Northumbria Research Link

Citation: Elsweiler, David and Harvey, Morgan (2015) Engaging and maintaining a sense of being informed: Understanding the tasks motivating twitter search. Journal of the Association for Information Science and Technology, 66 (2). pp. 264-281. ISSN 2330-1643

Published by: Wiley-Blackwell

URL: http://dx.doi.org/10.1002/asi.23182 <http://dx.doi.org/10.1002/asi.23182>

This version was downloaded from Northumbria Research Link: http://nrl.northumbria.ac.uk/id/eprint/22211/

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: http://nrl.northumbria.ac.uk/policies.html

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

Northumbria University NEWCASTLE

University Library

Engaging and Maintaing a Sense of Being Informed: Understanding the Tasks Motivating Twitter Search

DAVID ELSWEILER[1] and MORGAN HARVEY[2]

[1]Chair of Information Science
Institute for Information, Media, Language and Culture
University of Regensburg
31. Universitätsstrasse, 93053 Germany
Telephone: +49941 943-1708 Telefax: +49941 943-1954
Email:david@elsweiler.co.uk

[2] Faculty of Informatics
Università della Svizzera Italiana (USI)
Via Giuseppe Buffi 13
CH-6904 Lugano, Switzerland
Telephone: +41 58 666 43 00
Telefax: +41 58 666 45 36
Email: morgan.harvey@usi.ch

Abstract

Micro-blogging services such as Twitter represent constantly evolving, user-generated sources of information. Previous studies show that users search over such content regularly, but are often dissatisfied with current search facilities. We argue that an enhanced understanding of the motivations for search would aid the design of improved search systems, better reflecting what people actually need. Building on previous research, we present qualitative analyses of two sources of data regarding how and why people search Twitter. The first, a diary study (p=68), provides descriptions of Twitter information needs (n=117) and important meta-data from active study participants. The second data set was established by collecting first person descriptions of search behaviour (n=388) tweeted by twitter users themselves (p=381) and complements the first data set by providing similar descriptions from a more plentiful source.

The results of our analyses reveal numerous characteristics of Twitter search that

differentiate it from more commonly studied search domains, such as web search. The findings also shed light on some of the difficulties users encounter. By highlighting examples that go beyond those previously published, this article adds to our understanding of how and why people search such content. Based on these new insights, we conclude with a discussion of possible design implications for search systems that index micro-blogging content.

1 Introduction

Twitter is a socially-focussed short messaging ("micro-blogging") service that allows users to post and read short messages - known as "tweets" - of up to 140 characters in length. In these tweets users post about what they are currently reading, thinking and doing and often post URLs to web sites of interest to them (Java et al., 2007; McFedries, 2007). Twitter is incredibly popular and is increasingly embedded in everyday life. As of June, 2013 Twitter has 218 million monthly active users, who collectively send around 500m tweets a day (Rushe, 2013) and as of February 2012, some 18% of online american adults use Twitter and users of the service have diverse demographics (Brenner and Smith, 2013).

In addition to being a platform for socially sharing thoughts and opinions, work has shown that Twitter also represents a valuable, user-driven source of information of unprecedented volume (Boyd et al., 2010). Tweets can provide "specific information, useful links, and insights from personal experiences" (Hurlock and Wilson, 2011). Previous work has shown that many tweets are questions directed to the user's followers (people who sign up to receive tweets from that user) in the hope that they can provide an answer (Morris et al., 2010). Twitter also offers an oft-used search interface to publicly available tweets (Lin and Mishne, 2012) and major search engines have recently started to include appropriate tweets as separate verticals in their search results, highlighting the importance of the medium. Teevan et al. (2011) report 126,000 searches from 33,000 users over a period of just two weeks and Lin and Mishne (2012) reveal that up to two billion requests are made to the Twitter search API every day.

Despite the frequency of their use, there is some evidence to suggest that users are dissatisfied and frustrated by Twitter's search features in their current form (Ingram, 2011), a fact that Twitter themselves are aware of and are taking steps to address (Shin, 2013). Query log analyses have shown that Twitter searches have very different properties to other kinds of search e.g. web search (Teevan et al., 2011; Lin and Mishne, 2012). Twitter information needs are often highly temporal with high levels of query churn (Lin and Mishne, 2012), but, at the same time, repeated queries are more commonly re-issued than on the web (Teevan et al., 2011). Furthermore, the social networking aspect of Twitter influences search behaviour with links between users (@

links) and topics (hashtags) being vital parts of the experience not present in other systems.

While we know what searches on Twitter look like, very little research has been undertaken to understand the information needs behind these searches. We argue that if researchers were to understand more about the motivations behind Twitter searches – what do people want to find, why and what problems do they face – it would lead to the design of improved retrieval models and interfaces and, therefore, an enhanced user experience. Furthermore, knowledge of the kinds of information people want to find through Twitter could be valuable when designing services that make use of Twitter data.

We add to this understanding by describing the results of a diary study designed to learn about the diversity of information needs that motivate searching Twitter content and a second collection of data from Twitter to confirm and expand upon the patterns found. The findings reveal numerous characteristics of Twitter search that makes it different to more commonly studied search problems such as web search, as well as some of the difficulties that can be experienced while searching. We report several findings of note and discuss the implications these have for the design of search systems that exploit micro-blogging data.

2 Related Work

We structure the related work for this article into two parts. In Sub-section 2.1, we review background literature relating to Twitter to demonstrate the value of a study such as the one described in this article. In Sub-section 2.2, we summarise work from Information Seeking on classifying search tasks. This relates to the results of our investigation and provides a basis from which discuss our findings.

2.1 Twitter Research

The popularity of Twitter has made it a topic of research interest in many fields. Prior work has evaluated the way in which Twitter is used to share information in various contexts, e.g. during elections (Gaffney, 2010) and natural disasters (Vieweg et al., 2010) and for different purposes, e.g. to engage particular groups of people (Boyd et al., 2010). Twitter content has also been used to understand sentiment (Pak and Paroubek, 2010), predict future trends (Bollen et al., 2011) and replace tags as information sources for URLs (Harvey et al., 2012).

The field of Information Retrieval (IR) has also contributed significantly to social media research. Such work has shown that people frequently search over Twitter content (Lin and Mishne, 2012), although the properties of tweets, such as their short length, method of creation and short lifespan, means they are searched differently from web pages. People often want real-time search results (Teevan et al., 2011) and the most popular queries often reflect celebrities and news stories, both of which change in

importance and relevance with time (Teevan et al., 2011). Freshness is an important concept in social-media search (Mishne and de Rijke, 2006) and, as such, many social networks order results in reverse chronological order (Thelwall and Hasler, 2007).

In 2011 the TREC micro-blog track was launched as a platform to experiment with retrieval models for such media. Reflecting the organisers' beliefs regarding search tasks, topics are currently grouped into three categories: News Categories, Geographical Interest and Topic Target (entity sought-after) (Soboroff et al., 2012). While these tasks are perfectly plausible, little research has been done to investigate different usages of Twitter search i.e. to understand what people are really trying to achieve. To our knowledge, the only previous work in this direction is a survey of 54 Microsoft employees on their Twitter search habits (Teevan et al., 2011). The findings emphasise the temporal patterns in Twitter search with Memes, Twitter user names, and celebrity names all being popular Twitter queries. Twitter search results include more social content and events information, while Web results contain more basic facts and navigational content. Additionally, the authors identify three main motivations for searching Twitter: *Temporal motivation* e.g. information relating to trending news or events; *Social motivation*, e.g. looking for a specific person or people with specific interests; and *Topical motivation*, e.g. looking for something about a specific topic e.g. "astronomy or science stuff".

While Teevan et al. provided examples of motivations, the main focus of their work was on *how* people search, which they investigated by analysing transaction logs from the Bing toolbar. We, instead, look in more detail at the *motivations for search* (i.e. the *why*) through two complementary methods of data collection – an online diary study and analysis of self-reported search activities on Twitter. The results corroborate many of Teevan et al's findings but, at the same time, provide a more detailed and nuanced understanding of information needs that drive searches, as well as offering details of the user experience, outcomes and some problems that occurred. The outcome of our work is a coding scheme describing different kinds of search tasks people perform with Twitter. Similar coding schemes have been developed for other search contexts. The following sub-section summarises some of the important literature in this area.

2.2 Task Classifications in Information Seeking Research

Information Retrieval and Seeking tasks relate to the activity that results in a need for information (Ingwersen, 1992). Tasks have been defined, studied, and classified in different ways and in many different contexts. In this section we provide a brief overview of the extensive IS literature on tasks, which 1) motivates the work described in this article by illustrating the benefits of task classifications and 2) serves as a basis to relate our findings to those already reported in the literature. An exhaustive review of the literature is beyond the scope of this article. For a more detailed discussion on tasks we

refer the reader to (Toms, 2011) or the work of Wildemuth and Freund (2009), who have embarked on an ambitious project cataloging and relating all of the IS literature on tasks.

One dimension along which tasks can be delineated is the goal the user has in mind when carrying out the task. For example, Hackman (1969) distinguishes between tasks dealing with production [of information] e.g. idea generation; discussion [of a topic]; and problem solving. Similarly, Campbell (1988) draws a distinction between tasks for decision making; judgments; and problems and both Kellar et al. (2007) and Toms et al. (2008) differentiate between fact-finding and information gathering.

Algon (1997) used the activity surrounding the task as the means of classifying tasks. He had categories for administrative, communication, information location, report generation, analytic, strategic formulation / design, and operational activities.

