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Impact of Gender and Age on performing Search Tasks Online

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Abstract

More and more people use the Internet to carry out tasks of their daily work routine. To find the right information online Web search engines are the tools of their choice. Apart from finding facts, people use search engines to also execute rather complex and time consuming search tasks. So far search engines have been following the one-for-all approach to serve its users and little is known about the impact of gender and age on people's Web search performance. In this article we present a study that examines (1) how female and male Web users carry out simple and complex search tasks, and (2) how the age of the users impacts their search performance. The laboratory study was done with 56 ordinary people carrying out 12 search tasks each. Our findings confirm that age impacts the search performance significantly while gender influences were smaller than expected.

1 Introduction

Due to the unprecedented growth of the Internet and it steadily being integrated into our daily routines, more and more tasks are carried out online. People perform online banking transactions, read the news, communicate online, write blog articles, and are also immersed in other activities that require learning and decision making. A whole lot of information needs arise from the latter. As the amount of information available on the Internet grows on a daily basis, search engines have become the dominant tools to search for information. Yet, search engines are machines to find documents based on keywords. Hence when it comes to more complex search tasks, search engines do not support those needs equally well (White and Roth 2009; Marchionini 2006).

Especially as the Internet has grown into a mainstream medium, its users now comprise all population groups, women, men, children and elderly, tech savvy people and also beginners. Little is known so far about the differences of the behavior of theses user groups, in particular as far as complex search tasks are concerned. In addition, most of the user studies investigating Web search behavior are done with non-representative groups such as college students, who naturally show a different behavior than ordinary Web users due to their educa-

tional background. We assume that especially when it comes to more complex tasks such as planning a family gathering or a holiday trip online, or also researching information to make an important decision such as purchasing an apartment, less Web-savvy users might be struggling more than expected. In those situations when users work on more complex search tasks, they are required to review a number of different documents and Web sites, they have to explore all the aspects relevant for their information need and finally need to synthesize the outcome of their search into a single document of reference (White et al. 2008; Singer et al. 2012a). We present a study with a systematically selected user sample comprising of 56 ordinary Web users with diverse backgrounds, roughly representing the demographics of our society in terms of age (18 to 59) and gender. The study was done in a laboratory environment. All users and their search behavior were logged using the Search-Logger tool (Singer et. al. 2011). We put the focus of this study on examining the differences between men and women carrying out simple and complex search tasks and finding out more about how age impacts the search performance.

The rest of this paper is structured as follows: First, we review the literature on gender and age impact on search, followed by literature on simple, complex, and exploratory search. Then we state the research questions that guided our research. After that we describe our methods followed by the results. These are discussed and in the conclusions section we sum up the outcomes and limitations of our study.

2 Literature Review

Research on gender differences when carrying out complex or exploratory search tasks does not seem to exist. More papers can be found on the relationship between gender and online behavior in general. Lorigo et al. (2006) used eye tracking to examine how different classes of users evaluate search engine results pages and found significant behavioral differences between men and women. Jackson et al. (2001) carried out a survey with 630 Anglo-American undergraduates to examine their Internet usage patterns and according gender differences. They found out that women were mainly using the Internet for communicating (e-mail), while men were mainly searching for information. Hupfer and Detlor (2006) carried out a survey-based study with 379 respondents, mainly students, to examine gender differences in Web information seeking. They present a self-concept orientation model and note that significant gender differences exist in Web searching. While women use the Internet for communication and are interested in finding medical information and information about government and politics, men seem to be more interested in hobby-related information, and investment and purchasing information. Liu and Hang (2008) did a survey consisting of 203 completed copies at a University campus in China with people aged between 18 and 23. Their findings are that female readers prefer reading from paper to reading online, and that there are significant differences between the choices what to read and also regarding sustained attention. Roy and Chi (2003) conducted a study with 14 eighth grade students, 7 boys and 7 girls. The study participants had to carry out search tasks and were observed by two observers. Their findings show that boys used different search strategies than girls. Boys spent more time to enter queries and to scan and filter the hits on search engine results pages

(horizontal search). When girls on the other hand clicked on search results, they browsed more deeply and investigated entire web sites more carefully (vertical searchers).

