Interaction also conceptualizes a dialogue between the "intermediary functions" and a user with an information problem within an IR interaction. Saracevic, Mokros and Su (1990) present a dialogue-based process model in the context of mediated IR - including an interaction triad between a user, search intermediary and IR system. They identified elements within such a dialogue-based model, including three stages of an IR search process: (1) opening gambit, (2) tactical maneuvering and (3) closing downdrift. They also proposed the following elements for inclusion in a dialogue-based model of IR interaction - eight categories of utterances: contextual, terminology and restrictions, systems explanation, search tactics, review and relevance, action, prompts/pauses and extraneous. Saracevic, et al., (1990) also suggest the inclusion of commands and responses by the IR system within a dialogue-based model of IR interaction.

In order to develop a dialogue-based model of interactive IR, it is necessary to first develop a grammar of IR interaction and identify the elements within this grammar. Elicitations can be regarded as a basic syntactic structure of a grammar of IR interaction in need of further exploration. The study reported in this paper focuses on elicitations within a triad dialogue-based model of IR - elicitations made by search intermediaries of users

with information requests before and during their interaction with an IR system. Elicitations are also a significant part of human communication in general, not only the specific user- IR system interaction. We propose that elicitations, or requests for information, also form an important component of a dialogue-based model of IR and the functioning of intelligent interfaces assisting users with IR tasks and building interactive processes the way humans conduct them. A greater understanding and categorization of elicitation purposes of IR users is useful for the development of better IR interfaces and systems, and interactive IR models.

This paper first discusses previous elicitation research in communication studies and information retrieval. The research questions and methodology guiding the study are then followed by the presentation and discussion of the study results, and the implications of the findings from three recent studies of elicitations during interactive IR, for the development of dialogue-based model and grammar of IR interaction, and IR system design.

RELATED STUDIES

Elicitations and Communication

Question asking or elicitation behavior, as requests for information, form a significant part of day to day human communication. Elicitations are a significant part of interpersonal communication studies examining models of discourse analysis (Cicourel, 1980), models of dialogue (Levinson, 1981), turn taking during conversations (Sacks, Schegloff & Jefferson, 1974), and replies and responses (Goffman, 1976). Kearsley (1976) studied the replies and responses process and identified a taxonomy of major question function, including echoic, expressive, epistemic and social control. IR research and models have increasingly adopted language from communication studies to conceptualize interactive IR as a conversation within a dialogue framework.

Information Retrieval Studies

Elicitations by users are of significant interest to IR researchers aiming to improve the effectiveness of IR interactions and develop intelligent interface that simulate the functional behavior of a good search intermediary and interactivity (Brooks, 1986). Studies have explored the major functions required for information provision by IR systems (Belkin, Seeger & Wersig, 1983; Belkin, Brooks & Daniels, 1987; Vickery, 1985) and elicitations were found to form part of the dialogue through which search intermediaries develop a model of the user's goals, intentions and background during an IR interaction (Belkin, 1984). Such requests for information also form part of the dialogue through which users develop a model of a search intermediary's tasks and the IR system functioning. The study reported in this paper further examined the nature of elicitations and elicitation purposes of search intermediaries during 40 mediated IR interactions to further develop an understanding of elicitations as a syntactic structure with a grammar of interactive IR.

Many previous studies have conducted empirical and theoretical investigations of user - librarian interaction and questions during reference interviews. Some studies have focused on the benefits of librarians' asking open questions with little structure, as opposed to closed questions with a tight structure during reference interviews (Allen, 1988). Aspects of online reference interviews have also been examined. Dervin and Dewdney (1986) discussed the role of neutral questioning during reference interviews, and studies by Auster and Lawton (1984), Crouch and Lucia (1981), Horne (1990) and Ingwersen (1982) found that the interaction between users and search intermediaries includes questioning behavior.

Previous studies have classified search intermediary questions as either open or closed questions, and examined the utility of open versus closed questions. However, these studies have produced mixed results. Auster and Lawton (1984) varied the number of open and closed questions asked by search intermediaries and found a significant but moderate correlation between user satisfaction and open questioning. Crouch and Lucia (1981) examined the presearch interviews and also found some correlation between user satisfaction and open questions. Allen (1988) concluded the difference between open and closed questions asked during mediated

online searching was not statistically significant.

These studies have established the place of elicitations in IR interactions, but not clearly identified the purposes of the elicitations. Recent research has begun to focus on gaining an understanding of the purposes for elicitations during interactive IR

Elicitation Purposes

End-User Questions

In a recent study (Nahl & Tenopir, 1996) identified a total of 1343 questions (mean 34 questions) asked by seven end-users of a human search monitor during their search interaction with a full-text database. The questions were further divided into twelve categories (Figure 1).

