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ONLINE HEALTH INFORMATION SEEKING BEHAVIOUR: UNDERSTANDING DIFFERENT SEARCH APPROACHES

Patrick Cheong-Iao Pang, Department of Computing and Information Systems, The University of Melbourne & NICTA Victoria, Melbourne, VIC, Australia, cipang@unimelb.edu.au

Shanton Chang, Department of Computing and Information Systems, The University of Melbourne, Melbourne, VIC, Australia, shanton.chang@unimelb.edu.au

Jon Pearce, Department of Computing and Information Systems, The University of Melbourne, Melbourne, VIC, Australia, j.pearce@unimelb.edu.au

Karin Verspoor, Health and Biomedical Informatics Centre & Department of Computing and Information Systems, The University of Melbourne, Melbourne, VIC, Australia, karin.verspoor@unimelb.edu.au

Abstract

People intuitively use search engines to look for health information. However, people take an exploratory search approach to find the information in some scenarios, and current search engines do not support these cases well. This exploratory information seeking behaviour is rarely investigated by researchers in the context of online consumer health information. We report on a qualitative study to conceptualise the health information seeking behaviour of lay-people. This paper describes the result of this study, and makes a contribution towards a conceptual understanding of search approaches by people seeking health information, search strategies used by health information seekers, and design implications for providing a better exploratory health search experience.

Keywords: search approach, exploratory search, focused search, consumer health information, information seeking behaviour.

1 INTRODUCTION

Studies have shown that lay-people increasingly choose to obtain information on their own when they encounter health problems (Fox & Jones 2009; Fox & Duggan 2013). With the rapid development of the Internet, it has become more convenient to access a number of online health resources, ranging from healthy lifestyle advices to details of diseases. These are readily available in various websites including official government health websites, private health service websites and online community forums. People seem to prefer to retrieve health information by themselves to assist their decision-making processes. The Internet is an economic and convenient channel to obtain such information.

Whenever people look for information on the web, they will naturally think of making use of search engines. This is also true for obtaining online health information. Eysenbach and Köhler (2002) and Hansen et al. (2003) have conducted observations to understand the process of seeking health information. Both studies conclude that information seekers used search engines in this process. In order to obtain accurate results from search engines, seekers need to describe the required information with clear and precise keywords. However, sometimes lay-people may not be able to describe what is needed, or they may not know the best terms for the query.

When dealing with unfamiliar and unknown problems (as may be the case for health-related concerns), the search approach used in the information seeking process usually become more *exploratory* (Marchionini 2006). In contrast to performing a normal keyword search and examining the result, *exploratory search* involves a series of cognitive learning and query reformulation processes. During exploratory search, a more complete picture of the knowledge domain is being built. The exploration also implies the existence of both learning and investigating activities. Users end up knowing more information than they expect at the beginning. For health information seekers, we argue that such exploratory search is more desirable and enjoyable to fulfil their needs of accurate and relevant information regarding specific scenarios.

Current search engines seem not to support exploratory health search well. As a result seekers are less engaged with search engines for health information, or turn to other channels like online health forums and social networks for asynchronous information from other users. Studies have shown that the mismatch between design of search engines and intention of seekers significantly affects the outcomes (Kumar et al. 2005; Lorence & Greenberg 2006).

Recent research has started to investigate exploratory health search (Cartright et al. 2011; Zarro 2012), but they rarely concentrate on the interactions between users and search engines as well as the information needs of seekers. With the aim of improving the understanding in these aspects, we conducted a qualitative study of health information seeking to further investigate lay-people's behaviours. Twenty participants were interviewed in our lab and demonstrated their own ways of obtaining online health information.

This paper presents: a brief summary of current trends in obtaining health information online; a literature review related to information seeking behaviour and exploratory search; the result of our qualitative study; additional understanding towards exploratory health search; and design implications to better support exploratory health search.

2 RELATED WORK

2.1 Online Health Information Seeking

The Internet has become an important channel for people looking for health information. A recent study showed 72% of U.S. Internet users at some point have tried to access health information online,

and 77% of these people used search engines to start looking for that information (Fox & Duggan 2013). From another point of view, Spink et al. (2004) found that 7.5% of queries submitted to search engines were related to medical or health information. In an observational study conducted by Hansen et al. (2003) for clarifying the method of finding health information, 60 out of 68 cases looked into the results provided by search engines. It is clear that searching is a critical strategy for obtaining online health information, in addition to browsing medical websites directly.

