HUMAN PRIORITIZING AND COORDINATING INFORMATION BEHAVIOR DURING INFORMATION SEEKING AND RETRIEVAL IN THE WEB ENVIRONMENT

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The primary goals of this research were to: 1) understand general characteristics of human prioritizing and coordinating information behaviors in Web information seeking and retrieval contexts; 2) identify the factors, influencing the processes of prioritizing multiple information tasks; and 3) obtain a multidimensional understanding of human prioritizing and coordinating information behavior with a focus on perception, effort, emotion, time and performance.

The sample consisted of twenty volunteers drawn from diverse academic disciplines at the University of Pittsburgh. The study was conducted in a laboratory setting. Subjects were asked to perform four different information tasks (three assigned and one non-assigned) using a PC with the time limit of one hour. The data collected included think-aloud utterances during the searches, pre/post questionnaires, search logs, and post-search interviews. The data was analyzed using content analysis and quantitative analysis techniques.

Major findings of this study include: 1) people are different in dealing with multiple information tasks in terms of the task they engage in and their backgrounds, e.g., age, gender, status, and disciplines; 2) human prioritizing behavior is affected by multiple factors, such as task attributes, emotion, and time; and 3) dynamic interactions exist among the components of human prioritizing and coordinating information behavior. This research indicates that effort, time, or perception may all be necessary factors in producing good performance in dynamic and complex information situations, but how we manage our emotions ultimately yields successful performance.

A model was developed from the results of this study to depict the dynamic internal and external processes people employ in order to efficiently and effectively deal with their multiple information tasks while interacting with the Web. It offers a deep insight into how multidimensional components of an individual's behavior of managing multiple information tasks are functionally coordinated and put into effect. This model will make a major contribution by enlightening the existing areas of human information interaction. In addition, the model can be employed as a theoretical base for designing human-friendly user interfaces, which function as intelligent and affective central mechanisms and help users to prioritize, monitor and coordinate their needs/tasks/goals effectively and efficiently.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND

Our adaptation occurs from our ability to process information and modifies our information behavior accordingly (Morgan, 2002). Since the advent of the Web, humans have lived in dynamic, volatile digital information environments. Due to the dynamism and complexity of the Web information environment, people are getting more involved in multiple information task behaviors (Waller, 1997). Multiple task performance is an important human behavior that allows people to manage complex situations by handling more than one task in an effectively coordinated way (Burgess, 2000; Carlson & Sohn, 2000; Lee & Taatgen, 2002).

According to the Compact Oxford English Dictionary definition, multiple task performance is "the ability to perform concurrent tasks of jobs by interleaving." In cognitive science, the concept of multiple task performance is more complicated than "interleaving" tasks in a multiple task sense. The complex situations people face often demand further mental activities, such as prioritizations and planning (Burgess, 2000).

How we manage our complex situations is important to effectiveness in everyday life. With recent findings from a cognitive science perspective, Burgess (2000) suggests that the characteristics of multiple task situations often faced in our everyday lives are as follows:

- *Numerous tasks:* A number of different tasks have to be completed.

- *One task at a time*: Due to physical or cognitive limits, it is not possible to do more than one task at a time.
- *Interleaving required*: The most time-effective course of action on multiple tasks is not to completely finish one task before moving to another, but to switch between them as appropriate.
- *Delayed intentions:* The time for a switch to a task is not informed directly by the situation.
- *Interruptions:* Occasionally, interruptions will occur.
- *Differing task characteristics*: Tasks usually differ in terms of priority, difficulty, and the time duration they will take.
- *No feedback:* People do not receive minute-by minute performance feedback.

Multiple task performance has been important to the research of cognitive science, engineering psychology, human computer interaction, and human factors (e.g., Damos, 1991; Treisman, 1960; Wickens, 1989). Early studies in the literature of multiple task performance in cognitive science focused mainly on dichotic listening skills (e.g., Broadbent, 1958; Treisman, 1960), in which people were asked to listen to two simultaneous messages and shadow one. Later research has focused on both cognitive and motor task performance (e.g., Wickens, 1989). According to Wickens (1989), researches in multiple task performance include both task characteristics and coordination processes.

Research in task coordination processes concerns how people manage their activities to perform decision-making and problem-solving tasks (Waller, 1997). The studies concerning task coordination processes in self-regulating individuals suggest that performance feedback plays an important role in individuals' efforts to manage multiple task activities over time (Cummings, 1978).

Wickens' (1992) information processing model of decision-making processes suggests that individuals: (1) perceive environmental information cues, (2) derive a recognition based on the perceived cues, and (3) choose one action among several actions to put into effect. A model of cognitive workload management suggests that when people face a multiple task situation, they: (1) plan activities using available information, (2) prioritize tasks, and (3) schedule the actions to be carried out (Raby, Wickens, & Marsh, 1992).

The task characteristics to prioritize multiple tasks include (Waller, 1997): (1) familiarity and difficulty; (2) the source of the task and immediacy; (3) the task deadline; (4) the status of the task in terms of its completion; (5) the sequence of the task in terms of any interdependence among the tasks.

Human multiple task interaction, in general, involves "a person's allocation of his/her cognitive resources among multiple different tasks and the coordinating effect of task elements, processes, and resources on multiple task performance" (Waller, 1997, p.225). The way we manage our multiple task situations is influenced by self-regulating processes that allow us to prioritize, monitor, and coordinate task performance (Iani & Wickens, 2004). It has been an issue how such self-regulating processes arrange multiple tasks and assign our efforts to them allowing us to manage them effectively (Iani & Wickens, 2004).

1.2 PROBLEM STATEMENT

As the Web becomes an important tool of information access and use in electronic information environments, there is a need to understand user interactions with Web technologies during their information seeking and retrieval processes. Recent studies in human multiple information task behavior show that people often have more than one information task at hand at the same time when interacting with an information retrieval system (Spink, Ozmutlu & Ozmutlu, 2002; Spink, et al., 2006). In this case, people may batch their information problems or tasks and decide to solve these problems or tasks at once (Spink, 2004). Recent studies also indicate that users searches may have multiple goals, topics, or problems in information seeking and retrieval contexts (Miwa, 2001; Spink, 2004).

In an exploratory study of human multiple information task behavior, Spink, Park, & Koshman (2006) found that information task prioritizing processes were influenced by the following factors: level of interest, level of knowledge, perceived level of information available on the Web, level of difficulty, level of importance, and information seeking from general information problems to specific ones. Spink (2004) suggested that factors, which influence information task ordering processes, are the levels of interest and familiarity.

Multiple task performance has been an important area of study in cognitive science, engineering psychology, human computer interaction, and human factors, but human multiple information task interaction during information seeking and retrieval processes in the Web environment is under-explored.

Recent studies show that people often perform multiple information tasks while using Web information retrieval (IR) technologies and looking for information on more than one information task over multiple search episodes (Spink, 2004; Spink, Ozmutlu, & Ozmutlu, 2002). However, a limited number of studies have examined how people manage their multiple information tasks, especially during their interactions with IR systems.

While some tasks can be easily performed concurrently, others compete for cognitive capacities (Wickens, 2002; Wickens et al., 2003) and, as a consequence, people need to efficiently prioritize and coordinate their tasks with appropriate efforts in order to accomplish each task successfully. The way in which task prioritizations, task characteristics, and mental effort (cognitive resources) are connected has not yet been explored in information seeking and retrieval contexts. A model of human multiple information task interaction in such contexts is needed for a greater understanding of human information behavior in dynamic and complex information environments.

1.3 SIGNIFICANCE OF THE STUDY

People live in the world of ever-changing information technologies and such environments have been bringing us new ways of accessing and utilizing information in diverse information repositories (e.g., digital libraries, the Web, personalized information systems). Due to the dynamism and strength of the hi-tech information environments, we are getting more involved in multiple information task situations.

Even though some recent studies discuss the nature of task in information seeking and retrieval contexts (e.g., Vakkari, 2003), current human information behavior models do not take account of human multiple information task interaction phenomena (e.g., Bates, 1989; Dervin, 1983; Ellis, Cox, & Hall, 1993; Kuhlthau, 1993; Vakkari, 2001). Such models are limited to explain the information access and use process of a single task (Spink & Park, 2005).

Human information behaviors may be more complex and dynamic than the consideration of a single task in today's information environments. For instance, the Web has become a major form of information access and use for many people worldwide in electronic environments. Web users are freed from the linear flow of information (Marchionini, 1988; Marchionini, 1995). They are allowed to navigate and utilize the huge amount of information, easily accessible, without restraints or intermediaries. However, Web users also require new cognitive models to guide navigation strategies in order to make the best use of their time and effort (Marchionini, 1995).

Schumacher et al. (1999) emphasize the theoretical and practical values of study in human multiple task performance. According to Schumacher et al. (1999), research in multiple task performance is "important practically because it may produce results of benefit to people who perform multiple tasks efficiently under real world circumstances. Moreover, research in this area is critical theoretically because the performance of multiple tasks imposes demands on the human information processing systems and thus potentially enables deep insights into how the system's components are functionally organized and implemented" (p.791).

Multiple task performance is a critical human behavior that allows people to manage complex environments by handling multiple tasks in an effective way. Yet, this important behavioral phenomenon is still under-researched in the contexts of information seeking and retrieval. Theoretical and empirical studies are needed to further understand how humans handle multiple information tasks. The research problem addressed is the growing and crucial need for a greater understanding of human multiple information task interaction in information seeking and retrieval contexts.

1.4 RESEARCH QUESTIONS

The proposed study is to model human prioritizing and coordinating information behaviors in the Web environment by observing the way people manage their multiple information tasks in information seeking and retrieval contexts. The study addresses the following research questions:

Research Question 1:

What are the general characteristics of human prioritizing and coordinating information behavior in Web information seeking and retrieval contexts?

Research Question 2:

What are the factors, which influence the processes of prioritizing multiple information tasks during information seeking and retrieval in the Web environment?

Research Question 3:

What are the relationships of task demand, mental effort, affective state, temporal demand, and performance in the processes of prioritizing and coordinating multiple information tasks in the contexts of information seeking and retrieval on the Web?

1.5 OBJECTIVES AND SCOPE OF THE STUDY

Figure 1 describes the goals and scope of the study.

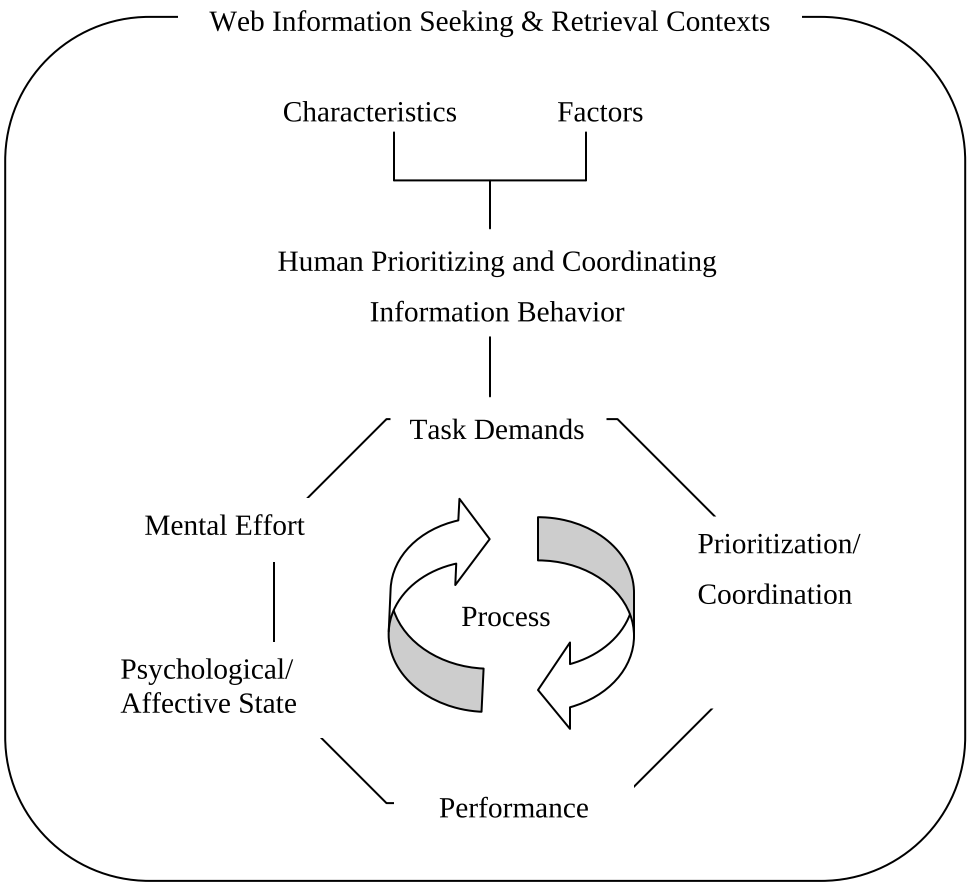

Figure 1. Goals and Scope of the Study

The general goals of the study are to: 1) understand the general characteristics of human prioritizing and coordinating information behaviors; 2) identify the factors affecting the process of prioritizing and coordinating within the contexts of Web information seeking and retrieval. In addition, the study aims to obtain a multi-dimensional understanding of the process of prioritizing and coordinating information seeking and retrieval behavior on the Web and in particular examines: 1) how perceived task demands affect the process of prioritizing multiple information tasks; 2) how task demands influence mental effort investments; 3) how mental efforts affect task performances; and 4) how psychological/affective states influence task performances.

Ultimately, the purpose of the study is to create a model, which describes the processes people use in order to manage their multiple tasks in information seeking and retrieval contexts. In addition to offering this description, the model may be used to enlighten existing areas of information seeking and retrieval study as to dynamism and complexity of human information interaction in the Web environment.

1.6 STRUCTURE OF DISSERTATION

The following Chapter 2 provides an overview of the research into general multiple task performance, multiple information task behavior, and prioritizing and coordinating behavior. The chapter discusses theories and mechanisms of attention and studies of task attributes, effort, and performance subsequently. It also introduces some empirical studies on human multiple information task behavior in electronic environments in general, the Web environment in particular. Chapter 3 details the research design, including methods, data collection, subject sample, and data analysis. Chapter 4 presents the results of this study. In Chapter 5, the major findings of the data analysis are discussed and a model is presented. Discussions on implications, limitation, and future research are included in Chapter 5.

2.0 LITERATURE REVIEW

This study is to investigate how people manage multiple information tasks in information seeking and retrieval contexts with a focus on the interplays of perceived task characteristics, cognition, emotion, time, and performance. Multiple task performance has been examined in three major bodies of research literature: in the cognitive science and engineering psychology literature; in the human computer interaction literature; and in the information science literature.

To get general ideas of multiple task performance, this chapter begins with reviews on the literature in cognitive science, which has a long history of multiple task performance research. Section 2.2 then provides studies in human information interaction and human computer interaction. Section 2.3 discusses how interdisciplinary fields have investigated prioritizing and coordinating behaviors in multiple task situations. The factors, which affect task prioritizations, are also discussed. Section 2.4 focuses on theories and mechanisms of attention. Section 2.5 discusses some studies of task attributes, mental effort, and task performance.

2.1 MULTIPLE TASK PERFORMANCE IN PSYCHOLOGY

Different theoretical and experimental approaches to multiple task performance suggest that researchers are far from agreeing on how to explain humans working with multiple information tasks. In general, multiple task performance is the ability of humans to handle the demands of multiple tasks concurrently through task switching or interleaving if necessary (Burgess, 2000; Carlson & Sohn, 2000; Just, et al., 2001; Lee & Taatgen, 2002; Rubinstein, Meyer & Evans, 2001).

Research in experimental psychology has focused on repetitive performance of individual perceptual-motor and cognitive tasks (Rubinstein, Meyer, & Evans, 2001). We often face multiple task situations. Our daily life often demands performing multiple tasks concurrently or subsequently. As working on a PC, we often check our emails or chat online with friends while surfing on the Internet to look for information or using an online catalog system. To explain how such multiple task performance is performed, some experimental psychologists have proposed that cognitive executive control systems govern the processes of the selection, initiation, execution, and termination of each task (Rubinstein, Meyer, & Evans, 2001).

In Rubinstein, Meyer, & Evans's (2001) study, performance was measured as a function of the level of task familiarity/unfamiliarity, the level of task simplicity/complexity, the level of visual cues about which tasks should be performed. In this study, task switching produced switching-time costs that increased with the level of task complexity but decreased with the level of task cuing. According to this study, if there is a certain rule of performing tasks, it takes more time to switch from familiar to unfamiliar tasks than to switch in the opposite direction. The results of this study also imply that the productivity of performance on multiple tasks is generally low.

Just et al. (2001) tried to understand multiple task performance in a neuro-cognitive science perspective. From a micro-level of multiple task performance, they found that when people conducted multiple tasks at the same time, the activation volume in the cortical systems underlying tasks decreased relative to the single task conditions. This study provides an explanation of why we cannot pay attention to and perform many tasks simultaneously; the cognitive limitation in multiple task performance causes a brain activation decline. The findings of this study show that people perform a task in multiple task situations at a high level of accuracy but the productivity level of performance is generally low (Just et al., 2001).

According to Wickens (1989), research in multiple task performance in engineering psychology focuses on both task characteristics and coordination processes. In multiple task situations, people may adopt time-sharing or time swapping behavior to manage their situations effectively (Wickens, 1991): Time-sharing is the simultaneous performance of multiple tasks, while time swapping is the sequential performance of multiple tasks.

Wickens et al. (1983) argue that research on the limitation of human cognitive capacity needs to cope with the fact of difficulty of measuring cognitive resources directly. Furthermore, according to Wickens et al. (1983), cognitive resources cannot be directly measured from the quality of task performance. To overcome these difficulties, Wickens et al. (1983) suggests that a technique for measuring cognitive resources allocation is to assign to the subjects a secondary task that must be performed concurrently with a primary task (Wickens et al., 1983).

Halford, Maybery, & Bain (1986) points out that the construct of cognitive capacity has been criticized in cognitive development. According to Halford, Maybery, & Bain (1986), research in this area focuses on how cognitive resources are assigned to tasks: limitations to cognitive resources have not yet been explained. Halford, Maybery, & Bain (1986) suggests that age differences are good variables to understand cognitive strategies used in performing multiple tasks.

Taken as a whole, this line of research implies that the cognitive capacity limitations of the human information processing system have long been recognized. When we pay attention to a thing, it is often difficult to perform others. Under some circumstances, however, many tasks can be performed at the same time (Wickens et al., 1983).

2.2 MULTIPLE TASK PERFORMANCE IN INTERDISCIPLINARY STUDIES

2.2.1 Studies in Human Computer Interaction

Another field, which has been studying multiple task performance, is human-computer interaction, which has captured the interest of computer and information scientists. Researchers in human-computer interaction have been trying to incorporate the concept of human multiple task performance to design of information systems, especially, user interfaces. To design effective user interfaces, we need to understand human behavior, when interacting with information systems to perform multiple tasks: how people process information and what the limitations of processing large amount of information at the same time are (Budzik & Hammond, 2000; Maglio, et al., 2000). Models of human multiple information task interaction can be employed for designing adaptive user interfaces, which monitor and analyze user behavior in order to anticipate user needs (Budzik & Hammond, 2000; Maglio, et al., 2000).

Miyata and Norman (1986)'s study gives us a good example of system support for multiple activities, (e.g., transitions between one activity to another focusing on two aspects: suspension of activity and reminding of activity). The example by Miyata and Norman, gives us a good insight of how the theoretical ideas on multiple task performance can be applied for system support of multiple activities. They also mentioned some aspects of support during execution of an activity, especially in regard to the execution of simultaneous activities.

According to Miyata and Norman (1986), “there are two styles of human information processing: task-driven processing and interrupt-driven processing. In a task-driven state, according to Miyata and Norman (1986), people generally pay attention to one event or task and they do not spend their mental effort to process other events or tasks. In an interrupt-driven state, people are easily distracted by extraneous events, extraneous thoughts, and/or external signals” (Spink & Park, 2005, p. 552).

2.2.2 Studies in Human Information Behavior

Research in multiple task performance in human information behavior shows that people often face multiple task situations in information contexts. When they have multiple information tasks or problems, they tend to batch those problems or tasks and try to solve them at once, often using information retrieval systems (Spink, 2004). Recent studies indicate that users searches may have multiple goals or topics in the contexts of human information interaction (Miwa, 2001; Spink, 2004).

In human information behavior, “the process of seeking information concurrently over time in relation to more than one, possibly evolving, set of information tasks (including changes or shifts in beliefs, cognitive, affective, and/or situational states), is called multitasking information behavior” (Spink, Ozmutlu & Ozmutlu, 2002, p. 649). How people manage more specifically, prioritize and coordinate multiple tasks using Web technologies in information seeking and retrieval contexts is an important area for the research in human information interaction.

Spink, Ozmutlu and Ozmutlu (2002) identified multitasking information seeking and searching processes in four different studies: Excite users using survey, Excite search sessions, mediated on-line searches, and university library users. The findings of this study show that 1) multitasking information seeking and searching is a common behavior, 2) the prevalence of multitasking information seeking and searching is not the same in different contexts (i.e., search engine users, mediated on-line searches, and library users), and 3) multitasking sessions (with more search queries and topic changes) are longer than single searching sessions. Spink, Ozmutlu & Ozmutlu suggests that people may face multiple task situations since the "complex nature of work or living tasks" (2002, p. 648).

In a case study, Spink (2004) further explored human multitasking behaviors in a public library context and found that library users often engaged in multitasking and task switching during their information seeking processes. According to Spink (2004), there are several factors, which affect multitasking information behaviors and information task switching (pp. 346-347):

> "the nature and complexity of content in relation to the information seeker's domain knowledge;
> the amount and depth of information processing required for different information tasks;
> the information seeker's level of interest, including their attention and focus, in the information task;
> the level of planning and priorities by the information seeker in relation to their information tasks;
> the pros and cons or the effects on effectiveness, efficiency and productivity of information task switching; and
> serendipity by the information seeker, prompted by visual information cues and tension with the planning and priority goals"

The findings of this study provide an understanding of multitasking information behaviors and information task switching as indicating the dynamic and complex nature of these behaviors.

In an exploratory case study, Spink, Park, & Cole (2006) studied the interplay of information and non-information problems by a business consultant. Key findings include: (1) 10.5% of business consultant daily tasks was information related tasks, (2) information related tasks happened within multitasking and task switching mostly with non-information tasks such as internet and verbal conversation tasks, and (3) information related tasks often existed to support or respond to non-information tasks, such as internet or verbal conversation tasks. Spink and Park (2005) extended Spink's (2004) model of multitasking and task switching by including cognitive styles and individual differences factors.

Spink et al. (2006) analyzed Alta Vista 2002 query set of two-query and three or more query sessions to understand multitasking and task switching behaviors using a Web search engine. The major findings of this study are: (1) 81% of two-query sessions contains more than one information task, (2) 91.3% of three or more query sessions contains more than one information task, (3) multitasking search sessions include various information topics or problems.

Spink, Park, and Koshman (2006) investigated assigned information problem ordering during Web search. The findings of this study indicate that assigned information problem ordering is influenced by: personal interest, knowledge level, information availability, level of difficulty in finding information, level of importance and information seeking in order from general information problems to specific information problems. In this study, personal interest and problem knowledge are the major factors, which influence the information problem ordering processes. These results support Spink's (2004) earlier study that when people have multiple concurrent information problems, they seek information on higher domain knowledge information and high personal interest information problems before other information problems.

In summary, the studies in human information/computer interaction indicate that people may find themselves faced with multiple tasks or goals in the contexts of information seeking and access. Studies in human information interaction (e.g., Spink, Ozmutlu & Ozmutlu, 2002, p.649) define multitasking information behavior as "a process of information seeking and retrieval associated with multiple information tasks, involving possible shifts in beliefs, cognitive, affective, and/or situational states." The prioritizing processes of multiple information tasks may be influenced by several factors, such as interest, familiarity, complexity, importance, etc.

2.2.3 Human Information Coordinating Behavior

The concept of Human Information Coordinating Behavior (HICB) has been introduced in the studies of human multitasking information behavior (Spink et al., 2006; Spink, Ozmutlu & Ozmutlu, 2002; Spink, Park, & Cole, 2006). General meaning of coordinating is "bringing the different elements of (a complex activity or organization) into a relationship that will ensure efficiency or harmony" (Oxford American Dictionaries). Spink, Park, & Cole (2006, p.150) emphasize that:

> "… the concept of HICB is an important linking and sustaining process for a science of information that binds together the many HIB processes. The development of HIB necessitates a theoretical and empirical explication of the important nature and role of HIB's, including HICB. In HICB, humans coordinate a number of elements, including their cognitive state, level of domain knowledge, and their understanding of their information problem, into a coherent series of activities that may include seeking, searching, interactive browsing, retrieving, and constructing information. A key process for HCIB is to sustain these activities toward completion of some information goal or object."

Research is needed to understand how people *actually* coordinate their behaviors in multiple information task situations. The following section discusses prioritizing and coordinating behavior in engineering psychology.