Regarding age and its influence on search performance a couple of studies can be found, but fewer than expected. Meyer et al. (1997) investigated the impact of age and training on the Web search activity. In their study with 13 older and 7 younger users (ages not mentioned), they were able to show that the main difference between older study participants and younger ones was that both groups could fulfill most of the tasks, but it took the older ones more steps. Morrell et al. (2000) conducted a survey consisting of 550 adults to examine Web usage patterns among middle aged (40-59 years old), young-old (60-74 years old) and old-old adults (75-92 years old) Web users. They report distinct age and demographic differences in individuals who use the Web. Kubeck (1999) examined the differences between older and younger adults when searching for information on the Web in a naturalistic setting. His sample consisted of 29 older (mean age 70.6 years) and 30 younger people (mean age 21.8 years). He was able to show that both groups found answers of similar quality but the older users were considerably less efficient at searching. Aula (2005) gave a set of search tasks to 10 older adults. She observed the study participants while they carried out the tasks. She discovered that they were quite successful, but they had some operational difficulties in understanding how the Web was structured and also with understanding the terminology and basic operations such as text editing. She proposed an "elderly friendly" search user interface. Dickinson et al. (2007) presented a prototype for a Web search system for older people without any Internet experience. They also conducted a user study and asked the users to rate the system. The study confirms that older people search differently and have different requirements regarding user interface and usability.

Task complexity can on the one hand be defined objectively, independent of the person carrying out the task (March and Simon 1958; Shaw 1971). Campbell (1988) proposes a classification for task complexity that is derived from a combination of the following complexity impacting factors: presence of multiple paths to a desired end-state, presence of multiple desired end states, presence of conflicting interdependence and presence of uncertainty or probabilistic linkages. On the other hand complexity can also be defined subjectively by looking at the cognitive demands that are required from the person who carries out the task (Campbell and Gingrich 1986). This definition also relates to the number of sub-tasks that the user needs to carry out (Li and Belkin 2010).

When it comes to defining complex search and complex search tasks (as opposed to simple search tasks) it needs to be stated that a clear and simple definition is still missing. Marchionini (2006) indirectly defined exploratory search as searching in a way which is not supported by today's search engines and mentions eight aspects that characterize exploratory search. Defining the concept based on what today's search engines cannot do, makes the definition unstable as Web search engines are also developing and supporting a broader range of tasks. Other disciplines such as interactive information retrieval (IIR) (Robins 2000) examine the longer term search process and work on reducing the artificial distinction between user and system. Exploratory search in comparison to IIR points out the discovery aspect in search more. Singer et al. (2012a) decomposed the complex search process into the main steps aggregation, discovery, and synthesis. Exploratory search as coined by Mar-

chionini (2006) can be seen as being part of complex search as there are many search tasks that are complex but do not necessarily carry all attributes of exploratory search such as learning and decision making.

Compared to many of the just presented studies we do not use a convenience sample consisting of a small number of students or another specific group, but we work with a systematically selected number of people representing a cross-section of society in terms of age, gender, profession and also web experience. A sample of 56 study participants is in comparison to the studies mentioned a relatively large number of participants. The value of our study not only lies in the results themselves, but also in validating (and falsifying) findings from older studies that are based on less realistic user samples.

3 Research Questions

To guide our research, we formulated the following research questions:

RQ1: What is the difference between women and men carrying out simple search tasks?

RQ2: What is the difference between women and men carrying out complex search tasks?

RQ3: What is the influence of age on the search performance for simple search tasks?

RQ4: What is the influence of age on the search performance for complex search tasks?

4 Research Method

This paper is based on a body of data, which was collected in the course of one larger experiment in August 2011. The experiment was conducted in a laboratory environment. The carefully selected user sample originally consisted of 60 volunteers, roughly representing a cross-section of society in terms of age and gender as outlined in Table 1. The effective number of study participants providing data to our study was 56 (30 men, 26 women), due to insufficient computer skills or corrupt log data of 4 users. While we are aware that such a sample size is still not perfectly representative, it is relatively large for a lab-based user study, and due to the wide span of users the results from our study will be widely valid and not limited to a certain user group only as in many studies mentioned in the related work section. The experiment was conducted in Germany, and the language of the search tasks was German. Participants were recruited in various ways (e.g. through advertising).

Age span	**Gender**		
	Female	Male	Total
18-24	5	4	9
25-34	9	7	16
35-44	7	8	15
45-54	8	8	16
55-59	3	1	4
Total	32	28	60

Table 1: User Sample

The study participants were invited to the laboratory – 15 people at a time. The Search-Logger study framework (Singer et. al. 2011) was installed at each of the computers in the laboratory. The Search-Logger is an add-on for

Firefox browsers, which allows administering work tasks to users in an experimental setting. While the study participants carry out the tasks it automatically creates a log of certain user events such as links clicked, queries entered, browser tabs opened and bookmarks added. User specific information such as demographics and also task specific user feedback is gathered through automatic questionnaires. At the beginning of the experiment the study participants were briefly instructed on how to use the Search-Logger tool for the experiment. After the instruction, each person was assigned a computer to be used throughout the experiment. The users were given 3 hours to carry out the tasks.