Researchers have investigated what type of health information people searched for (Andreassen et al. 2007; Bessell et al. 2002; Fox & Jones 2009; Fox & Duggan 2013; Johnson & Meischke 1991; McMullan 2006; Nicholas et al. 2003; Zhang and Fu 2011). A number of these studies have discovered that the Internet has been used for information about specific medical conditions, symptoms and diseases. In addition, needs of treatment and drug information are also reasons of health information seeking behaviour on the Internet. People show an interest in keeping a healthy lifestyle, losing weight, dieting and maintaining body fitness. Studies have shown that Internet is also used to find patients with similar symptoms, community support groups and health providers as well. Similar results were found in different parts of the world including developing countries (Gavvani 2010).

While using a search engine is the dominant way to access health information, is it the best way for consumers to address their information needs? Past research has shown that search engines do not always provide results relevant to the user's query in the health context (Berland et al. 2001; Benigeri 2003). We cannot entirely blame the search engine for this because, in many cases, users cannot provide accurate search queries. Indeed, researchers found that general health information consumers had only limited domain knowledge (Zhang 2011), and faced difficulties in searching due to insufficient knowledge of technical and medical language (Keselman et al. 2008; Chapman et al. 2003). Sometimes users even described their symptoms in plain English sentences and thus made the search results unsatisfactory (Luo et al. 2008). Karimi et al. (2011) discovered patients had discussed drug usage and side-effects in online forums, showing online social networks of patients is another way to obtain health information.

Before we develop a deeper understanding about searching and exploring for health information, we need to know how seekers transform their information needs into actual seeking behaviours, and how these needs affect such behaviours. The following section reviews the current literature on information seeking theories and models.

2.2 Health Information Needs

Information needs arise when people realise their existing knowledge is inadequate to satisfy their goal (Case 2002). There are also information needs when people feel stressed and uncertain while facing threats (such as health problems) and as a result look for information to reduce the stress and uncertainty (Wilson 1997; 2006). Furthermore, 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 (Case 2002). This process is also known as a *sense-making process* (Wilson 1999). In the health information seeking context, a person may not know clearly about a particular health problem, that represents a knowledge gap of the disease, so there is a need to look up detailed information on this problem.

Gorman (1995; 1999) classified information needs into four types: recognised, pursued, satisfied and unrecognised. Researchers often put their concerns over recognised and pursued needs because they associate with actual information seeking behaviours and thus easier to observe. Other types of information needs (namely satisfied, recognised but not pursued, and unrecognised needs) are often neglected. Alzougool et al. (2008; 2013) derive an abstract model for understanding all these information needs, particularly in the health information seeking context (Figure 1). This model labels combinations of information needs and actual behaviours with four descriptors in a matrix: demanded, undemanded, recognised and unrecognised.

		Demanded	Undemanded
Recognised		Recognised Demanded	Recognised Undemanded
Unrecognised		Unrecognised Demanded	Unrecognised Undemanded

Figure 1. A framework of states of information needs (adapted from Alzougool et al. 2013)

Recognised needs are often found in health information seeking. A person looking for detailed information about certain symptoms falls into the “recognised demanded” category. Conversely, people may choose to refuse or avoid information that relates to them, which can be seen as “undemanded needs”. For example, patients with a severe disease such as cancer may choose to deny information, possibly to avoid a negative psychological effect on the ongoing treatments. Exploratory search is likely to be invoked when the seeker demands the information, unless he/she is very familiar with the topic at hand.

Another highlight of exploratory information needs is *unrecognised needs*. According to Alzougool et al. (2013) unrecognised needs are information needs that the seeker has not clearly identified, but somehow he/she realises certain existing but unknown information is important for the current scenario (for example concerns when taking care for a diabetes patient). Information needs triggered by passive reception (like hearing something interested) are considered in this category. In the case of unrecognised needs, the seeker will likely explore for all relevant information to clarify exactly what information is further required.

2.3 Information Seeking Behaviours

Traditional information seeking theories have studied seeking behaviours that involve a certain level of exploration. Wilson (1997) has identified four modes of information seeking behaviours. In addition to “searching”, a concept of “acquisition” is formulated to represent the passive reception of information even if people do not realise their information needs. Kuhlthau (1991) suggests an *information search process (ISP)* model, which uses six stages to describe the behaviour of seekers, emphasising the changes of their thoughts and feelings during the search process. Ellis and his colleagues (Ellis 1989; Ellis et al. 1993; Ellis and Haugan 1997) propose a model that showed a linear sequence of behaviour that people follow to achieve information needs. Lambert and Loiselle (2007) summarise literatures about health information seeking behaviour.