2.3 PRIORITIZING AND COORDINATING BEHAVIOR

Engineering psychologists, whose interests lie in human task performance, have studied the factors that affect task prioritization in complex environments, mainly, aviation and military settings.

Some researchers found that people seemed to be efficient in allocating cognitive resources according to the priority given to a task (Gopher & North, 1977; Navon & Gopher, 1979). Gopher & North (1977) found that performance was improved during training under time-sharing conditions and the performance improvements were affected by (feedback indicators) manipulating performance demands, relative priorities of tasks, and adaptive adjustment of task levels in repeated presentation of single task, dual task conditions. In this study, difficult performance demands (single task levels) caused a stressful situation, and subjects did not maintain maximum mental effort to perform or improve. This study suggests that differential improvement on the two different tasks results both from the manipulation of task priorities and the repeated presentation of a single task/dual task sequence. This study also indicates that that people pay more attention to a task when they consider the task is more important than others.

Navon and Gopher (1979) studied the flexibility of attention. According to this study, each set of cognitive resources has its own separate source of capacity. According to Navon and Gopher (1979), if two different tasks require the same set of resources, then the capacity available to them may be allocated in a flexible way, depending on current task demands. In contrast, if two tasks require entirely different sets of cognitive resources, then progress on them may proceed at the same time without any interruptions, because there is no shared capacity (Navon and Gopher, 1979).

However, some researchers argue that in real life settings, task prioritization is not always efficient. When dealing with multiple tasks, people tend to employ less cognitive load strategies, that is, planning out the appropriate sequence in which to perform tasks of different priority (Raby & Wickens, 1994). Furthermore, people tend to be more proactive in task management when a task is easy and simple and more reactive when a task is difficult and complex (Hart & Wickens, 1990).

According to Freed (2000), reactive prioritization is to “make rapid priority decision just before committing to a course of action. Unlike the more deliberative approach in which priority decision are made arbitrarily far in advance of execution, a reactive prioritization process makes such decisions in response to newly available information about, e.g., which tasks are eligible for execution at a given moment, whether they interact, and what timing constraints apply to each” (p.1).

Raby and Wickens (1994) investigated how pilots strategically manage cognitive workload in multiple task situations. In this study, when cognitive workload increased, the amount of time in performing the high priority tasks also increased and the time in performing those of lowest priority decreased, and did not affect optimal strategies of scheduling of tasks of any priority level. This study suggests that high performing people schedule tasks earlier and shift more often between different activities. Raby and Wickens’s (1994) study indicates that the higher the task priority, people are more optimal at managing their performance.

Colvin (2000) conducted the most comprehensive examination of factors affecting task management. This study identified prioritization factors, including task status (i.e., degree of completion), procedure, and task importance. The findings of this study however show limited effects of task status, and instead strong effects of task importance. Colvin (2000) suggests that the processes of prioritizing tasks are dependent upon the characteristics of the task context.

Freed (2000) found that task prioritization in uncertain environments under time pressure, is influence by four main information types: urgency (i.e., the time remaining to perform a task); importance (i.e., how costly can be not to perform the task); duration (i.e., how long it takes to perform a task); and interruptive/switching cost (i.e., the cost associated with interrupting an ongoing activity and switch to another task.)

Puffer (1989) studied how students managed the completion of assigned tasks with attributes (boredom and difficulty) over the course of a semester. She found that earlier completion of tasks resulted in better performance and that more difficult tasks were completed later. This study suggests that difficult, specific tasks or goals that are accompanied by feedback have the most positive impact on performance and the task performance is influenced by the plan developed (Puffer, 1989).

Several factors have been addressed in playing a role in managing multiple tasks (Iani & Wickens, 2004): Task complexity may influence the ability of people to allocate their cognitive resources to tasks competing with the ongoing one. Iani & Wickens (2004) argue that people in an optimal situation, need to allocate their cognitive resources to a task considering its importance relative to other tasks. This study also suggests that physically salient stimuli and events might capture attention, irrespective of the observer’s intentions. For some people, salient stimuli are not only often difficult to ignore, but they may also interfere with the ongoing task (Iani & Wickens, 2004).

Research on multiple task performance implies that individual differences may exist in conducting multiple tasks (Schneider & Fisk, 1982). For instance, individuals who effectively allocate their cognitive and physical resources to each task generally perform better than those individuals who less effectively allocate resources to tasks (Schneider & Fisk, 1982). Individuals who reallocate priorities at times of increased demands generally achieve higher performance than those individuals who do not so adjust (Tsang & Wickens, 1988). In multiple task situations, there may be individual differences in the ability to plan and carry out multiple task performance in an optimal way.

In the processes of prioritizing tasks, it may be possible to assume that people with optimal strategies process a mental priority scale that can provide the basis for appropriate task coordination when cognitive workload becomes excessive (Huey & Wickens, 1993). The performance of multiple tasks can be controlled by self-regulating processes, which are central mechanisms that enable humans to choose and prioritize tasks, and monitor, adjust task performance (Iani & Wickens, 2004). How such central mechanisms orchestrate the elements of a dynamic and complex situation has been an issue in the research area of multiple task performance. It is therefore necessary to understand the basic mechanisms of human information processing to explain such problems further.

2.4 ATTENTION: THEORIES AND MECHANISMS

Mental effort, attention, concentration, cognitive capacity, and mental workload all refer to similar concepts and relate to an increase/decrease in the cognitive resources devoted to processing information (Britton, Muth, & Glynn, 1986). Attention is, in general, the ability to focus selectively on a subset of the world of stimuli and thoughts. How do we study attention? Normal functioning is difficult to study. Researchers push the envelope of human performance (e.g., increase task difficulty, multitask, etc.) and look at changes in performance for clues (e.g., errors, reactions, time, efficiency, etc.)

Selective focusing makes the internal world more manageable since attention is finite and constrained. Attentional bottlenecks and errors provide clues as to the underlying processes. The more attention we pay to something the more likely it will stay around in memory. But unattended information is not completely lost and can influence behavior since it is often still beyond conscious access.

Different tasks require different amounts of attention to perform, e.g., reading scholarly articles and listening to music. Controlled task processing can become automatic through practice. The simpler the task, the easier the shift from controlled to automatic. The fewer the resources, the easier the shift. Early explanations hinged on the rapid switching of attention from one task to the other. However switching attention takes time, performance rates for dual-task are slower than those for single task. According to Logan & Etherton (1994), learning is the result of attending and attending is the mechanism through which memories are most strongly encoded.

2.4.1 Theories and Mechanisms of Attention

Different theoretical approaches to attention suggest that psychologists are far from agreeing on how to explain attentional phenomena. Just et al. (2001) defined attention as limited cognitive capacity that can be distributed over tasks, such as in divided attention tasks. Kahneman (1973) viewed attention as a set of cognitive processes for categorizing and recognizing stimuli; the more complex the stimulus, the harder the processing, and therefore the more resources are engaged. Despite the different theoretical approaches, attention has been shown to a flexible aspect of cognition (Kahneman, 1973). We see that attention, rather than being rigidly and mechanically limited, is instead a more flexible system, affected by things such as the complexities of tasks and the person's intention.

Broadbent (1958) originally described attention as a bottleneck that squeezed some information out of the processing area. According to Broadbent (1958), at high attentional load, we filter out information based on physical characteristics, e.g., pitch, cadence, voice, loudness, etc. Unattended information never makes it to our awareness. Filter theory could not explain how important messages can get through. The selective filter by Broadbent (1958) is confined to acting on physical cues of intensity, time or frequency differences without any characteristics of meaning while Treisman's (1960, 1964) experiments show that the selective filter acts by selectively raising thresholds for signals from the unattended messages rather than acting as an all-or-none barrier.

In Treisman's (1960, 1964) attenuation theory, irrelevant messages (or less important messages) are turned-downed through the multi stage processing (physical/sensory processing, linguistic processing, and semantic/meaning processing), leaving more attention for important information. The turned-downed messages are still partially accessible and monitored occasionally. Some messages have low thresholds and are easily processes, e.g., names, danger signals. Unattended information is still available, just less accessible. It requires little constraint on what gets through.

Moray (1959) showed that when a person is listening selectively to one channel and ignoring the other, calling his name on the rejected channel would on a certain proportion of instances cause him to switch his attention to this channel. In this study, this was explained by assuming that the person's name had a higher priority for the filter than the message to which he had been attending. That is, the person's name has a significantly lower threshold than other name.

We are able to switch our attention from one message to another when it is important to do so. All messages are subjected to basic meaning processing. The most important is selected and further elaborated. Elaborated messages are the most memorable. Late-selection theory is similar to filter theory, but it places the bottleneck (threshold) after semantic processing. (Filter theory lets too little information in and late-selection theory lets too much in).

Work such as that by Johnston and Heinz (1978) has led many to use new metaphors when explaining attention. For instance, some compare attention to a spotlight that highlights whatever information the system is currently focused on (Johnson & Dark, 1986). Accordingly, psychologists are now interested less with determining what information can not be processed than with exploring what kinds of information people choose to focus on.

In multimode theory (Johnston & Heinz, 1978), attention is assumed to be flexible in that attended and non-attended information can be differentiated at different depths of perceptual analysis. In this theory, attention requires capacity, and the amount of capacity required increases from early to late modes of attention. Late-mode theory is superior to early-mode theory in its ability to account for divided attention, as well as selective attention. Late-mode theory explains that later stage receives semantically analyzed inputs from all sources and will admit only the more important or pertinent of these into consciousness. Messages can be selected at any stage through multi-stage processing, i.e., sensory processing, semantic processing, and conscious awareness. Multimode theory assumes that the more processing needed, the greater the capacity and mental effort required, and the later the selection, the harder the task. Free attentional capacity decreases the later the selection occurs.

Attention can be directed at more than one task at a time, depending on the capacity demands of each task (Cave & Bichot, 1999). According to Cave and Bichot, “the concept of attention as a resource to be allocated goes back to Kahneman (1973). If attention is allocated to a large area, then fewer resources can be dedicated to any single location, and the entire area will be processed somewhat less efficiently than if a smaller are had been selected. Thus, spreading attention over a large are entails a cost, even if no distracters appear within that area.” (1999, p. 220)

Kahneman (1973) presented a slightly different model for what attention is. He viewed attention as a set of cognitive processes for categorizing and recognizing stimuli. The more complex the stimulus, the harder the processing, and therefore the more resources are engaged. However, according to Kahneman, people have some control over where they direct their mental resources: They can often choose what to focus on and devote their mental effort to. The main attributes of attention by Kahneman (1973, p. 201) are the following:

- Attention is limited, but the limit is variable from moment to moment. Physiological indices of arousal provide a measure that is correlated to the momentary limit.
- The amount of attention or effort exerted at any time depends primarily on the demands of current

activities. While the investment of attention increases with demands, the increase is typically insufficient to fully compensate for the effects of increases task complexity.

- Attention is divisible. The allocation of attention is a matter of degree. At high levels of task load, however, attention becomes more nearly unitary.
- Attention is selective, or controllable. It can be allocated to facilitate the processing of selected perceptual units or the execution of selected units of performance. The policy of allocation reflects permanent dispositions and temporary intentions.

Kahneman's (1973) model of attention indicates how attention can be considered as a flexible system affected by several factors but it has a limitation to explain how individual's enduring dispositions and momentary intentions affect the processes of resource allocation. Essentially, this model suggests that we pay more attention to things we are interested in or have judged important.

2.5 TASK DEMAND, EFFORT, AND PERFORMANCE

2.5.1 Mental Effort

Everyday observations tell us that the more one concentrates, the better one performs. Many researchers have employed the notion of mental effort (cognitive resources) as a hypothetical construct to explain performance differences (Bandura, 1982; Salomon, 1981; Salomon, 1983; Salomon & Leigh, 1984).

Bobrow and Collins (1975, p.145) pointed out: "Data which either were deemed to be important or which could not easily be accounted for would receive sufficient processing effort, as a result, they would probably be remembered later. Moreover, we suspect that they would receive conscious attention at the time of their arrival and processing. Thus data which are expected or otherwise, readily accounted for would be ill remembered."

To explain the common essence of what is meant by such constructs as depth of processing and cognitive capacity, Salomon (1981, 1983) used the construct of amount of invested mental effort (AIME). AIME is defined as "the number of non-automatic mental elaborations applied to a unit of material." (Salomon, 1984, p. 648) This concept is based on Kahneman's (1973) attention theory which assumes that one has a pool of available mental effort (cognitive capacity) that can be allocated to tasks and that conscious information processes demand mental effort and therefore tap the pool of cognitive resources (Kahnman, 1973).

According to Salomon (1983), AIME indicates cognitive and motivational attributes: "It is cognitive in the sense that it pertains to mental elaborations of information material. But as these elaborations are controlled, rather than automatic, their employment implies a measure of choice, as all controlled activities do (Steiner, 1979). The exercise of choice, the preference of one alternative course of action over another, implies in turn the existence of motivation (Brigham, 1979). Non-automatic effort demanding elaborations are at one's disposal; their actual employment is a matter of choice and motivation" (Salomon, 1983, p.44).

2.5.2 Task Characteristics and Performance

Motivation, curiosity, anxiety, or arousal may all be necessary factors in producing greater AIME (Salomon, 1981). But according to Salomon (1981) AIME ultimately produces learning. High motivation, even when accompanied by comprehensive knowledge or skill, is not sufficient to produce high performance unless one actually invests mental effort in processing information (Clark, 1980).

Langer, Blank, and Chanowitz (1978) showed that when information or stimuli is considered as highly familiar, people tend to respond to them mindlessly, thereby resulting in low performance. The perception toward task difficulty is also thought to influence the amount of effort expended (Weiner, 1985). Weiner (1985) found that individuals seem to perform best at tasks of intermediate difficulty. According to Weiner (1985), when faced with tasks of intermediate difficulty, people invest more effort since these individuals believe that the best performance strategy for high achievement in such situations is to try harder. These studies suggest that AIME may depend on the perceived demand characteristics (PDC) of the stimulus, the task, or the context.

More demanding, difficult, or novel stimuli are generally expected to evoke more effort investment than simple stimuli (Salomon, 1983). But according to Salomon (1983), the nature of stimuli, their complexity, novelty, and the like, in interaction with learners' abilities, affect performance or learning outcomes only to some extent. Perceptions, in the sense of predispositions, preconceptions, attitudes, or attributions, also play an important role in the way one processes information (Salomon, 1983).

In a series of studies (Salomon 1983; Salomon, 1984; Salomon & Leigh, 1984), Salomon addressed the question of how individuals' perceptions of information categories related to the amount of invested mental effort and performance. The findings of these studies indicate that differential perceptions of tasks are related to AIME, which in turn is related to performance and learning. The results suggest that individuals' performance may depend on what they perceive the tasks to be.

Taken as a whole, this line of research suggests that individuals' perceived demand characteristics of tasks or contexts affect AIME. The more demanding PDC is, the more AIME would be expended. When people face a task they perceive to be easy relative to their abilities, they may invest less mental effort in processing or performing it. For example, a skilled driver or Web surfer may perceive the task of driving or Web surfing to be easy and thus rely more on automatic processes. This is due to knowing that no additional effort investments needed to perform the task that is perceived to be well mastered (Salomon, 1984).

2.6 SUMMARY

Multiple task performance is a mechanism that helps people deal with the complex environment in which they live. People often face the need of managing multiple tasks and shifting their attention among different types of tasks, such as computing tasks, reading tasks, communication tasks, Web surfing task, etc. Multiple task performance, in general, refers to the self-regulating process, which governs the way people coordinate tasks and shift among the tasks.

Human multiple task performance generally involves "a person's allocation of his/her cognitive resources among multiple tasks and the coordinating effect of task elements, processes, and resources on multiple task performance" (Waller, 1997, 225).

The studies in human information/computer interaction indicate that people may find themselves faced with multiple tasks or goals in the contexts of information seeking and access. Studies in human information behavior (e.g., Spink, Ozmutlu & Ozmutlu, 2002) define multitasking information behavior as a process of information seeking and retrieval associated with multiple information tasks, involving possible shifts in beliefs, cognitive, affective, and/or situational states. The prioritizing processes of multiple information tasks may be influenced by several factors, such as interest, familiarity, complexity, importance, etc.

Research on human multiple task performance implies that individual differences may exist in managing multiple information tasks (Schneider & Fisk, 1982). For instance, individuals who effectively allocate their cognitive and physical resources to each task generally perform better than those individuals who less effectively allocate resources to tasks (Schneider & Fisk, 1982). Individuals who reallocate priorities at times of increased demands generally achieve higher performance than those individuals who do not so adjust (Tsang & Wickens, 1988). How we deal with our multiple task situations in an effective way is often influenced by self-regulating processes that allow us to prioritize, monitor, and coordinate task performance (Iani & Wickens, 2004).

Much research in attention assumes that there is a limited pool of attentional resources, or capacity, that can be distributed across tasks (Kahneman, 1973). Capacity experiments typically examine how performance trades off between two different tasks as task demands and subject effort change (Navon & Gopher, 1979).

The common meaning of attention is mental effort (Posner & Bores 1971, Johnston & Heinz, 1978; Johnson & Dark, 1986). The view of attention as mental effort derives from the assumption that attentional resource or capacity is limited in some central mechanism (Kahneman, 1973). This mechanism is associated with conscious information/stimuli processing and it delimits divided attention, that is, the extent to which different cognitive resources of information can be processed at the same time (Kahnman, 1973).

Everyday observations tell us that the more one concentrates, the better one performs. Many researchers have employed the idea of mental effort as a hypothetical construct to explain performance differences (Bandura, 1982; Salomon, 1981; Salomon, 1983; Salomon & Leigh, 1984). Mental effort, attention, concentration, cognitive capacity, and mental workload all refer to similar concepts and relate to an increase/decrease in the cognitive resources devoted to processing information (Britton, Muth, & Glynn, 1986). In a series of studies of mental effort and task performance (Salomon 1983; Salomon, 1984; Salomon & Leigh, 1984), Salomon and his colleagues found that differential perceptions of tasks are related to the levels of mental effort, which in turn are related to performance and learning. These studies suggest that individuals' performance may depend on perceived task demand characteristics and the amount of mental effort.

2.7 THEORETICAL MODEL

From the analysis of the studies reviewed above, a theoretical model of human prioritizing and coordinating information behavior in the contexts of information seeking and retrieval has emerged.

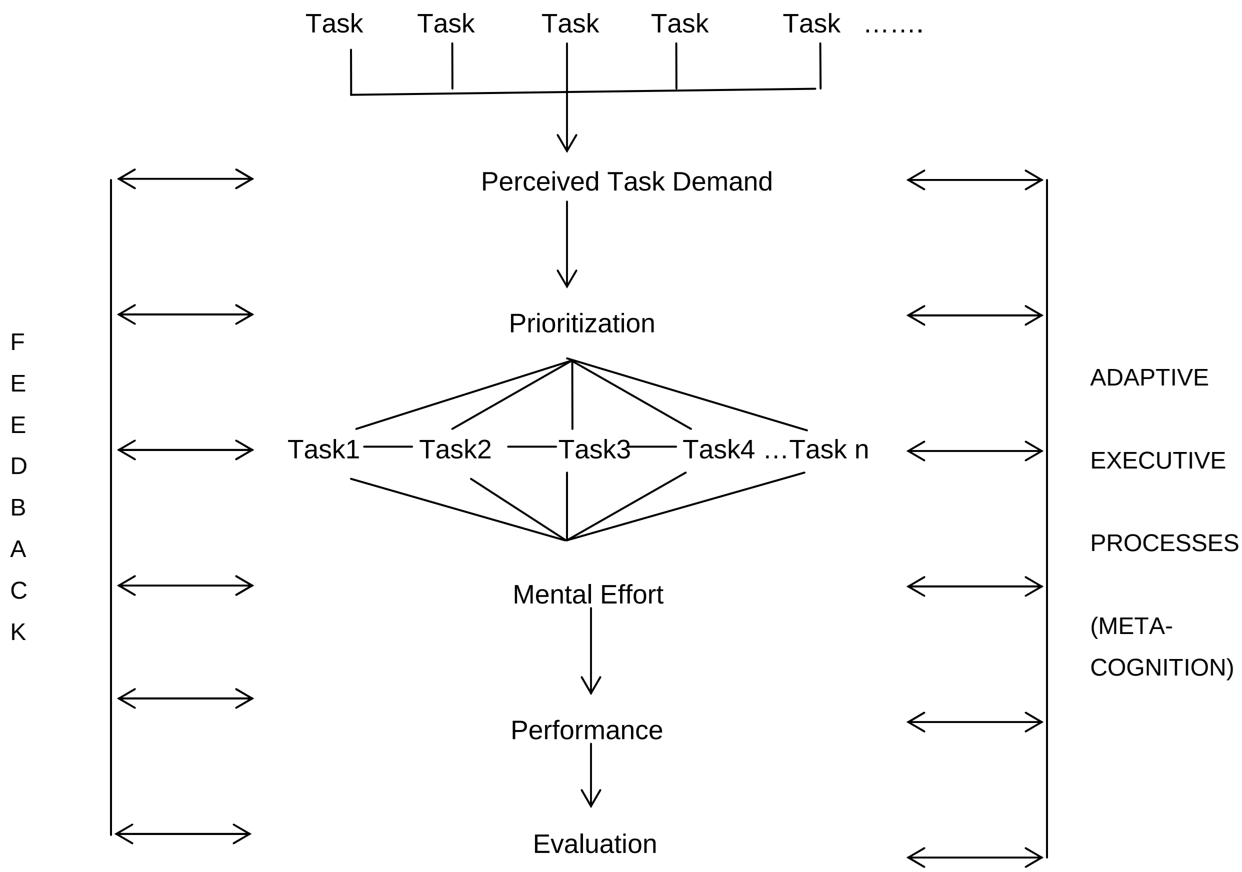

Figure 2. Theoretical Model of Human Prioritizing and Coordinating Information Behavior

Figure 2 depicts the process of prioritizing and coordinating multiple information tasks in the contexts of information seeking and retrieval. The model is fundamentally based on the global single-channel hypothesis, which is all of the mechanisms between stimulus input and response output (stimulus perception, response selection, movement initiation) together constitute a single-channel and can be used by only one task at a time (Craik, 1948).

In this model, differential perceptions of tasks influence the activities of prioritization and the amount of mental effort. The level of mental effort is in turn related to the level of task performance. Performance is then followed by evaluation. Feedback and (adaptive) executive function play an important role in the process of coordinating multiple information tasks over time.

Executive function involves selecting, monitoring, and modifying behavioral strategies, based on task analyses, planning and reflectivity in problem solving or decision making (Borkowski & Muthukrishna, 1992). Executive process is often viewed as a component of metacognition (Borkowski, Milstead, & Hale, 1988; Flavell & Wellman, 1977). Research on cognitive executive process seems to be important to understanding adaptive human information behavior in dynamic and complex Web environments.

In this study, the notion of multiple task performance is coming from an interdisciplinary perspective of human information interaction. The conceptual foundation of multiple task performance has been built on the studies of cognitive psychology, human factors, and educational psychology and it has been extended in the contexts of information seeking and retrieval in human information interaction. This proposed study is to understand the general characteristics of human prioritizing and coordinating information behavior and identify the factors, which influence the process of prioritizing in information seeking and retrieval contexts. In addition, the study aims to obtain a multi-dimensional understanding of human prioritizing and coordinating information behavior by investigating the interplays of task demand, mental effort, psychological/affective state, and performance. The next chapter details the methodology designed for the study.

3.0 RESEARCH DESIGN

The first section describes the data collection methods used in this study and discusses the merits of employing multiple data gathering techniques. It also compares the advantages and disadvantages of natural settings and laboratory settings. Section 3.2 details the sources of data including pre/post questionnaires, verbal protocols, search logs, and post-search interviews. Discussions on sampling, data collection, and data analysis are covered in the subsequent sections. Finally, section 3.6 discusses the justification of methodology with a focus on reliability and validity issues.

The overall goal of this study is to investigate how people manage their multiple information tasks while interacting with Web information systems in information seeking and retrieval contexts. Specifically, this study aims at understanding: (1) what are the general characteristics of human prioritizing and coordinating information behavior during information seeking and retrieval on the Web; (2) What are the factors, which influence the processes of prioritizing multiple information tasks in dynamic and complex information situations under time pressure; and (3) what are the relationships of perception, effort, emotion, time, and performance when people manage multiple information tasks using Web information technologies.

Experiments were conducted in a laboratory setting to collect data from multiple sources including search logs, think aloud reports during the searches and interviews, and pre/post questionnaires. Employing triangulation technique enhances the validity of the data collected.

The sample consisting of twenty volunteers was drawn from diverse academic disciplines at the University of Pittsburgh, including Library and Information Science, Telecommunications, Environmental Studies, Sociology, Health and Community Systems, Nursing, and Health Information Management. No demographic and disciplinary limits were set in order to minimize bias in the sampling process.

Each participant was asked to conduct four different information tasks (three assigned and one non-assigned) using a PC with the time limit of one hour. The individuals were requested to think aloud, i.e., verbalize their thoughts as they do actions. All actions were logged and analyzed. Subjects' verbal reports during the searches were transcribed and analyzed. The post-search interviews were designed in partially structured format and conducted with individual participants at the end of search interaction to help the researcher probe participants' responses and obtain clarification of participants' responses.

