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Abstract

Purpose – The purpose of this paper is to explore the general nature of human multiple information task behavior in Web information seeking and retrieval contexts and identify the factors that influence the processes of prioritizing mul.tiple information tasks.

Design/methodology/approach – Experiments were conducted in a laboratory setting to collect data from multiple sources including search logs, think aloud reports during the searches and interviews, questionnaires, and post-search interviews. Quantitative and qualitative analysis techniques were both used.

Findings – The findings of this study reveal that effort, time and perception may all be necessary factors in producing good performance in dynamic and complex information situations, but how the author effectively manages the emotions ultimately yields successful performance. High mental effort, even when accompanied by productive time management, is not sufficient to produce high performance unless the author effectively deal with the emotions and feelings in such situations.

Originality/value – A comprehensive understanding of the affective, cognitive, and physical processes underlying the human multiple information task behavior is vital if the author is to design emotionally intelligent information systems that can support people when managing dynamic and complex information situations in hi-tech environments.

Keywords Coordination, Emotion, Emotionally intelligent information system, Human multiple information task behavior, MIT behavior model, Prioritization

Paper type Research paper

1. Introduction

People live in the world of ever-changing information technologies and such environments have been bringing us new ways of accessing and utilizing information. Due to the dynamism and strength of hi-tech information environments, we are getting more involved in multiple information task situations.

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 the information seeking and retrieval processes. Studies in human 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 *et al.*, 2002, 2006). In this case, people may batch their information problems or tasks and decide to solve these problems or tasks simultaneously (Spink, 2004). Studies also indicate that searches performed by users may have multiple goals, topics, or problems in information seeking and retrieval contexts (Miwa, 2001; Spink, 2004).

Even though some studies in human information behavior 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 the human multiple information task interaction phenomena (e.g. Bates, 1989; Dervin, 1983; Ellis *et al.*, 1993; Kuhlthau, 1993; Vakkari, 2001). Such models are limited to explaining the process of information access and use while carrying out a single task (Spink and Park, 2005).

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

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behavioral phenomenon is still under-researched in the contexts of information seeking and retrieval. Theoretical and empirical studies are needed to further the understanding of how humans handle multiple information tasks. The research problem addressed represents the increasing need for a greater understanding of human multiple information task interaction in information seeking and retrieval contexts.

The purpose of this study is to explore the nature of human multiple information task behavior on the Web. More specifically, this study aims at understanding the general characteristics of multiple information task behavior and the factors affecting information task priority.

2. Related studies

Different theoretical and experimental approaches to understanding multiple task performance suggest that researchers are far from agreeing on how to explain the multiple task behavior. 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 and Sohn, 2000; Just *et al.*, 2001; Lee and Taatgen, 2002; Rubinstein *et al.*, 2001).

Research in experimental psychology has focused on the repetitive performance of individual perceptual-motor and cognitive tasks (Rubinstein *et al.*, 2001). Just *et al.* (2001) tried to understand multiple task performance in a neuro-cognitive science perspective. From a micro-level of multiple task performance, this study provides an explanation of the reason we are unable to pay attention to and perform many tasks simultaneously; the cognitive limitation in multiple task performance causes a decline in brain activity.

Another field that has been studying multiple task performance is human-computer interaction, which has captured the interest of computer and information scientists. Miyata and Norman's study (1986) gives us a good example of system support for multiple activities. The example demonstrated by Miyata and Norman gives us an insight on 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.

In human information behavior, Spink *et al.* (2002) identified the multitasking processes of information seeking and searching in four different studies: excite users using a survey, excite search sessions, mediated on-line searches, and university library users. The findings of this study show that multitasking information seeking and searching is a common behavior, the prevalence of multitasking information seeking and searching is not the same in different contexts, and multitasking sessions (with more search queries and topic changes) last longer than single searching sessions.

Spink *et al.* (2006) analyzed a 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: 81 percent of two-query sessions contain more than one information task, 91.3 percent of three or more query sessions contain more than one information task, multitasking search sessions include various information topics or problems.

Spink *et al.* (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.

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. 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 yet strong effects of task importance. Colvin (2000) suggests that the processes of prioritizing tasks are dependent upon the contextual characteristics of the task.

Freed (2000) found that task prioritization in uncertain environments under time pressure is influenced by four main information types: urgency (i.e. the time remaining to perform a task); importance (i.e. the cost of not performing 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 switching to another task).

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

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 and adjust their task performance (Iani and Wickens, 2004). How the central mechanisms orchestrate the elements of a dynamic and complex situation has long been of interest 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.

