Designing for Health Exploratory Seeking Behaviour

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ABSTRACT
The Internet has become a popular source of health information. However, in-depth understanding of the information seeking behaviour of online health information is limited. We conducted an experiment to investigate the information needs and behaviours of health information seekers. This paper reports on a model of behavioural patterns drawn on the experimental results, and implications for designing a better user experience for the exploration of online health information.

Categories and Subject Descriptors
H.1.2 [**Information Systems**]: User/Machine Systems – *Human information processing.*

General Terms
Design, Experimentation, Human Factors.

Keywords
Exploratory search, health, information seeking, human behaviour

1. INTRODUCTION
The Internet provides a variety of choices for consumer health information, from official health websites, private health service providers, personal blogs, to discussion forums. Studies have shown that lay-people look for health information online when they encounter health problems [1][2]. While we understand the demands of accessing health information on the Internet, there are few studies investigating the information needs and the characterising information seeking behaviours of these seekers. Our research aims to bridge this gap.

Search engines are the de-facto primary method of finding information on the web. This also applies to health seekers. However, the user experience in the health context is often not satisfactory due to a number of factors, including the nature of health information, the level of knowledge possessed by the seeker, and the skill of formulating search keywords [3][4][5][6].

When dealing with unfamiliar and unknown problems, or involving a task for which the goal remains unclear, the information seeking processes tends become more exploratory [7][8]. We argue that this exploratory search behaviour applies to health information seekers as well. In contrast to executing a search query and reading through the result, exploratory search involves a series of cognitive learning and query reformulation processes. A more complete picture of the knowledge domain is being built in this process. The exploratory process also implies the existence of both learning and investigative activities. Seekers end up knowing more information than they expected at the beginning. One of our goals is to design a system that better supports such exploration, which traditional search engines are not designed for.

In order to understand more deeply the effects on human behaviour of these health information needs, we ran interview sessions and observation experiments with 20 participants. During the observation, the participants displayed diverse behavioural patterns. Summarised from these patterns, we propose a model to describe the seeking behaviour in terms of research tactics and reading engagement. The findings indicate there exists a lack of features in both search engines and health websites to support health information seeking, which is essentially an exploratory search. We plan to build an experimental health website to address these problems in the next phase of our research.

2. LITERATURE REVIEW
In this section we draw on the literature to explain what we mean by the three phrases: online health information seeking, health information needs and exploratory search. These concepts are guiding the direction of this research.

2.1 Online Health Information Seeking
Health information seeking on the Internet is different from other types of searches in many ways. Lay-people usually have only limited knowledge in the medical domain [9], or face difficulties in utilising technical or medical language for searching [4][5]. On the other hand, dealing with health issues is stressful and uncertain and very likely to demonstrate a different information need [10].

A study showed 72% of U.S. Internet users have tried to access health information online [2]. Seekers look for a broad range of health information, which includes disease information, causes and treatments, diet information, health lifestyles, etc. [1][2][9][12][13][14][15], and in various stages of a health problem [16][17]. The diverse types of health information demanded reflect differences in information needs which result in different seeking behaviour.

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2.2 Health Information Needs

Information needs arise when people realise their existing knowledge is inadequate to satisfy their goal. Finding information is an attempt to bridge a knowledge gap. A knowledge gap appears whenever people perceive there is not enough information in their minds and as a result they will start searching for information to fill the blanks [11]. This process is also known as a sense-making process [18].

Alzougool et al. investigated different information needs in the health context [10][19]. They propose that health information needs can be further classified into recognised and unrecognised needs. Cartright et al. [20] argued that health information seeking can be split into two partitions – evidence-based and hypothesis-directed. Through analysing queries in search engine sessions, they clustered the foci of searches in terms of causes, symptoms, remedies, or combinations of any of these. This could be useful to predict the information needs of exploratory health seekers.

2.3 Exploratory Search

Exploratory search involves learning and investigation in addition to lookup efforts, where the seeker interacts with information systems to retrieve a wider range of information [7]. Exploratory search can be found when the individual tries to address unfamiliar or unknown problems [21], as may be the case for health-related concerns. White and Roth add that people who are unfamiliar with the domain of their goals, or unsure about the ways to achieve their goals, or even unsure about their goals, will engage in exploratory search [8].

3. RESEARCH METHOD

Previous research about health information seeking behaviours does not capture well the actual patterns of the interactions among search engines and health websites. The aim of this experiment was to form an in-depth understanding of information needs and the patterns of related information seeking behaviours. We arranged sessions with individual participants in which we interviewed them about their experiences on health information seeking, and then gave them two tasks to carry out. We recorded the interviews and screen activities for further analysis.

The study was carried out from October to December of 2013. Posters were presented in various locations across the university for recruiting participants. E-mail invitations were sent out to encourage participation. Participants were also allowed to invite potential participants to our study through their connections. Recruitment continued until data saturation was achieved. This experiment was voluntary and no incentive was given to participants for the study.