[PLACE FIGURE 1 HERE]

The 12 categories of questions were found to group into three domains: affective, cognitive and sensorimotor. Affectively-oriented questions were those reflecting the end-user's "need for continuing motivation to carry out their intentions in the moment-to-moment cognitive decision-making that constitutes a search" (Nahl & Tenopir, 1996. p. 281). Question categories within this domain included: an end-user seeking confirmation (34%), checking their progress, showing surprise and personal chat. Those questions related to cognitive information needs formed a quarter (26%) of end-user questions related to the system aspects of the search, including system image (8%), search strategy, clarification and article content. Another quarter (26%) of the end-users' questions related to their sensorimotor information needs and dealt with correctly formatting input (19%) or screen format questions (5%).

User Elicitation Purposes

Wu (1993, 1994) identified a total of 852 user elicitations to search intermediaries during 38 mediated searches with a mean of . Figure 2 lists the 10 categories of user elicitation purposes identified.

[PLACE FIGURE 2 HERE]

During the pre-search stage about half (52.5%) of user elicitations were requests for information from search intermediaries about search terminology. However, the vast majority of user elicitations occurred during the online stage of the search interaction - during discussions with the search intermediary as the online search progressed. During the online stage, the largest category of user elicitations related to search terminology (28%) and secondly to search procedures (21%). None of the 38 online searches contained all categories of user elicitation purposes with a mean number of categories per search of seven within a range of 4-11. However, all online searches included search term and strategy related elicitations. Some 95% of searches included user online relevance elicitations. These studies have expanded our understanding of user and end-user interactions by identifying categories of elicitation purposes.

Search Intermediary Elicitations

Following an analysis of two user-search intermediary interactions, Belkin (1984) proposed that search intermediaries develop user models through verbal interaction with a user regarding the user's background, goals and intentions, and state of their information problem. In contrast to Belkin (1984), Kuhlthau, Spink & Cool (1992) found search intermediaries made few elicitations regarding users' previous information-seeking behavior related to their information problem. However, previous studies have not fully investigated many aspects of a dialogue-based model of IR, particularly search intermediary elicitation purposes. An understanding of the elicitations made by end-users, users and search intermediaries during the modeling of the information problem, can provide an important contribution to the development of a dialogue-based model of IR and the development of more effective IR systems. There is also a need for research that seeks to understand

the information problem modeling process into the development of dialogue-based IR models and incorporated into IR systems design.

RESEARCH QUESTIONS

The goals of the study were to identify the:

1) Purposes of search intermediary elicitations during mediated IR interaction

2) Occurrences of search intermediary elicitations during the pre-online and online stages of the IR interaction

3) Differences between end-user, user and search intermediary elicitation purposes.

4) Search intermediary, user and end-user elicitation related to major searching tasks.

RESEARCH DESIGN

Data Corpus

The study reported in this paper, separately analyzed data previously collected by Saracevic and Su (1989). The data analyzed included the transcribed discourse from videotapes of 40 users interactions with one of four search intermediaries in the service of Rutgers University Libraries (Table 1).

[PLACE TABLE 1 HERE]

The study utilized data from a real setting of IR interaction. The search topics included humanities, social sciences, sciences, and medicine. Online searches were conducted in real life situations, with no restrictions on length or topic. Experienced professional searchers performed online searches on DIALOG within the area of their subject expertise.

Unit of Analysis

The primary unit of analysis in the study was an *elicitation*, based on a definition by Wu (1993, 1994) as "a verbal request for information" (p. 32). For this study an elicitation was defined as any utterance by person *A*, which directly produces (i.e., elicits) a response from person *B*, and for which, it was the intent of the elicitor to do so. To judge the elicitor's intent, strong evidence of such intent had to be present in the discourse transcripts, i.e., an utterance had to generate a response from the elicitee to be counted as an elicitation. Rhetorical questions for which no response was expected from the elicitee were not counted as elicitations (e.g., "You know what I'd like to do?"). Responses such as "Okay," or "Umhum," to statements of fact did not constitute an elicitation utterance. If the elicitor did not clearly intend (based on evidence in the transaction log) to elicit a response from the elicitee, the utterance(s) were not counted as an elicitation. It was possible for several utterances by an elicitor to constitute an elicitation. For example, two utterances may constitute a single elicitation by a search intermediary to a user.