Other scholars have looked at the behaviour people exhibit to accomplish their goal. Choo (2002) classified tasks into those requiring undirected viewing, conditional viewing, informal search and formal search, whereas Marchionini (2006) classified tasks into lookup, learn and investigate. The latter two categories involve more exploratory behaviour. Morville (2009) classified based on the amount of information that will satisfy the task: For "Sample tasks" it is sufficient to find a sample of a few good items to complete the task; "Existence tasks" involve searching for a known-item; and "Exhaustive tasks" require full recall, i.e. finding all of the relevant items available.

Yet another approach is to use properties or characteristics of the task, for example whether the task is open or closed (Marchionini, 1989), the complexity of the task (Byström and Järvelin, 1995) or the phase of the project in which a task occurs (Kuhlthau, 1991). Other investigations, such as those by Kim and Soergel (2005) and Li and Belkin (2008) have explored a wide range of other characteristics, including intrinsic and extrinsic motivations, the person performing the task and the performer's perception of the task (e.g. regarding saliency or difficulty).

It should be clear from this small sample of the literature that tasks can be delineated in many ways and the dimensions that have been suggested are not always completely orthogonal to one another. Despite the ambiguity, the outcomes of this work have offered several benefits to our community. Not only have such classifications pointed us towards the best way to support users in their tasks (Russell-Rose and Tate, 2012) and evaluate developed systems (Toms, 2011), but they have also allowed us to better investigate the influence tasks have on how searchers perceive their information needs e.g. (Vakkari, 1999) and how they attempt to find information e.g. (Byström and Järvelin, 1995).

As the categorisations in the literature overlap and can be ambiguous (Toms, 2011), making generalisations for any specific context or domain is difficult. This has resulted in task classifications being created for specific contexts of use. To name a few: Broder (2002) classified Web searches according to 3 classes of intent: Navigational, Informational and Transactional. Church and Smyth (2008) divided mobile search tasks into Informational, Geographical and Personal Information Management classes.

Elsweiler and Ruthven (2007) classified search tasks in the context of web and email re-finding into Lookup, Item and Multi-item tasks. Again, there is considerable overlap between the classifications for these differing contexts and also between these and the more general classifications described above. This overlap, however, does not, diminish their value. Taking Broder's article as an example, this publication has been cited over 1000 times and has been used to, amongst other purposes, analyse search logs e.g. (Jansen et al., 2008), help search engines anticipate user needs e.g. (Lee et al., 2005) and guide further evaluations (Joachims et al., 2005).

The examples cited in this sub-section, including the three classifications in specific contexts, illustrate the value of studies, such as the one described in this article, which lead to task classification schemes. Currently, our knowledge of why people search Twitter is limited and, based on experiences in other contexts, a better understanding of will help inform the design of better search tools and interfaces, guide the evaluation of these tools, as well as informing future studies to understand user behaviour. It is important, however, to examine how the findings relate to those in more general contexts. We shall return to this point in Section 5.2, where we compare our findings with those described in this section.

In the following section we outline the methodology of our investigation into Twitter search tasks in detail.

3 Data Collection

To learn about the various different Twitter search tasks and the motivations behind them we use 2 different (but complementary) sources of information: a diary study and a collection of tweets collected via the Twitter API in which users self-report a recent search task. By combining evidence from 2 sources we are able to identify a wider range of tasks and, in many cases, can use one source to confirm a finding derived from the other.

3.1 Diary Study

Diary studies involve participants recording their experiences, feelings and opinions about a given situation of interest soon after it happens. Participants are typically given a small notepad, often with semi-structured questions, where they record details and / or answer questions about the situation devised by the researcher, but diaries can also be digital (Elsweiler and Ruthven, 2007). Diary studies capture objective and subjective data in a natural setting, without the distracting influence of an observer (Palen and Salzman, 2002). This technique has been used successfully to learn about many phenomena including interactions with voicemail (Palen and Salzman, 2002), memory problems (Crovitz and Daniel, 1984), and related to this work, information needs in various contexts (Sohn et al., 2008; Elsweiler and Ruthven, 2007). One advantage of this

approach, in contrast to surveys, is that participants are not required to subjectively evaluate typical behaviour, which can be biased in several ways, particularly due to inaccurate memories. Rather, they report specific instances of behaviour that took place in the very recent past and are thus less open to memory bias.

There are a number of challenges when performing diary studies including recruitment, maintaining participation and getting people to record the data you want (Elsweiler and Ruthven, 2007). Our aim was to gain an insight into the breadth of Twitter search tasks from as many Twitter users as possible. Reflecting this and to counter the above mentioned challenges, we designed a short web-based questionnaire to learn about a single search task. Being aware of the questionnaire, the next time the participant searched Twitter they recorded details about what they were trying to find and why. The form elicited information regarding the information need and motivation, whether it was work or leisure based and the success of the task. The form (see Figure (1), took less than 1 minute to complete. We assumed that most people would only complete this form for one task, but users had the option to sign-up to record details about multiple tasks as they happened, which 33 participants chose to do. These participants were sent reminders via email at regular intervals.

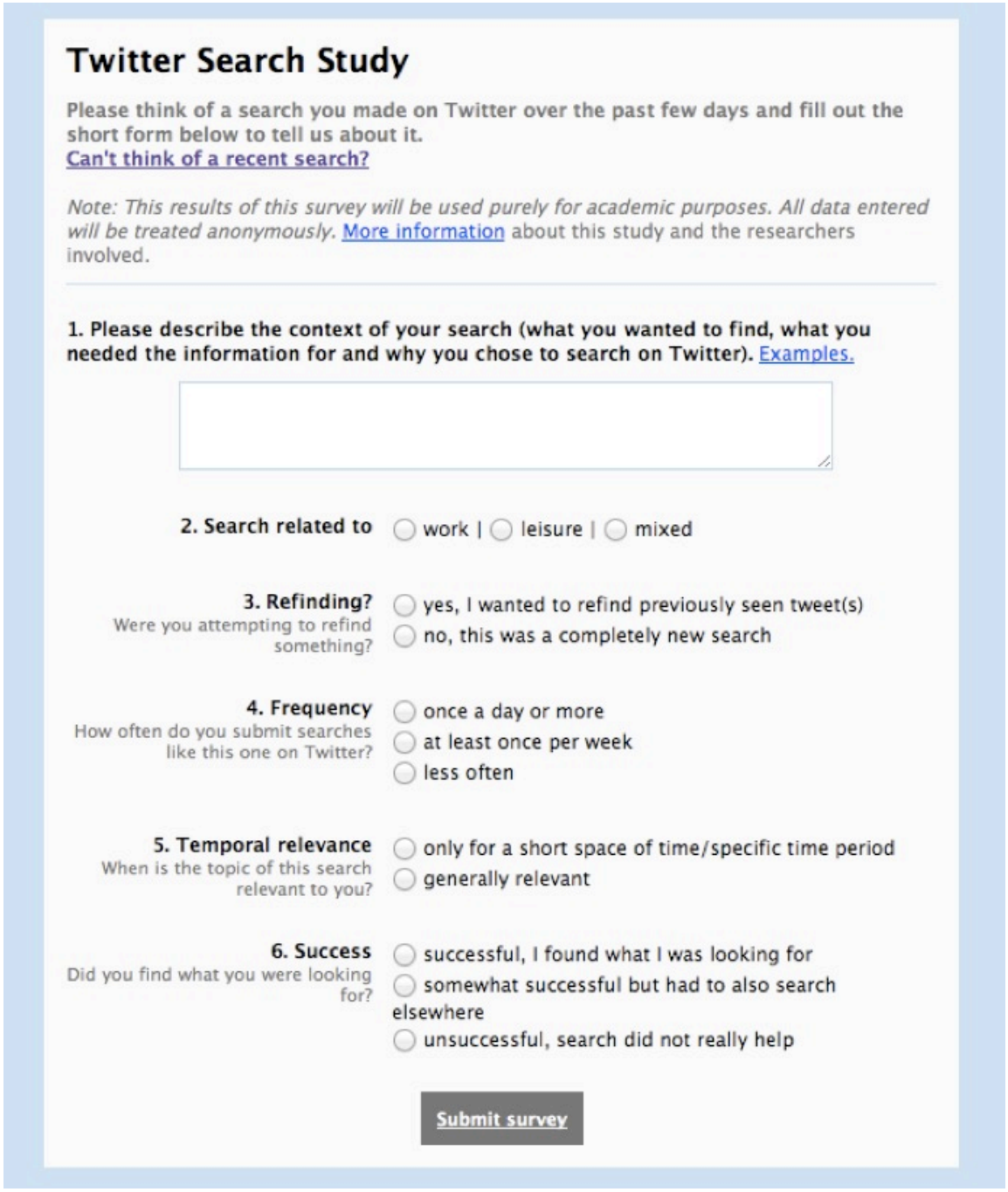

Figure 1: Diary study form

The medium of interest, Twitter, was used as the principal means of recruitment. The authors tweeted a link to a web page providing information about the study, the motivation and what participation would entail, as well as instructions on how to take part. The tweet gave explicit requests to recipients to retweet it to their followers in the hope that the study would go "viral" and generate a large and diverse dataset (the "snowball" sampling approach). We also invited Twitter users with large numbers of followers to retweet our advertising tweets. Our original tweet was retweeted by prominent journalists, politicians and researchers in our field and beyond. The web page was available through the months of June, July and August of 2012 and again in January 2013 and was visited a total of 1089 times.

Despite the relatively high number of page views, we had a low conversion rate into tasks, demonstrating the difficulties faced when recruiting for this kind of study.