The assignment for the study participants consisted of 12 search tasks – 6 simple ones and 6 complex ones. The answers had to be available on public websites in German as of August 2011. Simple tasks typically allow users to find the required information in a single document with a single query. Complex tasks are characterized by an open task description, accompanied by uncertainty and ambiguity and an open outcome (Kules and Capra 2009). While working on complex tasks users typically issue multiple queries, check various Web sites and discover unknown aspects of their information needs (Singer et al. 2012a). We set the sequence of tasks in a way so that users could alternatively solve simple and complex ones. Users could also switch between tasks. They could start working on a task, pause it and work on another task and later return to the previously started task.

Some of the six simple tasks (indicated by S), and six complex tasks (indicated by C) were:

- (S) Joseph Pulitzer (1847-1911) was a well-known journalist and publisher from the US. The Pulitzer price is also carrying his name. In which European country was Pulitzer born?
- (S) How hot can it be on average in July in Aachen/Germany?
- (C) Are there differences regarding the distribution of religious affiliations between Austria, Germany and Switzerland? Which ones?
- (C) What are the most important 5 points to consider if you want to plan a budget wedding?

At the beginning of the experiment each study participant completed a demographic form. In the demographic form we asked the users to fill in their gender and age. In addition we asked them about their Internet usage profile, how often they were using the Internet per week, how long per day and for what purposes they were going online. A more detailed description about the experimental set-up and the complete list of tasks used in the experiment can be obtained from Singer et al. (2012b). That paper covers different aspects of the experiment and the results presented there are based on a distinct subset of data.

We used the following set of standard measures in our analysis:

- Ranking: Ranking of the users according to their performance in the whole experiment; first by the number of correct answers and then, in case of users with the same number of correct answers, by answers with right elements
- SERP time: Time users spent on search engine results pages (SERPs)
- Read time: Time users spent on reading Web pages (other than SERPs)
- Task time: Time it took users to finish a task
- Number of opened tabs: Number of browser tabs opened per search task

- Number of queries: Number of queries entered into search systems per task
- Average query length: Average number of words per query
- Number of pages visited: Number of Web pages visited per task

We ran paired-sample t-tests (assuming unequal variances) to analyze the statistical significance of the results and assumed a confidence interval of 95%.

5 Results

RQ1: **What is the difference between women and men carrying out simple search tasks?**

Table 2 outlines our findings when comparing female (n=30) and male users (n=24) carrying out 6 simple search tasks as described in the methods section. Despite some mean values slightly differing, the differences are not statistically significant (indicated by high p-values). The sample size here is only 54 (as opposed to 56) as the data of two users was corrupt.

Simple tasks	**Ranking (1-10)**	**SERP time (sec)**	**Read time (sec)**	**Number of tabs**	**Task time (sec)**	**Number of queries**	**Query-length (words)**	**Number of pages**
Female users	3.8±0.6	32±5	96±9	4.6±0.7	128±13	1.9±0.2	2.9±0.2	2.2±0.1
Male users	3.5±0.6	33±6	117±15	4.9±0.7	150±19	2.1±0.3	2.9±0.4	2.8±0.3
p-value	0.74	0.85	0.23	0.73	0.33	0.45	0.87	0.05

Table 2: Comparison of female (n=30) and male users (n=24) carrying out simple search tasks

RQ2: **What is the difference between women and men carrying out complex search tasks?**

Table 3 shows the results for comparing female (n=30) and male users (n=24) carrying out 6 complex search tasks. Although the differences for the measures in the case of complex search tasks become bigger, only the number of browser tabs (3.8 vs. 2.6) and the number of queries (5.4 vs. 7.7) are significantly different between female and male users. Again the sample size is only 54 (as opposed to 56) as the data of two users was corrupt.

Complex tasks	**Ranking**	**SERP time**	**Read time**	**Number of tabs**	**Task time**	**Number of queries**	**Query length**	**Number of pages**
Female users	5.6±0.5	101±10	320±30	3.8±0.4	421±32	5.4±0.4	4.0±0.3	6.8±0.7
Male users	4.5±0.6	145±19	292±26	2.6±0.3	436±41	7.7±1	4.7±0.8	8.3±0.9
p-value	0.16	0.05	0.48	**0.02**	0.77	**0.048**	0.39	0.22

Table 3: Comparison of female (n=30) and male users (n=24) carrying out complex search tasks

RQ3: **What is the influence of age on the search performance for simple search tasks?**

We examined the relation between age and the performance when carrying out simple search tasks. Table 4 shows our findings, comparing selected measures for younger users (the first quartile of the user sample, consisting of n=11 users and the age ranging from 18-26) and older users (the fourth quartile of the user sample, consisting of n=11 users and the age ranging from 49-59). The task time is significantly smaller (83 sec. vs. 186 sec.) for the younger age group in comparison to the older age group. Apart from the task time also the SERP time (19 sec. vs. 40 sec.) and the read time (64 sec. vs. 146 sec.) were significantly different.