Methodology

The study employed content analysis to analyze the data. Using the same data as discussed in the Data Corpus section above (Table 3), the purposes of search intermediary elicitations or requests for information of users (Spink, Goodrum & Robins, 1995a,b). The analysis of the search intermediaries elicitation purposes was an iterative process of analyzing 40 search transcripts. Three researchers (coders) coded one search together and the remaining 39 searches were divided into three groups of approximately 13 searches. To identify an elicitation, a coder needed explicit evidence from the transcript that the search intermediary was seeking information in the form of a response from the user. If an elicitation was identified, an appropriate notation was made beside the utterance and Wu's (1993) elicitation purpose categories were consulted. If an existing category was not found, the coder suggested an appropriate elicitation category. Suggested category revisions reflecting search intermediary processes were discussed until a consensus was reached.

Search intermediary elicitations were re-analyzed based on the revised categories. Inter-coder agreement is defined as the similarity in which each coder in the study, (a) decided whether an utterance was an elicitation, and (b) decided which category an elicitation should be placed. To check coding consistency, each researcher recoded four searches previously coded by another researcher. After exchanging and recoding the searches, the researchers met again in order to make final decisions about how the categories. One category was subsumed into another as the distinction between the original two was too fine to be made with any consistency. The categories were then reworked for all 40 searches.

RESULTS

A total of 1557 search intermediary elicitations were identified and divided into 15 elicitation purpose categories listed in Figure 3.

[PLACE FIGURE 3 HERE]

Table 2 details the frequency and percentage occurrence of search intermediary elicitations within each category - also broken down into elicitations made during the pre-online and online interaction.

[PLACE TABLE 2 HERE]

Search intermediaries primarily requested information from users regarding *search terminology and databases* to be selected, as well as search procedures used. For example, during Search 16 on giant fresh water prawns, the search intermediary continues questioning the user during the online search about the usefulness of particular search terms.

Search Intermediary: Yeah, procreation. That doesn't get it does it? Are you really talking about the mating process - sex and sexual, reproductive isolation?

Other search intermediary elicitations related to the *technical aspects of the search*, *related information issues and current immediate plans* during the online interaction. For example, during Search 17 on the

northern deer tick, the search intermediary asks the user about a disc for downloading of the search results.

Search Intermediary: Are these databases companies pretty profitable do you know?

Frequently search intermediary elicitations (15.8%) related to the *relevance evaluation of the IR system's output* - requesting users to make interactive relevance judgements. For example, during Search 25 on fertility of female horses, the search intermediary points to the screen and requests the user to make an interactive relevance judgment.

Search Intermediary: Ok, so you don't like this one, you actually want that one?

A smaller number of search intermediary elicitations requested information on *user's domain knowledge, knowledge of database searching or information-seeking behavior, or were repeated requests for information - echoic - or elicitations on social topics*. For example, during Search 14 on drug delivery systems, the search intermediary elicits information from the user regarding the amount of literature available on the search topic.

Search Intermediary: Do you have a sense of how many things you know you expect to find?

Search intermediaries' made more elicitations during the online search stage than the presearch stage (41.4 % presearch, 58.6% online stage) - with a mean of 16 presearch elicitations per search, a mean number of 23 online elicitations per search, and a mean of 39 total elicitations per search. Elicitations during the online search stage related mainly to search strategy and terms, followed by the online relevance elicitations requesting users to judge the relevance of the output. Some 383 (25%) of the search intermediary elicitations related to output purpose categories: i.e., output relevance, output magnitude, output terms, output format. Overall, search strategy and terms accounted for the greatest percentage of either presearch and online elicitations (50% total) - of the 645 total presearch elicitations, 453 (73%) related to search strategy and terms. Elicitations related to the selection of search terms and making relevance judgments were a major feature of most searches (Table 3).

[PLACE TABLE 3 HERE]

Differences Between Search Intermediary, End-User and User Elicitation Purposes

Users and search intermediaries were both concerned primarily with eliciting information from each other about selection of search terms and strategies, and interpreting the IR systems' output. But a major difference between users and search intermediaries (Saracevic & Su, 1990) was their elicitation activity level at different stages of the search process. Search intermediaries were slightly more actively eliciting during the online interaction than the pre-online stage - as they continued to model the user's information problem into search terms throughout the search process. This included asking users to make relevance judgments on the results of search statements as part of query reformulation. Users were more active elicitors during the online stage as they began the task of interpreting the IR systems output and dealing with the requirements of the interactive tasks, such as query formulation. End-users were more focused on eliciting information from their human search monitors in the form of seeking confirmation and approval for their actions, or asking questions to clarify the correct format for their input. Although differences appeared between end-user, user and search intermediary elicitations, there were many similarities that enabled the elicitation purposes to be related to four major searching tasks.