Each study lasted about an hour and consisted of three sections: the first section was a semi-structured interview about their past experiences of finding health information on the web; participants were then given a computer to find online health information for two pre-defined tasks in the second part; the last section included another semi-structured interview to help researchers further understand how participants performed the tasks. We did not restrict the participants to use a specific website or instruct them to use a search engine. To avoid bias, we cleared the home page and all browsing history in the browser prior to each session. All interview content and screen activities were recorded.

The search tasks represented two different styles of common health scenarios. In one scenario, participants were asked to find information on how to care for a diabetic family member; in the other, participants were tasked with identifying information to append to a Wikipedia page on urination problems and their symptoms. The first scenario was designed with the aim of observing seeking behaviours for explicit recognised needs, whereas the second targeted for unrecognised needs with a more vague description of a health problem.

Interviews were transcribed and reduced to a number of codes iteratively [22]. Content that was relevant to health information seeking behaviours were organised into themes. Themes were derived with a thematic analysis approach [23]. Screen recordings were reviewed manually. A navigation graph was built for each participant to describe the web activity patterns in each session.

4. RESULTS

In total 20 participants completed our lab experiment (11 male; 9 female). In terms of identity, they comprised 8 students, 9 university staff and 3 external participants. The age distribution is listed in Table 1.

Table 1. Age Distribution of Participants

Age Group	N	Percentage
21-30	8	40%
31-40	6	30%
41-50	4	20%
Over 50	2	10%

4.1 Motivation for Exploratory Search

One of the themes emerging from the interviews regarded the motivation for exploratory search. Not every search about health topics is an instance of exploratory search, however, we have observed that both recognised and unrecognised information needs motivated people to perform exploratory search in our study.

Firstly, searches triggered by recognised needs are found to be more exploratory. For example, participants with health problems or those diagnosed with a certain illness. The need is also demanding if the issue is related to people's loved ones. They had a clearer mind about what information is helpful for the scenario, and possessed explicit information needs on aspects such as treatments and remedies. In this case, the recognised need mainly has the purpose of helping to understand the complete picture of the situation or getting more options for facing the health problem. The seeker is persistent in trying different ways to discover and read information as well.

Unrecognised needs were observed to stimulate exploratory search as well. People do not have a clear target, and therefore tend to approach different sources to make sense of the information – this is illustrative of exploratory behaviour during the search. Examples include people passively encountering contradictory messages, suspecting the validity of the information, or simply feeling curious about certain information. They seek additional sources without knowing what exactly is needed nor why it is needed. They usually become more open minded to the information obtained but are still cautious about it to avoid wrong information.

4.2 Behavioural Patterns

Participants were requested to perform two search tasks in our lab study sessions. For each task, we manually constructed a navigation graph to describe the pattern of the interaction among search engines, individual web pages and clicks on hyperlinks. 36

graphs were generated while 4 tasks not completed by participants due to time constraints on these lab sessions. From these graphs we identified four common patterns (Figure 1). During the search process of each task, the overall patterns of the individual's activities may contain one or more these common patterns shown in the figure.

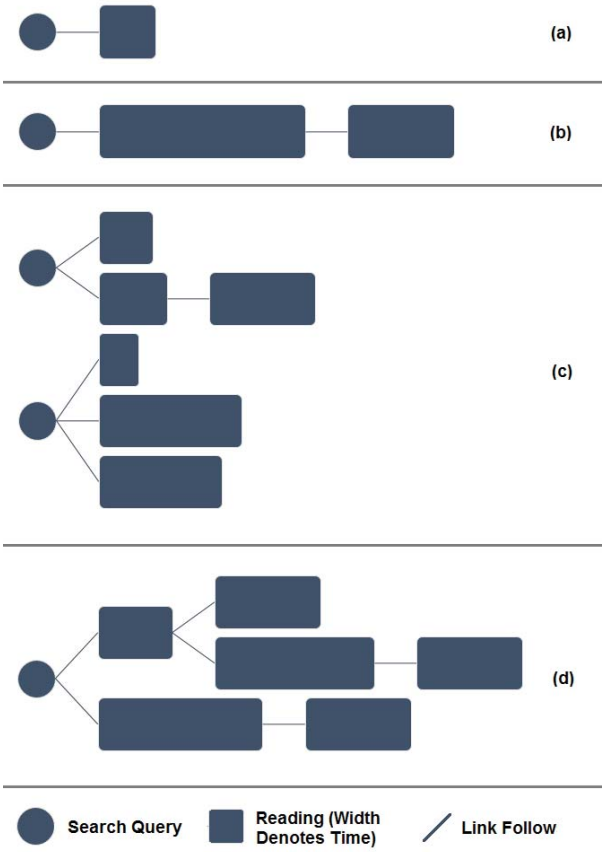

Figure 1. Typical Patterns of Health Exploratory Search

Figure 1(a) shows the simple pattern of executing a keyword query on a search engine, skimming one of the search results, and then finishing the information seeking process. This is common when the seeker just wishes to have some quick facts. The search stops once the information is found.