The above information behaviour models were formulated before the Internet was in widespread use, and mainly focus on how people use non-electronic ways to access information (such as looking up a library catalogue). Choo et al. (2000) bridge the gap between traditional and online data source by mapping the anticipated operations on the web to the activities in Ellis’ ISP model. With this work we can capture the user’s interaction and map these interactions to the above models.

2.4 Exploratory Search

Exploratory search is a search approach that involves learning and investigation in addition to lookup efforts, where the seeker interacts with information systems to retrieve a wider range of information (Marchionini 2006). Exploratory search can be found when the individual tries to address unfamiliar or unknown problems (Pearce et al. 2012). White and Roth (2009) 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.

Exploratory search is different from the traditional iterative search by way of query refinement strategy and the range of the target information space (White and Roth 2009). Figure 2 shows an illustration of the comparison. Iterative search involves fewer query reformulations around the search target, more overlaps on similar topics in each iteration and the spotted ranges of information space are smaller. Whereas exploratory search displays a larger number of queries in different aspects, and as a result the seeker covers more information in the space which helps to deal with open-ended and uncertain situations.

Marchionini (2006) points out three important elements of exploratory search: *lookup, learn and investigate*. Exploratory search does not only mean how to locate the needed information but also emphasises learning new knowledge and investigating. The key to learning is to receive new information. It drives cognitive processing on the search results and expands the knowledge space for further queries. Investigating represents the effort to maximize the number of relevant results that can be accessed, rather than minimizing the number of irrelevant content to be shown. In other words, it focuses on how to discover and locate fresh information. Indeed, this implies that current information retrieval tools are not supporting exploratory search well as these tools are designed to enhance accuracy instead of giving more choices for discovering.

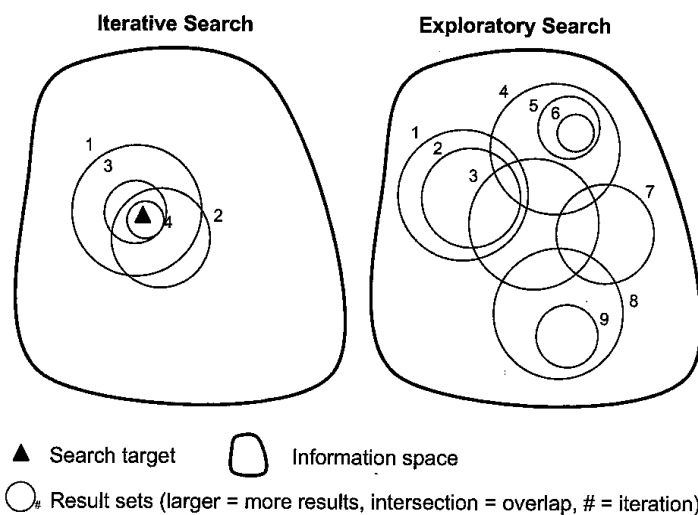


Figure 2. Iterative vs. Exploratory Search (adapted from White and Roth 2009)

In contrast to the exploratory approach, *focused search* means the seeker looks closely at a small and relevant range within the search result, refines the search in a similar pattern, and extracts relevant information in a limited set of results (White and Roth 2009). Directed search is comparable to focused search, which happens when the user clearly knows what the information need is (Teevan et al. 2004). In this case the seeker takes a series of small steps to narrow down the scope, known as *orientteering* (O'Day and Jeffries 1993). A search engine is acting as a tool to *teleport* the user to a particular target that the seeker wants to access (Teevan et al. 2004).

Exploratory search has been investigated in different areas. For online customers, Hodkinson et al. (2000) suggest consumers perform intra-site and inter-site search depending on the nature of product. He also points out the concept of depth of search vs. breadth of search along with the study. Huang et al. (2009) propose that different strategies are applied when customers look for search goods and experience goods. Cartright et al. (2011) have analysed search engine queries to understand the intentions and patterns of exploratory health search. They argue that exploratory health search can be

decomposed into evident-based and hypothesis-directed categories. Zarro (2012) proposes to look into exploratory search from a social psychology perspective.