The study used both qualitative and quantitative methods to analyze the data collected. For quantitative analysis, statistical computer programs, EXCEL and SPSS, were employed. Content analysis was used to develop a relational taxonomy of various types of actions and variables, using principles and criteria derived from the grounded theory.

To avoid any impact of extraneous variables, the experimental conditions were made the same as possible across the subjects in this study. The study was held in a laboratory setting, where the researcher conducted experiments with the same equipments (e.g., PCs, software programs), procedures and standardized instruments (e.g., pre/post questionnaires, written descriptions of tasks and post-search interview protocols).

Twenty (20) volunteers were recruited regardless of their disciplinary and demographic backgrounds and academic status and therefore the subjects in the study can be expected to be representative of the target population. This study was focused on prioritizing and coordinating information behaviors in information seeking and retrieval contexts in the Web environment, so there could be a limitation to generalize the results beyond such contexts. Both using standardized instruments (e.g., partially structured questionnaires and interview protocols) and conducting the experiments in an established way (i.e., following the written procedures) produced replicable results. For the analysis of data collected, manual and automatic techniques were employed to produce high reliable results. The assessment of intercoder reliability produced satisfactory levels, which were distributed from .77 to 1.00, indicating acceptable for qualitative studies. The next sections discuss in detail methods, data collection instruments, sampling, data collection, and data analysis.

3.1 METHODS

The first step in research design is to decide in which setting – laboratory setting or natural setting—the data need to be collected. According to Tague-Sutcliffe, "In information retrieval, a laboratory test is one in which the sources of variability stemming from users, databases, searchers, and search constraints are under the control of the experimenter. By contrast, an operational test is one in which one or more existing systems—with their own users, databases, searchers, and search constraints—are evaluated or compared" (1992, p. 469). There is a range from laboratory tests, with all four components (users, databases, searches, search constraints) controlled, to tests in which only one is controlled (Tague-Sutcliffe, 1992).

In this study, only search constraints (e.g., tasks and time) were controlled. Users were recruited from the same population (e.g., students) in an academic environment. The databases that the subjects searched on were Web-based information repositories.

The extent of control is mainly determined by the research questions and objectives of a study. Robertson (1981) states that in order to answer specific questions directly, a test must be designed to exclude any extraneous variations and conducted under laboratory settings. In this way, a researcher can avoid any confusion over the results. On the other hand, in order to answer questions related to real problems and to provide answers, which are applicable to real situations, a test must be conducted in an operational environment. It is, however inappropriate to differentiate specific questions from real problems since they both are coming from our observed phenomena in the real world. In addition, laboratory research with specific questions often provides the results, which are applicable to real situations.

Operational researchers rely heavily on verbal description and they are their own main instrument of data collection and interpretation. It is commonly noted that in naturalistic research the researcher is directly involved in the research method (Gay & Airasian, 2003). The naturalistic method has its limitations in collecting data in real time. In other words, the method often collects data after which a process or event occurs. The naturalistic method is therefore inappropriate for this study, which aims to understand how people prioritize and coordinate multiple information tasks during their interaction with information retrieval systems. To explain the mechanisms of prioritizing and coordinating multiple information tasks, it is required to obtain real-time data on how, what, and why people think and do. Moreover, the laboratory approach offers considerable control over problem variables and hence provides evidence with strong internal validity (Krathwohl, 2004). For this reason, study was conducted in a laboratory setting in which the researcher could collect data in an effective way for this study.

The methods employed in this study are based on the assumption that subjects are able to provide momentary and retrospective assessments of their mental and physical activities directly through think-aloud utterances, questionnaires, and post-search interviews. Human information interaction and human computer interaction is a highly interactive cognitive process that cannot be understood simply by one method. Employing multiple methods is needed to obtain a full picture of such interactions.

By combining different methods, we can compensate for the flaws of one method with the strengths of another, and obtain different perspectives and details (Krathwohl, 2004). Using more than one method provides complementary evidence that can reinforce our confidence in the results. Multiple data gathering techniques were therefore used including pre/post questionnaires, verbal protocols, search logs, and post-search interviews.

3.2 DATA COLLECTION INSTRUMENTS

Data was collected from multiple sources, including pre/post questionnaires, verbal protocols during the searches, search logs, and post-search interviews. The procedures included the following steps: Subjects were asked to come to the laboratory to perform their search sessions. They were first provided with pre questionnaires for general background information and task perceptions. During the search sessions, they were asked to verbalize their thoughts. This might be challenging for the first time performers, so they were requested to practice before the actual search sessions. Their comments and searches were recorded using a software program, Camtasia Studio. After completing their sessions, the subjects filled out post questionnaires to measure the levels of task demands, mental efforts, affective states, temporal demands, and performances. The individuals were then interviewed by the researcher. This methodological approach helped the researcher collect both concurrent and retrospective data to observe the individuals' prioritizing and coordinating information behaviors while they were interacting with Web information technologies to manage multiple information tasks.

3.2.1 Pre/Post Questionnaires

Pre and post questionnaires were applied to obtain general background information and examine the research questions. The pre-questionnaire in this study contained closed and open-ended questions. It partially consisted of rating scales, applied to identify the subjects' perceptions toward the assigned and non-assigned information tasks. The post-questionnaire was mainly made up of rating scales, applied to collect data on the levels of each of the four dimensions associated with assessment of the following variables: Task demand (task dimension), mental effort (cognitive dimension), performance (behavioral dimension), temporal demand (temporal dimension), and psychological/affective level (psychological/affective dimension). The post questionnaire in this study was designed based on the Subjective Workload Assessment Technique (SWAT; Reid & Nygren, 1988) with substantial modifications for the purposes of this study. Each scale in the pre and post questionnaires was presented as a 12-cm line with bipolar descriptors at each end (e.g., high/low, excellent/poor). Numerical values were not displayed on the rating scales.

Researchers in human factors are generally interested in both the levels of mental efforts and the reason(s) for the levels. Research in the field has demonstrated that rating instruments are among the most successful techniques for effort estimation (e.g., Hart & Staveland, 1988; Reid & Nygren, 1988; Wierwille & Casali, 1983). The SWAT and the NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988) provide some diagnostic information and both techniques are highly recommended, based on thorough testing and application (Wierwille & Eggemeier, 1993). A questionnaire was chosen because it has the potential to collect cognitive data quickly and easily. Another advantage of a questionnaire is that the data may be both qualitative and quantitative, allowing them to play a part in both quantitative and qualitative studies (Su, 1991).

3.2.2 Verbal Protocols

The subjects were asked to think aloud as they performed. In other words, they were requested to verbalize their thoughts, especially the reasons for their actions. This verbal stream was recorded using Camtasia Studio. It was later transcribed and analyzed to create a relational taxonomy of intentions associated with these interactions with a focus on understanding the processes of human prioritizing and coordinating behavior in information seeking and retrieval contexts.

Verbal protocol analysis is a research method that is frequently used in the studies of cognitive psychology in order to understand users' thought as they engage in a task or problem solving (Ericsson & Simon, 1993). Despite the difficulties of data interpretation, privacy concerns, and the amount of data gathered, verbal protocols allow researchers to obtain accurate, unobtrusive, longitudinal, transactional, and real-time data and data can be automatically collected and processed (Wang, Hawk, & Tenopir, 2000).

3.2.3 Search Logs

Subjects' searches were logged onto a disk using a software program, Camtasia Studio, that records audio and video stream by capturing any activities (e.g., keystrokes and screen actions) on the Windows desktop. More specifically, the software program was installed to record URLs visited, continuous screen shots (actions), and think-aloud utterances with timelines. The logs with timelines and verbal reports were recorded throughout the entire process.

This type of time-lined data is especially useful for an understanding of the patterns and transitions of behavioral sequences. Using this technology allows researchers to easily create search log files and collect data on individual users' processes and behaviors as they interact with information systems to look for information. Search logs are a widely used method to understand users characteristics and behaviors during human computer/information interactions. One major merit of using this technique is that, based on the data collected, researchers can develop an understanding of the phenomenon and a theory, or explanation, of how the phenomena are grounded in our observations—called grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1994). This also applies to the case of verbal protocols mentioned earlier.

3.2.4 Post-Search Interviews

The post-search interview was designed in partially structured format and conducted with individual participants at the end of search interactions. Partially structured interviewing refers to a situation in which area is chosen and questions are formulated but order is up to interviewer (Gay & Airasian, 2003). The researcher added additional questions or modified them as deemed appropriate. Camtasia Studio was used to record the interviews. These recorded files provided a verbatim account of the sessions. Also the records provided the researcher with the original data for use at any time.

The main purpose of the post-search interviews was to collect data for understanding prioritizing and coordinating processes during the performances. Interviews, in general, help researchers probe participants' responses, explore unplanned topics that arise, and obtain clarification of participants' responses (Gay & Airasian, 2003).

3.3 SUBJECT SAMPLE

The first step in choosing a sample is to decide who is included in the population of interest (Krathwohl, 2004). For this study, students and faculty members were the sampled population. The reason for choosing this population was that it was assumed that they regularly interacted with the Web for information/knowledge. Web information technologies have played an important role in electronic learning environments. Students and faculty are getting more involved in interactions with information and information retrieval systems (e.g., the Web, databases, digital libraries, etc.) to solve their information problems and/or broaden their knowledge horizons in electronic learning environments.

Purposive sampling, also referred to as judgmental sampling, was used to select a sample, which was representative of the population. Krathwohl (2004) states that in purposive sampling, "the researcher selects individuals presumed to be typical of segments of the populations who as a group will provide a representative panorama of the population" (p. 172). The sampling technique is most often used in qualitative research (often also in quantitative research) to select individuals or behaviors that will better inform the researcher regarding the current focus of the investigation (Krathwohl, 2004).

Twenty (20) volunteers with diverse academic backgrounds, including Telecommunications, Library and Information Science, Environmental Studies, Health and Community Systems, Sociology, Nursing, and Health Information Management, participated in this study. All students and faculty members at the University of Pittsburgh were asked to take part in the study. A notice of recruitment was distributed through emailing lists and notice boards. No demographic and disciplinary limits were set in order to minimize bias in the sampling process.

3.4 DATA COLLECTION

3.4.1 Task

After given general instructions, the subjects were asked to create one information problem for the non-assigned task. They were then given general descriptions of three different information tasks in random order. It was the participants who decided the whole processes of their searching sessions, e.g., which task they were going to begin with. They had a maximum of one hour to finish their sessions regardless of the state of completion of all tasks. The subjects conducted one task at a time. The three assigned tasks were related to medicine, travel, and research. The descriptions of the assigned tasks were as follows:

- Medicine: One of your family members has just been diagnosed as having skin cancer, and you want to learn about the disease and medical treatments (e.g., currently existing and newly developed). You are also interested to know how to protect yourself from the disease.

- Travel: You and your best friend are planning to travel somewhere you can enjoy one of your favorite sports. You are trying to figure out how to prepare for this adventure and what kinds of information you need.

- Research: You are currently working on a term project. You have still enough time to finish it but you want to work hard on this one and get a good grade because you are really interested in the topic of the term project. Now, you are trying to find some good materials, which can provide some background information of the topic area you chose for the term project.

The tasks described above were not direct and answer driven. Each task was designed to be generic to engage the subjects in cognitive and physical actions to solve the problems and further accomplish the goals the subjects might have. The ambiguous use of the term, task, has been an issue in the studies of information seeking and retrieval. Vakkari (2003) provides a clear explanation of the nature of a task in information retrieval contexts (p. 4):

> "A task is an activity to be performed in order to accomplish a goal (Hackos & Redish, 1998; Hansen, 1999; Shepherd, 1998). Tasks have been conceptualized in two different ways: first, as an abstract construction, which does not include performance (Bystrom,

> 1999; McCormick, 1979; Shepherd, 1998). A task, especially a complex one, may include specifiable, smaller subtasks. In the second definition, a task is viewed from a functional perspective: as a series of actions undertaken in pursuit of a particular goal by an actor. The performance of a task includes physical and cognitive actions. This performance has a recognizable purpose, beginning, and end. It consists of a series of subtasks. A task, when performed, results in a meaningful product (Bystrom, 1999; Hackos & Redish, 1998; McCormick, 1979)."

A task in this study was not simply a topic or an information search task. A task entailed several activities such as problem solving and planning to pursue certain goals by the subjects.

3.4.2 Research Setting

The researcher conducted the study in a controlled environment. The research took place in a laboratory of School of Information Sciences. The lab was equipped with PCs, and a microphone. The model of the PCs was Dell 3.06GHz Pentium with 512 MB RAM and a 80 GB hard disk running Windows XP. All PCs were installed with Camtasia Studio to record search logs and verbal reports for this study. They also had Microsoft Office 2003 packages and several different kinds of Web browsers including the newest versions of Safari, Firefox, Netscape, and Internet Explorer.

The researcher was present in the laboratory to observe and monitor the searching sessions. The investigator maintained objectivity. She remained quiet and was separated from participants and rarely interacted directly with them except when there was a need to remind participants to think aloud. This unobtrusive observation was to minimize observer effect, which naturally arises because people tend not to behave typically when they know they are being observed.

3.4.3 Procedures

The data collection instruments of this study mainly consisted of pre/post questionnaires, search logs, and post-search interviews. The procedures of the data collection were as follows:

1. Upon arrival, the subjects were asked to read and sign a consent form regarding their participation, confidentiality, and rights/protections under the University of Pittsburgh Institutional Review Board (IRB) Human Subjects Research guidelines. The purposes of the study were described in the consent form to give them a general idea of what the study was about.

2. The subjects were asked to create one information task they would like to conduct during their performance sessions. After finishing designing the task, they were given three different information tasks with general descriptions (Appendix A) in random order.

3. The participants filled out pre-questionnaires (Appendix C) to obtain data such as general background information, Web experiences, and task perceptions.

4. The researcher provided general instructions of tasks (Appendix B) applied to both the assigned tasks and the non-assigned task. The instructions included that they had one hour to finish their search sessions, during the searches, they were asked to think aloud, and they

would make a decision on task priority and time duration per task. While they were reading the instructions, the researcher got Camtasia Studio ready to record the search sessions.

5. The subjects started their sessions. The researcher stayed behind quietly, observed the participants' interactions during the searches, and took notes, if necessary.

6. After completing their sessions, the subjects were provided with post-search questionnaires (Appendix D) to complete. The post-search questionnaires consisted of questions assessing the levels of each of multiple dimensions including task demands, temporal demands, mental efforts, performances, and affective states.

7. Finally, after finishing the post-questionnaires, the participants were interviewed by the researcher. The purposes of the post-search interviews were to probe participants' responses, explore unplanned topics arisen (if any), and obtain clarification of participants' responses/actions by going through the searching session files together. The researcher used a post-search interview protocol (Appendix E) during the interviews. The interview sessions were recorded using Camtasia Studio.

3.5 DATA ANALYSIS

This study used both qualitative and quantitative methods to analyze the data collected. In general, the purpose of quantitative approach is to generalize phenomena, while that of qualitative research is to provide in-depth descriptions of setting and people (Gay & Airasian, 2003). For quantitative research, according to Gay and Airasian, descriptive methods collect numerical data to answer questions about the current status of the participants of a study. In qualitative research approaches, more detailed descriptions and interpretations of participants and their settings are provided.

The data analyzed included pre/post questionnaires, search logs, and transcribed think aloud protocols and interviews. For quantitative analysis, a statistical computer program, SPSS, was employed. The pre/post-questionnaires were tabulated, compiled and analyzed with SPSS. Cross-tabulated tables provide “information on the variation of responses with various demographic and other independent variables that can throw considerable light on the respondents’ underlying characteristics, value structures and thinking processes” (Krathwohl, 2004, p. 372).

Task durations and certain activities, such as task switching, tabbed browsing, strategic search planning, and information evaluation, were drawn from the search logs. The think-aloud reports and interviews were transcribed. The researcher then integrated the data collected from three different sources: search logs, transcribed verbal reports, and transcribed post-search interviews. The integration of the data was to create a unified coding scheme by analyzing the subjects’ actions/responses from the search logs, their concurrent verbalized thoughts from the think aloud protocols, and retroactive verbal reports from the post-search interviews, all together. This helped the researcher get a situational/contextual understanding of the participants’ behaviors, i.e., reasons for their actions, during information seeking and retrieval. The investigator focused on understanding how the subjects prioritized and coordinated the multiple information tasks.

Here is an example of the coding process employed in this study (see also Table 1). When the researcher identified task switching and tabbed browsing cases from the transcripts of think aloud reports and post-search interviews, she also used the search logs to check the subjects' actions. After analyzing both the transcripts and the search logs, codes were assigned to the cases of task switching (221) and tabbed browsing (230). These code numbers were quantitatively analyzed later. Data of task duration, drawn from the search logs, was incorporated in the coding table (e.g., RT: 265, Total: 865). During the coding process, continuous screen shots/activities not a single screen capture were used for a *contextual* understanding of human multiple information task interaction on the Web.

Table 1. A Sample of the Coding Table Used

	100 Prioritization		200 Coordination		500 Mental Effort		600 Affective State		700 Temporal Demand		800 Performance	
S05 RT			[T5: RT] So I switch back to the…Scholar.Google.com. that I al—I already opened. … Okay. … open in new tab, feature. So that—the link that relevant to the subject can be in the same page, and I'll group them together.	221 230 230					So I think it may—it might take a while for me to gather all the information from this website. So… I think it'll take me about 30-40 minute to get at least some information (background) about it. (RT: 265)	710	I think I can be done, yeah. (Total: 865)	811
S08 MT			[T1: MT] … the Carnegie library's data bases … While that's working, …… I'm going to go back to skin cancer . . . ah ha, Medline Plus! …… Looks kind of reliable because it's cancer.org. No results were found …… So I'm going to go back to the Google tab.	230 269 252 230							So, I found a lot for the first one, so I'm gonna move on right on down the line and just do travel. (MT: 480)	811
S10 PSI	so I decided to do the easiest search first to get it out of the way (Medicine)	111	I did switch between the tasks once. I had not found much information for the research questions so often I checked my usual job list websites.	221					I think I spent the majority of my time researching for a class project since it's due in a week and a half! (RT: 1570)	720		

Note: S05 means subject number 5; RT and MT means research task and medicine task; PSI means post-search interview

Content analysis was employed to identify and categorize: (1) the perceived characteristics of an information task; (2) the activities associated with task coordination; (3) the factors, which influenced the process of prioritizing; and (4) the interplays of the dimensions of perception, cognition, emotion, time, and performance. The analysis technique is often used to develop the taxonomies of the relations of various types of actions and specific variables, using principles and criteria derived from the grounded theory (Strauss & Corbin, 1994).

Content analysis is "a research method that uses a set of procedures to make valid inferences from text" (Weber, 1990, p. 9). According to Weber, the central issues of content analysis originate mainly in the data-reduction process by which the many words of texts are classified into much fewer categories. One set of problems concerns reliability and validity, both growing out of the ambiguity of word meanings, category definitions, or other coding rules of word meanings and category or variable definitions (Weber, 1990).

Following Weber (1990), the basic units of the texts classified were each word, word sense (e.g., semantic unit, such as idioms), sentence, and theme. Long and complex sentences were broken down into shorter thematic units or segments. Also, ambiguous phrases and pronouns were identified manually. These steps were taken before coding the content. The quantitative indicators (i.e., codes) created by content analysis were analyzed further using a statistical method. The researcher then interpreted and explained the results with relevant studies and theories.

3.6 JUSTIFICATION OF METHODOLOGY

Validity and reliability are important characteristics in evaluating a research study. There are two types of validity: internal validity (also called linking power (LP)) and external validity (also referred to as generalizing power (GP)). Internal validity is the power of a study to link the variables in a causal relationship and external validity is the power of the study to show generality of the findings (Krathwohl, 2004, p. 128).

The internal validity of a study hinges on control of extraneous variables. An extraneous variable is a variable other than the independent variable that is likely to influence or have an impact on the dependent variable. Uncontrolled extraneous variables can be considered as threats to the internal validity of an experiment[1]. To avoid any impact of extraneous variables, the experiment conditions were made the same as possible across the subjects in this study. The study was held in a laboratory setting in which the researcher conducted experiments with the same equipments (e.g., PCs, software programs), procedures and standardized instruments (e.g., pre/post questionnaires, written descriptions of tasks, and post-search interview protocols). There was no noise in the laboratory, which might distract participants during the experiments.

External validity concerns with how well results can be generalized to participants and settings beyond those used in the study. The goal of experimental research is to make conclusions that are not restricted to the sample being studied but rather can be generalized to other similar groups and similar settings. Only a small number of people benefit from a research study if the conclusions can only be applied to the sample being studied.

There are two main aspects of external validity: population validity and ecological validity (Krathwohl, 2004): Population validity is concerned with the extent to which results can

[1] Controlling extraneous variables means removing their influence.

be generalized to other persons while ecological validity is concerned with the extent to which results can be generalized to other environmental conditions. The evidence of population validity originates from sampling. The volunteers were recruited regardless of their disciplinary and demographic backgrounds and academic status and therefore the subjects in this study can be expected to be representative of the target population. The study was focused on human prioritizing and coordinating information behavior in the Web environment, so there could be a limitation to generalize the results beyond this context.

One of the strengths of the study is in the data collection. Investigations of the mental effort have been limited by the methodology. Beentjes (1989) states that "…although self-reports about an intentional process like investing mental effort are possible in theory, validation studies in which mental effort is assessed by multiple methods are called for" (p. 56). Following Beentjes (1989), data was collected from multiple sources, including search logs, think aloud reports, interviews, and questionnaires. The employment of triangulation, which refers to collecting data using multiple instruments, enhanced the validity of the data collected and subsequently corroborated the findings.

Final issue regarding validity is replication of research. Krathwohl (2004) states that "knowledge that replicated and reconfirmed is held with considerable certainty" (p. 51). According to Krathwohl, replicability is an important concern of external validity (GP). He also states that "replicable result is a summary judgment of the forgoing judgments and of the extent to which the results of this study could be replicated in the target to which it is being generalized" (Krathwohl, 2004, p. 181). Considering the data collection methods used in the study, the search logs and verbal reports during the subjects' searches and interviews were saved using Camtasia Studio, transcribed, and analyzed. This recorded type of data is sufficiently replicable in different studies because there is no certain limit of utilizing such technologies and producing data. Both using standardized instruments (e.g., partially structured questionnaires and interview protocols) and conducting the experiments in an established way (i.e., following the written procedures) also produced replicable results.

The next issue to be discussed is reliability. Reliability is “the degree to which a test consistently measures whatever it is measuring” (Gay & Airasian, 2003, p. 141). How to analyze and interpret data in a consistent way is an important issue in content analysis. Content analysis can be done by a person or a software program (e.g., ATLAS/ti or QSR NUD*IST). There are some advantages and disadvantages in using human labor and a computer program. If a researcher decides to transcribe and analyze manually, there will be a need for intercoder reliability testing. This can be done employing different coders, comparing results, and calculating reliability coefficients. This can be time and labor consuming, but still can get reliable results. On the other hand, employing a software program is a kind of ‘quick and dirty’ approach. With a computer program, it is relatively easy to encode data and the coding scheme is made clear, allowing for high intercoder reliability.

Since the content analysis in this study was conducted manually, the coding scheme used was tested for the consistency of the content analysis, using the following widely used Coefficient of Reliability (C.R.) formula (Holsti, 1969): $C.R. = 2M / N1 + N2$, the ratio of coding agreement (2M) to the total number of coding decisions (N1 + N2). Two coders were recruited for assessment of intercoder reliability. Each coder was given data (i.e., transcripts of think-alouds and post-search interviews and search logs) from two subjects along with a table of the categories and definitions used. This sample was selected randomly. Each coder was then asked to code the data.

From Subject 12, the researcher identified a total of 44 instances, including 14 prioritization, 24 coordination, 1 mental effort, 1 affective state, 2 temporal demand, and 2 performance cases. Coder I identified 49 instances from the same subject, including 12 prioritization, 31 coordination, 1 mental effort, 1 affective state, 2 temporal demand, and 2 performance cases. We agreed on 41 of them, including 12 prioritization, 23 coordination, 1 mental effort, 1 affective state, 2 temporal demand, and 2 performances cases. So,

1) C.R. (Prioritization) = 2(12) / 14 + 12 = .92
2) C.R. (Coordination) = 2(23) / 24 + 31 = .84
3) C.R. (Cognitive Effort) = 2(1) / 1 + 1 = 1.00
4) C.R. (Affective State) = 2(1) / 1 + 1 = 1.00
5) C.R. (Temporal Demand) = 2(2) / 2 + 2 = 1.00
6) C.R. (Performance) = 2(2) / 2 + 2 = 1.00

From Subject 16, the researcher identified a total of 51 instances, which included 5 prioritization, 32 coordination, 3 mental effort, 2 affective state, 3 temporal demand, and 6 performance cases. Coder II identified 46 instances from the same subject, including 5 prioritization, 25 coordination, 1 mental effort, 2 affective state, 4 temporal demand, and 9 performance cases. We were in agreement on 41 of them, including 5 prioritization, 22 coordination, 2 mental effort, 2 affective state, 3 temporal demand, and 7 performance cases. Therefore,

1) C.R. (Prioritization) = 2(5) / 5 + 5 = 1.00
2) C.R. (Coordination) = 2(22) / 32 + 25 = .77
3) C.R. (Cognitive Effort) = 2(2) / 3 + 1 = 1.00
4) C.R. (Affective State) = 2(2) / 2 + 2 = 1.00
5) C.R. (Temporal Demand) = 2(3) / 3 + 4 = .86

6) C.R. (Performance) = 2(7) / 6 + 9 = .93

The scores of the consistency measures of the content analysis between the researcher and the two coders reached satisfactory levels, which were distributed from .77 to 1.00, indicating acceptable for qualitative studies (Krippendorff, 1980).