In total we received details of 117 search tasks from 68 users (33 of whom registered for an account). In addition to these search tasks we also received comments from 9 participants who told us that they did not search Twitter and explained why. For reasons of clarity we do not include these in the main analysis, however we do discuss their submissions later in the article. The study participants originated from 8 countries, most prominently from the United Kingdom, Germany and the USA. The participants were generally quite active on Twitter and represent a relatively broad sample: median # tweets: 3,413 (min: 16, max: 19,234), median # followers: 279 (min: 15, max: 16,996). They had a wide range of professions, including: research (computer scientists, biologists, physicists and mathematicians), programming, journalism, design and business management.

3.2 Complementary Tweet Corpus

We exploited the autobiographical nature of twitter - the fact that users often describe what they do, think and feel - to supplement the task descriptions from the initial study. We constructed an additional tweet corpus consisting of first-person descriptions of Twitter search tasks reported by twitter users themselves. During the period 13th of March - 27th of May 2013 we used the Twitter Search API, on a weekly basis, to retrieve and store tweets containing the keyword "twitter" plus at least one of some derivation of the keywords "search", "find", "refind", "look", or "monitor" in their past or present tenses, including the "ing" form. The keywords were chosen based on the findings of Teevan et al. and the initial analyses of the diary study entries. The aim was to return tweets such as "Searching twitter for …", "I looked for …on twitter" etc.. Duplicate tweets and retweets were removed. The approach is similar to that taken by Wilson and Elsweiler (2010) who used Twitter to learn about leisure information seeking behaviour.

Via this method we obtained 1,351 tweets. While many of these tweets were noisy

and provided little useful information regarding the motivations for search, others provided descriptions comparable with those collected during the diary study. To establish tweets of value, two researchers separately examined all of those returned and flagged them as useful if they represented a first-person testimony of a search task performed on twitter. Agreement was reached in 94.2% of cases and for the remaining tweets the researchers discussed together how each should be classified, yielding a total of 457 tweets containing first-person testimony of a Twitter search.

The second set of data comes from an even more heterogeneous sample of Twitter users. Nevertheless we do not claim our sample to be fully representative of all Twitter users. It does however, provide a set of Twitter search tasks demonstrating a breadth of uses for Twitter search not reported previously in the literature, including examples that were repeated by multiple users. Furthermore it gives us the opportunity to analyse search needs reported by users who were not involved in a research study at the time. We explain the utility of our findings below.

4 Results

The data provided by the diary study participants show that Twitter is searched both for work and leisure purposes; more tasks were described as being for leisure purposes than work: 39% and 33% respectively, but there is considerable overlap between these domains, with the remaining 28% of tasks being described as "mixed". The majority (68%) of diary study search tasks were described as being only temporarily relevant i.e. the information found was useful at the time of the search, but would only be relevant for a short time. This confirms the assertion made earlier that Twitter is often used for information needs which have a short life time.

We also asked users to indicate how frequently they performed the kind of search tasks they were reporting. 18% of tasks were said to be conducted once per day or more, 27% at least once per week and the remaining 55% less often than that. These responses underline that many of the tasks recorded were not unusual, but were often repeated. Regarding success, the majority (54%) were deemed by participants to have been completed successfully; 31% as partially successful and 15% of tasks were described as being unsuccessful.

We analysed the diary study responses from the first round of data collection (June-August, 2012) qualitatively using an approach aligning with the ideas of Glaserian Grounded Theory (Glaser and Strauss, 1967). As there are so many different ways in which search tasks can be classified (see Sub-section 2.2), it made sense "to let the data talk" in order to establish a theory (coding scheme) that reflected the points emphasised in the the diary study entries.

The first stage of the analysis involved assigning codes to interesting or illuminating aspects of the diary study descriptions. These codes "serve as shorthand devices to label,

separate, compile, and organise data" (Charmaz, 1983). The generated codes were then grouped in a bottom-up fashion into concepts (these are at the level of those labelled 1.1, 2.1 etc. in Figure 2). This step is referred to in the literature as "open coding", which involves "breaking down, examining, comparing, conceptualising and categorising data" (Strauss and Corbin,1990). The concepts were then further organised into higher-level categories (the top level labels in Figure 2), which, in our view, best reflected the phenomena observed in our data. This step, which Strauss and Corbin (1990) name axial coding, involves "a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories". The outcome of this step was a complete coding scheme - a set of categories that reflects the described motivations for searching twitter at a useful level of abstraction. Throughout the analysis, the raw data were treated as potential indicators of concepts and the indicators are constantly compared - a point emphasised by Glaser and Strauss (1967) - to see which concepts they best fit with. This means that the link between the data and more abstracted concepts and categories is not lost.

After a second round of data collection (January 2013), we used directed coding, an approach commonly associated with Strauss (Strauss and Corbin, 1998) to validate and develop the coding scheme. That is, we looked to see if the coding scheme made sense with respect to the new descriptions submitted by determining where new data fitted within the coding scheme. If the data could not be appropriately coded, the coding scheme was amended to reflect all of the data that had been seen up until this point. Subsequently, over a period of several weeks, samples of tasks were drawn from the combined datasets and coded separately by two researchers. Disagreements were discussed and used as a basis to iteratively develop and improve the coding scheme.

We continued the Straussian approach with the data sourced from Twitter (March-May, 2013). This demonstrated that the majority of existing concepts were robust, but a few new concepts had to be added (C1.6, C8 and C5.3) as a result of testing with the new data. Analysing the tweeted descriptions was not always straightforward because they were not provided with a study in mind. In many cases the researchers needed to examine the context of other tweets in a thread of conversation to understand the content and others required an Internet search to discover names of people, places or specialist terminology to establish the intention. There were also cases where such examinations yielded little extra understanding and these tweets were necessarily omitted from the analyses.

When we were satisfied that the coding scheme could be universally applied, we tested the coherency of the final coding scheme, which is presented in Figure (2. 3 coders (1 of whom did not participate in the categorisation creation process and who had no other involvement in the project) re-coded 50 tasks selected at random from the dataset. The 2 authors achieved an unweighted Cohen's Kappa of 0.828, $z=10.9$ and all three coders achieved a Fleiss' Kappa score of 0.718, $z=15.2$ (). Both scores indicate

substantial agreement between the coders (Landis and Koch, 1977), suggesting that the derived scheme is unambiguous and appropriate for the data.

Both datasets were then reclassified in their entirety to ensure consistency. During this second round of classification 69 of the 457 examples obtained from tweets were found to be unsuitable, due to either being retweets or being impossible to accurately classify, resulting in a final total of 388. Note that individual search tasks can be assigned multiple codes in order to more accurately reflect the information needs expressed. Furthermore, it was not always possible to accurately identify an appropriate concept for a task based on the description provided. This was particularly true of people search, where for many examples it was difficult to determine whether or not the sought-after person was a friend [C5.1] or not [C5.2]. In such cases the higher-level category [C5] was assigned. In Figure 2 this is communicated by having the counts for categories without parentheses and the total counts for category and appropriate concepts in parentheses. Figure 2 provides the frequency information for the diary study data, the twitter sourced data and the combined totals from both sources.

The following sections describe the principal categories in detail, explaining, with examples, the significance of the findings. After describing the categories individually, we continue to explain the final stage of analysis - selective coding - "the procedure of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development" (Strauss and Corbin, 1990)(p116).

After the derived categories have been explained, we discuss trends and contrasts across these and interpret what the findings mean in terms of the way search systems for Twitter, and micro-blogging content in general, should be designed. To make comparison easier, each diary study search task is allocated a unique reference number in brackets, preceded by the letter D, for example [D10]; descriptions from tweets are given codes beginning with T e.g. [T281]. We refer to codes (categories or concepts) using a similar syntax, e.g. [C2.1] would refer to the concept 'Ego monitoring" (see Figure 2).

	DS	*TD*	*COMB*
1. Standalone informational	**0 (43)**	**6 (201)**	**6 (244)**
1.1 Current up to date info./news/context/event	20	59	79
1.2 About past event	3	20	23
1.3 Looking for media	3	20	23
1.4 Info. related to document/tweet/hashtag	11	23	34
1.5 General topical search	4	58	62
1.6 Checking novelty (idea/info.)	2	6	8
1.7 Learning about human behaviour	0	9	9
2. Monitoring	**0 (10)**	**2 (39)**	**2 (49)**
2.1 Ego monitoring	2	32	34
2.2 Monitoring hashtag	4	1	5
2.3 Monitoring topic	4	5	9
3. Sentiment/opinion finding	**17**	**20**	**37**
4. Sense-making of conversations/info. filtering	**2**	**3**	**5**
5. People search	**4 (22)**	**22 (102)**	**26 (124)**
5.1 Friends/contacts	9	40	49
5.2 Not friends/contacts (celebrities)	8	32	40
5.3 Organisation	1	8	9
6. Querying social network	**0 (2)**	**0 (10)**	**0 (12)**
6.1 Asking question yourself	1	10	11
6.2 Following answers to someone else's query	1	0	1
7. (True) Refinding	**3 (36)**	**12 (24)**	**15 (60)**
7.1 External resource linked to in tweet	18	4	22
7.2 Content of tweet itself	15	8	23
8. Boredom motivated	**0**	**13**	**13**

DS: diary study
TD: Twitter-sourced data
COMB: Combined totals

Counts for top-level category without parentheses, total counts for category combined with appropriate sub-concepts in parentheses.