INFORMATION RETRIEVAL ELICITATION TASK MODEL

The 13 end-user (Nahl & Tenopir, 1996), 10 user (Wu, 1993) and 15 search intermediary (Spink, Goodrum & Robins, 1996a,b) elicitation categories were found to group into four major searching task areas, including: (1) information problem modeling task, (2) IR system task, (3) interaction task, and (4) the social task. Figure 4 presents an IR elicitation model including user and search intermediary elicitation categories grouped into four searching tasks.

[PLACE FIGURE 4 HERE]

Information Problem Modeling Task

Many elicitations related to the task of modeling the information problem and the translation of the user's information problem into appropriate search terminology. This task occupied end-users, users and search intermediaries during both the pre-online - as part of the initial search strategy development - and the online stages of the search - as part of query reformulation. Some search intermediary elicitations requested information from the user to assist in user modeling tasks related user domain knowledge (UDK), user knowledge of database searching (UDS), users' previous information-seeking (UIS), and search terms and strategy (SST). Most eleicitations were related to the eliciting of search terms, with little discussion regarding the user's information seeking processes. Elicitations by users regarding search terms were also part of the user modeling task - as the user and search intermediary cooperatively worked on the modeling task. End-users elicited information on formatting input, search strategy development and progress checking.

IR System Task

A number of elicitations by end-users, users and search intermediaries related to information required to technically conduct the online interaction, including elicitations regarding databases and search commands selected, logging on and off, and printing. The IR system task was a feature of the elicitations occurring primarily during the online search stage. Users made more of this type of elicitation in the online search stage, requesting information from search intermediaries in an effort to understand the technical requirements and capabilities of online searching.

Interaction Task

During the online search stage, a large number of elicitations related to the interactive task of assessing the IR system's output. Search intermediaries were primarily concerned with prompting user evaluations of the IR systems output - a total of 60 user elicitations versus 383 by search intermediaries. A major search intermediary task was to ask (or prompt) the user to interpret and evaluate the output of the IR system - either for relevance (OR), magnitude (OM), potential search terms (OT) or format (OF). Users were often unfamiliar with the interactive requirements of the IR task and aspects of the IR systems' output in need of evaluation. End-users were focused on time limits and system image questions.

Social Task

Users and search intermediaries often engaged in a social dialogue on personal matters not directly related to the conduct of the online search. Nahl and Tenopir (1996) highlight the affective aspects of the IR interaction when novice end-users engaged in personal chat and sought confirmation from research assistants "to humanize the stressful search by transforming it into a normal and reassuring social environment" (p. 283). These elicitations related to the social or human tasks, norms and practices of human communication - getting the search done within the context of a social interaction (Mokros, Mullins and Saracevic, 1995). These four tasks form part of an IR elicitation model that can be incorporated into dialogue-based models of IR interaction (such as Belkin (1984), Saracevic (1996), and Ingwersen (1996)). Elicitations or requests for information, and subsequent answers, express what is not clear to a user and what is being modeled during interactive IR.

DISCUSSION

Search intermediaries were primarily focused on eliciting search terms from the user, not only during the pre-online strategy formulation, but also during the online search strategy reformulation stage - modeling the user's information problem into search terms. In fact, search intermediaries making more elicitations during the

online interaction stage than the pre-online interaction stage of the search. They frequently continued to model the user's information problem throughout the entire IR interaction, maintaining a constant focus on search terms and strategy. Saracevic, Mokros, Su & Spink (1991) also pointed to the terminological determinant nature of the IR process. Search intermediaries were also strongly focused, particularly during the online interaction stage, with eliciting relevance judgements from the user on the retrieved items. This supports Spink and Saracevic (in press) who found search intermediary prompted user relevance feedback judgments were major determinants during mediated online searching.

Other purposes represented a small percentage of the elicitations by search intermediaries, including elicitations regarding the user's domain knowledge or previous information-seeking related to their information problem. Kuhlthau, Spink & Cool (1992) also found search intermediaries asked few direct questions of users related to the user's information seeking and work stage. They found users often made unsolicited statements regarding their information-seeking and work stage during their conversation with a search intermediary. The data from real mediated online searches, does not seem to support a model of the search intermediary user modeling beyond search terms and strategy to include the user's background, goals or intentions, and the state of their information problem (Belkin, 1984).

IR interaction models, such as the model proposed by Ingwersen (1996) leave open many elements with regard to IR interaction. The studies reported here represent an attempt to fill gaps in our understanding and models of the interactive IR process. The elicitation analysis provides an elicitation model based on a better understanding of end-users, users and search intermediaries information needs and purposes during an IR interaction. The results give an indication of what search intermediaries (whether human or expert system) and users needed to know, what is not clear to users during an IR interaction process, and forms part of a grammar of IR interaction.