Recent studies in the fields of communication, education, cyberpsychology, media, and technology, show that multitasking has recently received growing attention and it is increasing among young generation (Brasel and Gips, 2011; Carrier *et al.*, 2009; Judd and Kennedy, 2011; Le *et al.*, 2012; Lee *et al.*, 2012; Yeykelis *et al.*, 2014). Young people, who grow up with advanced technologies and online networks, easily adjust themselves to nonlinear information processing behavior (Lin, 2009). Carrier *et al.*'s study (2009) also shows that changes in technological and social settings result in changes in the multitasking abilities of young generation. In terms of designing user-friendly interfaces, it needs to consider increasing usage of single devices displaying various kinds of content, rather than dividing attention between content on multiple devices (Yeykelis *et al.*, 2014). Digital technologies enable people to do many things simultaneously and smart multitasking is no longer an option in today's world (Le *et al.*, 2012).

3. Research design

The overall goal of this study is to investigate how people manage multiple information tasks while interacting with Web information systems in information seeking and retrieval contexts with a focus on understanding the general characteristics of human multiple task behavior and identifying the factors affecting the process of task priority during information seeking and retrieval on the Web.

This study did not intend to provide a clear-cut definition of human multiple information task behavior. Instead, the multiple dimensions of this phenomenon were characterized based on our observations on the verbal and written statements given by the subjects that were associated with prioritization and coordination in the contexts of information seeking and retrieval on the Web.

Experiments were conducted in a laboratory setting to collect data from multiple sources including search logs, think aloud reports during the searches and interviews, questionnaires, and post-search interviews. Pre- and post-questionnaires were applied to obtain the subjects' demographic information and task demands. Employing triangulation technique enhances the validity of the collected data.

In total, 20 volunteers were recruited regardless of their disciplinary and demographic backgrounds and academic status and therefore the subjects in the study are expected to be representative of the target population. A notice of recruitment was distributed through emailing lists and notice boards. The sample was drawn from diverse academic disciplines at a university, including Library and Information Science, Telecommunications, Environmental Studies, Sociology, Health and Community Systems, Nursing, and Health Information Management.

The subject was asked to create one information task. After finishing designing the task, s/he was given three different information tasks in random order. Each participant was asked to conduct four different information tasks (three assigned and one non-assigned) using a PC within a time limit of one hour. The three assigned tasks were related to medicine, travel, and research. The participants were requested to think aloud, i.e., verbalize their thoughts as they do actions. All actions were logged and analyzed. The verbal reports of the subjects 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 the search interaction to help the researcher probe the participants' responses and obtain clarification.

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.

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 (CR) formula (Holsti, 1969): $CR = 2M/N1+N2$, the ratio of coding agreement (M) 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. The assessment of intercoder reliability produced satisfactory levels for qualitative studies with distribution ranging from 0.77 to 1.00.

To avoid any impact of extraneous variables, the experimental conditions were maintained to the best extent for all 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).

The utilization of standardized instruments (e.g. partially structured questionnaires and interview protocols) and execution of the experiments in an established way (i.e. following the written procedures) produced replicable results. For data analysis, manual and automatic techniques were employed to ensure high reliability.

The analyzed data included questionnaires, search logs, and transcribed think aloud protocols and post-search interviews. The researcher integrated the collected data from three different sources: search logs, transcribed verbal reports, and transcribed post-search interviews. The reason for the integration 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, simultaneously. 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.

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. Content analysis was employed to identify and categorize: the perceived characteristics of an information task; the activities associated with task coordination; the factors, which influenced the process of prioritizing. 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 and Corbin, 1994).

4. Results

4.1 The classification

As shown in Table I, the content analysis in this study identified six major categories and ten sub-categories of multiple information task behavior, 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 and 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, and 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.

The results in Table II indicate that the frequencies (utterances counted) of the categories and sub-categories of multiple information task behavior are different depending on the task in general. Regarding prioritization, task difficulty was mentioned most for the travel task (6.2 percent), task complexity for the research task (3.1 percent), and task knowledge/familiarity for the additional task (3.7 percent).