Figure 2: Coding scheme developed

4.1 Standalone Informational

Standalone Informational tasks [C1.1-C1.7], which represent approximately 46% of the applied codes, are defined as having a one-shot requirement for specific information or being a general topical search the user believes could be fulfilled on Twitter. By

standalone, we emphasise that these tasks are isolated and not part of a larger, more complicated search session. Many of the diary study tweets contrast with what Teevan et al. refer to as topical searches, in which the user is looking for more general information on a specific topic e.g."astronomy or science stuff" (Teevan et al., 2011). Only 4 tasks (9%) from the diary study corresponded to this kind of need, for example 'Web 2.0, online marketing, startups, funding, healthcareIT" [D28], which does not seem to be referring to a single task, and for which we allocated a separate code [C1.5]. Topical searches that were recorded were often related to monitoring tasks [C2.1] and [C2.2], where the users are looking for new information, updates and changes. Monitoring tasks are discussed in detail in the following section. The situation is, however, not the same for the Twitter sourced tasks where nearly 29% of those assigned to the standalone informational tasks category were topical in nature.

The tasks coded as standalone informational give clues as to why Twitter may be used as an alternative to or to supplement more traditional search engines. For example, many emphasise that Twitter is perceived as providing up-to-date information, much more so than search engines [C1.1]:

"I searched for [Microsoft vanity fair], to find an article that a coworker recommended reading. I was looking for a link to the article, and i knew it was just published, which usually means it may not be in the top of google's search results yet" [D58] and "[I looked] to find if my city had an earthquake.. and chose Twitter because that's the fastest way for getting almost live information" [D59].

As has been reported previously in the literature, many of the needs motivating Twitter search are temporal in nature, i.e. the relevance of the search is restricted by time. 83% of diary study needs classified in the standalone informational category were marked by the participants as being temporal. While we do not have explicit information from the users about which of the Twitter sourced tasks are temporally limited, it is clear from many of the descriptions that they are. For example in the following example the user is trying to find out why their mobile phone connection is not working at the time of creating the tweet: "@RachelCowell I just did a twitter search on it to see why my EE isn't working lol so I wouldn't recommend it! " [T837].

The data indicate that Twitter is also perceived as a good alternative to other traditional media, such as television, for finding out facts or rumours, again particularly for up-to-date information.

"I wanted to find about the Italy vs. England Euro 2012 match and who won in penalties, as I don't have TV at home. So I searched on Twitter" [D6].

Despite search engines offering explicit support for this kind of need, e.g. vertical search features, it appears that some users simply associate Twitter more strongly with up-to-date information than they do search engines. Another case where people may be inclined to prefer Twitter over search engines is in the case of small, geographically localised events which may not appear in a search engine's indices quickly enough or may even be too localised to be reported at all. "Heard sirens near my house, wanted to see if anyone was tweeting about it" [D63]; "looking for information regarding arson event in my

neighbourhood" [D27].

This strategy is not always successful; sometimes news relating to the event of interest is drowned out by noise of several events being reported on.

"Heard gunshots on my block, searched twitter to see who in SF [San Francisco] has details. Saddened by results. gunshots everywhere. all over this country." [T1115].

Some of the tasks we referred to as standalone informational related to past events [C1.2]. One example that featured a lot in the Twitter sourced data related to a terrorist incident in Woolwich, London in May 2013 where a soldier was murdered. Again, the tweets emphasised some problems encountered when using Twitter as a source of fact.

"Searching twitter for 'Woolwich' paints a very confused picture involving soldiers, road rage, samurai swords, axes and beheading." [T1064].

Here, because multiple people were commenting on different aspects of the story, it was not easy to comprehend exactly what had happened. A further problem in the Woolwich example was that the event prompted a number of political and often racist opinions that were also reflected in tweets. There was evidence that this blocked and clouded the search for news:

"A twitter search for 'Woolwich AND False flag' yields some fairly depressing results - not all tongue-in-check either... *headdesk*" [T1015] .

Several users made comments to similar effect: "@Grumpyhatlady I made the mistake of searching twitter for 'Woolwich'. Don't."[T1078] .

Other past event standalone informational tasks were also motivated by the wish to find media [C1.3] e.g. "Wanted to know what people thought of a music festival I went to and to see if someone posted interesting pictures [D13]". This example was also coded as an example of sentiment / opinion finding [C3] (described below).

Other media examples included looking to find legal or illegal sources of specific music content (e.g. "@The_PurpleHayes @KendaleGober I already got it. I just twitter searched wolf album leak" [T320] and "@mindtrappa i twitter searched 'jai paul zippyshare' and there was one result ;-;"[T571]); looking for images, (e.g. "Twitter searching pictures of puppies"[T890]) and in particular pornographic images (e.g. "i fell into the great dick abyss twitter searching dick print." [T519]). It seems that finding this kind of content on Twitter is assisted by knowing specific hashtags such as #dickprint [T519] or #twitterafterdark:

"Just searched twitter after dark & I didn't know it still existed. It's too much for my eyes lol" [T1126].

Code [C1.6] referred to using Twitter to verify if a thought or an idea was novel. For example, jokes, fancy dress costumes and terminology: "Just Twitter searched 'Baselona'. Really thought I'd be the first to come up with that. Ah well."[T586]; "I just made up that joke and then I conscientiously twitter searched it to find out how unoriginal my brain is. the answer: very"[T1058];

The final concept in the standalone informational category relates to tasks where Twitter is used to satisfy the user's curiosity regarding some aspect of human behaviour [C1.7]. For example, grammar and spelling mistakes ("RT @Logann_Taylor: I love browsing twitter looking for errors in people's tweets. #nerdporn" [T939]); racist opinions ("Depressed myself

with a Twitter search for 'I'm not racist but'. Yes, yes you are." [T1016]) and bullying ("Thanks to @rsslldnphy I have been lost in twitter looking for examples of sexist bullying/behaviour. IT IS EVERYWHERE. Pretty shit really." [T462]).

The examples in this section evidence differing origins and causes for information needs for which Twitter is seen as a potential solution: Some were motivated out of curiosity, e.g. the sirens example [D63], others out of general interest, such as the Euro 2012 match result example [D6] and another where the user simply wanted to find out about a local ocean swim event [D5].

Other tasks were prompted by documents, tweets or hashtags [C1.4]. For example, "I was interested in the article about sexism in science by the guardian today [D121] and "trying to find out why a hashtag is trending" [D110]. Others still were borne of out some kind of need anchored in the situational context [C1.1] e.g."[I'm trying] To find a public lounge wifi password in an airport" [D22] or watching or missing a television programme e.g ."@marylouiseg haha don't worry i twitter searched #apprenquiz haven't been watching! you got your winner picked? " [T812] . Several motivating contextual examples were problems for which Twitter seemed to be very helpful: "LInkedin is Down! and I just love the way I verified that by searching Twitter and found many a man lost with what to do" [T299] and "@m_in_m Cheers. Yeah I was just searching Twitter to see if anyone else had that problem. :P @lipglossgirl86" [T689]

Thus, standalone informational needs can be varied in terms of topic, can be temporal or not, can have different contextual motivations and can be susceptible to several problems.

4.2 Monitoring

Another type of need identified was what we refer to as monitoring tasks, where the user issues the same query repeatedly to check for any changes or updates in information. Monitoring tasks, can also be informational. The key difference to the examples in the previous section is that these tasks involve repeated behaviour looking for changes or the current state of information. Monitoring tasks are common on the web (Kellar et al., 2007) and Teevan et al. also mention them in their Twitter analyses (Teevan et al., 2011). Teevan et al. report two types of monitoring; very short-term (within sessions) and long-term, which they assume to always be between-sessions repeated queries. However, participants in their survey did not mention monitoring behaviour explicitly. Our data had several monitoring examples; in all 9% of the codes were categorised as such and give an insight into what people monitor and why.

One motivation for monitoring was to keep abreast of and monitor development of subjects of personal interest to the user [C2.2] and [C2.3]. An example of such a task, reported by multiple users in the tweet data, referred to monitoring rumours about a football manager 'Vitor Pereira' moving to the users' favourite team 'Everton'. The descriptions emphasise how regularly the search had been submitted:

"The amount of times I've searched Vitor Pereira' on Twitter this evening is worrying."[T1123]

"@Fo0tballista True. Got an entire day of twitter searching tomorrow! " [T1092]

Several users reported using hashtags for monitoring purposes [C2.2] e.g. "Research on learning and performance support topic via hashtags such as #lrnchat #performchat #socialearning #pln #ple #km" [D36]. This is a case of a long-term monitoring task, however, hashtags were also used for short-term monitoring tasks. For example, specific conference hashtags were left open to monitor news both from a conference that was running (but the participant wasn't attending)[D62]; and also to check for news regarding notifications of paper acceptance for a future event "Any news from EuroHCIR? "[D20].

Other topic monitoring tasks did not mention hashtags [C2.3]. In a similar vein to the localised searches discussed previously, people used Twitter to monitor whether or not an area or activity is currently safe: "Frequently search to see if city is safe/[sic]political stable","to find out if conditions are safe enough to travel" [D24]. Again, this is something that might be difficult, or perhaps even impossible, using traditional media and search engines. This would normally require the user to find a trustworthy source who provides very regular updates. However on Twitter this need may be met if many users are tweeting about the same situation, allowing Twitter to serve as a compiled source of information.

A further type of monitoring task revealed by our data, which turned out to be a very common use-case, is what we refer to as "Ego monitoring" [C2.1]. In these tasks, users keep track of references to themselves or projects and events directly related to them. For example,"[looking for] references to myself and my own projects" [D31] and "Searching for feedback on a club night I performed at, by Twitter-searching the club's name" [D66]. This last example shows that use of Twitter's @syntax, which refers to specific users, does not always suffice for ego-searches. While Twitter could potentially contain the information this user is looking for, i.e. opinion regarding his performance, this could be a difficult task to solve from both a user and a system perspective because not all relevant tweets will contain unambiguous references to the individual of interest.