4.0 RESULTS

This chapter discusses the results of the data analysis on human prioritizing and coordinating information behavior on the Web. Pre-questionnaires (Part I: general background information and Part II: task demand) and post-questionnaires were analyzed quantitatively mainly using Excel and SPSS. Transcripts of post-search interviews and verbal reports during the performances were analyzed using content analysis techniques. Search logs including task duration, task switching, tabbed browsing, strategic search planning/problem solving, and information evaluation were manually analyzed. These analyses were based on the data collected from 20 subjects recruited from the University of Pittsburgh.

The first two sections describe demographic information of 20 subjects and Web browsers and search engines used during the searches. Section 4.3 discusses a classification of human prioritizing and coordinating information behavior on the Web including definitions, keywords, and examples. The next three sections talk about the results in context of the research questions.

4.1 SUBJECT PROFILES

Table 2 summarizes the demographic information of 20 participants.

Table 2. Subject Profiles

Subject ID	Web Experience (yrs)	Academic Status	Academic Discipline	Gender	Age
S01	11	Master's	Library & Information Science	M	24
S02	10	Master's	Library & Information Science	F	27
S03	13	Master's	Library & Information Science	F	31
S04	12	Faculty	Environmental Studies	F	40
S05	10	Doctoral	Telecommunication	M	29
S06	8	Master's	Library & Information Science	F	30
S07	12	Faculty	Health & Community Systems	F	35
S08	13	Master's	Library & Information Science	F	28
S09	8	Master's	Library & Information Science	F	22
S10	9	Master's	Library & Information Science	F	24
S11	6	Master's	Library & Information Science	F	57
S12	10	Bachelor’s	Sociology	M	20
S13	10	Master's	Library & Information Science	F	30
S14	8	Bachelor’s	Nursing	F	20
S15	10	Bachelor’s	Nursing	F	20
S16	10	Master's	Library & Information Science	F	30
S17	6	Master's	Health Information Management	F	28
S18	10	Master's	Telecommunication	M	25
S19	10	Master's	Library & Information Science	F	22
S20	10	Doctoral	Telecommunication	M	34

The subjects consisted of two faculty members, two doctoral students, thirteen master’s students, and three undergraduate students. The subjects were distributed across different academic discipline areas. The two faculty members were affiliated with environmental studies, and health and community systems. The two doctoral students both were majoring in telecommunications. The thirteen master’s students were in library and information science (eleven students), telecommunication (one student), and health information management (one student). The three undergraduate students were majoring nursing (two students) and sociology (one student). Academic disciplines were categorized into four areas for further analysis. Engineering included telecommunications (two doctoral students and one master’s student). Social sciences consisted of library and information science (eleven master’s students) and sociology (one undergraduate student). Health sciences covered nursing (two undergraduate students), health and community systems (one faculty member), and health information management (one master's student). Natural sciences comprised environment studies (one faculty member). In Table 2, three subjects were in age between 18 and 21, nine subjects in between 22 and 29, six subjects in between 30 and 39, and two subjects were over 40 years old. Fifteen subjects were females and five subjects were males. All participants were experienced Web users. Fifteen of them mentioned that they have used the Web for more than six years and five subjects for more than eleven years. Eighteen of the subjects were using the Web daily and two participants were using the Web weekly.

Table 3. Frequency and Percentage of Subject's Demographic Data

Category	Sub-category	Frequency	Percentage (%)
Age	18-21	3	15%
	22-29	9	45%
	30-39	6	30%
	40+	2	10%
	TOTAL	20	100%
Gender	Female	15	75%
	Male	5	25%
	TOTAL	20	100%
Academic Status	Undergraduate	3	15%
	Master's	13	65%
	Doctoral	2	10%
	Professor	2	10%
	TOTAL	20	100%
Academic Discipline	Social Sciences	12	60%
	Engineering	3	15%
	Health Sciences	4	20%
	Natural Sciences	1	5%
	TOTAL	20	100%

In summary, the subjects in this study had varying backgrounds (see Table 3), including different genders (e.g., female and male), diverse academic status (e.g., faculty, doctoral students, master's students, and undergraduate students), different ages, and diverse academic discipline areas (e.g., engineering, social sciences, natural sciences, and health sciences). All participants were regular and experienced Web users.

4.2 WEB BROWSERS AND SEARCH ENGINES

Table 4 below shows that there were three major Web browsers used during the searches including Internet Explorer by eleven subjects, Firefox by eight participants, and Safari by three subjects.

Table 4. Web Browsers Used

Web browsers	Frequency	Percentage
Firefox	8	36%
IE	11	50%
Safari	3	14%
TOTAL	**22**	**100%**

Table 5 indicates that the individuals in this study had different reasons for using different Web browsers.

Table 5. Reasons for Using the Web Browsers

	IE		Firefox		Safari	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Availability	10	77%	1	9%	-	-
Compatibility	-	-	1	9%	2	50%
Familiarity	1	8%	1	9%	-	-
Feature	-	-	1	9%	1	25%
Function	2	15%	3	27%	1	25%
Security	-	-	4	36%	-	-
TOTAL	**13**	**100%**	**11**	**100%**	**4**	**100%**

The subjects using Internet Explorer responded that they used the Web browser simply because it was there on computers (77%). Function (15%) and familiarity (8%) were also mentioned by the Internet Explorer users. Here are some examples directly quoted from the Internet Explorer users' statements:

- Because that is what our home computer is set up with (S03)
- It was on my PC when I got it (S10)
- Set up on my job (S11)
- It is the browser that is on all the computers I use (S12)
- It is what is on my computer (S14)
- It was the web browser installed on my computer (S15)
- Usually on the desktop (S16)
- It came with my computer and it is easy to use (S19)

The subjects using Firefox addressed security (36%) and function (27%) as the reasons for using the Web browser. The following examples show how the Firefox users concerned security and functional issues while on the Internet:

- It is open source, supposedly has an added level of security and isn't IE (S01)
- It seems to be safer than IE (S02)
- IE is more acceptable to hackers, cookies, viruses, pop-ups, etc. All things bad (S07)
- Sometimes Internet Explorer has issues, won't let me view a page (S09)
- It is faster than IE (S17)

Compatibility (50%), feature, (25%), and function (25%) were considered as the reasons for the Safari users. For examples:

- I have a Mac at home and my work environment is Mac (S08)

- Compatible with Macs, doesn't have much problems (S04)
- Tabbed browsing (S13)

The subjects in this study were predominantly Google users (Table 6). There were diverse reasons for the preferred search engine.

Table 6. Web Search Engines Used

Web search engines	Frequency	Percent (%)
Google	19	95%
No Preference	1	5%
TOTAL	20	100%

Among the reasons, search feature (44%) and interface (26%) were the majors. The subjects using Google responded that they used the search engine because it provided them with "relevant," "prioritized," "accurate," comprehensive," "good," and "multi-media" search results. Useful search features (ex. Google Scholar, tabbed browsing) and neat interface were also mentioned for the reasons. For examples:

- Lack of adverts, single interface, familiarity with commands/options (S01)
- It's habit, and it usually gives me a good starting point (S02)
- I'm comfortable with Google and it seems to work just fine (S03)
- Very useful (S04)
- Help me do research (e.g., Scholar.google.com) (S5)
- Relevant and prioritised listing of responses; habit (S06)
- I like the interface and I get good results (S08)
- Easy to use, is well known (S09)

- I think it get the most relevant results (S10)
- Best I think (S11)
- I feel really comfortable with it. I have always used it (S12)
- It works, and I like its interface (S13)
- I think it works the best and is accurate (S14)
- Because it provides me with the most information (S15)
- Habit. I know it's not the best for everything, but I use it a lot (S16)
- Google has more comprehensive result compared to others (S17)
- Image, video, web searches are better. Cached web pages. Quick (S18)
- I use it most commonly to bring up quick facts (S19)
- Most of the time I get what I need with and few queries/clicks (S20)

One subject using GoodSearch mentioned that she used the search engine for charity reasons. For example, "the church I attend gets a penny for every search." (S07)

4.3 CLASSIFICATION OF PRIORITIZATION AND COORDINATION

This study aimed at understanding how people prioritize and coordinate multiple information related tasks while interacting with the Web and identifying the factors which affect the processes of prioritizing multiple information tasks. It was also designed to get a multi-dimensional understanding of human prioritizing and coordinating information behavior by analyzing the dynamic interplays of perceived task attributes, mental efforts, affective states, temporal demands, and performances. This study described the distinctive nature of human information interaction on the Web with a focus of prioritizing and coordinating multiple tasks. It also identified which factors influence the decision of task prioritization by categorizing verbal and written statements of task prioritization from the subjects. In addition, task demand, mental effort, affective state, temporal demand, and performance were also analyzed to investigate if there were any relationships among them.

This study did not intend to provide a clear-cut definition of human prioritizing and coordinating information behaviors. Instead, the multiple dimensions of this phenomenon were characterized based on our observations on the individuals' verbal and written statements associated with the activities of prioritizing and coordinating in the contexts of information seeking and retrieval on the Web.

Operational definitions are given in terms of: 1) think-aloud protocols that individuals make statements during and after their performances; 2) self-report ratings that individuals provide at the beginning and end of their performances.

Prioritizing generally means determining the order for dealing with a series of tasks according to their relative value to ensure maximum productivity (Oxford American Dictionaries). In this study, prioritization was defined as the extent to which subjects expressed that the decision of ordering tasks was based on certain task elements, e.g., task difficulty, task importance, task interest, etc. Task prioritization was operationalized as being composed of the level of each of multiple dimensions, such as task dimension, cognitive dimension, affective dimension, temporal dimension, and behavioral dimension.

Coordinating is conceptually defined as bringing the different elements of a complex activity into a relationship that will ensure productivity (Oxford American Dictionaries). Coordination was identified as the extent to which subjects stated that their activities were intended to lead high productivity in dealing with multiple information tasks under time pressure. Coordinating activities included task switching, tabbed browsing, strategic search planning (problem solving), and information evaluation. Coordination was operationalized as being composed of the level of each of task, cognitive, affective, temporal, and behavioral dimensions.

Six main categories of prioritization and coordination were identified by analyzing post-search interview transcripts, think-aloud transcripts, and search logs. The major six categories were further sub-categorized as presented in Table 7. All subjects were asked to verbalize their thoughts, i.e., reasons for their actions during the searches. The participants were asked three questions directly related to prioritization and coordination: (1) What factors were considered to prioritize the multiple tasks?; (2) Was it difficult to coordinate or/and complete the multiple tasks at the same time with the time limit?; and (3) Did you switch between the tasks? If so, please explain the reasons why you did so.

Table 7. Categories: Coding Numbers and Keywords

Categories/Sub-categories				Keywords mentioned by the subjects (Quotes)
100		**Prioritization**		priority, schedule, planning,
	110	Attributes of Tasks (Perceived)		
		111	Difficulty	Difficult, easy, simple
		112	Importance	Important, significant
		113	Interest	Interesting
		114	Knowledge/Familiarity	Familiar with, know, previously
		115	Complexity	Vague, broad, huge, open-ended,
	120	No Priority		In the order listed
200		**Coordination**		
	220	Task Switching		
		221	Task Switch	Switch, shift, go back to
		222	Go/Come Back Later	Will go back later, need to come back
		223	Maybe	Maybe, in another instance, I might
		224	Topic Change	Let's try another (topic)
	230	Tabbed Browsing		
	240	Strategic Search Planning		
		241	Broad -	Broad, uncertain
		242	Specific -	Specific, certain,
	250	Attributes of Sources		
		251	Author/Creator Credentials	Affiliation, doctors,
		252	TLD Type	.gov, .org, .edu, .com
		253	Familiarity	Familiar with, I know, previously known,
		254	Preference	The one that I liked
		255	Reputation	Well known, reputable, the Ivy League schools,
		256	Source Type	Organization, university site, national site,
	260	Attributes of Information		
		261	Accurate	Accurate, correct
		262	Basic	Basic, general, detailed
		263	Current	Current, up-to-date, new, old
		264	Good	Good, better, best, nice, neat, cool
		265	Important	Important
		266	Interesting	Interesting
		267	Official	Official
		268	Relevant	Relevant, related, appropriate
		269	Reliable	Reliable, trustworthy, valid,
		270	Scholarly	Scholarly, professional,
		271	Useful	Useful, helpful, easy to use, informative
500		**Mental Effort**		Level of understanding, in depth,
600		**Affective State**		Tiresome, tedious, confident, felt lost, disappointed
700		**Temporal Demand**		
	710	Duration		Ongoing, going to have to do more,
	720	Urgency		Less intense, due, not pressured,
800		**Performance**		
	810	Evaluation		
		811	Completion	That's all, I think I'm done, I accomplished,
		812	Do Not Know	Don't know, not sure,
		813	Others	Distracted, halfway done, what else needs to be done

The following are the definitions, keywords, and examples of the categories.

(1) Prioritization

The subject mentions the decision of ordering/priority to deal with a series of tasks to ensure maximum productivity of performance and efficiency of time management is based on certain task elements. The sub-categories related to task prioritization are difficulty, importance, interest, knowledge/familiarity, and complexity. The following are some examples:

- I would say, in terms of my priorities, I would want to do the task that seemed the least complex and move to the most complex. So, um… in terms of order, I think I'm going to do first the medicine task; second, the additional task; third, travel; and fourth, research. (S01, attribute - complexity).
- I think the task for medicine is very important and I'm really interested to know, so I think it's gonna be the first one that I will search (S05, attribute – importance, interest)
- I sort of followed the list from the 1st task down. I left the 3rd task (Research Task) till last because I was unsure of what topic for research. Other factors considered were did I know where to look for the information already (S08, attribute – knowledge/familiarity).
- Well, I thought if someone in my family had cancer that would be the first thing on my mind (Medicine Task). School would be second (Research Task) because the last two tasks seemed to be really simple and would not task long at all (Travel task, Additional Task (music)). (S12, attribute – importance, difficulty).
- I did the ones I thought would be easier first to get them done with. The ones I chose to do first and second were also the most interesting to me (S14, attribute - difficulty, interest).
- I went to my most familiar resources over and over, so familiarity is the major factor. I also chose the tasks I found easiest first – my own question is something I have a few go-to sites already memorized for (S16, attribute - knowledge/familiarity, difficulty).

(2) Coordination

The subject makes a statement implying that his or her activity is intended to lead high productivity of performance and high efficiency of time management in dealing with multiple information tasks. The sub-categories associated with coordinating activities include task switching, tabbed browsing, directions of problem solving (strategic search planning), and information evaluation. Here are some examples:

- instead of going, um, straight into very overwhelming search, I was thinking about maybe going to an official body, uh, that has to do with dermatological health (S01; Medicine Task; Strategic search planning; Information evaluation).
- Caring4Cancer.com, Cancer.gov, … I usually look at the name of the, like the web address to see if it seems like it would be a good fit (S03; Medicine Task; Information evaluation).
- Browsers allow for many tabs to be opened increasing the ability to multi-task and/or shift between tasks (S06; Task switching; Tabbed browsing).
- I think that that's a good starting point. I guess with research, I probably have to come back and figure out what's missing and do some more research later (S16; Research Task; Task switching).
- While that's working (the Carnegie library's data bases), … I'm going to go back to skin cancer … ah ha, Medline Plus! ... Looks kind of reliable because it's cancer.org. …I'm not seeing anything terribly interesting there (the search results of the Carnegie library's data bases) so I'm gonna go back to Google. (S08; Medicine Task; Tabbed browsing; Information evaluation).
- I'm going to a website that I know indexes other websites. So I'm just gonna start and do them one at a time and try and spend, you know, 15 minutes, 20 minutes on each one (S09; Medicine Task; Strategic search planning).

- did switch between the tasks once. I had not found much information for the research questions so often I checked my usual job list websites. I decided I would use the extra time to try my research questions on a few more databases (S10; Task switching).
- I used Google Scholar because it's a research paper, so I (need) like, actual, uh… good data that I know is from a good, reliable source (S12; Research Task; Strategic search planning; Information evaluation).

(3) Mental effort

The subject mentions the extent to which s/he has to work mentally to accomplish a certain level of performance. The examples are as follows:

- Think of level of understanding (S07).
- The information that I had to get was simple. The only task that I thought I would need in depth information on was the research project (S12).
- If I had been searching for a specific fact or statistic in each case, rather than an area of general study, I would have been very difficult to coordinate. If I had to find a statistic about skin cancer death or an opportunity for a specific kind of artist who lived in a specific part of the country, I might not have finished very quickly (S16).
- I did not switch between tasks, but I probably would have if I had to find a fact of statistic and if I was doing the research task in depth, I would return to the project again and again (S16).
- This looks much easier to deal with than reading something really in-depth (S16).
- Not a problem. I just have to limit the level of detail on each one (S20).

(4) Affective state

The subject mentions how s/he feels during the task. S/he makes an affective or emotional statement while working on a task/managing multiple tasks. The examples include:

- I feel a little bit lost on this page, Cancer Control and Populations Sciences, I don't really know that it's going to be in laymen's terms (S03, Medicine Task).
- I wish they would stop that! That's annoying (S11, Additional Task).
- It continues to give me this message that I can't—oh, you have to be a member and actually log in to go through all this extra stuff, which is kinda disappointing (S12, Additional Task).
- Felt pretty confident about 1 and 2, so zipped those out of the way (S13, Medicine Task & Additional Task).
- I am not very good at finding information about sports travel vacations (S13, Travel Task).
- I did not find it difficult to complete each of the tasks in the given time period. I felt confident in my abilities to search and gather the information that was asked for (S15).
- I'm quite confused of what information that will be beneficial to me (S17, Research Task).

(5) Temporal demand

The subject mentions how much time pressure s/he feels due to the rate or pace at which the tasks or task elements occur. The following are some examples:

- I thought the medical task might take the longest, but because the aliment type was common, information was readily available. I still had to go through several sources to find reputable site with free information. I knew the research topics would also take a while because from my experience writing papers. This step has always seemed to take the longest. I have used trip-planning techniques frequently, so I decided to put this short task between the harder ones (S19).
- How long it would take me to get some information about it (S20).

- I think I spent the majority of my time researching for a class project since it's due in a week and a half! (S10).

(6) Performance

The subject mentions his or her evaluation on performance after the task or during the task. The sub-categories related to performance evaluation include completion, do not know, and others. The examples are as follows:

- I think I could move on from this task, simply because … I know where the event's taking place and how ticketing is set up and how much time in advance I should allow to buy tickets for this event (S01; Travel Task; Completion).
- Okay and this is a huge topic. There's a ton of information so . . . now we could even . . . not sure what I'm looking for here (S02; Research Task; Do not know).
- let's see, what else needs to be done? (S04; Medicine Task; Others).
- And that's pretty much covers all our task. We, um, accomplished the medicine task, the travel task, the research task, and the additional task, which was a supplement to the research task (S04; Completion).
- I think I feel pretty good about this site. I think I actually finished everything up, so, I'm done (S16; Medicine Task; Completion).
- Okay that's all what I want to do for searching information about skin cancer, and now I will stop and I will go to the next one (S17; Medicine Task; Completion).

In summary, the content analysis in this study identified six major categories and ten sub-categories of information task prioritization and coordination, which were inductively derived from the data of post-search interviews, think-aloud utterances, and search logs. The six major categories include: prioritization, coordination, mental effort, affective state, temporal demand, and performance. The ten sub-categories were attributes of tasks, task switching, tabbed browsing, attributes of sources, attributes of information, duration, urgency, and evaluation. These sub-categories were extended into thirty-two sub-subcategories to further characterize human prioritizing and coordinating behavior in Web information seeking and retrieval contexts. The sub-subcategories of attributes of tasks were difficulty, importance, interest, knowledge/familiarity, and complexity. The sub-subcategories of task switching included task switch, go/come back later, maybe, topic change. The sub-subcategories of directions of problem solving were broad and specific. The sub-subcategories of attributes of sources covered author/creator credentials, TLD type, familiarity, preference, reputation, source type. The sub-subcategories of attributes of information included accurate, basic, current, good, important, interesting, official, relevant, reliable, scholarly, and useful. Finally, the sub-subcategories of evaluation were completion, do not know, and others.

4.4 RESEARCH QUESTIONS 1 AND 2

Research Question 1: **What are the general characteristics of task prioritizing and coordinating behavior in Web information seeking and retrieval contexts?**

Research Question 2: **What are the factors which influence the process of prioritizing multiple tasks in Web information seeking and retrieval contexts?**

This section discusses the results related to the first two research questions. Prioritization and coordination were coded when the subject makes statements which imply that the decision of ordering/priority to deal with a series of tasks to ensure maximum productivity of performance and efficiency of time management is based on certain task elements and that his/her activities are intended to lead high productivity of performance and high efficiency of time management in dealing with multiple information tasks.

The aspects of mental effort, affective state, temporal demand, and performance were coded when the subject mentions that the extent to which s/he has to work mentally to accomplish a certain level of performance, how s/he feels during the task. S/he makes an affective or emotional statement while working on a task or managing multiple tasks, how much time pressure s/he feels due to the rate or pace at which the tasks or task elements occur, and that his or her evaluation on performance after the task or during the task. The sub-categories related to performance evaluation include completion, do not know, and others.

Table 8. Frequencies of Categories

Categories/Sub-categories				Frequency	Percent
100		**Prioritization**		**93**	**8.7%**
	110	Attributes of Tasks (Perceived)		**87**	**8.1%**
		111	Difficulty	23	2.1%
		112	Importance	10	0.9%
		113	Interest	15	1.4%
		114	Knowledge/Familiarity	17	1.6%
		115	Complexity	22	2.1%
	120	No Priority		**6**	**0.6%**
200		**Coordination**		**799**	**74.5%**
	220	Task Switching		**28**	**2.6%**
		221	Task Switch	14	1.3%
		222	Go/Come Back Later	9	0.8%
		223	Maybe	3	0.3%
		224	Topic Change	2	0.2%
	230	Tabbed Browsing		**56**	**5.2%**
	240	Strategic Search Planning		**44**	**4.1%**
		241	Broad -	10	0.9%
		242	Specific -	34	3.2%
	250	Attributes of Sources		**273**	**25.5%**
		251	Author/Creator Credentials	3	0.3%
		252	TLD Type	38	3.5%
		253	Familiarity	27	2.5%
		254	Preference	1	0.1%
		255	Reputation	12	1.1%
		256	Source Type	192	17.9%
	260	Attributes of Information		**398**	**37.1%**
		261	Accurate	5	0.5%
		262	Basic	36	3.4%
		263	Current	40	3.7%
		264	Good	126	11.8%
		265	Important	8	0.7%
		266	Interesting	57	5.3%
		267	Official	9	0.8%
		268	Relevant	18	1.7%
		269	Reliable	18	1.7%
		270	Scholarly	13	1.2%
		271	Useful	68	6.3%
500		**Mental Effort**		**12**	**1.1%**
600		**Affective State**		**26**	**2.4%**
700		**Temporal Demand**		**60**	**5.6%**
	710	Duration		54	5.0%
	720	Urgency		6	0.6%
800		**Performance**		**82**	**7.6%**
	810	Evaluation			
		811	Completion	55	5.1%
		812	Do Not Know	7	0.7%
		813	Others	20	1.9%
TOTAL				**1072**	**100%**

A total of 1072 instances were coded from the search logs and the transcripts of post-search interviews and think-aloud utterances (Table 8). Most of occurrences related to prioritization (N=93, 8.7%) were responses to the question during the post-search interviews asking the factors which were considered in prioritizing the multiple tasks. Task difficulty (N=23, 2.1%) and task complexity (N=22, 2.1%) were the major factors that the subjects considered during the process of task priority, followed by task knowledge/familiarity (N=17, 1.6%), task interest (N=15, 1.4%), and task importance (N=10, .9%). Six subjects (.6%) performed the tasks in the order as listed.

A total of 799 instances (74.5%) were coded under the category of coordination. Most of them were from the think-aloud transcripts and the search logs and some of them were responses to the questions during the post-search interviews such as “was it difficult to coordinate or/and complete the multiple tasks at the same time with the time limit?” and “did you switch between the tasks? If so, please explain the reason why you did so.”

Among the coordination related occurrences, attributes of sources (N=273, 25.5%) and attributes of information (N=398, 37.1%) were the sub-categories that the subjects mentioned most while they were managing the tasks. The subject often stated multiple attributes at the same time when accessing and using information and sources. For example, “outdated but reliable,” “useful, reliable, interesting.”