The following section outlines a framework for the notion of a grammar of IR interactions.

A NOTION OF A GRAMMAR OF IR INTERACTION

Clearly, elicitations are but one of the elements in IR interactions. There are many others. While this study addressed the nature of elicitations, it did not and could not provide for an overall picture of IR interactions. As yet such a picture does not exist, despite some excellent recent synthesizing works, such as by Ingwersen (1992, 1996). But an outline of a picture is emerging. Eventually, it will be necessary to place the findings on elicitations and other aspects of interaction, into such a broader context, unifying a variety of elements in interaction. To do this it will be necessary to develop a broader structure which may be labeled a grammar of IR interactions.

This section discusses the possibilities and nature of such a grammar, an idea that was first proposed by Mokros and elaborated by Spink (1993) and Saracevic (1996).

Grammar in Language

In its usual and classic sense, grammar refers to a systematic description of the ways in which words are used in a particular language; comparative grammar involves several languages. The central point of a grammar is grouping words that behave similarly into classes and devising rules on how each class of words behaves.

Originally, grammar developed as a prescriptive grammar specifying the rules for a language with the intent to standardize and/or improve the language. In contrast, the modern approach to grammar is toward descriptive grammar, that is towards the study of actual usage or standard practices of words in speech. Among others, this involves, classification of words and parts of speech, and language structure as used. In addition, this may also involve explanations on how the rules of prescriptive grammar would apply where there are differences. Descriptive grammar of a language is a dynamic proposition, for a language changes over time, and exhibits usage differences in differing contexts. These concepts of grammar are elaborated in numerous works and studies on contemporary language usage.

But as the concept of "language" is not only limited to spoken words, the concept of "grammar" is not only limited to speech. The notion of language has been extended to other expressions, such as the language of painting, music, dance, non-verbal behavior and so on. Consequently, the notion of grammar can be and has been extended to systematic study and description of forms, elements, structures and usages of many expressions and subjects, e.g., the grammar of dance. In this sense, we can talk of a grammar of interaction involving humans and information systems, or in a broader sense, a grammar of human-computer interaction.

Expansion to IR Interactions

A special and probably the most complex case of human-computer interaction is the triadic interaction or mediated IR, involving a user, an intermediary and an information system. We may think of such an interaction as having a language involving both spoken speech and computer commands and responses, geared towards a communicative relation to achieve some defined retrieval ends. Consequently, we may think of a grammar of mediated (or non-mediated) IR interactions. Such a grammar should attempt to study and describe elements, forms and structures involved in the interaction, and moreover, attempt to elucidate the various rules of usage.

As in spoken language grammars, there are prescriptive and descriptive grammars on IR interactions. Numerous textbooks, manuals, handbooks, guides, command sheets, help messages etc., provide prescriptive grammar in the sense that they tell what are the elements (e.g., in the interview process, databases, computer commands) and then prescribe their usage. Overwhelming numbers of contemporary works on IR interactions are of the prescriptive grammar type.

In contrast, there are a small but growing number of studies that are oriented toward studying and observing actual interactions and subsequently identifying elements involved, grouping them into classes that behave similarly, and deriving descriptive rules on how each of these classes behaved in respect to actual usage. Such studies are beginning to formulate a descriptive grammar of IR interaction. The present research falls directly into this category. It can be viewed as an attempt to identify and classify some (and by no means

all) of the critical elements and their behavior in information retrieval interaction, as part of a larger descriptive grammar of such interactions.

Place in IR Studies

An important distinction between types of studies in IR interactions should be made in order to place the studies of interaction grammar. In language, grammar addresses words and their usage, but does not address the effects of their usage or the associated variables. These are very distinct types of studies, the former done in linguistics and latter in communication research and many other fields. A similar distinction can be made with respect to IR studies. The studies of interaction grammar do not address effects of retrieval. Grammar studies have a goal to identify interaction elements, structures and rules of usage; they do not concentrate on outcomes. IR test studies have a goal to identify variables that affect retrieval effectiveness or efficiency, that is, they do address outcomes.

The distinction is important. Each type of study of IR interactions, grammar and effect contributes a different picture of the same complex process. Each is illuminative and useful in its own way, paralleling such illumination and usefulness of the grammar and effect studies of languages such as English. Thus, the question is not of grammar versus effect studies in IR interactions, as each does a different job. The ultimate question is whether at some time in the future they can feed on each other. The tradition in IR leans much more towards effect studies; the grammar studies are not as yet that well developed. To fruitfully interact with the effect studies, the grammar studies will need to be developed further.