Other reasons for searching one's own name from tweets include seeing if any responses to items tweeted had been missed [T922], finding out if there were other people with the same name [e.g. T819,823,1122] and to assess privacy risks. For example, one Twitter user searched for herself to see how easy it would be for teachers and college coaches to learn about aspects of her life:

"Searched my name and the first thing that came up was twitter, college coaches don't even have to work that hard to see your tweets" [T1213].

While many of these ego searches were performed to make the user feel good about themselves, this was not always the outcome. "Went searching twitter for my name and found old accounts i've made..i've never felt more embarrassed in my entire life" [T161] .

The reported needs show that monitoring tasks can span different lengths of time; they can be informational (topic developments) or can be opinion-based (club feedback). Monitoring tasks of all kinds often require the collation of information, perhaps from different sources. Assessing the safety of travel conditions [D24] would likely involve combining evidence from multiple tweets before making a final judgement. Similarly, to

get a general feeling for how a club night was perceived, it would be helpful to find opinions from several visitors.

The descriptions also reveal a pressure involved when conducting monitoring tasks that if the user takes his or her eye off the ball, vital information may be overlooked or missed in the flood: "@vegcoastvan Gah. I wish I'd been more up on my Twitter searching and seen this sooner. At least I'll be back in #PDX in just over 2 weeks! "[T1304] .

4.3 Sentiment/opinion finding

An oft-reported form of social information need relates to looking for people's opinions on particular topics (Teevan et al., 2011). In our data, several of the recorded needs reported explicitly looking for opinions or feelings [C3]. [C3] represented 6.8% of all applied codes, but was much more prevalent in the diary (12.9%) data than in the collected tweets (4.8%).

One diary study participant remarked that he uses Twitter as a barometer for feelings on just about everything "I'm usually interested to know what people are saying about everything: weather, football, cities, etc." [D25]. However, especially popular were looking for opinions on sports events "[wanted to know what] people were saying about Paul Lawrie almost leading the open again" [D48], new products "Disney's new 'Botanicus Interacticus'"[D64], companies [D44], and about news events e.g. 'Air India flight allowed to land in Nawabshah yesterday, wanted to know sentiment of Pakistani people over it" [D21]. Again, there seem to be different motivations for these kinds of searches; some were to inform purchases, whereas others were simply out of curiosity.

Another sentiment / opinion finding motivation relates to making oneself feel better (for example, after an exam or test) by confirming that others had similar experiences or felt the same way about a topic:

"Twitter searching 'SQA' [Scottish Qualifications Authority] and 'higher maths' [exam] to make myself feel better"[T1103]

"just twitter searched F211 biology and everyone else found it super impossible, thank GOD"[T1051]

The defining characteristic for needs of this type, however, is that the participants were explicit that it was opinions they were looking for as opposed to facts. This is another example of a key information need expressed, which may not be easy to fulfil using more traditional tools on the web. In the diary data, a subset of the sentiment tasks (n=3) were marked as being performed daily or more frequently, 5 were performed around once per week and the remaining 5 were reported to be conducted very infrequently. None of the tasks with code [C3] were described as being completely unsuccessful, suggesting that Twitter is a useful tool for discovering sentiment and opinion. 5 were described as "partially successful", suggesting that in some cases users could use further assistance with this task.

4.4 People search

Previous work has emphasised the importance of the social aspect of Twitter search. 26% of Teevan et al.'s (2011) survey participants reported searching for information about other Twitter users with motivations including looking for individuals with specific interests, to discovering what certain people were saying, or following responses they made. All of these tasks featured in our data, however, we also identified other use cases for people search. Needs mentioning some kind of people search represent a large percentage (22.8%) of applied codes. What becomes clear from the findings is that people are often used as a kind of hub; a means to solve many kinds of information needs.

People reported looking for users who were already contacts (to find out how to spell their name [D37], or ascertain their Twitter handle [D47]) or friends who were not yet contacts [D72]. 3 diary study participants reported doing this on a weekly basis or more often. People were searched for: To find out if they're on Twitter at all [D47,74], to find how active they were [D50], to find opinions about them [D34], to find out what they look like [T1122] and to block them [T900]. There were also examples of looking for other people (e.g. celebrities/famous tweeters) e.g. "Wanted to know who Franky Ocean is. Never heard of him, but he got a good review in the guardian. I want to establish how popular he is, what his music is like and what people think of him" [D34] . This final example [D34] highlights the breadth of potential information that Twitter users search for, particularly relating to people.

Other task descriptions highlighted that people search does not only include looking for a particular individual, but can also involve looking for groups of individuals meeting a particular criteria. For example, looking for likeminded people or people with a shared experience to follow or make social contact with:

"I'm so glad all those like minds I've been searching for throughout my life, were like minded enough to all get twitter accounts. [T615]

or the opposite, looking for people with differing opinions to start debates or arguments:

"twitter searching people who didn't like Beyonce's song and disagreeing with their opinions "[T74]

There were even examples of people search for philanthropic reasons, including a comedian searching for people to give gig tickets to who perhaps wouldn't otherwise be able to come for financial reasons: "I like to do a little Twitter search for people who genuinely can't afford tickets and offer them some".[T485]

A further interesting case was a response to a company using Twitter to search for potential candidates for an open position: "companies looking to recruit @ICHOCOLATE_DROP I just searched Twitter for 'need a job' and saw your status. Don't want to be a troll but we may be able to help! " [T917]

As we will discuss in more detail below, people were also frequently used as a principal means to refind previously seen tweets, performing a very similar function as in email search (Harvey and Elsweiler, 2012). For example, "Trying to find a link to a video that I remember one of my friends had posted" [D3]. Furthermore, there was evidence of Twitter being

used as a means to link the interests of two people: "Looking for the tweet from @anon which had a nice quote in that Jenny would love." [D18].

The final code within the people search category relates to looking for organisations that have a Twitter account [C5.3] e.g. "Searched twitter for 'niagara riding stables' and it pulled up PM Harper's profile? "[T906].

Based on the diary study data, only half of the tasks coded as people search were reported as being completely successful and the descriptions participants provided seem to corroborate this. They also hint at some of the reasons why looking for people can be difficult. For example, when a sought-after Twitter user takes a break from tweeting it can become more difficult to find them: "...she hasn't tweeted in a while which is making it hard to find her" [D50]. One participant reported looking for someone on Twitter, but "Despite having his Twitter handle, this is not straightforward" [D70], hinting that users could be better supported during such tasks.

4.5 Miscellaneous

Two codes [C4] and [C6] were not used frequently in the coding process, but nonetheless deserve attention as they provide further insights into the diversity of needs that searchers of Twitter content have.

[C4] referred to the use of Twitter search facilities to help keep track of and make sense of long conversations on Twitter: "I use it to find a comprehensive set of @ replies to particular Tweeters when there is a large conversation taking place" [D30]. The user reported conducting such a search at least once per week, hinting that, although tasks of this type were only recorded twice in our diary sample (and 3 times in the tweet data), they could still be a fairly common use case.

[C6] refers to a use of Twitter already reported in the literature, that is, using Twitter to answer questions by querying one's social network (Morris et al., 2010). Tasks with this code share characteristics with codes we have already discussed e.g. [C1,C3 and C5] but differ in the method used to locate the sought after information. In this case, searchers pose the information need as a question to their social network in the hope that a contact will be able to find the information they are seeking. In our diary study data there are only 2 instances where this use case is mentioned. Once when the participant posted the question him/herself [C6.1] "Asked Twitter followers about user-experience design best practise and research on naming of the security code field for online card payments. It has so many (jargon) names that I want a consensus"[D33] and another time where the participant was piggy-backing on the question of another user [C6.2] "[searched for] responses to question asked by someone I follow"[D23]. It could be, however, that many study participants did not consider this to be an example of searching and therefore did not record it. Although, in the case of [D33] the user stated that they performed this kind of search at least once per day, hinting that such searches may be important for a small subset of users.

In the tweet data, on the other hand, this use case appeared a total of 10 times and

was often users looking for recommendations: "Ok Twitter looking for some good Pizza downtown CHI, any suggestions price don't matter..."[T933] . In another instance someone was querying their social network to help locate a company they thought might be represented on twitter: "Anyone know if Biddenden Vineyard is on Twitter? Searching on blackberry not easy admittedly, so far no joy."[T504]. This example, has multiple aspects: the user is looking for a company [C5.3] which may or may not have a Twitter presence [uncertainty], is using a mobile device to do the search, and is having difficulties.

Posting questions to Twitter to realise information needs can lead to strong feelings of empowerment as expressed in the following description: "@SuonJenny HELL YES I'm having all of twitter searching for a car for me"[T86]]

4.6 Refinding

The most common task reported in the diary study involved refinding information previously seen on Twitter. Refinding is very common in web (Teevan et al., 2007) and personal search (Elsweiler et al., 2011a; Dumais et al., 2003). 43% of all diary study tasks were described by participants as being refinding tasks, in marked contrast to the findings of Teevan et al., where only 2 of 54 participants mentioned refinding when surveyed (Teevan et al., 2011). Teevan et al. did observe a high amount of query repetition in the logs, but concluded that these were likely to be monitoring tasks and not refinding. Our data suggest this may not be the case. Of the 132 codes applied to the diary study tasks, 36 were assigned the "refinding" code [C7], where refinding was explicit in the task description. However, regarding the codes derived from the tweet data, only 24 of 412 were determined to be refinding.