The subjects also mentioned the sub-categories of task switching (N=28, 2.6%), tabbed browsing (N=56, 5.2%), and directions of problem solving (N=44, 4.1%). There were only 12 instances (1.1%) related to mental effort and 26 instances (2.4%) associated with affective state. 60 instances (5.6%) were coded as temporal demand including the sub-categories of duration (N=54, 5%) and urgency (N=6, .6%). There were 82 occurrences (7.6%) related to performance with the sub-categories of completion (N=55, 5.1%), don't know (N=7, .7%), and others (N=20, 1.9%).

The following sections describe the results of the content analysis in terms of the task the subjects engaged in and the participants' backgrounds, such as age, gender, academic status, and academic discipline.

4.4.1 Task

This section discusses the results of content analysis from a task perspective.

Table 9. Subject Categories of Additional Task

Subject Category	Frequency	Percent (%)
Job	6	30%
Music	3	15%
Research	3	15%
Sports	2	10%
Finance	2	10%
News	1	5%
Travel	1	5%
Shopping	1	5%
Technology	1	5%
Total	20	100%

The topics for additional tasks are described in Table 9. Among the topics, Job (N=6, 30%) was the number one topic created most by the subjects. Music (N=3, 15%) and Research (N=3, 15%) were the second ones. The third topics were Finance (N=2, 10%) and Sports (N=2, 10%), followed by Travel (N=1, 5%), Shopping (N=1, 5%), and Technology (N=1, 5%), respectively. One subject (S04) chose a topic which was supplementary to the research task.

The results in Table 10 (by task) indicate that the frequencies of the categories and sub-categories of prioritization, coordination, and other aspects are different depending on the task in general. Regarding prioritization, task difficulty was mentioned most for the medicine task

(1.6%) and travel task (6.2%), task complexity for the research task (3.1%), and task knowledge/familiarity for the additional task (3.7%).

The subjects mentioned the facets of coordination on each task at a similar level: the medicine task (83.4%), the travel task (71.4%), the research task (80.3%), and the additional task (78.8%). Task switching was stated most for the research task (3.3%) and tabbed browsing for the additional task (7.4%) followed by the medicine task and the research task (both 5.5%). The subjects started with specific strategies at the beginning of the additional task (5.5%).

It was found that the subjects were concerned about the quality of sources to a greater extent while they were working on the medicine task (34.6%) than on the additional task (27.7%), research task (23.8%), and travel task (21.3%). They were attentive to the attributes of information to a greater extent for the research task (45.6%) than they did for the other tasks. This indicates that people pay attention to the quality of sources and information in a different way depending on the task. For example, they pay closer attention to current, official, and reliable resources for medicine related tasks and scholarly and authoritative resources for research oriented information tasks.

The subjects expressed temporal demand to a greater extent when they were working on the additional task (5.9%) and the research task (3.4%) than on the other tasks. The subjects often mentioned the categories of task switching and temporal demand at the same time while they were working on the research task which was perceived highly complex.

Table 10. Frequencies of Categories By Task

Categories/Sub-categories				Medicine		Travel		Research		Additional	
				Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent
100		**Prioritization**		**9**	**3.6%**	**18**	**12.4%**	**17**	**5.2%**	**18**	**6.7%**
	110	**Perceived Attributes of Tasks**		**9**	**3.6%**	**18**	**12.4%**	**17**	**5.2%**	**18**	**6.7%**
		111	Difficulty	4	1.6%	9	6.2%	2	0.6%	7	2.6%
		112	Importance	2	0.8%	-	-	-	-	-	-
		113	Interest	2	0.8%	6	4.1%	1	0.3%	1	0.4%
		114	Knowledge/Familiarity	1	0.4%	1	0.7%	4	1.2%	10	3.7%
		115	Complexity	-	-	2	1.4%	10	3.1%	-	-
	120	**No Priority**		-	-	-	-	-	-	-	-
200		**Coordination**		**212**	**83.4%**	**104**	**71.4%**	**264**	**80.3%**	**208**	**76.8%**
	220	**Task Switching**		**1**	**0.4%**	**3**	**2.1%**	**11**	**3.3%**	**5**	**1.8%**
		221	Task Switch	1	0.4%	1	0.7%	4	1.2%	5	1.8%
		222	Go/Come Back Later	-	-	2	1.4%	5	1.5%	-	-
		223	Maybe	-	-	-	-	-	-	-	-
		224	Topic Change	-	-	-	-	2	0.6%	-	-
	230	**Tabbed Browsing**		**14**	**5.5%**	**4**	**2.7%**	**18**	**5.5%**	**20**	**7.4%**
	240	**Strategic Search Planning**		**10**	**3.9%**	**10**	**6.8%**	**7**	**2.1%**	**16**	**5.9%**
		241	Broad -	-	-	4	2.7%	4	1.2%	1	0.4%
		242	Specific -	10	3.9%	6	4.1%	3	0.9%	15	5.5%
	250	**Attributes of Sources**		**88**	**34.6%**	**31**	**21.3%**	**78**	**23.8%**	**75**	**27.7%**
		251	Author Credentials	1	0.4%	-	-	2	0.6%	-	-
		252	TLD Type	13	5.1%	8	5.5%	13	4.0%	4	1.5%
		253	Familiarity	9	3.5%	3	2.1%	6	1.8%	9	3.3%
		254	Preference	-	-	1	0.7%	-	-	-	-
		255	Reputation	4	1.6%	1	0.7%	3	0.9%	3	1.1%
		256	Source Type	61	24.0%	18	12.3%	54	16.5%	59	21.8%
	260	**Attributes of Information**		**99**	**39.0%**	**56**	**38.5%**	**150**	**45.6%**	**92**	**34.0%**
		261	Accurate	-	-	2	1.4%	3	0.9%	-	-
		262	Basic	23	9.1%	3	2.1%	4	1.2%	6	2.2%
		263	Current	7	2.8%	7	4.8%	16	4.9%	10	3.7%
		264	Good	24	9.4%	14	9.6%	60	18.3%	28	10.3%
		265	Important	6	2.4%	-	-	2	0.6%	-	-
		266	Interesting	12	4.7%	9	6.2%	22	6.7%	14	5.2%
		267	Official	2	0.8%	2	1.4%	1	0.3%	4	1.5%
		268	Relevant	5	2.0%	4	2.7%	6	1.8%	3	1.1%
		269	Reliable	8	3.1%	2	1.4%	7	2.1%	-	-
		270	Scholarly	3	1.2%	-	-	6	1.8%	4	1.5%
		271	Useful	9	3.5%	13	8.9%	23	7.0%	23	8.5%
500		**Mental Effort**		**5**	**2.0%**	**-**	**-**	**1**	**0.3%**	**-**	**-**
600		**Affective State**		**3**	**1.2%**	**9**	**6.2%**	**9**	**2.8%**	**4**	**1.4%**
700		**Temporal Demand**		**7**	**2.8%**	**2**	**1.4%**	**11**	**3.4%**	**16**	**5.9%**
	710	**Duration**		**7**	**2.8%**	**2**	**1.4%**	**11**	**3.4%**	**16**	**5.9%**
	720	**Urgency**		-	-	-	-	-	-	-	-
800		**Performance**		**18**	**7.1%**	**13**	**8.9%**	**25**	**7.7%**	**25**	**9.2%**
	810	**Evaluation**		**18**	**7.1%**	**13**	**8.9%**	**25**	**7.7%**	**25**	**9.2%**
		811	Completion	12	4.7%	10	6.8%	10	3.1%	23	8.5%
		812	Do Not Know	-	-	1	0.7%	5	1.5%	-	-
		813	Others	6	2.4%	2	1.4%	10	3.1%	2	0.7%
TOTAL				254	100%	146	100%	327	100%	271	100%

The following subsections discuss the categories of task prioritization and coordination in terms of the subjects' demographic characteristics, such as age, gender, academic status, and academic discipline.

4.4.2 Age

In Table 11, in terms of task priority, task difficulty was mentioned most by the subjects in the age group of 18-21 (8.2%). The subjects in the 22-29 age category (2.9%) expressed task complexity as a major factor of task priority. The subjects in the age category of 30-39 concerned task difficulty and task knowledge/familiarity most (both 2%). The subjects in the age group of 40 and over (2.7%) mentioned task interest most as a factor affecting task priority.

Regarding the categories of coordination, task switching was mentioned most by the oldest group (40+) (5.4%) and the least by the youngest group (18-21) (.9%). Tabbed browsing was most frequently mentioned by the subjects between the ages of 22 and 29 (7.2%) and the least by the subjects in the 18-21 age category (.9%). The subjects in the 30-39 age group (4.2%) seemed to begin their tasks with specific strategies. The subjects in the age categories of 20-29 (4.8%) and 30-39 (4.5%) seemed that they planned out their actions specifically or started their tasks in a broad perspective at the beginnings of their task performances. The subjects between the ages of 18 and 21 (.9%) seemed that they did not have any certain strategic directions in solving their task related problems.

Affective remarks were made most by the subjects in the 30-39 age category (5.2%) and the least by the oldest group (40+) (.9%). Utterances with respect to temporal demand were made most by the subjects between the ages of 22 and 29 (6.5%) and the least by the oldest subject group (40+) (2.7%).

Table 11. Frequencies of Categories By Age

Categories/Sub-categories			18-21		22-29		30-39		40+	
			Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent
100		**Prioritization**	**17**	**15.4%**	**47**	**8.8%**	**20**	**6.7%**	**9**	**8.1%**
	110	**Task Attributes**	**17**	**15.4%**	**44**	**8.1%**	**19**	**6.4%**	**7**	**6.3%**
		111 Difficulty	9	8.2%	6	1.1%	6	2.0%	2	1.8%
		112 Importance	2	1.8%	5	0.9%	2	0.7%	1	0.9%
		113 Interest	2	1.8%	8	1.5%	2	0.7%	3	2.7%
		114 Knowledge/Familiarity	1	0.9%	9	1.7%	6	2.0%	1	0.9%
		115 Complexity	3	2.7%	16	2.9%	3	1.0%	-	-
	120	**No Priority**	**-**	**-**	**3**	**0.6%**	**1**	**0.3%**	**2**	**1.8%**
200		**Coordination**	**73**	**66.3%**	**419**	**77.2%**	**218**	**71.1%**	**89**	**79.8%**
	220	**Task Switching**	**1**	**0.9%**	**13**	**2.4%**	**8**	**2.6%**	**6**	**5.4%**
		221 Task Switch	-	-	7	1.3%	1	0.3%	6	5.4%
		222 Go/Come Back Later	-	-	5	0.9%	4	1.3%	-	-
		223 Maybe	1	0.9%	-	-	2	0.7%	-	-
		224 Topic Change			1	0.2%	1	0.3%	-	-
	230	**Tabbed Browsing**	**1**	**0.9%**	**39**	**7.2%**	**11**	**3.6%**	**5**	**4.5%**
	240	**Strategic Search Planning**	**1**	**0.9%**	**26**	**4.8%**	**14**	**4.5%**	**3**	**2.7%**
		241 Broad -	-	-	8	1.5%	1	0.3%	1	0.9%
		242 Specific -	1	0.9%	18	3.3%	13	4.2%	2	1.8%
	250	**Attributes of Sources**	**33**	**30.0%**	**138**	**25.4%**	**73**	**23.9%**	**33**	**29.5%**
		251 Author Credentials	-	-	4	0.7%	3	1.0%	-	-
		252 TLD Type	6	5.5%	15	2.8%	16	5.2%	1	0.9%
		253 Familiarity	4	3.6%	12	2.2%	8	2.6%	3	2.7%
		254 Preference	-	-	-	-	1	0.3%	-	-
		255 Reputation	-	-	6	1.1%	2	0.7%	4	3.6%
		256 Source Type	23	20.9%	101	18.6%	43	14.1%	25	22.3%
	260	**Attributes of Information**	**37**	**33.6%**	**203**	**37.4%**	**112**	**36.5%**	**42**	**37.7%**
		261 Accurate	2	1.8%	2	0.4%	1	0.3%	-	-
		262 Basic	2	1.8%	17	3.2%	16	5.2%	1	0.9%
		263 Current	3	2.7%	23	4.2%	12	3.9%	2	1.8%
		264 Good	11	10.0%	68	12.5%	40	13.1%	7	6.3%
		265 Important	-	-	7	1.3%	1	0.3%	-	-
		266 Interesting	7	6.4%	29	5.3%	15	4.9%	6	5.4%
		267 Official			7	1.3%	1	0.3%	1	0.9%
		268 Relevant	1	0.9%	12	2.2%	3	1.0%	2	1.8%
		269 Reliable	2	1.8%	7	1.3%	3	1.0%	5	4.5%
		270 Scholarly	1	0.9%	4	0.7%	4	1.3%	3	2.7%
		271 Useful	8	7.3%	27	5.0%	16	5.2%	15	13.4%
500		**Mental Effort**	**1**	**0.9%**	**3**	**0.6%**	**8**	**2.6%**	**-**	**-**
600		**Affective State**	**3**	**2.7%**	**6**	**1.1%**	**16**	**5.2%**	**1**	**0.9%**
700		**Temporal Demand**	**7**	**6.3%**	**35**	**6.5%**	**15**	**4.9%**	**3**	**2.7%**
	710	Duration	5	4.5%	32	5.9%	15	4.9%	2	1.8%
	720	Urgency	2	1.8%	3	0.6%	-	-	1	0.9%
800		**Performance**	**9**	**8.2%**	**34**	**6.2%**	**29**	**9.5%**	**10**	**9.0%**
	810	**Evaluation**	**9**	**8.2%**	**34**	**6.2%**	**29**	**9.5%**	**10**	**9.0%**
		811 Completion	7	6.4%	23	4.2%	21	6.9%	4	3.6%
		812 Do Not Know	2	1.8%	5	0.9%	-	-	-	-
		813 Others	-	-	6	1.1%	8	2.6%	6	5.4%
TOTAL			110	100%	544	100%	306	100%	112	100%

4.4.3 Gender

Regarding prioritization in Table 12, task difficulty was mentioned most by the male group (3.2%) and task difficulty and complexity by the female group (both 1.8%). Overall, the male group (11.7%) mentioned the attributes of tasks influencing the process of prioritizing the tasks to a greater extent than the female group (6.8%) did.

In terms of coordination, both task switching and tabbed browsing were expressed by the female group (3.2% and 5.7% respectively) to a greater extent than the male group (1.1% and 3.9% respectively). It seemed that the male group (31.7%) concerned more about the attributes of sources than the female group (23.3%) while the female group (38.4%) concerned more about the attributes of information than the male group (33.9%).

Remarks on affective state and temporal demand were expressed by the female group (3.2% and 6.2% respectively) to a greater extent than the male group (.4% and 3.9% respectively).

Table 12. Frequencies of Categories By Gender

Categories/Sub-categories			Male		Female	
			Frequency	Percentage	Frequency	Percentage
100		**Prioritization**	**34**	**12.1%**	**59**	**7.4%**
	110	**Task Attributes**	**33**	**11.7%**	**54**	**6.8%**
		111 Difficulty	9	3.2%	14	1.8%
		112 Importance	5	1.8%	5	0.6%
		113 Interest	7	2.5%	8	1.0%
		114 Knowledge/Familiarity	4	1.4%	13	1.6%
		115 Complexity	8	2.8%	14	1.8%
	120	**No Priority**	**1**	**0.4%**	**5**	**0.6%**
200		**Coordination**	**211**	**75.2%**	**588**	**74.5%**
	220	**Task Switching**	**3**	**1.1%**	**25**	**3.2%**
		221 Task Switch	3	1.1%	11	1.4%
		222 Go/Come Back Later	-	-	9	1.1%
		223 Maybe	-	-	3	0.4%
		224 Topic Change	-	-	2	0.3%
	230	**Tabbed Browsing**	**11**	**3.9%**	**45**	**5.7%**
	240	**Strategic Search Planning**	**13**	**4.6%**	**31**	**3.9%**
		241 Broad -	2	0.7%	8	1.0%
		242 Specific -	11	3.9%	23	2.9%
	250	**Attributes of Sources**	**89**	**31.7%**	**184**	**23.3%**
		251 Author Credentials	-	-	3	0.4%
		252 TLD Type	15	5.3%	23	2.9%
		253 Familiarity	9	3.2%	18	2.3%
		254 Preference	-	-	1	0.1%
		255 Reputation	5	1.8%	7	0.9%
		256 Source Type	60	21.4%	132	16.7%
	260	**Attributes of Information**	**95**	**33.9%**	**303**	**38.4%**
		261 Accurate	-	-	5	0.6%
		262 Basic	13	4.6%	23	2.9%
		263 Current	3	1.1%	37	4.7%
		264 Good	25	8.9%	101	12.8%
		265 Important	1	0.4%	7	0.9%
		266 Interesting	16	5.7%	41	5.2%
		267 Official	8	2.8%	1	0.1%
		268 Relevant	7	2.5%	11	1.4%
		269 Reliable	3	1.1%	15	1.9%
		270 Scholarly	3	1.1%	10	1.3%
		271 Useful	16	5.7%	52	6.6%
500		**Mental Effort**	**5**	**1.8%**	**7**	**0.9%**
600		**Affective State**	**1**	**0.4%**	**25**	**3.2%**
700		**Temporal Demand**	**11**	**3.9%**	**49**	**6.2%**
	710	Duration	**11**	**3.9%**	**43**	**5.4%**
	720	Urgency	**-**	**-**	**6**	**0.8%**
800		**Performance**	**19**	**6.8%**	**63**	**8.0%**
	810	**Evaluation**	**19**	**6.8%**	**63**	**8.0%**
		811 Completion	19	6.8%	36	4.6%
		812 Do Not Know	-	-	7	0.9%
		813 Others	-	-	20	2.5%
TOTAL			281	100%	791	100%

4.4.4 Academic Status

Table 13 shows that the undergraduate students (15.4%) mentioned the attributes of tasks influencing task prioritization most and the faculty members none. The faculty members did not prioritize the tasks and performed them in the order as listed. Task difficulty was mentioned most by the undergraduate students (8.2%), task complexity by the graduate students (2.6%), and task importance and interest by the doctoral students (both 2.5%).

Remarks on coordination were made most by the faculty members (86%) and the least by the undergraduate students (66.3%). Task switching was mentioned most by the faculty members (6.1%), followed by the graduate students (3.9%), the doctoral students (3.7%), and the undergraduate students (.9%). Utterances on tabbed browsing were made by the graduated students (5.22%) most, followed by the faculty members (3.8%), the doctoral students (2.5%), and the undergraduate students (.9%). Strategies associated with problem solving were mentioned most by the faculty members (6.8%) and the least by the undergraduate students (.9%). It also seemed that the subjects in all the groups except the undergraduate one, performed their tasks with specific planning at the beginnings of a task. The faculty members (33.8%) seemed to be concerned with the quality of sources more than the other groups did.

It was noticed that most of the expressions regarding cognitive and temporal aspects were made by the doctoral students (3.7% and 8.6% respectively) and were rarely mentioned by the faculty members (.8% and 1.5% respectively). The faculty group also did not make any comments associated with affective state.

Table 13. Frequencies of Categories By Academic Status

Categories/Sub-categories			Faculty		Doctor's		Master's		Undergraduate	
			Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent
100		**Prioritization**	**2**	**1.5%**	**6**	**7.4%**	**68**	**9.2%**	**17**	**15.4%**
	110	**Task Attributes**	-	-	**6**	**7.4%**	**64**	**8.7%**	**17**	**15.4%**
		111 Difficulty	-	-	1	1.2%	13	1.8%	9	8.2%
		112 Importance	-	-	2	2.5%	6	0.8%	2	1.8%
		113 Interest	-	-	2	2.5%	11	1.5%	2	1.8%
		114 Knowledge/Familiarity	-	-	1	1.2%	15	2.0%	1	0.9%
		115 Complexity	-	-	-	-	19	2.6%	3	2.7%
	120	**No Priority**	**2**	**1.5%**	-	-	**4**	**0.5%**	-	-
200		**Coordination**	**114**	**86.0%**	**58**	**71.6%**	**554**	**73.6%**	**73**	**66.3%**
	220	**Task Switching**	**8**	**6.1%**	**3**	**3.7%**	**29**	**3.9%**	**1**	**0.9%**
		221 Task Switch	5	3.8%	3	3.7%	19	2.5%	-	-
		222 Go/Come Back Later	3	2.3%	-	-	6	0.8%	-	-
		223 Maybe	-	-	-	-	2	0.3%	1	0.9%
		224 Topic Change	-	-	-	-	2	0.3%	-	-
	230	**Tabbed Browsing**	**5**	**3.8%**	**2**	**2.5%**	**39**	**5.3%**	**1**	**0.9%**
	240	**Strategic Search Planning**	**9**	**6.8%**	**3**	**3.7%**	**31**	**4.2%**	**1**	**0.9%**
		241 Broad -	1	0.8%	-	-	9	1.2%	-	-
		242 Specific -	8	6.0%	3	3.7%	22	3.0%	1	0.9%
	250	**Attributes of Sources**	**45**	**33.8%**	**21**	**25.9%**	**172**	**23.3%**	**33**	**30.0%**
		251 Author Credentials	2	1.5%	-	-	1	0.1%	-	-
		252 TLD Type	6	4.5%	8	9.9%	18	2.4%	6	5.5%
		253 Familiarity	2	1.5%	1	1.2%	18	2.4%	4	3.6%
		254 Preference	-	-	-	-	1	0.1%	-	-
		255 Reputation	2	1.5%	-	-	10	1.4%	-	-
		256 Source Type	33	24.8%	12	14.8%	124	16.9%	23	20.9%
	260	**Attributes of Information**	**47**	**35.5%**	**29**	**35.8%**	**283**	**38.6%**	**37**	**33.6%**
		261 Accurate	1	0.8%	-	-	2	0.3%	2	1.8%
		262 Basic	4	3.0%	9	11.1%	21	2.9%	2	1.8%
		263 Current	4	3.0%	2	2.5%	31	4.2%	3	2.7%
		264 Good	6	4.5%	5	6.2%	104	14.1%	11	10.0%
		265 Important	-	-	-	-	8	1.1%	-	-
		266 Interesting	4	3.0%	2	2.5%	42	5.7%	7	6.4%
		267 Official	1	0.8%	1	1.2%	7	1.0%	-	
		268 Relevant	3	2.3%	5	6.2%	9	1.2%	1	0.9%
		269 Reliable	1	0.8%	1	1.2%	14	1.9%	2	1.8%
		270 Scholarly	4	3.0%	1	1.2%	7	1.0%	1	0.9%
		271 Useful	19	14.3%	3	3.7%	38	5.2%	8	7.3%
500		**Mental Effort**	**1**	**0.8%**	**3**	**3.7%**	**7**	**1.0%**	**1**	**0.9%**
600		**Affective State**	-	-	-	-	**23**	**3.1%**	**3**	**2.7%**
700		**Temporal Demand**	**2**	**1.5%**	**7**	**8.6%**	**44**	**5.9%**	**7**	**6.3%**
	710	Duration	2	1.5%	7	8.6%	40	5.4%	5	4.5%
	720	Urgency	-	-	-	-	4	0.5%	2	1.8%
800		**Performance**	**14**	**10.5%**	**7**	**8.6%**	**52**	**7.1%**	**9**	**8.2%**
	810	**Evaluation**	**14**	**10.5%**	**7**	**8.6%**	**52**	**7.1%**	**9**	**8.2%**
		811 Completion	10	7.5%	7	8.6%	31	4.2%	7	6.4%
		812 Do Not Know	-	-	-	-	5	0.7%	2	1.8%
		813 Others	4	3.0%	-	-	16	2.2%	-	-
TOTAL			133	100%	81	100%	748	100%	110	100%

4.4.5 Academic Discipline

Table 14 shows that the subjects in social sciences (10.9%) and engineering (8.8%) mentioned the category of prioritization to a greater extent than did the health sciences (3%) and natural sciences (1.3%) groups. Among the task attributes, importance was most frequently stated by the engineering group (3.3%) and difficulty and complexity by the social science group (2.9% and 3% respectively).

Remarks related to coordination were made most by the natural sciences group (91.5%) and the least by the engineering group (68.5%). Task switching was mentioned more often by the natural sciences group (6.3%) than the other groups. Tabbed browsing was more often occurred in the health sciences group (9.7%) and the natural sciences group (8.8%) than the engineering and social sciences groups (5.4% and 3.7% respectively). The engineering (4.3%) and social sciences (4.5%) groups seemed to have more specific/broad planning processes than did the health sciences and natural sciences groups (2.9% and 2.5% respectively).

It was noticed that the engineering group (9.8%) seemed to concern the aspect of temporal demand to a greater extent than the other groups did.

Interestingly, the natural sciences group did not prioritize the tasks and conducted in the order as listed. The subjects in this group also did not make any remarks on the aspects of mental effort, affective state, and temporal demand.