Elements in IR Interaction Grammar

The basic element in language grammars are words. As yet, no agreement exists as to what should be the basic elements in IR interaction grammar. It is suggested here that we should consider three types of basic elements in the development of an interaction grammar:

1) Utterance: a set of words (and possibly non-verbal gestures translatable into words such as nods, grunts etc.) expressed continuously by one party in the interaction at a given time. Utterances in a triadic interaction are by the user and intermediary. In a dyadic interaction they are by user or intermediary, whoever interacts with the system.
2) Computer Commands: the instruction to the system to perform a given task.
3) Computer Responses: the response from the system resulting from a command.

These three elements are present in any and all interactions. In a triadic interaction, utterances are spoken, but in a dyadic interaction they may not be uttered aloud (to record them in this situation a user or intermediary will have to be requested, as in similar observations, to voice the utterances as the interaction progresses). There is a fourth element that may be present in some, but not necessarily in all interactions: a written text bearing on the search at hand, such as a written question or a relevant document, brought to the interaction by the user. Such a text can be treated as a set of utterances, classified as to subject or another chosen group.

The next step in development of a grammar is to define or derive classes for each of the elements, that will group together the utterances, commands, responses (and text if present) according to similarities of behavior, or some other criteria. Rules for each class should then be elucidated. A further and more complex step is to take a number of same and different elements in a defined sequence that expresses what is the equivalent of a sentence in the language. In language, a sentence may be defined as "a meaningful group of words that is grammatically independent and complete". It is much more difficult to define a sentence in IR interaction, than in language. In this work, the unit of analysis for an elicitation can be considered as part of an attempt to define an interactive sentence. Similarly, in research on the nature of user elicitations in IR interaction, the sentence was the user utterance representing an explicit or implicit question.

Thus, definition of a sentence in IR interaction can differ depending on the criteria for observation. Considerable work needs to be done to reconcile and relate these criteria, and devise a classification of various

sentence schemes. Study of interaction sentences, as the study of sentences in language grammars, can proceed in several directions, concentrating on different, but related aspects. One direction is to classify the nature of sentences (in language as declarative, imperative, interrogative etc. sentences). The other is to determine the syntax, or internal structure, of the various types of sentences and try to uncover rules by which the sentences were derived.

The studies discussed in this paper contribute to the development of an IR interaction grammar, including types of sentences dealing with elicitations were classified. The study by Saracevic, Mokros and Su (1990) which includes derived classifications of user and intermediary utterances and computer commands, can be considered as an attempt to classify defined sentences in IR interaction into sentence types. Feedback sentences were first identified and then classified (Spink, in press); five types of feedback sentences and their distributions were noted. Although syntax (internal structure) of each of the types of feedback sentences was not explored, a larger external syntax of the set of sentences was identified through sequences of feedbacks; even some rules in formation of these sequences were uncovered. This may lay the base for formulation of a feedback grammar, a narrower grammar within the broader grammar of elicitation sentences with IR interaction are beginning to be identified.

Semantic Aspects

The notion of a grammar for IR interaction was proposed in this section. After a discussion of what is entailed in a "grammar" of a language, a parallel was drawn to possibilities of developing a grammar of IR interactions. Elements of such a grammar were suggested, followed by strategies to develop syntax based on observed interactions. Examples of works that can be considered as addressing development of an IR interaction grammar were given, showing that the work has already begun. But there is along way to go before a coherent unified grammar of IR interactions will emerge.

In language studies there is some argument whether grammar is restricted to use of words and therefore to

syntax, or to meaning of words or semantics as well. In other words, is semantics a separate area, or does it fall into grammar? If we take the approach that many modern linguists (but not philosophers) argue that semantics needs to be studied as part of grammar, then we also have to address the semantics of an IR interaction grammar. As the semantics of language is a much more difficult and less developed study than syntax of language, so is the semantics of interaction in contrast to the syntax of interaction.

Studies of search terms (Spink & Saracevic, in press) may be considered as addressing some of the semantic aspects involved in interaction. Similarly, the study of sources of search terms can be considered as related to possible semantic studies in a grammar of IR interactions. However, as in language studies, semantic studies in IR interactions are more complex, difficult and involved, and less developed. A grammar of IR interactions is a necessity, and that such a grammar will have to involve not only syntax, but semantics as well. Pragmatics, may be further down the line.

IMPLICATIONS FOR IR SYSTEM DESIGN

Many IR tasks and system functions are not clear to users during an IR interaction. The findings of this studies of elicitation purposes indicate areas of consideration for the design of IR systems.