In our coding scheme we distinguish between two subtypes of refinding task. In 37% of refinding tasks, the user was looking for the content of the tweet itself e.g. "Looking for the tweet from @anon which had a nice quote in that Jenny would love" [D18] and in 38% of cases they were looking for a tweet that they had seen that pointed to some external resource somewhere else on the web e.g. "Looking for a link to a story about an awesome graduation gift that took years to make. Want to start something like that for T" [D39]. External resources were in the form of URLs, images, articles, lists of Twitter handles, software, videos and cartoons. For the remaining 15 cases it was not possible to determine decisively whether the user was looking for the tweet content or an external resource linked to in the tweet and these were simply allocated to [C7].

On at least three occasions a diary study participant was trying to refind tweets they had posted themselves [D45,49,61] e.g. "…trying to find an article…I thought I had tweeted,". In only 1 one of these cases did the user report successfully refinding the tweet in question. Two refinding tasks clearly involved aggregating information from several tweets [D49,54] e.g. "[want to find] Times that I had complained about trains [I always tweet about this]."

Refinding tasks were not nearly as common in the tweet data, constituting only 6.4% of all codes and a number of these were also coded as people search, i.e. the aim was to

find a person again on twitter: "@MatthewSkyy I had to refind you on twitter"[T975] . There were also instances of people trying to refind media on twitter: "I'm on twitter looking for this picture that I found to be really funny. It was a onion being compared to a black girls hair."[T1161] , hinting at twitter being used like a digital repository.

Refinding on Twitter seems to be a particularly difficult task: "@sammabird24 I'm not gonna lie I just searched thru my whole twitter feed to find the tweet lol #mylife" [T1200].

A Pearson product-moment correlation coefficient test between the variables "refinding" and "success" on the diary study metadata yields a p-value of 0.044, indicating that these two factors are significantly correlated. This means that knowing if the task involves refinding strongly predicts whether it will be successful or not, where refinding tasks are significantly less likely to be successful than non-refinding tasks.

As with the previous section, the need descriptions given reveal some difficulties people have when refinding tweets. As has been reported in other search situations (Gonçalves and Jorge, 2006), uncertainty seems to be a major barrier. "Trying to find a link to a video that I remember one of my friends had posted. Pretty sure I saw it on Twitter" [D3]; "…trying to find an article …which I thought I had tweeted, retweeted or favourited" [D61]. Uncertainty is not always the problem however. Even very short-term refinding can be challenging: "Looking for the tweet with the link to a study about tomatoes. I have the page open, but don't know where i found it. it was literally about a minute ago" [D57]. The fact that Twitter is not persistent and constantly changes can also be problematic: "@Blueraydre @Blue_Nox i tried to find the tweet, searched twitter, all that, shit was deleted in record time lmaoooooo" [T785]. "I was looking for a specific tweet [to retweet] it, but it was 'too old' for Twitter :(" [D40] and participants reported looking for relatively old content on Twitter: "…trying to find an article that I had read some time in the last year…" [D61].

Hashtags can be helpful and it seems that the task becomes noticeably more difficult for users when they are not present: "…wanted to look for The Dark Knight Rises reviews incredibly hard to find tweets you have already seen, unless there is a # tag" [D54]. Users had to occasionally resort to using an external search engine to find what they were looking for: - "…had to search google's index of Twitter to find it" [D11].

An interesting refinding problem that went unsolved was when a user was in possession of a tweet that had been retweeted but wanted to find the original so they could retweet that themselves [D16]. This means that despite having the full message text and the name of the original author, they were still unable to find the tweet they were looking for using Twitter's existing search system.

4.7 Explicit Leisure / Boredom searches

We noted above that many tasks in the diary study were not work related. It could also be said that many of the tasks already described had hedonistic motivations. For example, many of the media searches [C1.3], i.e. those for music and pornographic images, could be argued to be concerned with the pursuit of pleasure. Similarly, several ego monitoring

[C2.1] and sentiment analysis tasks [C3] were performed to make the user feel better about him or herself. These properties are all part of what Elsweiler and his colleagues (Elsweiler et al., 2011b) describe as casual-leisure information behaviour.

Some of the task descriptions explicitly mention that search tasks were motivated by no reason other than boredom. Such tasks were given the code [C8].

"Nothing to do at harkness so I'm sitting on twitter looking for something interesting...nothing yet Dx" [T926]

"Searching twitter for something that will give me meaning! ! ! #unsuccessful #jkimjustbored #sickgirlpobz" [T407]

Neither of these examples seem to have been particularly successful, but others were:

"Have you ever searched twitter and facebook during an NBA Playoff game? SO entertaining" [T909]

Similar to the findings reported in Elsweiler et al. the descriptions hint at the addictive nature of searching Twitter.

"@signedUnk yeah I can never get back to my room and just sleep, I always need to search twitter first lol"[T359] .

4.8 Reasons for Not Searching Twitter

As mentioned above, in addition to the participants who recorded reasons *for* searching Twitter, 9 extra participants instead gave details why they *do not* search Twitter. While there is insufficient data to analyse these responses formally, we report some general themes and give some examples as they are of interest and in one case corroborate findings discussed above.

One participant reported not having any explicit need for search facilities. Instead, he satisfies information needs by browsing: "I do everything via browsing (e.g. exploring hashtags that friends tweet about, reading the stream of someone a friend retweets). Basically if nothing related comes up in my stream through people I follow I won't see it." This participant proclaims to restrict himself to information that appears in his stream - information that he has explicitly chosen to receive - electing not to make use of other portions of Twitter. Another user reports similar reasons for not making use of the search tools: "Rarely looking outside my social network for information." In a further example the participant is apparently unaware of the potential usefulness of Twitter information and makes the assumption that search engines will reliably deliver appropriate results from Twitter: "Actually your questionnaire only told me that there may be a point to search twitter. Usually I use google and would have expected it also shows twitter results if relevant".

This last point that search facilities were not required because of the strength of existing search options e.g. Web Search Engines, was reported by three different users. "Have enough search capabilities with the current search engines". "Searching is easier on Google. You don't need to use # or @ and it has autocomplete. Generally I don't need to think much about searching on Google, while twitter searching is a bit of a chore". This example succinctly illustrates the main motivation for this work, that Twitter search should be improved; perhaps also that

people are not used to leaving their regular search engine for a site-specific search. It also seems to endorse the conjecture above that some users only choose to use Twitter search itself as a backup solution when a search engine fails to return relevant results. What should be clear from our analyses above, however, is that micro-blogging search is not and should not only be a fall-back solution. Indeed, there are many use cases for which users are not well supported by search engines. The assumption is that search engines will reliably return appropriate social media results as a separate vertical, if they are available. However, due to reasons of scalability and trustworthiness, actually only a very small number of Twitter users (trusted celebrities and organisations) are used to populate these verticals (Chilton and Teevan, 2011).

5 Summary and Discussion

The above sections have outlined and exemplified the variety of Twitter search tasks that people perform. Some were obvious uses and aligned with typical search tasks previously identified in the literature, while others were novel and more surprising. The descriptions not only illustrate some of the benefits Twitter search offers over more traditional media, but also highlight some of the limitations and problems Twitter users experience.

We have shown that people search Twitter for a variety of reasons, often looking for very different things. In many cases the information needs are similar to those which are common in web or desktop search, however in other cases the needs are much more social and context-sensitive. From timely and local information, to monitoring topics of interest, locating individual people or establishing opinions and sentiment about products, companies or events. These tasks align well with the core ideas of Twitter: to be social and provide a means to divulge and find small snippets of useful or interesting information and highlight the ways in which it is different to more conventional sources of information. The task descriptions collected and diary study meta-data underline that these were not unusual tasks, but are performed regularly.

Before discussing the implications of our findings, it is important to acknowledge the limitations of an investigation of this nature. The diary study only captured tasks performed by 68 participants out of the millions who use Twitter and only reflect the tasks that the participants remembered to report i.e. the most salient tasks. The tweet-sourced descriptions - while providing similar kinds of data from a larger and more heterogeneous user base - have similar sampling biases. It is likely that some tasks will be more readily shared than others and the language used and detail of the tasks was sometimes different to that of the diary study. These biases are illustrated in the differences between the distributions of assigned codes of the two datasets. Overall, there was a smaller percentage of sentiment and refinding tasks in the Twitter dataset and a larger percentage of standalone informational needs, people search and boredom-

motivated searches in the tweeted descriptions . We have provided this frequency information because it presents the reader with a feel for how often the examples we cite appeared in our data. We do not claim these figures to be representative of how often such tasks are performed generally and do not claim that our user sample is reflective of the Twitter population. The contribution of this article lies primarily with the qualitative insights provided. The tasks we have reported on demonstrate a breadth of motivations for searching on Twitter that go beyond anything reported in the literature and have consequences for how we think about improving search facilities for Social Media and Microblogging content.

In this following sub-sections, we try to establish the implications of our findings. We do this first, in Sub-section 5.1, by describing the results of final stage of the qualitative analysis - selective coding - which involved deriving a core category and establishing relationships between the categories we have discussed before. Second, in Sub-section 5.2, we draw comparisons between our coding scheme and the Information Seeking literature summarised in Section 2.2. In a third step, in Sub-section 5.3, we compare our findings with those Teevan and her colleagues established in the context of Twitter search and with more traditional search situations, such as email and the web. In this third section, where appropriate, we highlight potential design implications for Twitter search systems (and indeed other social search systems) *(italicized)* and discuss potential future research.