3 RESEARCH DESIGN

Previous research does not capture well the actual information seeking behaviours on the Internet and users' interactions with search engines. The aim of this experiment was to form an in-depth understanding of health information needs, search approaches and 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 (for observing the differences between focused search and exploratory search approaches). We recorded the interviews and screen activities for further analysis.

The study was carried out from October to December of 2013. E-mail invitations were sent out to recruit participants. Posters were displayed in student common areas in the university. A snowball approach was also used to allow participants to invite potential participants to our study. Recruitment continued until data saturation was achieved. The project was approved by the Human Ethics Committee of the university. Participation was voluntary and no incentive was given to participants for the study. Participants were required to give consent about the recording at the beginning of the study. Twenty participants completed the study (11 male; 9 female). The descriptive statistics of their ages and relations to the university are listed in Table 1.

Age	No. of People	%	Relations to the University	No. of People	%
21-30	8	40%	Student	8	40%
31-40	6	30%	Staff	9	45%
41-50	4	20%	None	3	15%
50+	2	10%			

Table 1. Descriptive statistics of the participants

The study consisted of three sections and lasted about an hour. The first section was a semi-structured interview about their past experiences of finding health information on the Internet. Participants were then given a computer to find online health information for two pre-defined tasks. To avoid the bias of using a search engine at the first scene, we cleared the home page and all browsing history in the browser prior to each session to ensure the current participant's behaviour was not affected. In the third section another semi-structured interview helped researchers further understand how participants performed the tasks.

Interviews were transcribed in full and reduced to a number of codes iteratively (Creswell 2002). Data relevant to search approaches and information seeking behaviours were organised into various themes. Themes were derived with a thematic analysis approach (Braun & Clarke 2006). The process involved reading transcripts multiple times, categorising codes into themes and refining the theme list iteratively along the analysis. The number of participants connected to each theme was tracked for verifying the generality of themes.

The two pre-defined tasks were drawn from health scenarios that are common to lay-people, but expressed in two different ways – one contained a straightforward diagnosis whereas the other had only vague descriptions of symptoms. We hoped to show the behavioural differences between focused and exploratory search with a contrastive setup of tasks. The first task requested the participants to look for information about type II diabetes for a fictional family member, jotting down notes about caring for a diabetic family member. In the second task, the participants were told to locate information for completing a Wikipedia article about frequent night urination. This Wikipedia article was classified as “needed to be enhanced” and contained only a simple description of the health problem. Hints were provided to instruct volunteers to strengthen the article, regarding the type of

missing information. Participants needed to find out the relevant information from other sources in the web and recorded their ideas on changing the article. No actual modification was submitted to Wikipedia, but the seeking behaviours were captured in the process of seeking information.

4 RESULTS

This section summarises the themes that emerged from the qualitative interviews. Each theme is accompanied by one or more representative quotes from the raw data. Throughout the section, we will introduce three main themes, namely: the emergence of exploratory health search, the characteristics of the search, and the search strategies used by the participants.

4.1 How Exploratory Health Search Emerges

Not every attempt for finding health information is exploratory, but we observed several potential factors that lead to the exploratory search approach in our experiment. This sub-section presents five sub-themes that are associated with the emergence of the exploratory search approach.

Most people seek online health information because of health problems. As reported by most of the participants, encountering health issues was one of the factors that drive them towards the exploratory approach. Note that the participants did not simply perform a simple search, but tried with different queries for exploring more around the issue:

“I would usually search if I think there is a health problem... If I go search for something, I don't stop at the first page comes up at Google. I explore, I read further, try different search terms, looking at the other results... And then occasionally I will think of new words, I go back to the search bar and type that different words.” (Participant #2)

Participants were observed to be more exploratory if they received conflicting information. They investigated different data sources, followed hyperlinks to different locations, and tried to verify the validity of the information:

“[When] I receive advice that seemed to be conflicting from different sources I often look for an answer... I cross [check] references, check another source... One thing leads to other things. They have links within the article, and I end up finding about more information than needed, still interesting and related.” (Participant #20)

They also felt the urgency and became more exploratory when the health issues were related to their loved one (for example: family members):

“But I guess if it was my mum like that, I would go back to look into, to compare information on sites... I would definitely look for more websites... I think I will continue to search afterwards as well.” (Participant #13)