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

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

Table I.
Categories: coding numbers and keywords

Table II. Frequencies of categories by task

Categories/sub-categories			Medicine		Travel		Research		Additional	
			Freq.	%	Freq.	%	Freq.	%	Freq.	%
100		*Prioritization*	*9*	*3.6*	*18*	*12.4*	*17*	*5.2*	*18*	*6.7*
		Perceived attributes of tasks	*9*	*3.6*	*18*	*12.4*	*17*	*5.2*	*18*	*6.7*
	110	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

(*continued*)

Categories/sub-categories			Medicine Freq.	Medicine %	Travel Freq.	Travel %	Research Freq.	Research %	Additional Freq.	Additional %
		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*		*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

Table II.

medicine task and the research task (both 5.5 percent). The subjects started with specific strategies at the beginning of the additional task (5.5 percent).

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 percent) than on the additional task (27.7 percent), research task (23.8 percent), and travel task (21.3 percent). They were attentive to the attributes of information to a greater extent for the research task (45.6 percent) 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 percent) and the research task (3.4 percent) 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.

4.2 Human multiple information task behavior: the content analysis

The content analysis revealed that, among the attributes of human multiple information task behavior, self-feedback may play a 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 tend to be well aware of their own knowledge and behavior (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 and Wickens, 2004). Interrupted tasks accompanied by self-feedback are 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 cases, the subjects were aware that they could be unexpectedly interrupted by unexpected 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).

In terms of interactions between 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 a major factor in the research task. It was noticed that knowledge/familiarity was considered as the factor with the highest priority for the additional task. The subjects were asked to create their own additional information tasks prior to their task execution. 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 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, to supplement the research task. In this case, she completed all the tasks in less time utilizing the 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 the tabbed browsing technique. She did not wait until the database page was fully opened and decided to open a new tab to search via Google. After 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 in less time than expected. This is a good example of how people actually manage their time efficiently, especially while coordinating 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).

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

It seems that patterns of solving information problems are related to the individual levels of task knowledge/familiarity. 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 prior to performing their searches when engaging in highly familiar information tasks. In this case, they were clearly aware of which search terms to use and 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 […] 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 in the beginning and often go through the processes of reformulating their search terms.

They first try to get a picture of the type of information that is needed to solve their problems. For example, "I'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.

People that demonstrate high performance seem to plan tasks earlier, shift more often between the tasks, and engage in 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 devised plan (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 they 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 […] Dot […] edu. Um, to find articles in books, […] let's focus on […] academic search premiere turned up 0, (Lexis Nexis) 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 as 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 case, the subject seemed to be aware of the time limit 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.

4.3 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 analyze the data further, using a quantitative technique to see if there were any other factors influencing the decision of the subjects on task priority. This section discusses the results of the additional statistical analysis on task priority.

Table III describes the mean scores of different task attributes, mental effort, affective state, temporal demand, performance (success and satisfaction), and duration based on 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, and performance). Time duration data was extracted from the search logs.

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 III. Multidimensional measures on task priority

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

In addition, the results of the data analysis using multivariate tests in Table III 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 were <0.05.

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 to execute a less challenging task first 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.

5. Discussion

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. The aim of coordinating multiple information tasks is to ensure high productivity 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

		Affective state	Temporal demand	Performance (success)
Effect		Sig.[a]	Sig.[a]	Sig.[a]
Priority	Pillai's trace	0.048	0.011	0.040
	Wilks' λ	0.048	0.011	0.040
	Hotelling's trace	0.048	0.011	0.040
	Roy's largest root	0.048	0.011	0.040

Note: [a]Computed using $\alpha = 0.05$

Table IV. Effects of emotion, time, and performance on task priority decide to come back to the previous one later. Individuals displaying 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 in the beginning 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 which search terms to use in advance. People tend to use generalized 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 they 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 how we perceive the information tasks. When we face an information task which is perceived to be easy relative to our abilities, we may try less mentally, experiencing less emotional frustrations and temporal constraints. This is partially due to knowing that no extra effort is 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.

In terms of task priority, 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 interesting or important to a similar extent, these tasks are done without any prioritization.

The findings of this study are similar to the previous studies on task prioritization in human factors: Colvin's (2000) study identified a 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 shows 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 before carrying out the tasks (Puffer, 1989).

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 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 behavior in a situation, in which multiple information tasks need to be completed within a time limit.

6. Conclusion: a model of human multiple information task behavior (MIT behavior model)

Park's recent study (2013) reveals the significant role of information seeker's emotional state as a factor in complex information seeking and retrieval contexts. Employing correlation measures, she explores the dynamic interplays of the components of multiple information task interaction. In this study, people get emotionally frustrated when facing highly difficult and complex tasks. Even though they invest more cognitive effort on the tasks, this negative emotional state leads to low performance in terms of success and satisfaction. The findings of this study imply that the success of multiple information task behavior depends on how people bring different human/task elements (e.g. perception, cognition, emotion, task attributes, etc.) into efficient and harmonious relationships in such dynamic and complex information situations, suggesting an "emotionally intelligent" information system as a solution.