5.1 Selective Coding - understanding how the categories relate

The categories derived from both data sources seem to be drawn from two primary aspirations: to engage oneself and to maintain a state of being informed. Engagement, as we observed in our data, can relate to the informational content Twitter provides. For example, in the boredom-motivated tasks [C8], users typically aim to discover entertaining or engaging content e.g. [T909, T926, T407]. This was also true of some of the standalone informational tasks [C1], in particular for those which involved looking for media [C1.3] and those where the user is trying to understand the behaviour of others [C1.7]. Engagement, while often desired, can be addictive and does not always result in a positive outcome. Similar to the findings Elsweiler et al. (2011b) reported in other contexts, our data contained negative examples of over-engagement where the user felt he or she had spent too much time engaging with Twitter.

Engagement in Twitter search can also relate to engaging socially; many of the people search examples [C5] had the aim of locating a person or multiple people either to connect or interact with them or to learn something about them and often to establish whether it might be possible or worthwhile to connect with them. As we saw in the

descriptions for those tasks coded as ‘querying social network” [C6], social engagement can also be a means of solving the other primary aspect of the derived categories - to stay informed. Some Twitter users make use of social relationships to solve information needs, such as finding places to eat or relevant content because this can be quicker or involves less effort (Morris et al., 2010).

Search is naturally about informing oneself, but Twitter search seems to be about both achieving and maintaining the state of being informed; a means of keeping one’s finger on the pulse. The data emphasise a desire or a need for the latest information on a variety of topics, ranging from football scores, to local and far-away happenings, to people’s opinions on diverse issues, to gaining access to the newest multimedia content. The code which epitomises up-to-date information [C1.1] is the most highly assigned code in both the diary study and Twitter-sourced data. However, there is a trend across the categories suggesting Twitter users desire high speed access to the latest information. People see Twitter as going beyond web search engines in this respect, a means of having such information at one’s finger tips.

The idea of maintaining a state of informedness is also present in monitoring tasks [C2]. In such cases, the user wants to know about a change of status as soon as the change occurs. This change can relate to external events, such as news or announcements, but it can also, in the case of Ego monitoring [C2.1], relate to the latest status regarding how the user is perceived by the outside world.

All of the categories emphasise the users’ desires to employ Twitter as a means to empower themselves with respect to their information world: an attempt to achieve the perhaps natural human desire to know everything and explain everything that is going on around us. Whether Twitter allows users to achieve this is open to debate; just over half of the tasks recorded in the diary study were successfully completed. We have reported a number of difficulties experienced and it seems Twitter users are very aware of Twitter’s strengths but also its shortcomings. These include the lack of persistence in the content and the limitations of the search facilities over both tweets and users. However, in spite of the difficulties, this does not seem to deter use of the service for purposes not well supported by Twitter in its current form. This suggests that users perceive the benefits brought by this information source to be worth the extra effort required to obtain it.

Perhaps unsurprisingly for a medium where information is created and shared in 140 characters, the desire to master information worlds seems to be at quite a shallow level. This is underlined by the refinding tasks [C7], where the users are aware of the existence of information, but need to lookup details or to share with others.

Our data analyses suggest that Twitter search is primarily a device for mental and social engagement and a means to stay informed in a dynamic information world and it is this social dynamism which makes this new source of information quite different to those of the earlier web. Instead of searching for (predominantly) professional documents, news items and reviews, as was the case in the past. Web users are now able to exploit

social media to gain access to shorter, more granular and time-constrained nuggets of information contributed by millions of other people, be these nuggets factual, opinion or merely expressions of emotion.

This sub-section has concluded the description our coding scheme and explained our thoughts on how the derived categories related and what this tells us about why people search Twitter. The following sub-section relates our coding scheme to those previously reported in the literature.

5.2 Relating our Coding Scheme to Information Seeking Literature

The coding scheme presented in Section 4 was derived from the data we collected through both a diary study and tweeted descriptions provided by Twitter users. We do not claim that the categories which emerged from the grounded theory analysis are all new or have not previously been reported in the literature. For example, people search [C5] has appeared in the Information Seeking e.g. (Hertzum and Pejtersen, 2000) and PIM literature e.g. (Whittaker et al., 2004), as have refinding [C7] (Capra and Perez-Quinones, 2005; Teevan et al., 2007) and monitoring tasks (Kellar et al., 2007). This is not surprising as Twitter serves as a source of information and as such one would expect existing schema to be - at least partially - applicable. The important points are that many of the task categories we described have not been reported before in the context of Twitter (see Section 2.1) and such tasks often have different characteristics when viewed in the context of the highly social, constantly updating Twitter platform. As an example, Twitter users often search for people just to see if they are on Twitter – this does not happen in contexts where people search is typically studied, such as on the web or in email search.

Our coding scheme overlaps with previous taxonomies in several places. The standalone informational tasks [C1] align strongly with what both Broder (2002) and Church and Smyth (2008) refer to as informational tasks. The final two concepts in this category (checking novelty [C1.6] and learning about human behaviour [C1.7]) are, however, unlikely to feature in web and email search contexts. These codes are more appropriate for social media search due to the very different properties of the collection, due to the way it is created and published. In social media, people are open with their thoughts, publish shorter documents (e.g. Tweets) more regularly, and demonstrate and describe behaviour which would simply not appear in other more closely controlled and edited contexts. This naturally influences the reasons people search over social media collections and the kinds of tasks they perform. For example, sentiment and opinion finding tasks do not appear in the traditional task classifications. We suspect this is not simply because people do not want to perform these kinds of tasks, but rather that traditionally collections - even dynamic ones, such as the web - have not really supported

this kind of task. Social media sites, such as Twitter, are venues where people feel free to be open about what they think and how they feel and the topics being discussed can change quickly. This makes searching to discover trends on opinions much more commonplace in social media domains.

A similar argument can be made for tasks categorised as Querying Social Network [C6]. Again, there is literature on using social contacts to find information e.g. (Hertzum and Pejtersen, 2000). However, information seeking task classifications do not tend to incorporate this task because up until recently only specialised information systems e.g. (Ackerman, 1998) supported this, despite it corresponding closely to Sir Tim Berners-Lee's original vision for the web (Berners-Lee et al., 1994).

The categories in our coding scheme reflect what people are looking for [C1,3,4,5] and the behaviour employed in achieving this [C2,5,7]. In this respect our coding scheme is most similar to those proposed by Campbell, Toms and Marchionini. However, our categories are different to these and are in several cases are orthogonal. Many Twitter searches across our coding scheme would be described as open using Marchionini's (1986) scheme, with people regularly going back for the same thing because they are looking for up-to-date information and because they are aware that the information can change. Using Marchionini's later coding system (2006), we observed many lookup tasks, such as checking novelty [C1.6], checking a football score [C1.1], and monitoring to see if something has changed [C2]. Exploratory (learn and investigate) tasks are relatively rare on Twitter; with perhaps the boredom tasks [C8], sentiment [C3] and learning about human behaviour [C1.7] being the only exceptions.

Tasks in our taxonomy had many different attributes in terms of those used by Byström and Järvelin (1995) , Kim and Soergel (2005) and Li and Belkin (2008). For example, tasks in all of the individual categories can have varying levels of complexity and difficulty, with the difficulty, as we have discussed above, depending on what the user wants, how well Twitter supports this (e.g. refinding tasks seem to be harder based on our data) and factors such as cross-conversational noise (e.g. Woolwich news example).

What this discussion highlights is that tasks already present in the IS literature, but not in task classifications, have become more pervasive because of the nature of the collections - they are shorter, updated more often, more opinionated and less controlled. We have also shown that our data - although perhaps not all of it - may have been categorised very differently according to schemas previously published in the literature. We, instead, derived our own coding scheme, which reflected the aspects prominent in the data provided by Twitter users. The primary benefit being that this Twitter-specific schema provides rich insights into how Twitter search systems may be improved and opens research questions relating to Twitter search behaviour. This is our focus in the following sub-section, with the principal work on understanding Twitter search tasks - the work of Teevan et al. - being our main point of comparison. We highlight potential

design implications for Twitter search systems (and indeed other social search systems) by *italicising* the text.

5.3 Relating our findings to Twitter

In their descriptions, participants were very clear if what they wanted was opinion or fact, but both cases were reported frequently. In the Woolwich examples [T1015,T1064], when the user was looking for facts and instead got racist opinions, this not only hindered the search for facts but were found to be quite disturbing. All of this suggests that if tweets could be classified successfully into opinion and fact-based tweets *then the search interface could allow the user to filter search results by this property*. Early attempts at automatically distinguishing between fact and opinion-based tweets using standard approaches have been relatively successful (Sriram et al., 2010). Our data suggest that sentiment and opinion findings tasks were on the whole more successful than more traditional, fact-based tasks and refinding tasks.

The recorded tasks provide some insight into the relationship between search engines and Twitter; when one is used in preference to the other. Twitter is perceived as a very up-to-date source of information and is used to find information that users assume will not be published on the web or have not yet been indexed (e.g. very new magazine and sports results). From the perspective of search engines, perhaps this perception could be changed by *making verticals with micro-blogging content more regular and more prominent on result pages*. In the tasks recorded in this study, search engines were used as a backup solution when Twitter search failed, with participants recognising the limitations of Twitter search.

We draw different conclusions to Teevan et al. regarding refinding on Twitter. While they assume repeated queries to be examples of monitoring tasks, we believe the high percentage of recorded refinding tasks in our study show that this is not always the case and that people clearly refind regularly on Twitter, for a variety of reasons. Our findings highlight that not only is Twitter an important source of information, but that people also use it as an information silo, regularly refinding content they have tweeted themselves or read in their stream.