While health threats were definitely one source of the exploratory search approach, curiosity also made people become more exploratory:

“Usually I end up finding information on the government websites and specific to the health information I am curious about... It lasts probably a few days. Because sometimes I started with one bit of information and I keep searching other websites as well and looking deeper to the topic. Just to get more information and a bigger picture – to see if there [are] any other related issues.” (Participant #4)

We were able to identify the relationship between search approaches and task clarity due to our setup of two comparable tasks in the qualitative study. Our participants described that the straightforward Task 1 led to the focused search approach whereas the more open second task appeared to be more

exploratory, because they had less of ideas about what to look for. They needed to explore more to build up an initial understanding for the task:

“In my mind searching is when you know exactly what information you need to find out. Just basically looking for, like a concrete direct answer [in the first task]... For the second task I have to do more exploratory because I didn’t know what I was looking for. So I need to find out more general information about the answer, including searching as part of that, but exploratory doing more.” (Participant #16)

The table below illustrates the number of participants who agreed with the above sub-themes.

Sub-Themes	Number of Participants (N=20)
Encountered Health Issues	18
Received Conflicting Information	12
Related to Loved Ones (e.g. Family Members)	12
Curiosity	9
Task Clarity	7

Table 2. Sub-themes related to the emergence of exploratory health search

4.2 Characteristics of Exploratory Health Search

In contrast to the focused search approach, which had a specific target, the target in the exploratory approach was unspecific or unclear. Participants did not have an idea about what keywords to search but they opened up their mind for incoming information:

“Searching tends to be focused. I feel like when I am searching, I have my keywords in my head, I have a reasonable idea of what I am looking for or find. So a lot of time I already go with some sort of information in keywords... Exploration is not so focused. Exploration suggests that you have more time. You are not going in so many keywords perhaps. You are much open to the information that’s coming to you.” (Participant #6)

Throughout the process of feeling a little bit “lost” in the exploratory search approach, participants tried to read the information, and learnt new keywords as well as new knowledge for future searches. The learning experience was emphasised, whereas normal searching was just about locating the information:

“For me searching is like Google and find the website; and exploring is taking time to read the information and check the information a website has, and learning. My perception of exploring would be more on the learning experience. Searching is just getting where to find the information.” (Participant #7)

“Because as I Google, I can find other words and connections that I can use to search.” (Participant #7)

Although we differentiated the behaviour of focused and exploratory search approaches, some participants suggested they were not completely distinct. They reported the two types of search existed and alternated at the same time:

“At the beginning I was searching, and then I started exploring things more and more, and opened various links. I think when I open multiple links that’s kind of exploring. Then I did another search, which is more specific and then I continue exploring.” (Participant #17)

Table 3 summarises the sub-themes and the number of participants agreed with these sub-themes.

Sub-Themes	Number of Participants (N=20)
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Unspecific Search Target	8
Learning of New Information	16
Exploratory Search Are Not Completely Distinct	7

Table 3. Sub-themes related to characteristics of exploratory health search

4.3 Search Strategies

In this experiment 19 out of 20 participants used Google to look for health information. In addition to normal keyword search, they were found to use Google as a web directory. In some sessions participants knew clearly the name but not the address of the website they wished to access, they used Google to directly jump to the website. At the same time, Google was identified to act as a “glue” of different parts of a website in the study. There were occasions that the participants could not find, or simply missed, a hyperlink, then they queried the information from Google (for example accessing another article in Wikipedia). However, hyperlinks were still preferable according to the participants as they are more convenient and easier to use. They needed only to discover and click to use those links.

Observing participants suggested that search engines are not satisfactory in handling both exploratory search and health queries. Knowing accurate keywords for health search was a problem, as Participant #1 said: *“I do not know sometimes what are the right keyword to use in order to get the right information.”* Also, they mentioned the difficulty of filtering and narrowing down the search results because of the lack of medical knowledge and the analytical skills:

“If you search for health, then there is so much information coming up. You are not the doctor, so you pick and choose whatever you want and that could be very wrong at the end, because you think you’re sicker. It all depends on what kind of symptoms you searched for.” (Participant #13)

Participants seemed to be very likely to use multiple websites for each topic in their search sessions. The reason was mainly about the trustworthiness of the online health information and a reassuring purpose. *“But sometimes you don’t know whether it’s genuine so I keep searching other sites for that.” (Participant #1)*

5 DISCUSSION

5.1 The Emergence of Exploratory Health Search

Health information seeking behaviour, or health search, is different from search of other information types in many ways. It occurs for dealing with health-threatening situations, making medical decisions, and behavioural changes and preventative measures (Lambert & Loiselle 2007). To better handle such situations, individuals often need a wide array of information and thus naturally become more exploratory in the information seeking process. Based on our observations, this section illustrates a number of factors that lead to the exploratory search approach when people look for health information.