Figure 1(b) is similar to (a) in the small number of searches performed, but the seeker engages in longer and deeper readings. The seeker examines the web page returned by the search engine, also follows hyperlinks provided page-by-page and continues reading. The duration of reading is longer as the seeker digests and absorbs the information. The series of reading continues until no more valuable information is found.

Figure 1(c) presents not much reading but more query reformulations. The seeker in this case relies on the search engine to explore new information. Most of the time, he/she tries to skim through the search results and picks up only web pages that are relevant to the information need. Meanwhile the seeker will adjust the query keywords with the information read and submit a new query, if the overall search result is not satisfactory. The query reformulation particularly occurs when the user cannot discover new useful information with visible means (e.g. links) and feels the information in the website is exhausted.

Seekers in Figure 1(d) use hyperlinks to discover new information. They choose a small number of good websites (usually large and reputable) for examination. In these well-designed health websites, connections among pages are well-defined and hyperlinks are placed in a useful manner. Seekers can trace the related information through levels of hyperlinks easily and do not need to query the search engine as often as in other scenarios.

4.3 Model of Behavioural Outcome

From the perspective of enhancing user experience and suggesting design implications, conceptualising the information seeking behaviour is crucial. Drawn on the patterns in the previous section, we build up a model to abstract the behaviour outcome of online health information seeking behaviour (Figure 2).

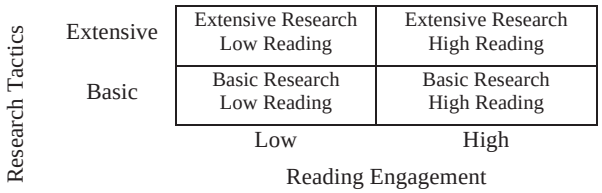

Figure 2. Model of Behavioural Outcome

This matrix presents a combination of seeker's research tactics and reading engagement. Research tactics represent the eagerness and motivation for finding out in-depth information. For more exploratory seekers, a wider range of information is needed, and thus the extensive tactics represent a greater effort to locate, filter, learn and discover other information within the current knowledge domain. Whereas less research effort will be put for the basic tactics, which often appear when looking for surfaced, easy-to-obtain and easy-to-read information.

Reading engagement measures the duration of reading and the intention of absorbing the information. Skimming and reading just the page summary fall into the group of low engagement while pursuing and digesting the information is considered as high engagement.

4.4 Guidelines for Design

Drawn on the abovementioned findings, we propose two areas of improvements for enhancing the user experience of exploratory health information seekers. These are (1) assisting the discovery of new information, and (2) adapting to users' reading needs.

The discovery of information within a website is important. In general, health websites collect many articles but we have noticed that seekers are not always able to reach all of them. This implies a problem of either users not knowing what they want, or that they cannot effectively use a search engine to explore. As seen in Figure 2, seekers with the basic research tactics stay within a single website rather than utilising a search engine for to look other sites. In this regard, a system that understands their information needs and recommends relevant information for further reading is preferable.

Figure 2 identifies a spectrum of reading engagement, suggesting that a health website needs to adjust to both low and high reading levels. In low engagement behaviour, users prefer to skim and quickly read through the articles to determine the usefulness before committing to a longer reading. In this case, an abstract or summary could be provided for their convenience. On the other hand, users with high reading engagement may prefer a design emphasising readability, such as font size, line spacing, section navigation, etc.

Extensive research seekers (the upper row in Figure 2) generally do not have major problems in finding the information. Corresponding to Figure 1 (c) and (d), they illustrate patterns of putting efforts to discover, locate and filter needed information. They also spend most of the time to judge the relevance of the materials, and seek alternatives if the information is not relevant. Both of the two design implications would be beneficial to this type of seekers.

5. CONCLUSION

This paper reports on a lab experiment with the aim to understand online health information seeking behaviour. From this study, we have identified that a variety of information needs that drive exploratory search, and a diversity in behavioural patterns. We have proposed a simple model using two factors, research tactics and reading engagement, that is useful for reflecting on user behaviour and starting to think about how we can design systems to provide better support for exploratory behaviours. These findings sight the directions we could work on to improve the user experience of health information seekers.

We will focus on designing a better environment for exploratory search in the health context. The next phase of this research is to build a testing health website with the goal on assisting the discovery of new information and enhancing reading engagement. A larger scale of user study will be launched to gather feedback and evaluate the new design elements in this new website.

6. ACKNOWLEDGEMENT

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