Table 14. Frequencies of Categories By Academic Discipline

Categories/Sub-categories			Engineering		Health Sci.		Natural Sci.		Social Sci.	
			Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent
100		**Prioritization**	**8**	**8.8%**	**5**	**3.0%**	**1**	**1.3%**	**79**	**10.9%**
	110	**Task Attributes**	**7**	**7.7%**	**4**	**2.4%**	**-**	**-**	**76**	**10.5%**
		111 Difficulty	1	1.1%	1	0.6%	-	-	21	2.9%
		112 Importance	3	3.3%	1	0.6%	-	-	6	0.8%
		113 Interest	2	2.2%	1	0.6%	-	-	12	1.7%
		114 Knowledge/Familiarity	1	1.1%	1	0.6%	-	-	15	2.1%
		115 Complexity	-	-	-	-	-	-	22	3.0%
	120	**No Priority**	**1**	**1.1%**	**1**	**0.6%**	**1**	**1.3%**	**3**	**0.4%**
200		**Coordination**	**63**	**68.5%**	**135**	**77.3%**	**73**	**91.5%**	**528**	**72.5%**
	220	**Task Switching**	**3**	**3.3%**	**4**	**2.3%**	**5**	**6.3%**	**16**	**2.2%**
		221 Task Switch	3	3.3%	-	-	5	6.3%	6	0.8%
		222 Go/Come Back Later	-	-	3	1.7%	-	-	6	0.8%
		223 Maybe	-	-	1	0.6%	-	-	2	0.3%
		224 Topic Change	-	-	-	-	-	-	2	0.3%
	230	**Tabbed Browsing**	**5**	**5.4%**	**17**	**9.7%**	**7**	**8.8%**	**27**	**3.7%**
	240	**Strategic Search Planning**	**4**	**4.3%**	**5**	**2.9%**	**2**	**2.5%**	**33**	**4.5%**
		241 Broad -	-	-	1	0.6%	-	-	9	1.2%
		242 Specific -	4	4.3%	4	2.3%	2	2.5%	24	3.3%
	250	**Attributes of Sources**	**23**	**25.0%**	**44**	**25.2%**	**28**	**35.0%**	**178**	**24.5%**
		251 Author Credentials	-	-	2	1.1%	-	-	1	0.1%
		252 TLD Type	9	9.8%	8	4.6%	2	2.5%	19	2.6%
		253 Familiarity	2	2.2%	5	2.9%	2	2.5%	18	2.5%
		254 Preference	-	-	-	-	-	-	1	0.1%
		255 Reputation	-	-	-	-	2	2.5%	10	1.4%
		256 Source Type	12	13.0%	29	16.6%	22	27.5%	129	17.8%
	260	**Attributes of Information**	**28**	**30.5%**	**65**	**37.2%**	**31**	**38.9%**	**274**	**37.6%**
		261 Accurate	-	-	3	1.7%	-	-	2	0.3%
		262 Basic	10	10.9%	5	2.9%	2	2.5%	19	2.6%
		263 Current	1	1.1%	8	4.6%	1	1.3%	30	4.1%
		264 Good	5	5.4%	13	7.4%	5	6.3%	103	14.2%
		265 Important	-	-	5	2.9%	-	-	3	0.4%
		266 Interesting	2	2.2%	13	7.4%	4	5.0%	38	5.2%
		267 Official	1	1.1%	-	-	-	-	8	1.1%
		268 Relevant	5	5.4%	2	1.1%	2	2.5%	9	1.2%
		269 Reliable	-	-	1	0.6%	-	-	17	2.3%
		270 Scholarly	1	1.1%	-	-	4	5.0%	8	1.1%
		271 Useful	3	3.3%	15	8.6%	13	16.3%	37	5.1%
500		**Mental Effort**	**3**	**3.3%**	**1**	**0.6%**	**-**	**-**	**8**	**1.1%**
600		**Affective State**	**-**	**-**	**5**	**2.9%**	**-**	**-**	**21**	**2.9%**
700		**Temporal Demand**	**9**	**9.8%**	**11**	**6.2%**	**-**	**-**	**40**	**5.6%**
	710	Duration	**9**	**9.8%**	**9**	**5.1%-**	**-**	**-**	**36**	**5.0%**
	720	Urgency	**-**	**-**	**2**	**1.1%**	**-**	**-**	**4**	**0.6%**
800		**Performance**	**9**	**9.8%**	**18**	**10.3%**	**6**	**7.5%**	**49**	**6.7%**
	810	**Evaluation**	**9**	**9.8%**	**18**	**10.3%**	**6**	**7.5%**	**49**	**6.7%**
		811 Completion	9	9.8%	12	6.9%	4	5.0%	30	4.1%
		812 Do Not Know	-	-	2	1.1%	-	-	5	0.7%
		813 Others	-	-	4	2.3%	2	2.5%	14	1.9%
TOTAL			92	100%	175	100%	80	100%	725	100%

4.4.6 Task Duration[2]

The results of the data analysis show that the subjects spent a different amount of time on different tasks. Task duration was also different depending on age, gender, academic status, and academic discipline. The following four sections discuss the results related to duration.

(1) Mean Time By Information Task and Age

Table 15. Mean Time (sec.) by Task and Age

AGE	Medicine	Travel	Research	Additional	Total Duration
18-21	317	482	324	400	1522
22-29	675	623	1059	642	2999
30-39	556	749	801	385	2491
40+	540	550	676	551	2317

The subjects between the ages of 18-21 spent the shortest time on the medicine task, longest on the travel task (Table 15). All the other age groups spent the longest amount of time performing the research task. It seemed that there was an age difference in performing a task in terms of duration. The youngest group tended to complete all the tasks with the shortest average total duration while the subjects in the 21-29 age category did with the longest one. Among the different age groups, the subjects in the age group of 21-29 spent the longest amount of time in performing the research task.

(2) Mean Time By Information Task and Gender

Table 16. Mean Time (sec.) by Task and Gender

GENDER	Medicine	Travel	Research	Additional	Total Duration
Female	554	630	917	539	2640
Male	628	639	581	460	2308

The female group spent longest in accomplishing the research task and shortest on the additional

[2] Task duration is the total span of active working time that is required to complete an information task.

task (Table 16). On the other hand, the male group spent the longest amount of time performing the travel task and the least on the additional task. It seemed that the female group finished the tasks with a longer average total duration than the male group did.

(3) Mean Time By Information Task and Academic Status

Table 17. Mean Time (sec.) by Task and Academic Status

STATUS	Medicine	Travel	Research	Additional	Total Duration
Undergraduate	317	482	324	400	1522
Mater's	647	713	1029	622	3011
Doctor's	463	398	493	263	1616
Faculty	580	568	663	289	2099

The undergraduate group spent less time in doing the medicine and research tasks than did on the other tasks, the additional and travel tasks (Table 17). The research task was the one that all the other groups worked more time on. All the groups except the undergraduate one spent longest in performing the research task and the shortest amount of time doing the additional task. They tended to spend longer time to accomplish all the tasks than the undergraduate group did.

(4) Mean Time By Information Task and Academic Disciplines

Table 18. Mean Time (sec.) by Task and Academic Disciplines

DISCIPLINES	Medicine	Travel	Research	Additional	Total Duration
Engineering	742	670	594	352	2357
Health sciences	719	542	645	364	2270
Natural sciences	510	255	405	198	1368
Social sciences	486	684	991	640	2802

It was noticed that the subjects in engineering, health sciences, and natural sciences spent longest performing the medicine task and the shortest amount of time on the additional task (Table 18). On the other hand, the social science group seemed to spend more time on the research task than the other tasks. It took the shortest time for this group to finish the medicine task. The natural science group finished all the tasks most quickly with a mean total duration of 1368 seconds. The social science group spent more time to accomplish the tasks than the other groups did.

4.4.7 Multidimensional Factors on Task Priority

The results of the content analysis indicate that the perceived attributes of information tasks may influence the way people prioritize multiple information tasks. The researcher decided to further analyze the data using a quantitative technique to see if there were any other factors influencing the decision the subjects made on task priority. This section discusses the results of the additional statistical analysis on task priority.

Table 19. Multidimensional Measures on Task Priority (I)

PRIORITY	Difficulty	Importance	Interest	Knowledge/ Familiarity	Complexity	-
1	3.615	8.275	7.715	5.335	5.595	-
2	4.275	6.250	7.105	6.130	6.130	-
3	4.705	6.865	6.840	6.415	5.735	-
4	5.300	7.075	7.195	6.280	6.410	-
PRIORITY	Mental Effort	Affective State	Temporal State	Performance (Success)	Performance (Satisfaction)	Duration
1	4.065	2.420	2.555	9.455	9.125	534.200
2	4.460	3.820	4.205	7.920	7.810	590.800
3	5.045	3.970	4.075	8.530	8.585	725.300
4	5.860	4.780	3.895	7.220	7.225	706.550

Table 19 describes the mean scores of different task attributes, mental effort, affective state, temporal demand, performance (success and satisfaction), and duration based on the task priority. The mean scores from the self-report ratings were calculated based on the data from the pre-questionnaires (i.e., perceived task demands) and post-questionnaires (i.e., mental effort, affective state, temporal demand, performance). Time duration data was extracted from the search logs.

The results in Table 19 show that the subjects chose first less difficult and more important tasks, investing less effort, experiencing less negative emotional conditions, thereby resulting in high performances. In this case, the individuals spent less time on the first task than the last one.

Table 20. Effects of Emotion, Time, and Performance on Task Priority

		Affective State	Temporal Demand	Performance (Success)
Effect		Sig.†	Sig.†	Sig.†
PRIORITY	Pillai's Trace	.048	.011	.040
	Wilks' Lambda	.048	.011	.040
	Hotelling's Trace	.048	.011	.040
	Roy's Largest Root	.048	.011	.040

† Computed using alpha = .05

In addition, the results of the data analysis using multivariate tests in Table 20 indicate that the levels of affective state, temporal demand, and performance (success) are associated with behaviors of prioritizing multiple information tasks: the p-values of affective, temporal, behavioral measures are less than .05.

Based on these results, we could say that the processes of prioritizing multiple information tasks are influenced by our perceptions toward tasks, e.g., task difficulty, task complexity, etc. People may choose first a less challenging task since they think the task can be easily done with their abilities, experiencing less emotional barriers and time pressure, thereby producing high performance outcomes. It seems clear that emotional and temporal aspects play an important role in managing dynamic and complex information situations.

4.5 RESEARCH QUESTION 3

<u>**Research Question 3:**</u> **What are the relationships of task demand, mental effort, affective state, temporal demand, and performance in the process of prioritizing and coordinating multiple tasks in Web information seeking and retrieval contexts?**

Table 21 describes the average scores of the multiple aspects associated with task prioritization and coordination in terms of the task.

Table 21. Multidimensional Measures on Individual Information Task (I)

	Medicine		Travel		Research		Additional	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Difficulty	3.870	2.1258	4.465	1.9680	5.690	2.3657	3.870	1.8388
Importance	8.585	2.4692	5.365	2.6039	8.550	2.0075	5.965	3.3137
Interest	7.540	3.2047	6.585	3.3611	6.150	3.1081	8.580	2.6333
Knowledge/Familiarity	4.815	3.1179	5.800	2.5381	6.455	2.6518	7.090	2.0619
Complexity	5.830	2.6474	5.315	2.5646	7.775	2.2148	4.950	3.0626
Mental Effort	4.685	2.5236	4.715	2.2115	5.940	3.2419	4.090	2.8011
Affective State	3.025	2.6248	3.765	2.3647	4.925	3.2973	3.275	2.8988
Temporal Demand	2.780	1.8171	4.185	2.7130	4.560	2.8840	3.205	2.3141
Performance (Success)	9.010	2.0047	7.265	3.1174	7.900	2.7719	8.950	2.3332
Performance (Satisfaction)	8.740	2.5124	7.275	3.4127	8.030	2.8603	8.700	2.6921
Duration	572.20	339.995	632.35	436.576	833.05	532.620	519.25	318.951

The results in Table 21 show that the medicine task was considered the least difficult and familiar with the mean scores with 3.8 and 4.8, respectively and most important with a mean of 8.5. The subjects felt the least emotional and temporal demands while working on the medicine task resulting in the highest levels of success and satisfaction regarding their performances.

The travel task was considered the least important ($\bar{X}$=5.3) with the lowest levels of overall success ($\bar{X}$=7.2) and satisfaction ($\bar{X}$=7.2). The additional task was evaluated as the least difficult ($\bar{X}$=3.8) and complex ($\bar{X}$=4.9) one. The subjects also thought that the additional task was most interesting ($\bar{X}$=8.5) and familiar ($\bar{X}$=7.0), requiring the least level ($\bar{X}$=4.0) of cognitive processing to perform the task. The subjects spent the least amount of time to conduct the additional task with a mean duration of 519 seconds.

The research task was considered most difficult ($\bar{X}$=5.6), complex ($\bar{X}$=7.7), and the least interesting ($\bar{X}$=6.1). It seemed that the subjects invested a high level of mental effort ($\bar{X}$=5.9). It was noticed that the levels of emotional state and temporal demand were highly evaluated while the subjects were working on the research task. They also seemed to spend longest in finishing the research task (833 sec.).

The additional task was considered most interesting ($\bar{X}$=8.5) and familiar ($\bar{X}$=7.0) and the least difficult ($\bar{X}$=3.8) and complex ($\bar{X}$=4.9). It was noticed that the subjects invested less time (519 sec.) and mental effort ($\bar{X}$=4.0) on the additional task than the other tasks.

This data was further analyzed to see if there were any statistically significant relations among the variables. The results of this analysis are discussed in the following sections.

4.5.1 Correlation Measures: Medicine Task

Table 22 presents the results regarding the correlations of the variables on the medicine task. It was found that among the task attributes, difficulty was negatively associated with knowledge/familiarity (r = -.446) and importance was positively related to interest (r = .876). Task difficulty had a positively relationship with the degrees of mental effort (r = .517) and affective state (r = .456). In terms of behavioral dimension, the degree of success was positively associated with several task attributes including task importance (r = .529), interest (r = .524), and knowledge/familiarity (r = .642). The level of satisfaction was related only with one task attribute, knowledge/familiarity (r = .558). In cognitive dimension, it was noticed that several significant relationships existed between mental effort and other variables, including affective state (r = .639) and temporal demand (r = .449). Interestingly, the degrees of success (r = -.446) and satisfaction (r = -.532) were negatively associated with the level of cognitive processing. It was found that a significant relationship existed between affective state and temporal demand (r = .532). The emotional degree was negatively associated with the levels of success (r = -.472) and satisfaction (r = -.473). A very strong relationship (r = .925) existed between success and satisfaction.

4.5.2 Correlation Measures: Travel Task

The results in Table 23 indicate that among the task attributes, task importance was positively associated with interest (r = .612) and knowledge/familiarity (r = .444). A positively significant relationship (r = .627) was found between interest and knowledge/familiarity. It was noticed that mental effort was related to affective state (r = .641), temporal demand (r = .458), both positively, and success negatively (r = -.501). It was found that there was a significant relationship (r = .604) between affective state and temporal demand. The degree of emotional state was also negatively associated with overall performance, including success (r = -.752) and satisfaction (r = -.719). There was a significant relationship between temporal demand and performance: success (r = -.718) and satisfaction (r = -.700). In the travel task, it was also found that the level of success was strongly related to the level of satisfaction.

4.5.3 Correlation Measures: Research Task

Table 24 shows that among the task attributes, importance was related to complexity (r = .449) and duration (r = .568). There was a significant relationship between interest and performance: success (r = .533) and satisfaction (r = .595). It was noticed that mental effort was associated with several variables including affective state (r = .680), temporal demand (r = .669), success (r = -.638), and satisfaction (r = -.615). Affective state was related to temporal demand positively (r = .509) and performance negatively (success, r = -.751; satisfaction, r = -.682). The degree of temporal demand was positively associated with task duration (r = .483) and negatively related to both success (r = -.563) and satisfaction (r = -.596). A significant relationship (r = .941) existed between success and satisfaction.

4.5.4 Correlation Measures: Additional Task

In Table 25, for the additional task, task complexity was associated with both difficulty (r = .562) and interest (r = .473). It was found that task interest perceived was related to importance (r = .465) and time spent (r = .482). It was noticed that the degree of mental effort was associated with several variables including affective state (r = .737), performance (success, r = -.548; satisfaction, r = -.448), and duration (r = .580). Affective state was also negatively related to performance (success, r = -.611; satisfaction, r = -.530). A significant relationship existed between the level of temporal demand and the time spent on the task (r = .464). In the additional task, the level of success was also strongly related to the level of satisfaction (r = .943).

Table 22. Medicine Task Correlation Matrix

		Difficulty	Importance	Interest	Knowledge/ Familiarity	Complexity	Mental Effort	Affective State	Temporal Demand	Performance (Success)	Performance (Satisfaction)	Duration
Difficulty	Pearson Correlation	1	-.267	-.078	-.446*	.400	.517*	.456*	.211	-.300	-.230	-.059
	Sig. (2-tailed)		.255	.743	.049	.081	.020	.043	.371	.199	.329	.806
Importance	Pearson Correlation		1	.876**	.280	.236	-.265	-.394	-.226	.529*	.334	.097
	Sig. (2-tailed)			.000	.231	.317	.259	.086	.337	.017	.150	.683
Interest	Pearson Correlation			1	.336	.300	-.095	-.088	.118	.524*	.365	.231
	Sig. (2-tailed)				.147	.198	.689	.711	.621	.018	.114	.326
Knowledge/ Familiarity	Pearson Correlation				1	.157	-.412	-.113	-.060	.642**	.558*	.112
	Sig. (2-tailed)					.509	.071	.635	.803	.002	.011	.637
Complexity	Pearson Correlation					1	.149	.046	-.054	.070	.063	-.043
	Sig. (2-tailed)						.531	.848	.821	.771	.792	.858
Mental Effort	Pearson Correlation						1	.639**	.449*	-.446*	-.532*	.360
	Sig. (2-tailed)							.002	.047	.049	.016	.119
Affective State	Pearson Correlation							1	.532*	-.472*	-.473*	.331
	Sig. (2-tailed)								.016	.035	.035	.154
Temporal Demand	Pearson Correlation								1	-.119	-.070	.315
	Sig. (2-tailed)									.617	.769	.176
Performance (Success)	Pearson Correlation									1	.925**	.020
	Sig. (2-tailed)										.000	.935
Performance (Satisfaction)	Pearson Correlation										1	-.147
	Sig. (2-tailed)											.536
Duration	Pearson Correlation											1
	Sig. (2-tailed)											

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed)

Table 23. Travel Task Correlation Matrix

		Difficulty	Importance	Interest	Knowledge/ Familiarity	Complexity	Mental Effort	Affective State	Temporal Demand	Performance (Success)	Performance (Satisfaction)	Duration
Difficulty	Pearson Correlation†	1	.151	-.021	.089	.261	-.026	.233	-.116	-.160	-.177	.290
	Sig. (2-tailed)		.525	.930	.710	.266	.912	.323	.626	.501	.455	.215
Importance	Pearson Correlation		1	.612**	.444*	.310	-.037	-.246	-.162	.337	.324	-.027
	Sig. (2-tailed)			.004	.050	.183	.875	.295	.496	.146	.164	.909
Interest	Pearson Correlation			1	.627**	.394	.216	-.157	-.168	.148	.231	-.131
	Sig. (2-tailed)				.003	.086	.361	.509	.480	.532	.326	.581
Knowledge/ Familiarity	Pearson Correlation				1	.121	.162	-.258	-.315	.185	.277	-.222
	Sig. (2-tailed)					.611	.495	.272	.177	.434	.236	.347
Complexity	Pearson Correlation					1	-.393	-.281	-.238	.161	.174	.232
	Sig. (2-tailed)						.087	.230	.312	.498	.464	.324
Mental Effort	Pearson Correlation						1	.641**	.458*	-.501*	-.347	.115
	Sig. (2-tailed)							.002	.042	.024	.134	.631
Affective State	Pearson Correlation							1	.604**	-.752**	-.719**	.292
	Sig. (2-tailed)								.005	.000	.000	.211
Temporal Demand	Pearson Correlation								1	-.718**	-.700**	.122
	Sig. (2-tailed)									.000	.001	.609
Performance (Success)	Pearson Correlation									1	.967**	-.397
	Sig. (2-tailed)										.000	.083
Performance (Satisfaction)	Pearson Correlation										1	-.371
	Sig. (2-tailed)											.107
Duration	Pearson Correlation											1
	Sig. (2-tailed)											

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed)

Table 24. Research Task Correlation Matrix

		Difficulty	Importance	Interest	Knowledge/ Familiarity	Complexity	Mental Effort	Affective State	Temporal Demand	Performance (Success)	Performance (Satisfaction)	Duration
Difficulty	Pearson Correlation	1	-.039	-.284	-.268	.432	.437	.372	.230	-.414	-.416	.062
	Sig. (2-tailed)		.872	.225	.253	.057	.054	.107	.329	.069	.068	.797
Importance	Pearson Correlation		1	.280	.300	.449*	.005	-.048	.087	.089	.092	.568**
	Sig. (2-tailed)			.231	.199	.047	.982	.840	.715	.709	.700	.009
Interest	Pearson Correlation			1	.374	-.112	-.160	-.273	-.259	.533*	.595**	-.078
	Sig. (2-tailed)				.104	.638	.500	.245	.270	.015	.006	.743
Knowledge/ Familiarity	Pearson Correlation				1	.023	.046	-.050	-.294	.238	.284	-.163
	Sig. (2-tailed)					.922	.847	.835	.208	.312	.225	.492
Complexity	Pearson Correlation					1	.181	.206	.315	-.294	-.284	.428
	Sig. (2-tailed)						.446	.383	.176	.208	.225	.060
Mental Effort	Pearson Correlation						1	.680**	.669**	-.638**	-.615**	.197
	Sig. (2-tailed)							.001	.001	.002	.004	.405
Affective State	Pearson Correlation							1	.509*	-.751**	-.682**	.259
	Sig. (2-tailed)								.022	.000	.001	.270
Temporal Demand	Pearson Correlation								1	-.563**	-.596**	.483*
	Sig. (2-tailed)									.010	.006	.031
Performance (Success)	Pearson Correlation									1	.941**	-.233
	Sig. (2-tailed)										.000	.323
Performance (Satisfaction)	Pearson Correlation										1	-.279
	Sig. (2-tailed)											.233
Duration	Pearson Correlation											1
	Sig. (2-tailed)											

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed)

Table 25. Additional Task Correlation Matrix

		Difficulty	Importance	Interest	Knowledge/ Familiarity	Complexity	Mental Effort	Affective State	Temporal Demand	Performance (Success)	Performance (Satisfaction)	Duration
Difficulty	Pearson Correlation	1	.441	.257	.111	.562**	.332	.288	.398	-.061	.095	.318
	Sig. (2-tailed)		.051	.275	.641	.010	.152	.218	.082	.798	.691	.171
Importance	Pearson Correlation		1	.465*	.399	.241	.241	.267	.412	-.020	.116	.306
	Sig. (2-tailed)			.039	.082	.306	.305	.256	.071	.934	.626	.190
Interest	Pearson Correlation			1	.012	.473*	.263	.279	.152	-.146	-.108	.482*
	Sig. (2-tailed)				.960	.035	.262	.233	.523	.539	.650	.031
Knowledge/ Familiarity	Pearson Correlation				1	.052	.025	.124	.139	.279	.363	.086
	Sig. (2-tailed)					.828	.918	.602	.559	.234	.116	.720
Complexity	Pearson Correlation					1	.014	-.075	.234	.123	.260	.116
	Sig. (2-tailed)						.952	.753	.321	.605	.268	.625
Mental Effort	Pearson Correlation						1	.737**	.388	-.548*	-.448*	.580**
	Sig. (2-tailed)							.000	.091	.012	.048	.007
Affective State	Pearson Correlation							1	.153	-.611**	-.530*	.240
	Sig. (2-tailed)								.521	.004	.016	.309
Temporal Demand	Pearson Correlation								1	.041	.142	.464*
	Sig. (2-tailed)									.864	.552	.039
Performance (Success)	Pearson Correlation									1	.943**	-.070
	Sig. (2-tailed)										.000	.770
Performance (Satisfaction)	Pearson Correlation										1	.058
	Sig. (2-tailed)											.809
Duration	Pearson Correlation											1
	Sig. (2-tailed)											

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

5.0 DISCUSSION AND CONCLUSION

This study aimed at understanding how people manage multiple information tasks while interacting with Web technologies especially with a focus on task prioritization and coordination behaviors. In 5.1, the major findings from the data analysis with regard to the three research questions addressed in this study are discussed. The research questions were as follows:

1. What are the general characteristics of human prioritizing and coordinating information behaviors in information seeking and retrieval contexts on the Web?
2. What are the factors which influence the processes of prioritizing multiple information tasks during information seeking and retrieval in Web environments?
3. What are the relationships of task demand, mental effect, affective state, temporal demand, and performance in the processes of prioritizing and coordinating multiple tasks in information seeking and retrieval contexts on the Web?

In 5.2, a model based on the empirical results and findings is presented. Discussions of implication, limitation, and future research are subsequently followed.

5.1 DISCUSSION OF MAJOR FINDINGS

Research Question 1: What are the general characteristics of human prioritizing and coordinating behaviors in information seeking and retrieval contexts on the Web?