1) In addition to eliciting user query terms during the presearch stage, IR systems should continue to elicit user queries throughout the interaction - to assist users in term selection and query reformulation during stages of the search process.
2) IR systems should provide continuous opportunity for the user to elicit information regarding databases, term and strategy selection throughout the search process.
3) IR systems should provide opportunities for the user to obtain assistance in making magnitude and relevance judgments throughout the search process.
4) IR systems should incorporate more opportunity for users to indicate their search stage, background etc.

A dialogue-based model of IR based on a grammar of IR interaction needs to include user and search intermediary (either human or IR system) elicitations or requests for information. This model would also include elicitations between user and IR system throughout a search interaction - including the presearching and searching stage. IR systems need to engage users in a dialogue - and begin modeling the user - on the topics of search terms and strategies, domain knowledge, information-seeking and searching knowledge - before a single search term is entered - as well as throughout the search interaction. Spink (1994, 1995) also found search terms used in query expansion identified in IR systems output, were highly productive in retrieving relevant documents. IR systems may need to prompt users to interpret and evaluate the IR system's output for relevance, magnitude, potential search terms and format. Both Spink and Saracevic (in press), and Nahl and Tenopir (1996) suggest that searching with a partner (if nor professional search intermediary is available) or discussing the search with another person during the search process might improve the effectiveness of interactive searches.

CONCLUSION & FURTHER RESEARCH

Users engage in complex interactions throughout their dialogue with an IR system. The results of the studies reported here indicate that elicitations are an important complex process for further research to develop a dialogue-based model of IR. This paper has identified the types of elicitations related to different tasks during interactive IR. Further research is need to validate these findings and extend the models of interactive IR to include other elements within a grammar of IR interaction.

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Figure 1. Categories of end-user questions (Nahl & Tenopir, 1996, p. 280).

Categories	Explanation
Seeking confirmation	**Affective need for continual motivation to proceed with the search**
Formatting input	**Sensorimotor need realted to proper entering technique, formatting and display syntax.**
Personal chat	**Affective need to humanize a stressful search by transforming it into a nornal and reassuring social environment.**
System image	**Cognitive need to understand system limits, capabilities and processes**
Search strategy	**Cognitive need tomunderstand Boolean logic, truncation or system commands**
Article content	**Cognitive need to understand the content**
Clarification	**Cognitive need to verify what is not understood**
Screen format	**Sensorimotor need to locate and identify information displayed on the screen**
Showing surprise	**Affective need to surprise or disbelief at unexpected results**
Progress check	**Affective need to recall previous steps**
Time limits	**Sensorimotor need to know length of time of the session**
Obtaining things	**Sensorimotor need for pen and paper**

Figure 2. Categories of user elicitation purposes (Wu, 1993).

Category	Explanation
Terms	**Related to search terms or concepts of the user's search questions, etc. occurring at the presearch, strategy formulation, or during review of outputs.**
Databases	**Capacity and restrictions: any elicitation about database coverage (e.g., content or year).**
Search Procedures	**Search related: Elicitation related to the technical aspectss of the search (e.g., logon, printer set-up).**
Other Online Issues	**Not search related: Elicitation related to the general technical aspect with no relationship to the search (e.g., online equipment).**
Other Information Services	**Requesting information about other related information services (e.g., interlibrary loan).**
Current/Immediate Plan	**Requesting information on the search intermediary's current action or plan, or situation during the interaction.**
Outputs	**Requesting information regarding output expectation, specification, or evaluation (exceptions 1) questions regarding search terms during review of outputs are assigned to "Terms"; 2) questions regarding technical aspects and processes, such as format of the output, go to "Search Procedures".**
Echoic	**Requesting repitition, such as "pardon?", "say that again?"; requesting further elaboration of the immediate preceeding utterence, such as, "what do you mean by that?", or seeking reassurance or reinforcement of what the speaker had said, for instance "are you sure?" or "really".**
Social or Metatopics	**Personal matters, such as "Does it take long to drive home?", or related to metatopics of the video-taping issues.**
Indiscernable or Unfinished	**Being indiscernable or unfinished and therefore the coder was not able to interpret the utterence properly.**

Table 1. Summary of the data corpus.

Searches:	
Number of searches	**40**
Hours of videotapes	**46.05 hrs**
Mean time per search	**69.08 min**
Mean time per search presearch interview	**13.04 min**
Mean time per online search	**56.04 min**
Search Intermediaries:	
Number of search intermediaries	**4**
Mean experience of search intermediaries	**8.5 years**
Bibliographic Records Retrieved:	
Number of bibliographic records retrieved	**6225**
Number of relevant (or partially relevant) bibliographic records retrieved	**3565**
Number of nonrelevant bibliographic records retrieved	**2660**
Mean number of relevant (and partially relevant bibliographic records) retrieved	**99**
Mean number of nonrelevant bibliographic records	**67**
Mean precision per search	**57%**
Databases Searched:	
Number of databases searched	**46**
Mean number of databases consulted per search	**3**

Figure 3. Categories of search intermediary elicitations.