Simple tasks	**Ranking**	**SERP time**	**Read time**	**Number of tabs**	**Task time**	**Number of queries**	**Query length**	**Number of pages**
Younger users	2.7±0.6	19±4	64±6	5.2±1.3	83±7	2.0±0.3	2.7±0.2	2.1±0.2
Older users	4.0±0.8	40±8	146±17	5.2±1.2	186±23	1.8±0.3	2.3±0.3	2.4±0.4
p-value	0.21	**0.03**	**<0.01**	0.99	**<0.01**	0.57	0.29	0.53

Table 4: Comparison of two age groups (1st quartile and 4th quartile) for simple search tasks

RQ4: **What is the impact of age on the search performance for complex search tasks?**

Next we investigated how the age influences the search performance when carrying out complex search tasks. Table 5 shows our findings, comparing selected measures for younger users and older users (same quartiles of users as described in previous research question RQ3). The ranking (as defined in the method section) is significantly better for younger users than for older ones (2.4 vs. 5.5). Also read time (229 sec. vs. 434 sec.) and task time (333 sec. vs. 555 sec.) are significantly smaller for the younger group than for the older group.

Complex tasks	**Ranking**	**SERP time**	**Read time**	**Number of tabs opened**	**Task time**	**Number of queries**	**Query length**	**Number of pages**
Younger users	2.4±0.5	104±19	229±17	3.0±0.6	333±33	6.8±0.8	4.1±0.5	6.4±0.7
Older users	5.5±0.7	121±17	434±58	4.2±0.6	555±60	4.9±0.6	3.6±0.3	9.0±1.5
p-value	**<0.01**	0.51	**<0.01**	0.19	**<0.01**	0.09	0.40	0.13

Table 5: Comparison of two age groups (1st quartile and 4th quartile) for complex search tasks

6 Discussion

As expected, in the case of simple tasks the way how men and women search with search engines is not significantly different. This confirms that the standard procedure of issuing a query and finding the right information quickly with search engines works well in the case of simple tasks. Eventual gender-related differences in search strategies simply do not seem to appear. In the case of complex search tasks the situation is only slightly different. Men opened fewer browser tabs and issued a higher number of queries. The fact that only two out of eight measures were significantly different confirms the findings from the simple search tasks. Men and women show quite similar behavior when carrying out search tasks. We assume though that the high variances of our measures are partly due to the composition of our user sample (consisting of people with diverse backgrounds, from housewife to university student). Taking a more homogeneous user sample would probably decrease the standard errors of the means. It would for example be interesting to see the results from a comparison between female housewives and male housemen only.

When examining the impact of age on the way ordinary Web users carry out simple tasks, our results show that differences between younger and older users are related to SERP time, read time and task time. Younger users are also quicker at carrying out the tasks. One would also expect the rankings in the experiment to be a differentiator. Although the mean values of the rankings of the two age groups are different, that difference is not significant due to the high corresponding standard errors of mean. It seems that it takes older people longer to carry out simple tasks, but they finally manage to retrieve information of comparable quality to the one collected by their younger counterparts. This finding is in line with the results published by Meyer et al. (1997). In the case of complex tasks also the ranking for younger users was better than for older users. In addition read time and task time were smaller. Hence in the case of complex tasks it took older people longer to carry out the task and also the outcome was not as good as for younger users. It seems that differences in search capabilities become more evident the more complex a search task is. We are aware that longer reading times could also be due to older people reading less quickly in general.

7 Conclusions and Limitations

We presented the results of a study examining gender and age differences for a user sample of 56 ordinary Web users carrying out 6 simple and 6 complex search tasks. This study is insofar quite unique, as we could not find many studies of this size, which were done with ordinary Web users. Most experiments are usually done with university students for various reasons (but also availability of cheap study participants). Therefore we doubt that the findings of many of those studies have a very general validity (apart from being valid for university students). Within our user sample of ordinary users (and very diverse experiences with web search) we found that the way men and women carry out simple search tasks is quite similar. In the case of complex tasks the differences became more evident. Women opened more browser tabs and issued fewer queries per task. These findings are in line with the results presented by Roy and Chi (2003). When it comes to age and its impact on search per-

formance, in the case of simple tasks it took older users longer to execute the tasks and their SERP and read times were also bigger. In the case of complex search tasks younger users also performed better according to their ranking, in addition they spent less time on reading and checking Web pages and also carried out the assigned tasks in a shorter time. Especially that younger users search more quickly than older ones is in line with the findings of Morrell et al. (2009), Kubeck (1999) and Aula (2005). One limitation was related to the broadness of our user sample. Due to the very diverse backgrounds (from university student to housewife), we were faced with quite high variances in our numbers. This again resulted in high standard errors of mean. Hence we hypothesize that experiments with more focused user samples (such as a younger and older group of e.g. office workers only) might produce more significant differences. In future experiments we plan to adjust e.g. the screen font sizes at computers used by older study participants to allow a fair comparison of reading times online.

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