Firstly, participants with health problems or being diagnosed with a certain illness were found to be more exploratory in the search process. They had explicit information needs on certain aspects, such as treatments and remedies. In this case the exploratory approach mainly has the purpose of understanding the complete picture of the situation or getting more options for facing the health problem. Thus, the usage of the exploratory approach serves as an outcome to the stress/coping theory (Wilson 1997; 2006) as the seeker finds information in an exploratory way to cope with the stressful

situation. This also denotes that people with recognised needs (Alzougool et al. 2008; 2013) of a particular health condition will lead to relatively exploratory seeking behaviour.

Participants reported that they would be more exploratory if the health condition was related to their loved ones. They used the Internet as a preventative information source to protect their loved ones. They would use all approaches to understand the problem, look for remedies and learn to support their loved ones. The Internet is a cheap and easy way for exploring these options – not only searching existing information, but also diving into websites and looking into every detail. At the moment of the issue is relevant to an important person, the level of concern is high. The nature of exploratory search is to retrieve as much as possible information to deal with the threat. Unrecognised needs (Alzougool et al. 2008; 2013) are also identified to stimulate exploratory search. In this case people do not have a clear target, and therefore they will approach different sources to make sense of the information. One example is people passively encounter contradictory messages or suspect the validity of the information. They seek additional sources to verify and become more open minded to the information obtained. At the same time they will be cautious to the new information to avoid wrong information. The Internet can be seen as a field for the exploration of a trustable answer.

Curiosity is another unrecognised need that contributes to the exploratory search approach. Such information seeking behaviour is usually triggered in passive scenarios, like hearing of pieces of information about health when watching TV, or becoming interested in a medical topic through a conversation. Although in this scenario the seeker may have a more fixed search target, the search is easily changed into exploratory as he/she may encounter other interesting material throughout the process. This also corresponds to the alternating modes of focused and exploratory search.

The clarity of the search task is also relevant to the level of exploration. This was reported by our participants after they had completed the pre-defined tasks. In real life we see that people are doing different kinds of search tasks on the Internet. Some are concrete and precise while some are not. Concrete search tasks are more likely to show a more focused search – a simple process of making a query, acquiring the information and leaving. On the other hand, exploratory search is observed for unclear and fuzzy tasks, where the seeker needs to look around to figure out what information is needed, and obtains an overview of the search target.

5.2 Characteristics of Exploratory Health Search

The interviews with our participants suggest that exploratory health search has unique characteristics as compared with other types of search. Firstly, the search target of exploratory search is not as specific as focused search. With the setup of two comparable tasks which lead to diverse styles of searching in the study, some participants noted the difference. As the quotes suggest, focused seekers have a clearer mind and a reasonable plan to search, whereas exploratory seekers need more time to filter out what is needed, narrow down the target and locate the information. This finding is in agreement with the definition of exploratory search (Marchionini 2006; White and Roth 2009): people need to look up in a wider range of information to satisfy unclear and unfamiliar information needs.

With regards to the range of search targets, participants were seen to use multiple sources to obtain health information. The reasons behind this varied: for reassuring the validity of the information, or forming an all-round understanding about the topic. For accessing multiple resources, hyperlinks played an important role in exploring additional information. Hyperlinks were found to be more convenient for participants to use. Searching needs a cognitive process to form a query and analyse the result. Users are more likely to visit relevant web pages within a site or even external websites by following hyperlinks.

Another characteristic of exploratory search is the desire to understand the information, beyond simply locating the information. Exploratory search is about discovering and learning new information (Marchionini 2006). We noticed a similar result in our study. Participants were open to various results and filtered the relevant information. They preferred to spend time reading the web pages to determine

whether the pages were useful. They also learnt new information encountered during the search that might have been unexpected beforehand. From the point of view of information needs (Case 2002), a knowledge gap appears at the beginning of the information seeking process. Exploratory search is the actual behavioural outcome to gradually gather knowledge to “bridge” the gap.