The content analysis identified six major categories and ten sub-categories of information task prioritization and coordination behavior, which were inductively derived from the data of think-aloud utterances, post-search interviews, and search logs.

Twenty subjects made a total of 1072 statements associated with information task prioritization and coordination behaviors during the search and interview sessions. The statements were categorized into prioritization (N=93), coordination (N=799), mental effort (N=12), affective state (N=26), temporal demand (N=60), and performance (N=82).

A total of 93 instances were categorized into prioritization. Most of them were related to task attributes such as task difficulty, task importance, task interest, task knowledge/familiarity, and task complexity.

The subjects made statements of attributes of sources and information to a greater extent during the processes of coordinating the information tasks, accounting for 62% of the total instances. Other reports that the subjects made during the processes of information task coordination include task switching, tabbed browsing, and strategic search planning.

Six facets of attributes of sources emerged including author/creator credentials, TLD type, familiarity, preference, reputation, and source type. Attributes of information were characterized with eleven facets including accurate, basic, current, good, important, interesting, official, relevant, reliable, scholarly, and useful.

Among the coordination related occurrences, attributes of sources (N=273, 25.5%) and attributes of information (N=398, 37.1%) were the sub-categories that the subjects mentioned most while they were engaging in the information tasks. It appears that the subjects often stated multiple attributes at the same time when accessing and using information and sources. For example, “outdated but reliable,” “useful, reliable, interesting.”

There were only 12 instances related to mental effort and 26 instances associated with affective state. 60 instances were coded as temporal demand including sub-categories of duration (N=54) and urgency (N=6). There were 82 occurrences related to performance, characterized with sub-categories of completion (N=55), don’t know (N=7), and others (N=20).

Self-feedback is thought to play an important role in evaluating performance during/after the performances. Self-feedback can be considered as a metacognitive tool which is highly related to an individual’s performance or learning. People with a self-feedback mechanism tends to be well aware of what he or she knows/does (often in problematic situations). For some people, physically salient stimuli are not only often difficult to ignore, but they may also interfere with the ongoing task (Iani & Wickens, 2004). The interrupted task that is accompanied by self-feedback is often positively influenced in terms of performance. For example,

> Okay, now I’ve gotten away from what I was doing. I think that’s the problem with the Internet. There are too many distractions. (S03, Research Task)

> … I was distracted by the birds. (S07, Additional Task)

What exactly am I trying to accomplish here? …… I'm not staying on task though. (S11, Research Task)

In these examples, the subjects were aware of they were interrupted by unexpected things during the searches. This awareness helped them ignore the things and continue to do their searches and complete the information tasks. It seems clear that performance feedback plays an important role in individuals' efforts to manage multiple task activities over time (Cummings, 1978).

From the findings, it appears that human prioritizing and coordinating behaviors in the contexts of information seeking and retrieval are different depending on the task, age, gender, academic status, and academic discipline. In other words, task characteristics and our individual backgrounds play a role in the way we deal with multiple information tasks while using the Web.

In terms of interactions of task attributes and prioritizing behaviors, for the medicine task and the travel task, task difficulty was the most important factor influencing the processes of prioritizing the information tasks. Complexity was the major factor for the research task. It was noticed that knowledge/familiarity was considered most as a priority factor for the additional task. The subjects were asked to create their own additional information tasks at the beginnings of their performances. This could influence the way people perceived the additional information tasks during the process of prioritizing the multiple information tasks.

Among the coordinating activities, tabbed browsing behavior was frequently found across all the information tasks. Task switching was occurred most during the research task. It appears that these two coordinating behaviors (tabbed browsing and task switching) are closely related to time management, especially when people face demanding information tasks. For example, one subject (S04), who perceived the research task as difficult and complex, chose her additional task, which was easy and familiar supplement to the research task. In this case, she completed all the tasks with less time duration, utilizing task switching technique and managing time efficiently. Here is another example:

> … the Carnegie library's data bases, …… looks interesting to me. ….. it's from scholarly… journals. …… While that's working, …… I'm going to go back to skin cancer . . . ah ha, Medline Plus! …… skin cancer facts. Looks kind of reliable because it's cancer.org. American Cancer Society, there you go! …… seems like a good page …… so now I'm going to back to EBSCO Host . . . um . . . I'm going to limit my results to full texts, scholarly journals . . . and I want everything published within the last two years. ……. No results were found …… So I'm going to go back to the Google tab. (S08, Medicine Task)

In this example, the subject used multiple searching tools, such as academic databases and commercial web search engines at the same time utilizing tabbed browsing technique. She did not wait till the database page was fully opened and decided to open a new tab to search with Google. When failing to find satisfactory results, she switched to another tab, which was already opened, to continue her search. In this case, she accomplished all the tasks with less time duration. This is a good example how people actually manage their time efficiently especially while coordinating their multiple information tasks on the Web.

> …I used this (task switching) technique to maximize use of my time, especially because some windows took a while to load… I searched in several tasks or windows for different topics (what I sometimes do on my own time). I feel I completed all tasks faster (total time). (S19)

In another example, this subject involved task switching activities using multiple windows for different tasks at the same time, resulting in high productivity of performance. He was also well aware of spending his time in an optimal way.

It seems that patterns of solving information problems are related to levels of task knowledge/familiarity people have. The occurrences regarding problem solving (or strategic search planning) were found in the additional tasks most and in the research task the least. It appears that people have specific strategic plans at the beginnings of their searches when engaging in information tasks, which are highly familiar with. In this case, they clearly know which search terms to use and what sites to go. For example,

> This task was the easiest because I have done some searching for library jobs before and knew how to go about it… I've already done a little bit of the searching for, because I'm interested to see what library jobs are out there, because I'll be graduating. …… there are all different kinds of sites that I can go to. There's USA, www.usa, uh, jobs.gov, and that has government jobs. …… And then there's this good website, …… libraryjobpostings.org. …… it's a pretty good resource. …… the University of Pittsburgh …… the ALA education and employment, …… it has a lot of good stuff…. (S09, Additional Task)

This subject perceived his additional task as the easiest one among the information tasks since he was highly familiar with the task. It seems that he had a specific strategic plan for the task. He also spent the shortest amount of time to complete his additional information task.

On the other hand, people tend to initiate their actions in a broad perspective when faced with information tasks they do not know well. They use general keywords at the beginning and often go through the processes of reformulating their search terms. They also try to first get a picture of what kinds of information is needed to solving their problems. For example, “we’ll just do a Google search to get me started because I’m not sure.” (S02, Travel Task). In this study some people initiated their searches simply by googling when they worked on tasks which were less familiar.

High performing people seem to plan tasks earlier, shift more often between the tasks, and involve tabbed browsing when faced with complex and dynamic information task situations under time pressure. It seems clear that difficult or specific tasks that are accompanied by feedback have the most positive impact on performance and the task performance is influenced by the plan developed (Puffer, 1989).

It appears that the subjects were concerned with the quality of sources for the medicine task to a greater extent than they did for the other tasks. They paid closer attention to the quality of information for the research task than did for the other tasks. For example,

> …the CDC…it’s cdc.gov, so maybe I’ll just go for it…Oh, this looks like it’s a good source… (S02, Medicine Task).

> …I used Google Scholar, …the website at University of Pittsburgh. Dot… pitt.edu. Um, to find articles in books, … let's focus on… academic search premiere turned up 0, (Lexus Nexus) turned up 125. Looks like many are just based generally on… turnips. … Um, that's peroxidase in general, not in the turnip phase. …Let's look at the Google search. It looks like the Google search may be slightly more fruitful, but throws a wider net. One thing that's useful ……This looks like it might be a useful article. (S04, Research Task).

People tend to access and use different types of information and sources depending on the information task they engage in. They often depend on current, official, and reliable resources for medicine related tasks, and scholarly and good resources for research oriented tasks.

Temporal expressions occurred more frequently when the subjects engaged in the research task and additional task. It was found that people often made statements of task switching and temporal demand at the same time while performing an information task, which was perceived highly difficult and complex. For example,

> …So I have another half an hour … By 1:10 … This one (Research Task) I figured would take me a long time to find this information because it's pretty broad… I'm gonna go back to the second one (Travel Task) in a little bit… (S02, Research Task)

In this example, the subject seemed to be aware of time when performing the research task, which was considered highly difficult and complex. To manage the multiple information tasks efficiently, she decided to switch to the travel task and then come back to the research task later.

Task difficulty was mentioned most by the youngest group (age 18-21) as a priority factor. Activities related to coordination, such as tabbed browsing and task switching hardly occurred in this age group. They also did not have any strategic directions to solving their problems. The subjects in the 22-29 age group considered task complexity as a major factor of task priority. Coordinating activities, such as tabbed browsing and planning (both broad and specific) were found to a greater extent in this age group. This group also expressed temporal concerns more often while engaging in an information task than did other groups. For the age group of 30-39, both task difficulty and task knowledge/familiarity were the major factors influencing their prioritizing behaviors. It seems that people in this age group have more specific strategic planning/problem solving at the beginnings of their performances in general. Affective remarks were made more often by this group. Task interest appears to be a main factor of prioritizing activity for the oldest group (age 40 and over). People in this group tend to express their feelings and emotions more often and be aware of time while engaging in coordination activities such as task switching.

Overall, the male group mentioned the attributes of tasks influencing the process of prioritizing the tasks to a greater extent than did the female group. Among the task attributes, difficulty was found to be the major priority factor for the male group and both difficulty and complexity for the female group. The female group coordinated the information tasks through task switching and tabbed browsing and expressed their feelings and time concerns to a greater extent than did the male group. The male group seems to be more concerned about the attributes of sources than the female group while the female group considered about the attributes of information more frequently.

The undergraduate student group mentioned the attributes of tasks influencing task prioritization most and the faculty members none. Task difficulty was mentioned most frequently by the undergraduate student group, task complexity by the graduate student group, and both task importance and interest by the doctoral student group. The undergraduate students were not active coordinators in general. They did not involve any coordinating activities, such as task switching, tabbed browsing, and strategies to solving their problems during the searches. It was noticeable that the faculty group did not prioritize the information tasks and performed them in the order as listed. It seems that the people in this group most frequently engaged in a variety of coordination activities, such as task switching, tabbed browsing, and strategic planning. The faculty group seems to be seriously concerned about the quality of sources. Expressions regarding their feelings, emotions, and temporal concerns rarely occurred during their performances.

The social science group mentioned the category of prioritization to a greater extent than did other groups in engineering, health sciences, and natural sciences. Among the task attributes, the social science group considered both difficulty and complexity most as the factors of task priority. Importance was most frequently occurred in the engineering group as a priority factor. The natural science group most frequently engaged in task switching and tabbed browsing while coordinating the information tasks. During their performances, prioritizing behavior did not occur. In other words, the natural science group conducted their tasks without a prioritizing process and they followed the given list from the 1st task down. Emotional and temporal expressions were rarely found in this group. Even though the occurrences associated with coordination activities were not frequently found in the engineering group, they seemed to plan out their actions to solving the information problems at the beginnings of the search session, as concerning the aspects of temporal demand and task importance to the greatest extent. The health science group seems to utilize most a Web browser's tabbed browsing feature and the social science group appears to have strategic plans to solving their problems during their performances.

In regard to time duration, the group between the ages of 18-21 spent the shortest time on the medicine task and longest on the travel task. All the other age groups spent the longest amount of time performing the research task. It seems that there is an age difference in performing a task in terms of duration. The youngest group completed all the tasks with the shortest average total duration while the age group of 21-29 did with the longest one. The subjects in the 21-29 age group also spent the longest amount of time in performing the research task.

The female group spent longest in accomplishing the research task and shortest on the additional task. On the other hand, the male group spent the longest amount of time performing the travel task and the least on the additional task. It was noticed that the female group finished the tasks with a longer average total duration than did the male group.

The undergraduate group spent less time in doing the medicine and research tasks than did on the other tasks, the additional and travel tasks. The research task was the one that all the other groups worked more time on. All the groups except the undergraduate one spent longest in performing the research task and the shortest amount of time doing the additional task. They tended to spend longer time to accomplish all the tasks than did the undergraduate group.

It was noticed that the groups in engineering, health sciences, and natural sciences spent longest performing the medicine task and the shortest amount of time on the additional task. On the other hand, the social science group seemed to spend more time on the research task than the other tasks. It took the shortest time for this group to finish the medicine task. The natural science group finished all the tasks most quickly with a mean total duration of 1368 seconds. The social science group spent more time to accomplish all the information tasks than did the other groups.

In Web information seeking and retrieval contexts, our coordinating activities are thought to entail several activities at the same time, such as shifting between the information tasks, engaging in tabbed browsing, planning search strategies, and evaluating information quality during multiple information task performances. Coordinating multiple information tasks aims at producing high productivity of performance and high efficiency of time management in general.

When faced with a demanding information task or unsatisfactory search results, people often do not complete the information task. They switch to another task and decide to come back to the previous one later. Individuals with tabbed browsing behaviors often produce high performance outcomes by retrieving the information they need and managing the tasks they engage in effectively and productively.

Individuals planning search strategies at the beginnings of their performances also seem to yield high performances in multiple task information situations. For example, they plan out their actions including what to focus on, which sites to visit, and what search terms to use in advance. People tend to use general search terms if they are not familiar with information tasks. From our observation, individuals often initiate their searches simply by googling to solve their unfamiliar information tasks.

People seem to be well aware of the quality of information while interacting with the Web. It appears that the level of quality control of information is different depending on the task they engage in. For example, people tend to access and use more scholarly, current, and authoritative information for research and medicine related tasks than entertainment oriented tasks.

When faced with information tasks of high difficulty and complexity, individuals seem to engage more in coordinating activities (especially task switching and tabbed browsing) since these individuals believe that the most time-effective course of action in such situations is not to completely finish one information task before moving to another, but to shift between them as appropriate.

The perceived attributes of an information task in interaction with an individual's ability influence task performance. How we perceive the information task acts as a trigger in processing and managing multiple information tasks in complex and dynamic information situations. More demanding, difficult, and complex information tasks are generally expected to evoke more stress and frustration than simple information tasks, often preventing people from producing successful performance outcomes.

The results of this study indicate that differential perceptions of information tasks are related to our affective and cognitive reactions, which in turn are associated with information task performance outcomes. Our prioritizing and coordinating behaviors in information seeking and retrieval contexts may depend on what we perceive the information tasks to be. When we face an information task which is perceived to be easy relative to our abilities, we may try mentally less as experiencing less emotional frustrations and temporal constraints. This is partially due to knowing that no extra effort needed to accomplish the information task that is perceived to be well mastered (Salomon, 1984). In the opposite situation, successful performance outcome may depend on how we effectively control negative emotional conditions we have and efficiently manage time we have.

Research Question 2: What are the factors which influence the processes of prioritizing multiple tasks in information seeking and retrieval contexts on the Web?

In content analysis, most of occurrences related to prioritization (N=93) were responses to the question during the post-search interviews asking the factors which were considered in prioritizing the multiple tasks. Task difficulty (N=23) and task complexity (N=22) are the factors that the subjects considered most during the process of task priority, followed by task knowledge/familiarity (N=17), task interest (N=15), and task importance (N=10). Six subjects performed the tasks in the order as listed. For example,

- do what is at the top of the list first (S07)
- I sort of followed the list from the 1st task down (S08)
- I completed the tasks in the order they were listed. This may be because in general I had a similar interest in all of them (S09)
- I had no more objectives than to finish the assignment. I started at the beginning and went to the end (S11)
- I did not prioritize the tasks as they seemed equally important for this test (S18)

People tend to perform difficult and complex information tasks later and plan to spend more time on them when faced with a situation in which they need to finish multiple tasks within certain time limit. The findings also indicate that when information tasks are considered similarly interesting or important, these tasks are done without any prioritizing activities.

Table 26. Multidimensional Factors on Task Priority (II)

PRIORITY	Difficulty	Importance	Mental Effort	Affective State	Temporal Demand	Performance (Success)	Performance (Satisfaction)	Duration (sec.)
1	3.62	8.28	4.07	2.42	2.56	9.46	9.13	534
2	4.28	6.25	4.46	3.82	4.21	7.92	7.81	591
3	4.70	6.87	5.05	3.97	4.08	8.53	8.59	725
4	5.30	7.08	5.86	4.78	3.90	7.22	7.23	707

Further statistical analysis of the data related to task priority from the rating scales shows that multi-dimensional factors influence the way people prioritize and manage multiple information tasks. Table 26 presents the major findings of the data analysis. The perceived characteristics of information tasks have an impact on prioritizing behaviors. People seem to first choose the tasks, which are less difficult ($\bar{X}$=3.6 on the 12 cm rating scale) and more important ($\bar{X}$=8.3) and decide to perform highly difficult and less important tasks later.

People invest less their cognitive effort ($\bar{X}$=4.1) on the first task, which is less difficult and more important, experiencing less affective load ($\bar{X}$=2.4) and less temporal demand ($\bar{X}$=2.6), and therefore resulting in higher success ($\bar{X}$=9.5) and satisfaction ($\bar{X}$=9.1) in performing the information task for the shortest time period ($\bar{X}$=534 sec.). In contrast, they try harder ($\bar{X}$=5.9) on the last task, which is more difficult, feeling more stress and frustration ($\bar{X}$=4.8) and time pressure ($\bar{X}$=4.0), and resulting in lower success ($\bar{X}$=7.2) and satisfaction ($\bar{X}$=7.2) in accomplishing the information task for longer time duration ($\bar{X}$=707 sec.).

The findings of this study are similar to the previous studies on task prioritization in human factors: Colvin’s (2000) study identified prioritization factor that includes strong effects of task importance, suggesting that the processes of prioritizing task are dependent on the characteristics of the task context. Freed’s (2000) study also show that task prioritization in uncertain environments under time pressure is influenced by importance, urgency, and time duration.

People may lack the skills to perform difficult or demanding information tasks or may have emotional barriers such as low self-confidence or a fear of failure. They may also delay challenging tasks in order to collect information or learn the requisite skills (Puffer, 1989).

In addition, multivariate tests, computed using alpha=.05, show that among the multiple measures, affective state (p=.048), temporal demand (p=.011), and success (p=.040) are significantly associated with our behavior of prioritizing information tasks. So we can say that people choose first the easy task because they feel confident about solving the problem, which is less challenging, investing less cognitive effort and feeling less frustration and time pressure, thus producing higher success in task performance. This positive attitude toward the tasks helps them deal with the information tasks effectively and accomplish their ultimate task goals.

Prioritizing behavior in information seeking and retrieval contexts is influenced not only by the perceived characteristics of an information task, but also by the levels of affective state and temporal demand. These factors subsequently affect the amount of effort to be invested, the levels of performances (e.g., success and satisfaction), and the total time spent on each task. All these multi-dimensional factors are dependent on each other, as dynamically interacting during the processes of human prioritizing and coordinating behavior in a situation where there are multiple information tasks to be completed under time pressure.

Research Question 3: What are the relationships of task demand, mental effect, affective state, temporal demand, and performance in the processes of prioritizing and coordinating multiple tasks in information seeking and retrieval contexts on the Web?

Human prioritizing and coordinating information behavior consists of multiple components. The success of task prioritizing and coordinating activities depends on how people bring those different elements into a relationship that will ensure efficiency or harmony.

Table 27. Multidimensional Measures on Individual Information Task (II)

	Medicine	Travel	Research	Additional
Difficulty	3.87	4.47	5.69	3.87
Importance	8.59	5.37	8.55	5.97
Interest	7.54	6.59	6.15	8.58
Knowledge/Familiarity	4.82	5.80	6.46	7.09
Complexity	5.83	5.32	7.78	4.95
Mental Effort	4.69	4.72	5.94	4.09
Affective State	3.03	3.77	4.93	3.28
Temporal Demand	2.78	4.19	4.56	3.20
Performance (Success)	9.01	7.27	7.90	8.95
Performance (Satisfaction)	8.74	7.28	8.03	8.70
Duration (sec.)	572	632	833	519

Table 27 lists the measures used and the mean for each scale across the information tasks. The mean scores of the measures are found to be different depending on the information task the subjects engaged in. A dynamic relationship seems to exist among the measures, which are associated with task prioritization and coordination behavior.

The medicine task was considered the least difficult and familiar with the mean scores with 3.8 and 4.8, respectively and most important with a mean of 8.5. The subjects felt the least emotional ($\bar{X}$=3.0) and temporal demands ($\bar{X}$=2.7) while working on the medicine task resulting in the highest levels of success ($\bar{X}$=9.0) and satisfaction ($\bar{X}$=8.7) regarding their performances.

The travel task was considered the least important ($\bar{X}$=5.3) with the lowest levels of overall success ($\bar{X}$=7.2) and satisfaction ($\bar{X}$=7.2). The additional task was evaluated as the least difficult ($\bar{X}$=3.8) and complex ($\bar{X}$=4.9) one. The subjects also thought that the additional task was most interesting ($\bar{X}$=8.5) and familiar ($\bar{X}$=7.0), requiring the least level ($\bar{X}$=4.0) of cognitive processing to perform the task. The subjects spent the least amount of time to conduct the additional task with a mean duration of 519 seconds.

The research task was considered most difficult ($\bar{X}$=5.6), complex ($\bar{X}$=7.7), and the least interesting ($\bar{X}$=6.1). It seemed that the subjects invested a high level of mental effort ($\bar{X}$=5.9). It was noticed that the levels of emotional state ($\bar{X}$=4.9) and temporal demand ($\bar{X}$=4.1) were highly evaluated while the subjects were working on the research task. They also seemed to spend longest in finishing the research task (833 sec.).

The additional task was considered most interesting ($\bar{X}$=8.5) and familiar ($\bar{X}$=7.0) and the least difficult ($\bar{X}$=3.8) and complex ($\bar{X}$=4.9). It was noticed that the subjects invested less time (519 sec.) and mental effort ($\bar{X}$=4.0) on the additional task than the other tasks.

The correlations between the measures were examined at the significant levels of .01 and .05. Table 28 shows the dynamic interplays of the components of human multiple information task interaction on the Web, employing a matrix to represent/visualize the numeric data in a meaning way.

Statistically significant relationships exist among the perceived attributes of the information tasks. Interest is related with importance (r=.88, medicine task; r=.61, travel task; r=.47, additional task). Knowledge/familiarity is associated with both importance (r=.44, travel task) and interest (r=.63, travel task). At the same time, knowledge/familiarity is negatively correlated with difficulty (r=-.45, medicine task). Complexity is associated with multiple task attributes, including difficulty (r=.56, additional task), importance (r=.45, research task), and interest (r=.47, additional task). Interesting information tasks are considered important. When people feel that the have some experience with some information task or they are familiar with the information task, they think the task is more important and interesting and less challenging. A complex information task is perceived as more difficult, important, and interesting.

Both mental effort (r=.52, medicine task) and affective state (r=.46, medicine task) are correlated with the perceived degree of task difficulty. Negative perceptions toward an information task (e.g., higher task difficulty) lead people to try harder but this feeling counteracts and increases stress and frustration. This might be caused by low self-confidence in performing the task.

In terms of performance, task importance (r=.53, medicine task), interest (r=.52, medicine task; r=.53, research task), and knowledge/familiarity (r=.64, medicine task) are all significantly correlated with success. Among them, only task interest (r=.60, research task) and knowledge/familiarity (r=.56, medicine task) are significantly related to satisfaction. There is a significant correlation between duration and task importance (r=.57, research task). Duration is also correlated with task interest (r=.48, additional task). It seems that people perform better with higher satisfaction when faced with more important, interesting, and familiar information tasks. In addition, they tend to spend more time on interesting and important tasks to complete.

It should be noticed that there are dynamic correlations among other measures, including mental effort, affective state, temporal demand, performance, and duration, for most of all the information tasks.

Mental effort is positively associated with multiple measures, such as affective state (r=.64, medicine task; r=.64, travel task; r=.68, research task; r=.74, additional task), temporal demand (r=.45, medicine task; r=.46, travel task; r=.67, research task), and duration (r=.58, additional task). At the same time, the cognitive measure is negatively correlated with performance in terms of success (r=-.45, medicine task; r=-.50, travel task; r=-.64, research task; r=-.55, additional task) and satisfaction (r=-.53, medicine task; r=-.62, research task; r=-.45, additional task).

Another measure, which is related to multiple dimensions is affective state. It was found that a statistically significant relationship exists between affective state and temporal demand (r=.53, medicine task; r=.60, travel task; r=.51, research task). Affective state is also negatively correlated with performance, with respect to success (r=-.47, medicine task; r=-.75, travel task; r=-.75, research task; r=-.61, additional task) and satisfaction (r=-.47, medicine task; r=-.72, travel task; r=-.68, research task; r=-.53, additional task).

A negative correlation exists between temporal demand and performance in terms of success (r=-.72, travel task; r=-.56, research task) and satisfaction (r=-.70, travel task; r=-.60, research task). In addition, temporal demand is positively correlated with duration (r=.48, research task; r=.46, additional task). There is a highly significant correlation between success and satisfaction (r=.93, medicine task; r=.97, travel task; r=.94, research task; r=.94, additional task).