Category	Code	Explanation
Search Strategy & Terms	SST	An elicitation relating to the concepts or terminology of the user's query in order to formulate or reformulate the search strategy or generate key words whether occurring at the pre-search stage or during the search stage. Includes languages to be selected and time period to be covered by the search.
Output (Relevance)	OR	Relates to the evaluation of items retrieved by the system.
User Domain Knowledge	UDK	A request for information regarding the user's knowledge of the domain of the topic at hand.
Social, Metatopics	SQ	Non-search related social elicitations.
Output (Magnitude)	OM	Relates to the number of items retrieved by the system in response to the search query.
Databases	D	Databases to be used, including database subject coverage, and restrictions.
User Information Seeking Behavior	UIS	The users' information seeking stage on this topic.
Echoic	E	Requesting the repetition or reinforcement of a previous utterance.
Output (Terms)	OT	Refers to terms generated by the system during the search phse including descriptors.
Output (Format)	OF	Relates to the format of outputs, i.e.: citations, abstracts, or full-text.
Technical Aspects of the Search	Tech	Technical aspects of the search. Includes elicitations about logging on, printer set-up, and computer commands.
User Knowledge of Database Searching	UDS	Seeks to determine the users' knowledge of database searches (whether online or CD-ROM).
Other Information Sources	OIS	Other sources of information for the user. (E.g., interlibrary loan, microfiche, colleagues).
Indiscernable	I	An elicitation that is either muted, unfinished, or interrupted to such an extant that it is indiscernible for this analysis.
Other Online Issues	OOI	General aspects of online database searching such as online fees and telecommunications.

Table 2. Frequency and percentage of search intermediary elicitations in presearch and online search stages.

Search Intermediary Elicitations						
Category	Frequency			Percentage		
	Presearch	Online	Total	Presearch	Online	Total
SST	453	325	778	29.1%	20.9%	50.0%
OR	5	246	251	0.3%	15.8%	16.1%
UDK	50	41	91	3.2%	2.6%	5.8%
SQ	24	47	71	1.5%	3.0%	4.6%
OM	7	52	59	0.4%	3.3%	3.8%
D	22	35	57	1.4%	2.2%	3.7%
UIS	28	21	49	1.8%	1.3%	3.1%
E	20	27	47	1.3%	1.7%	3.0%
OT	0	39	39	0.0%	2.5%	2.5%
OF	1	33	34	0.1%	2.1%	2.2%
TECH	4	28	32	0.3%	1.8%	2.1%
UDS	24	8	32	1.5%	0.5%	2.1%
OIS	4	8	12	0.3%	0.5%	0.8%
I	2	1	3	0.1%	0.1%	0.2%
OOI	1	1	2	0.1%	0.1%	0.1%
Total	645	912	1557	41.4%	58.6%	100%

Table 3. Number and percentage of searches containing each category of search intermediary elicitation.

Category	Presearch	Online	Total	Percentage
SST	40	40	40	100%
OR	2	38	38	95%
UDK	25	21	34	85%
D	13	20	26	65%
SQ	14	15	23	57%
OM	4	20	20	50%
UIS	17	8	19	47%
E	14	14	19	47%
OF	1	15	16	40%
UDS	12	4	15	37%
OT	0	13	13	32%
TECH	3	12	13	32%
OIS	5	6	9	22%
OOI	1	1	2	5%
I	1	1	1	2%

Figure 4. Four primary tasks of elicitations.

Task	Categories		
	Search Intermediary (Spink, Goodrum, & Robins, 1996)	User (Wu, 1993)	End-User (Nahl & Tenopir, 1996)
Information Problem Modeling Task (Pre-online & Online Task)	User domain knowledge User knowledge of database searching User information seeking Search strategy & terms	Terms	Formating input Search strategy Progress check
System Task (Online Task)	Other online issues Technical aspects of the search Other information sources Databases	Databases Search procedures Other online issues Other information services	Time limits System image
Interactive Task (Online Task)	Output (magnitude) Output (relevance) Output (terms) Output (format)	Immediate plan Output	Screen format Article content Showing surprise Obtaining things
Social Task (Pre-online & Online Task)	Echoic Social Meta-topics Indiscernable	Echoic Social Indiscernable	Personal chat Seeking confirmation