While we have identified a difference between exploratory and focused search, they are not totally distinct. Within the entire search process, the two types of search can be interchangeable and co-exist with each other. White and Roth (2009) suggest that exploratory search will change towards focused search as the search progresses because the uncertainty reduces when the seeker retrieves more information to fill the knowledge gap (Figure 3).

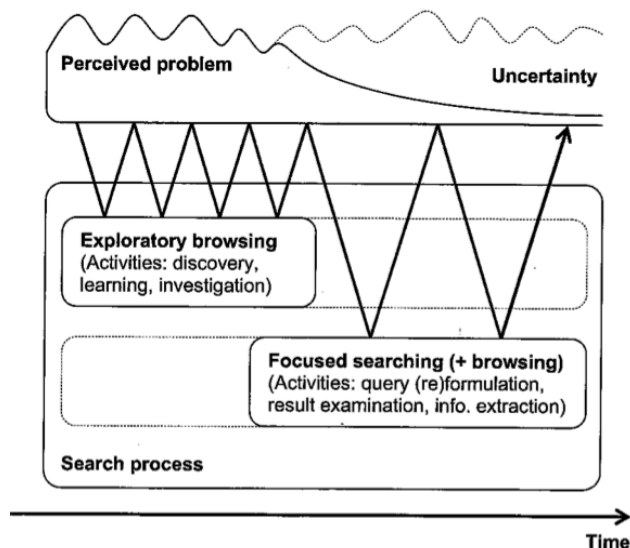


Figure 3. A model of exploratory search behaviour (adapted from White and Roth 2009)

We observed a different behaviour for health information seeking. While the information is being learnt, new and unknown information appears at some point. Consequently the uncertainty will climb again and thus the search will become more exploratory. In contrast to White and Roth’s idea of a single direction flow from exploratory to focused search, we believe that these two modes are alternating along the process until the search stops, and the seeker is seen to be going in and out between these two modes (Figure 4). Let’s examine an example from our study: a participant started with a search for diabetes management information. The search was exploratory at the beginning because he did not know much about this topic. After he learnt that he could control diabetes with eating, he performed a focused search on this area and continued to read. Gradually his uncertainty rose again because he felt confused what kinds of food and cooking methods could be helpful to the disease. At this point his search started to turn back to exploratory and started investigating multiple disciplines such as recipes for diabetics, diet suggestions, nutrition information, healthy vegetables, etc.

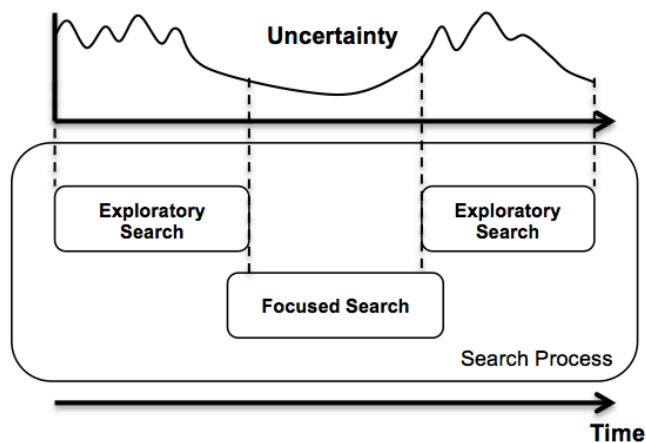


Figure 4. Interchangeable states in exploratory health search

Hence we have observed that, in the health domain, the search process appears to repeatedly move to and from between focused search and exploratory search.

5.3 The Exploratory Search Approach with Search Engines

Modern search engines are designed to handle keyword search queries. As we have stated, searching for health information is unique in various ways and search engines may not be the best tools for this task. Past studies show that lay-people have only limited knowledge of the medical domain (Zhang 2011), face difficulties in searching due to insufficient knowledge of technical and medical language (Keselman et al. 2008; Chapman et al. 2003) and obtain unsatisfactory search results because they have difficulties to describe the problem in plain English statements (Luo et al. 2008).

We have identified similar problems in our study. Participants did not know the keyword for searching in some cases, due to the lack of medical terminologies (such as not knowing the name of a disease) or simply not knowing what keywords to start with. They were not able to query precisely and narrow down the search results. For instance, given a set of symptoms, search engines returned multiple possibilities and the participants could not determine the precise one that they wished to read.