Those with higher cognitive effort experienced more stress and frustration and higher temporal demand, resulting in lower level of performance, even though they spent more time to finish the information task. It seems that cognitive, emotional, temporal, and behavioral aspects are closely related to each other across the tasks. When people consider a task demanding (e.g., higher difficulty or complexity), they often become frustrated. In this case, even though they try harder to solve the problem for a longer time period, their negative emotional state prevents them from performing the task successfully. In other words, high degree of temporal demand and negative emotional state lead people to perform the task poorly even though they invest more mental effort on the task. Our feelings and emotions seem to play a key role in our ability to dealing with a situation where multiple information tasks need to be done within certain time limit.

Table 28. Interactions of the Components of Information Task Prioritization and Coordination Behavior

	Difficulty	Importance	Interest	Knowledge/ Familiarity	Complexity	Mental Effort	Affective State	Temporal Demand	Performance (Success)	Performance (Satisfaction)	Duration
Difficulty				-.446*[MT]	.562*[AT]	.517*[MT]	.456*[MT]				
Importance			.876***[MT] .612**[TT] .465*[AT]	.444*[TT]	.449*[RT]				.529*[MT]		.568*[RT]
Interest				.627**[TT]	.473*[AT]				.524*[MT] .533*[RT]	.595*[RT]	.482*[AT]
Knowledge/ Familiarity									.642**[MT]	.558*[MT]	
Complexity											
Mental Effort							.639**[MT] .641**[TT] .680**[RT] .737**[AT]	.449*[MT] .458*[TT] .669**[RT]	-.446*[MT] -.501*[TT] -.638**[RT] -.548*[AT]	-.532*[MT] -.615**[RT] -.448*[AT]	.580*[AT]
Affective State								.532*[MT] .604**[TT] .509*[RT]	-.472*[MT] -.752**[TT] -.751**[RT] -.611**[AT]	-.473*[MT] -.719**[TT] -.682**[RT] -.530*[AT]	
Temporal Demand									-.718**[TT] -.563*[RT]	-.700**[TT] -.596*[RT]	.483*[RT] .464*[AT]
Performance (Success)										.925***[MT] .967***[TT] .941***[RT] .943***[AT]	
Performance (Satisfaction)											
Duration											

Note 1: * means moderate correlation; ** strong correlation; *** very strong correlation
Note 2: MT stands for Medicine Task; TT, Travel Task; RT, Research Task; AT, Additional Task

5.2 CONCLUSION

In this chapter, the theoretical model presented in Figure 2 on page 31 is revisited with the empirical results and findings of this study. This revised model is then followed by discussions on implications, limitation, and future research.

5.2.1 Model Revisited

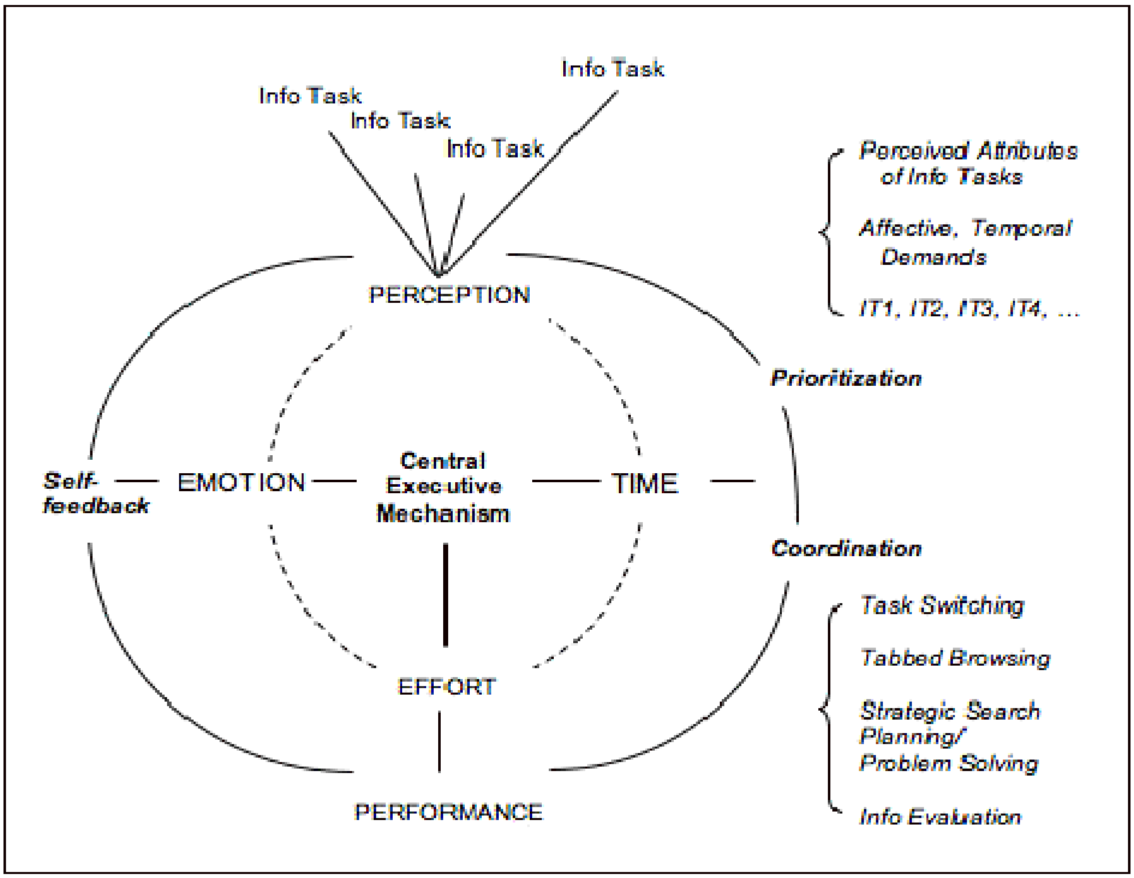

Figure 3. Model of Human Prioritizing and Coordinating Information Behavior

The model in Figure 3 is about what processes individuals engage in to manage multiple information tasks. The model shows how individuals carry out multiple information tasks in dynamic and complex information situations under time pressure. It indicates that, at the inner level, self-regulating individuals engage in information task perceptions and then, emotional, mental, and temporal reactions, which are followed by emotion control, effort application, and time management by individuals' central executive mechanisms. Once initial processes are operated at the internal level, a signal is sent out to the outer level to prioritize and coordinate multiple information tasks. The model further suggests that individuals monitor and coordinate their internal (i.e., emotion, effort, and time) and external (i.e., performance) activities through continuous self-feedback. Coordinating activities entail task switching, tabbed browsing, strategic search planning, and information evaluation, which are all closely related to time management.

When people face an information task of high difficulty and complexity in multiple information task circumstances, they may experience higher emotional anxiety and frustration, higher temporal demand, and higher cognitive demand. In this case, our negative emotional reactions (e.g., confusion, uncertainty, stress, etc.) on difficult information tasks prevent us from dealing with such situations effectively and efficiently, even though we tend to try harder on the demanding information task. This indicates that our emotions and feelings play a more powerful role in managing dynamic and complex information situations than other activities (e.g., mental effort).

With empirical evidence of this study, it may be reasonable to claim that: effort, time, or perception may all be necessary factors in producing good performance in dynamic and complex information environments. But how we control our emotions and feelings ultimately yields successful performance or learning. High mental effort, even when accompanied by productive time management, is not sufficient to produce high performance unless we effectively deal with our emotions and feelings in such situations.

5.2.2 Implications

This study had three purposes. The first was to understand the general characteristics of human prioritizing and coordinating information behavior in Web information seeking and retrieval contexts. The findings indicate that people are different in dealing with multiple information tasks in terms of the task they engage in and their backgrounds, e.g., age, gender, academic status, academic discipline. The second purpose of this study was to identify the factors which influence the processes of prioritizing multiple information tasks. The results show that human prioritizing behavior is affected by task attributes such as task difficulty and task importance. How people control emotion and manage time during their performances also plays a key role in dealing with such situations. The final purpose of this study was to investigate the correlations of perception, effort, emotion, time, and performance during information seeking and retrieval in multiple information task situations. It was found that dynamic interactions exist among the multidimensional attributes of human prioritizing and coordinating information behavior.

Humans have inhabited dynamic, volatile information environments since the advent of the Web. As Web information environments become more complex and dynamic, people often find themselves faced with multiple information tasks or goals while interacting with Web information technologies. Our adaptation occurs from our ability to process information effectively and adapt our information behavior accordingly. Despite the values, current studies of human-information interaction have limitations to explain our adaptive information behavior in dynamic and complex Web information environments.

The model presented in this study describes the dynamic internal and external processes people employ in order to efficiently and effectively deal with their multiple information tasks while interacting with the Web. It offers a deep insight into how multidimensional components of an individual’s behavior of managing multiple information tasks are functionally coordinated and put into effect. In addition to providing an understanding of human prioritizing and coordinating information behavior, the model can be used to enlighten existing areas of human information behavior. It also can be used as a theoretical base to design information systems which support efficient and effective human-information interaction and human-computer interaction in complex and dynamic information seeking and retrieval environments.

Research on human behavior in multiple task situations show that individual differences may exist in the ability to plan and carry out multiple information task in an optimal way (Schneider & Fisk, 1982; Tsang & Wickens, 1988). Performance differences in managing demanding information situations while utilizing new information technologies may not be random; they can be sufficiently predictable that we are able to begin to control them (Borgman, 1989). According to a learning point of view, it would be desirable for people to be able to plan their actions in advance and take into account what they know and do not know, which is referred to as metacognitive strategies.

Metacognition is any knowledge or cognitive activity that takes as its object, or regulates, any aspect of any cognitive enterprise (Anderson, 1995): The general idea is that metacognition consists of cognition about one's own cognition. It includes metacognitive knowledge-that is, knowledge about one's own cognitive abilities and limitations. Metacognition also includes metacognitive experiences, things that happen to you that pertain to your knowledge or understanding of your own cognitive processes, e.g., experiences of uncertainty or doubt, and periods of deep reflection over your performance, decision-making, or values.

Given a set of tasks to perform under time pressure, some individuals with high metacognition may come closer to an optimal multiple-task strategy of performance than others (Waller, 1997). Research on human multiple task performance show that individuals' behaviors result in better performances than other behaviors (Schneider & Fisk, 1982). For instance, individuals who effectively allocate their cognitive and physical resources to each task generally perform better than those individuals who less effectively allocate resources to tasks (Schneider & Fisk, 1982). Individuals who reallocate priorities at times of increased demands generally achieve higher performance than those individuals who do not so adjust (Tsang & Wickens, 1988). It seems to be clear that there may be individual differences in the ability to plan and carry out multiple information task performance in an optimal way.

From a system design of view, it would be recommendable for systems to support a user's individuality to close the gaps in performance differences. Adaptive (also called personalized) information systems are designed to deal with the fact that the users are individuals, taking into account individual features such as goals/tasks, knowledge, background, hyperspace experience, preferences and interests (Brusilovsky, 2001). To build such systems human-friendly, system designers first need to understand interactions between humans and information as well as interactions between humans and information systems.

Researchers in human-information interaction and human-computer interaction try to incorporate the concept of human multiple task performance to design of adaptive user interfaces. Creating effective user interfaces require acquiring knowledge of a phenomenon, that is, understanding how people actually deal with multiple information task situations physically, cognitively, and emotionally under dynamic and complex circumstances. The model presented in this study can be employed as a theoretical foundation for designing human-friendly adaptive user interfaces, which function as intelligent and affective central mechanisms and help users to prioritize, monitor and coordinate their needs/tasks/goals effectively and efficiently.

5.2.3 Limitations

The main purpose of this study was to get an understanding the phenomenon of human prioritizing and coordinating information behavior in Web environments. To seek knowledge for this research problem experimentation was run in a laboratory setting. Experimentation has its greatest control capacity in the laboratory study, where strong internal validity is often gained at the expense of external validity (Krathwohl, 2004). The advantage of adopting experimental method is reflected in the results of this study (i.e., strong correlations between the measures): Perceptions toward multiple information tasks influence our emotional reactions. These affective states play an important role in investing our efforts and managing time. The ability to control such multiple information task situations with our own central mechanisms at the inner level is in turn related to overall task performances.

There is a trade-off between internal validity (i.e., linking power) and external validity (i.e., generalizing power). This study was conducted in a laboratory using a small sample size. This may decrease the generalization of the findings of this study. The lack of generality can be reinforced by a larger sample size in different settings in future research. In natural conditions, researchers might use different designs (but still recommended to use triangulation for the validity of data collected), for example, letting participants keep diaries to record their thoughts, actions, etc. during/after their performances. In this case, subjects might have their own information problems, so with this research design it would be possible to get an extended understanding of human prioritizing and coordinating behavior in different contexts.

5.2.4 Future Research

The findings of this study indicate that people differ in their information behaviors in multiple task situations. They may be not the same in the ability to orchestrate the components of prioritizing and coordinating behaviors. Or they may have different styles in managing tasks in such contexts.

A style is considered to be a fairly fixed, inbuilt characteristic of an individual, while a strategy is a well-planned series of actions that may be used to cope with situations and tasks (Riding and Cheema, 1991). Cognitive style refers to an individual's preferred and habitual approach to processing information (Riding and Rayner, 1998).

The dimension of cognitive style identified by Witkin is field dependence and field independence (Witkin *et al.*, 1977). Field-independent individuals tend to experience the components of a task analytically. By contrast relatively field-dependent individuals tend to be less good at such analytic activity and to perceive a complex task/problem globally as a whole.

Another dimension of cognitive style is the holist-serialist, named by Pask (Pask, 1972). The holist is cognitively flexible and likes to juggle multiple tasks at the same time, engaging in task switching behaviors across the tasks. In contrast the serialist tends to manage tasks carefully and in a particular order, focusing on details.

In future research, how individual differences and cognitive styles are associated with our dynamic and complex information behaviors in digitally connected environments can be explored. The purpose of such studies is simply obtaining an understanding of the phenomenon around us. Such understanding can lead to eventual practical applicability (Krathwohl, 2004). There is normally a long lead time between publication of results and their incorporation into major developments (Mosteller, 1981).

Studies on individual differences and similarities in patterns formed by human minds in dealing with such dynamic and complex information situations can provide significant implications for the designs of information systems in e-learning environments.

A further comprehensive understanding of the emotional, cognitive, and physical processes underlying human prioritizing and coordinating behavior is vital if we are to develop better information systems of supporting people to manage demanding information situations and offering helpful guides for those with performance/learning disabilities.

APPENDIX A

DESCRIPTIONS OF ASSIGNED INFORMATION TASKS

TASKS

(given in random order)

- [MEDICINE] One of your family members has just been diagnosed as having skin cancer, and you want to learn about the disease and medical treatments (e.g., currently existing and newly developed). You are also interested to know how to protect yourself from the disease.

- [TRAVEL] You and your best friend are planning to travel somewhere you can enjoy one of your favorite sports. You are trying to figure out how to prepare for this adventure and what kinds of information you need.

- [RESEARCH] You are currently working on a term project. You have still enough time to finish it but you want to work hard on this one and get a good grade because you are really interested in the topic of the term project. Now, you are trying to find some good materials, which can provide some background information of the topic area you chose for the term project.

- [ADDITIONAL TASK]

APPENDIX B

INSTRUCTIONS FOR INFORMATION TASKS

GENERAL INSTRUCTIONS OF TASKS

Now, you are about to start your session for four different tasks: three assigned tasks and one non-assigned task.

There are three important things you need to keep in mind during the session:

- First, you will have *ONE HOUR* to complete your session and decide the amount of time per task you wish to allot.

- Second, You will make decisions on *TASK PRIORITIES*. You can move the tasks around and change the amount of time per task as needed during the session.

- Third, you will be asked to *THINK ALOUD* during the session, that is, you will be required to verbalize your thoughts while performing (e.g., reasons for your actions).

Please assume that you are actually involved in a real situation in which you have four different tasks to accomplish at the same time under a time constraint. Try to act as normally as you can.

APPENDIX C

PREQUESTIONNAIRE

For Research Use:
Subject #: _________
Place: _____________
Date: ______________

PREQUESTIONNAIRE

PART I: GENERAL BACKGROUND INFORMATION

HOW LONG HAVE YOU BEEN USING THE WEB TO LOOK FOR INFORMATION?

____

HOW OFTEN DO YOU USE THE WEB FOR INFORMATION?

❑ Daily ❑ Weekly ❑ Monthly ❑ Never

WHICH WEB BROWSER DO YOU USE MOST FREQUENTLY FOR INFORMATION?
(Ex. Internet Explorer, Netscape, Mozilla, FireFox, Safari, Etc.)

____

Reason: ______________________________________

WHICH WEB SEARCH ENGINE DO YOU USE MOST FREQUENTLY FOR INFORMATION?
(Ex. Google, Yahoo!, Vivisimo, Etc.)

____

Reason: ______________________________________

WHAT IS YOUR ACADEMIC STATUS?

❑ Undergraduate ❑ Graduate (Doctoral) ❑ Professor
❑ Graduate (Master's) ❑ Post-doctorate ❑ Other __________

PLEASE INDICATE ALL THE COLLEGE/UNIVERSITY DEGREES THAT YOU HAVE (OR EXPECT TO HAVE):

Degree	Major	Year
Degree	Major	Year
Degree	Major	Year
Degree	Major	Year

WHAT IS YOUR GENDER? ❑ Female ❑ Male

WHAT IS YOUR AGE? __________

PART II: TASK DEMAND

INSTRUCTIONS: PLACE A MARK ON EACH SCALE THAT REPRESENTS THE MAGNITUDE OF EACH FACTOR IN THE TASKS. (NOTE: MT – MEDICINE TASK; TT - TRAVEL TASK; RT - RESEARCH TASK; AT – ADDITIONAL TASK).

Example:

MT LOW | ____________ X ______________________________ | HIGH

**

DIFFICULTY: JUDGE YOUR PERCEIVED LEVEL OF DIFFICULTY ON EACH TASK.

MT LOW | ______________________________ | HIGH

TT LOW | ______________________________ | HIGH

RT LOW | ______________________________ | HIGH

AT LOW | ______________________________ | HIGH

IMPORTANCE: JUDGE YOUR PERCEIVED LEVEL OF IMPORTANCE ON EACH TASK.

MT LOW | ______________________________ | HIGH

TT LOW | ______________________________ | HIGH

RT LOW | ______________________________ | HIGH

AT LOW | ______________________________ | HIGH

INTEREST: JUDEGE YOUR PERCEIVED LEVEL OF INTEREST ON EACH TASK.

MT LOW | ______________________________ | HIGH

TT LOW | ______________________________ | HIGH

RT LOW | ______________________________ | HIGH

AT LOW | ______________________________ | HIGH

KNOWLEDGE/FAMILIARITY: JUDGE YOUR LEVEL OF KNOWLEDGE/FAMILIARITY ON EACH TASK.

MT LOW | ______________________________ | HIGH

TT LOW | ______________________________ | HIGH

RT LOW | ______________________________ | HIGH

AT LOW | ______________________________ | HIGH

COMPLEXITY: JUDGE YOUR PERCEIVED LEVEL OF COMPLEXITY ON EACH TASK.

MT	LOW	| ________________________________ |	HIGH
TT	LOW	| ________________________________ |	HIGH
RT	LOW	| ________________________________ |	HIGH
AT	LOW	| ________________________________ |	HIGH

** END OF PREQUESTIONNAIRE **
THANK YOU

APPENDIX D

POSTQUESTIONNAIRE

For Research Use:
Subject #: _________
Place: _____________
Date: ______________

POSTQUESTIONNAIRE

INDICATE HOW YOU ORDERED THE TASKS:

TASK	NO.
MEDICINE	
TRAVEL	
RESEARCH	
ADDITIONAL	

INSTRUCTIONS: PLACE A MARK ON EACH SCALE THAT REPRESENTS THE MAGNITUDE OF EACH FACTOR IN THE TASKS YOU JUST PERFORMED. THE NUMBERS (e.g., TASK1) INDICATE THE ORDER IN WHICH THE TASKS WERE CARRIED OUT.

TASK DEMAND:

How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, important or trivial, interesting or boring, familiar or less knowledgeable, simple or complex?

DIFFICULTY: JUDGE YOUR EXPERIENCED LEVEL OF DIFFICULTY ON EACH TASK

TASKI: LOW | ______________________________ | HIGH

TASK2: LOW | ______________________________ | HIGH

TASK3: LOW | ______________________________ | HIGH

TASK4: LOW | ______________________________ | HIGH

IMPORTANCE: JUDGE YOUR EXPERIENCED LEVEL OF IMPORTANCE ON EACH TASK.

TASKI: LOW | ______________________________ | HIGH

TASK2: LOW | ______________________________ | HIGH

TASK3: LOW | ______________________________ | HIGH

TASK4: LOW | ______________________________ | HIGH

INTEREST: JUDGE YOUR EXPERIENCED LEVEL OF INTEREST ON EACH TASK.

TASKI:	LOW	|	________________	|	HIGH
TASK2:	LOW	|	________________	|	HIGH
TASK3:	LOW	|	________________	|	HIGH
TASK4:	LOW	|	________________	|	HIGH

KNOWLEDGE/FAMILIARITY: JUDGE YOUR EXPERIENCED LEVEL OF KNOWLEDGE/FAMILIARITY ON EACH TASK.

TASKI:	LOW	|	________________	|	HIGH
TASK2:	LOW	|	________________	|	HIGH
TASK3:	LOW	|	________________	|	HIGH
TASK4:	LOW	|	________________	|	HIGH

COMPLEXITY: JUDGE YOUR EXPERIENCED LEVEL OF COMPLEXITY ON EACH TASK.

TASKI:	LOW	|	________________	|	HIGH
TASK2:	LOW	|	________________	|	HIGH
TASK3:	LOW	|	________________	|	HIGH
TASK4:	LOW	|	________________	|	HIGH

MENTAL EFFORT:

How hard did you have to work mentally to accomplish your level of performance?

Descriptions of rating mental effort:

- LOW: Very little conscious mental effort or concentration required. Activity is almost automatic, requiring little or no attention.
- MODERATE: Moderate conscious mental effort or concentration required. Complexity of activity is moderately high due to uncertainty, unpredictability, or unfamiliarity. Considerable attention required.
- HIGH: Extensive mental effort and concentration are necessary. Very complex activity requiring total attention.

TASKI:	LOW	|	________________	|	HIGH
TASK2:	LOW	|	________________	|	HIGH
TASK3:	LOW	|	________________	|	HIGH
TASK4:	LOW	|	________________	|	HIGH

AFFECTIVE/PSYCHOLOGICAL LEVEL:

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Descriptions of rating affective/psychological level:

- LOW: little confusion, risk, frustration, or anxiety exists and can be easily accommodated.
- MODERATE: Moderate stress due to confusion, frustration, or anxiety. Significant compensation is required to maintain adequate performance.
- HIGH: High to very intense stress due to confusion, frustration, or anxiety. High to extreme determination and self-control required.

TASKI: LOW | ______________________________ | HIGH

TASK2: LOW | ______________________________ | HIGH

TASK3: LOW | ______________________________ | HIGH

TASK4: LOW | ______________________________ | HIGH

TEMPORAL DEMAND:

How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Descriptions of rating temporal demand:

- LOW: Often have spare time. Interruptions or overlap among activities occur infrequently or not at all.
- MODERATE: Occasionally have spare time. Interruptions or overlap among activities occur frequently.
- HIGH: Almost never have spare time. Interruptions or overlap among activities are very frequent, or occur all the time.

TASKI: LOW | ______________________________ | HIGH

TASK2: LOW | ______________________________ | HIGH

TASK3: LOW | ______________________________ | HIGH

TASK4: LOW | ______________________________ | HIGH

PERFORMANCE (goals of task):

Describe the goals of each task set by yourself:

TASK 1: ______________________________

TASK 2: ______________________________

TASK 3: ______________________________

TASK 4: ______________________________

PERFORMANCE (levels of success):

How successful do you think you were in accomplishing the goals of the task set by yourself?

TASKI:	POOR	| ______________________ |	EXCL
TASK2:	POOR	| ______________________ |	EXCL
TASK3:	POOR	| ______________________ |	EXCL
TASK4:	POOR	| ______________________ |	EXCL

PERFORMANCE (levels of satisfaction):

How satisfied were you with your performance in accomplishing these goals?

TASKI:	LOW	| ______________________ |	HIGH
TASK2:	LOW	| ______________________ |	HIGH
TASK3:	LOW	| ______________________ |	HIGH
TASK4:	LOW	| ______________________ |	HIGH

END OF POSTQUESTIONNAIRE
THANK YOU

APPENDIX E

POST-SEARCH INTERVIEW PROTOCOL

For Research Use:
Subject #: __________
Place: ______________
Date: _______________
Time: _______________

POST-SEARCH INTERVIEW PROTOCOL

(Briefly describe the purpose of the interview)

Questions:

- What factors were considered in prioritizing the multiple information tasks?

- Was it difficult to coordinate or/and complete the multiple tasks at the same time with the time limit?

- Did you switch between the tasks? If so, please explain the reason why you did so.

- [Additional question]:

- [Additional question]:

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