Along with Park (2013)'s study, the findings here lead to a model of how people interact with multiple information tasks. The model in Figure 1 shows the processes individuals engage in to manage multiple information tasks in terms of how multiple information tasks are carried out in dynamic and complex information situations under time pressure. It indicates that, at an internal 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 the initial processes are operated at the internal level, a signal is sent out to the external 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 under multiple information task circumstances, they may experience higher emotional anxiety and frustration, temporal demand, and cognitive demand. In this case, our negative emotional reactions (e.g. confusion, uncertainty, stress, etc.) to 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 role in managing dynamic and complex information situations.

Based on the 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

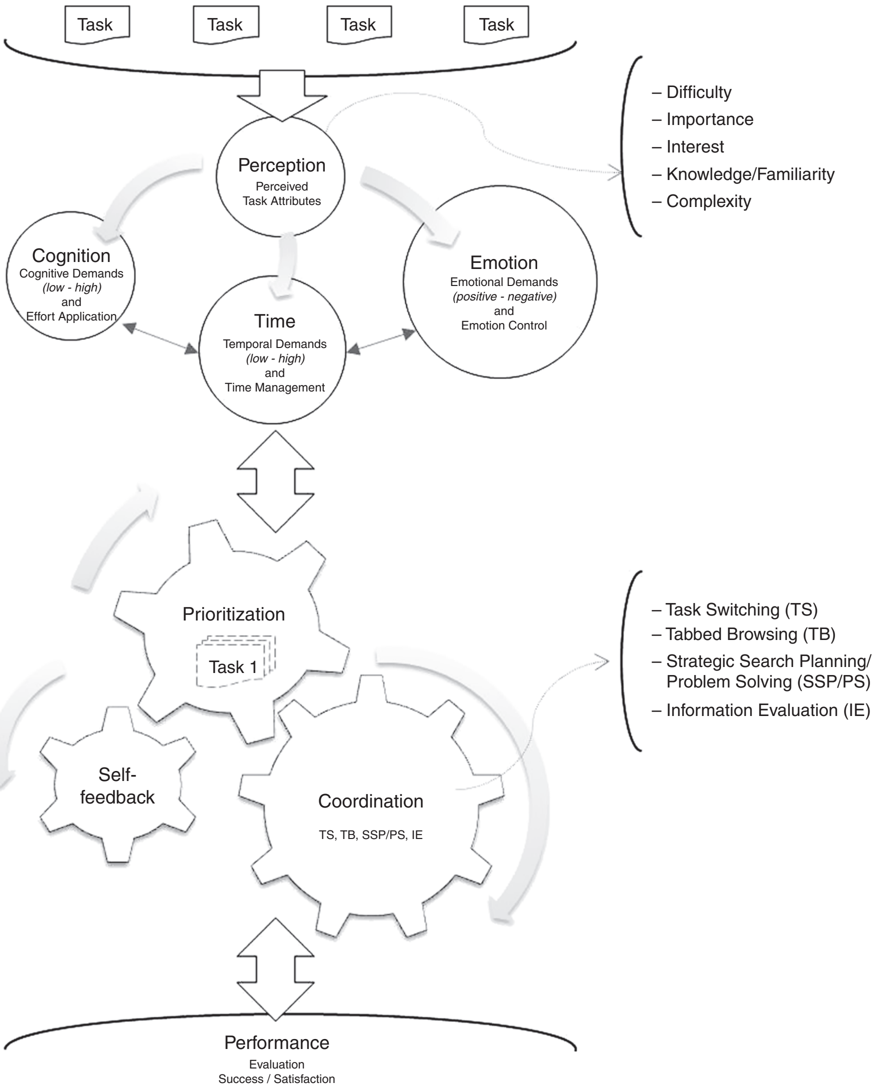

Figure 1.
Model of human multiple information task behavior (MIT behavior model)

high performance unless we effectively deal with our emotions and feelings in such situations.

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 considering the interaction with information systems to perform multiple tasks (Budzik and 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 and Hammond, 2000; Maglio *et al.*, 2000).

A comprehensive understanding of the affective, cognitive, and physical processes underlying the human multiple information task behavior is vital if we are to design emotionally intelligent information systems that can support people when managing dynamic and complex information situations in hi-tech environments.

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