Irrespective of the scenario, almost every participant started the search task with Google. They explicitly entered Google's web address or used the search toolbar even when we removed the default home page setting. This reflects the tendency of using search engines in health information seeking. Some participants reported that they used to save bookmarks of health websites to retrieve health-related information. However, these bookmarks were not used anymore after the growth of Google. They thought Google was a convenient and quick way to obtain health information. This behaviour adds to the work of Choo et al. (2000) that currently people prefer to start their information seeking behaviour (i.e. the "starting" stage) with a search engine.

There were some cases in which the participants clearly knew which website to go to but did not know its web address. Google was used to jump to a particular website, described as a teleport process in a previous study (Teevan et al. 2004). Also, Google was acting as glue of multiple web pages – linking different web pages so that the user could navigate from one to another. Some participants felt frustrated in navigating in a website because of an unsatisfactory design (such as unobvious/hidden links or menu items), they used Google to locate the information in this case. Past studies (Kuhlthau 1991; Choo et al. 2000) propose seekers use hyperlinks to collect interested and relevant information to build up an understanding. Now we see that people will also use search engines for this purpose.

As mentioned previously, people often do not know the keywords or medical terms while finding health information, but this does not stop them from using a search engine. We observed participants

who started with a few test queries and learnt new keywords through skimming the results or reading the information. They acquired relevant keywords for future searches. After the keyword learning stage, their understanding as well as their vocabulary about the health problem increased. The seeker felt engaged in the search process since he/she was able to learn new information about the concerned health problem.

5.4 Design Implications

This study has shed some important new light on issues relating to the design of systems that support people seeking health information. These include promoting the efficient usage of hyperlinks, encouraging information exploration, and information discovery.

Hyperlinks are useful for supporting the retrieval of a wide range of information in the health exploration process. For medical websites (e.g. PubMed), some studies have taken the approach of working on the search user interface and analysing users' queries to provide related keywords and results (Luo et al. 2008; Mu et al. 2011; Ong 2011). Our approach has been to give lay-people a web browser and observe how they used hyperlinks and search engine queries in order to obtain further information. From this we saw how a clear layout of web pages with hyperlinks could help exploratory seekers to more easily access relevant information targets. On the other hand, health information seekers are likely to acquire information from multiple sources. Setting up a "related links" or "further reading" section can also be convenient for users.

Differences in the readability of health information resources and the skills of the information seeker are crucial. This is a barrier of information exploration. Lay-people often do not have enough knowledge to distinguish useful information with matching readability from search results. At the same time, search results may contain "noise" information with similar keywords from other disciplines. As an information retrieval tool, a search engine may create a special category that holds only valid consumer health information, with filters for levels of readability.

Exploration engines would be used to engage users in the information discovery process. Software such as iFISH (Pearce et al. 2012) and SeCo system (Bozzon et al. 2013) may be extended to provide a keyword-free exploration for consumer health information. Additional features could be added to such an engine to let the seeker choose a suitable level of readability and topics for further exploration.

6 CONCLUSION

This paper presented an overview of information seeking behaviours for health information, which is built on the current literature and the result of a qualitative study. Individuals who need to handle health issues of themselves or their loved ones are more likely to use the exploratory approach to search. Other factors such as contradictory information, curiosity and task clarity also lead to exploratory health search. During the search process, an exploratory seeker has no specific targets but keeps learning new search keywords and information. Moreover, exploratory health search alternates with other approaches for searching, depending on the uncertainty level of the seeker.

The aim of this research was not to neglect the importance of traditional online search nor to create a new model to replace existing work. However, we have shown that there is a gap in the current literature regarding these aspects. Through this study, we have identified a new perspective on the search process in the health information domain. This will help in the design of better exploratory systems and providing better search experiences.

As with other qualitative studies, ours is subject to certain limitations. Participants were invited to a lab environment and performed artificial search tasks. Depending on the environment and the understanding of the tasks, the study may not truly reflect the real behaviours when they perform a health search in their daily lives. Secondly, the time constraint of our lab study may also cause the

participants to complete the experiment not at their usual paces. To minimize the problem, we included questions to learn more about the daily search experience in the interviews. For the next step, we plan to analyse the screen recordings and generalise the patterns of search actions that are relevant to exploratory health search. We plan to implement software systems based on these design guidelines and test them against exploratory seekers.

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