The evidence suggests they don't make great efforts to move interesting information out of Twitter and this can lead to difficulties for several reasons, including lack of persistence, uncertainty in recollections and lack of hashtags as cues. Twitter currently provides little in the way of support for the management and refinding of tweets and there is a lot of scope for improvement here. *Twitter could provide more features when browsing saved (or "favourites") tweets, for example faceted browsing by user, by age or by content type.* It was evident from task descriptions that people were clear if they were finding for tweet content itself or to find an external link. *Again, tweets could be classified on this dimension and users could be given the option to filter to narrow the*

search space.

Teevan reported that Twitter and search engines were often used together in the same search, but for different purposes. We had no mention of this in our data, other than when one failed and the other was used in its place. We did, however, have many examples where the user had to combine or compile information from multiple tweets, both for people-finding tasks and for refinding. *A scrapbook-like interface for collating and organising tweets into collections could support this behaviour. Visualisations of the content and characteristics of the collated tweets would provide at-a-glance details of each collection.*

Our results showed that people are extremely central to many Twitter searches and indeed the experience of using Twitter in general, often acting like "hubs" in joining up information. However, users commented that they find it difficult to locate other users they are looking for, even when they know the user's Twitter handle. This suggests that *improvements to people search features* could be extremely beneficial and that *exploitation of the social networks embedded in Twitter* - via methods such as collaborative filtering - could improve the experience for users, helping them to find interesting and relevant content. The people search examples we provided demonstrate a large number of motivations for people search, from checking the spelling of a name to finding who a person and is and what people think about them, to establishing how active a person is on Twitter. Regarding aspects such as activity, some of this information might be quite difficult to glean from tweets alone. Perhaps *user profile overviews being augmented by activity statistics or visualisations might be used to communicate these kinds of aspects in a more readily interpretable way*.

Monitoring was another common search type and included ego searches where people were frequently submitting queries to find out opinions about themselves from other Twitter users. *Can we provide interfaces that allow people to locate tweets directly relating to them or extract information (sentiment, activity / popularity) or aggregate several saved searches into a stream?*

We have evidence that being aware of existing hashtags is important when searching - having been mentioned in relation to needs of many kinds. We also saw examples where not knowing hashtags, e.g. [T519, T1126] can hinder access to the desired content. Perhaps, to counter this problem, *hashtags could be recommended as part of search results or even incorporated in retrieval algorithms*.

A good number of tasks were motivated by the surrounding contextual situation e.g. in some cases only local tweets would have been relevant. Geographic location filters are supported by Twitter, but are buried deeply in the Twitter advanced search interface, which is itself hard to find. *Linguistic approaches could be employed to simplify this process, for instance terms like "here", "local", "my neighbourhood" etc. could be used to infer local context*.

A particular context of interest was leisure situations. Our data show that many

searches were non work-related and some were motivated purely out of boredom, where people are looking for something of interest to them as a form of entertainment or simply to pass the time. Twitter - while containing varied content that might address this kind of need - doesn't provide any explicit support. Features such as recommendation of people to follow or hashtags that are currently provided do not really address these boredom needs and it could be useful to *supplement these with a personalised set of media (images, videos, raw tweets), according to the user's own profile of interests which can be browsed to maximise the serendipitous discovery of interesting content*.

Finally, it was surprising to us that despite several important tasks being reported, there was only one mention of trust or reliability in the recorded entries. *"*@bridger_w i am searching twitter for volleyball team news and your dishonest posts are littering the feed bridger [T1068]". None of the diary study entries mention trust at all.

One future line of research could be to establish whether or not this is a problem and whether users have strategies to gauge the reliability of the information they acquire via Twitter or whether this is not seen as an important factor. Perhaps the sheer amount of information available about most events or topics obviates the need for trustworthy sources with users simply relying on the "wisdom of the crowd".

6 Conclusions

In this paper, we have presented the results of a diary study of Twitter users' search tasks. While previous research has reported in detail on how people search, we argue that it is equally important to know why they are searching. Self-reported behaviour was analysed qualitatively and quantitatively to inform on what people searched, why they searched and some of the difficulties experienced. Twitter is a widely searched medium giving users access to a wealth of information, however the sheer quantity of data makes the quality of search important, with the breadth of uses going far beyond what such systems are currently designed to support. In this paper we have highlighted particular behaviours of interest, reflecting diverse information needs, and suggested ways in which these may be better catered for by improving existing search systems. The findings provide a more detailed and fine-grained understanding of search motivations than previously reported and in the case of refinding tasks, the complementary approach allows data reported on previously to be interpreted in a new light. The findings, furthermore, have implications for scholars interested in the more general field information seeking literature. A final contribution of the article was a discussion of how, in our opinion, our findings relate to this literature.

References

Ackerman, M. S. (1998), 'Augmenting organizational memory: a field study of answer garden', *ACM Transactions on Information Systems* **16**(3), 203--224.

Algon, J. (1997), Classifications of tasks, steps, and information-related behaviors of individuals on project terms, *in* 'Proceedings of an international conference on Information seeking in context', Taylor Graham Publishing, London, UK, UK, pp. 205--221.

Berners-Lee, T.; Cailliau, R.; Luotonen, A.; Nielsen, H. F. & Secret, A. (1994), 'The World-Wide Web', *Communications of the ACM* **37**, 76--82.

Bollen, J.; Mao, H. & Zeng, X. (2011), 'Twitter mood predicts the stock market', *Journal of Computer Science* **2**(1), 1 - 8.

Boyd, D.; Golder, S. & Lotan, G. (2010), Tweet, Tweet, Retweet: Conversational Aspects of Retweeting on Twitter, *in* 'Proceedings of th 43rd Hawaii International Conference on System Sciences', IEEE Computer Society, Washington, DC, USA, pp. 1--10.

Brenner, J. & Smith, A. (2012), '72% of Online Adults are Social Networking Site Users', *http://pewinternet.org/Reports/2013/social-networking-sites/Findings.aspx last accessed on 21.11.2013*.

Broder, A. (2002), A taxonomy of web search, *in* 'ACM SIGIR forum', pp. 3--10.

Bystrøm, K. & Jдrvelin, K. (1995), 'Task complexity affects information seeking and use', *Information Processing and Management* **31**(2), 191-213..

Campbell, D. J. (1988), 'Task Complexity: a review and analysis', *Academy of Management Review* **13**(1).

Capra, R. G. & Perez-Quinones, M. A. (2005), 'Using Web Search Engines to Find and Refind Information', *Computer* **38**(10), 36--42.

Charmaz, K. (1983), 'The grounded theory method: An explication and interpretation. R. M. Emerson, ed', *Contemporary Field Research*.

Chilton, L. B. & Teevan, J. (2011), Addressing people's information needs directly in a web search result page, *in* 'Proceedings of the 20th international conference on World Wide Web', ACM, New York, NY, USA, pp. 27--36.

Choo, C. W. (2002), *Information management for the intelligent organization: the art of*

scanning the environment, Information Today, Inc..

Church, K. & Smyth, B. (2009), Understanding the intent behind mobile information needs, *in* 'Proceedings of the 14th international conference on Intelligent user interfaces', pp. 247--256.

Crovitz, H. F. & Daniel, W. F. (1984), 'Measurement of everyday memory: toward the prevention of forgetting', *Bulletin of Psychonomic Society* **22**, 413-414.

Dumais, S.; Cutrell, E.; Cadiz, J.; Jancke, G.; Sarin, R. & Robbins, D. (2003), Stuff I've seen: a system for personal information retrieval and re-use, *in* 'Proceedings of the 26th ACM SIGIR conference on Research and development in Information Retrieval', pp. 72--79.

Elsweiler, D.; Harvey, M. & Hacker, M. (2011), Understanding re-finding behavior in naturalistic email interaction logs, *in* 'Proceedings of the 34th international ACM SIGIR conference on Research and development in Information Retrieval', pp. 35--44.

Elsweiler, D. & Ruthven, I. (2007), Towards task-based personal information management evaluations, *in* 'Proceedings of the 30th annual international ACM SIGIR conference on Research and development in information retrieval', pp. 23--30.

Elsweiler, D.; Wilson, M. L. & Kirkegaard Lunn, B. (2011), *New Directions in Information Behaviour*, Emerald Publishing, chapter Understanding Casual-leisure Information Behaviour.

Gaffney, D. (2010), #iranElection: quantifying online activism, *in* 'Proceedings of the WebSci10: Extending the Frontiers of Society On-Line'.

Glaser, B. G. & Strauss, A. L. (1967), *The discovery of grounded theory: strategies for qualitative research*, Aldine de Gruyter, New York, NY.

Gonçalves, D. & Jorge, J. A. (2006), Evaluating stories in narrative-based interfaces, *in* 'Proceedings of the 11th international conference on Intelligent user interfaces (IUI)', pp. 273--275.

Hackman, J. R. (1969), 'Toward Understanding the Role of Task in Behavioral Research', *Acta Psychologica* **31**.

Harvey, M.; Carman, M. & Elsweiler, D. (2012), Comparing Tweets and Tags for URLs,

in 'Proceedings of the 34th European conference on Advances in Information Retrieval (ECIR)', pp. 73-84.

Harvey, M. & Elsweiler, D. (2012), Exploring Query Patterns in Email Search, *in* 'Proceedings of the 34th European conference on Advances in Information Retrieval (ECIR)', pp. 25-36.

Hertzum, M. & Pejtersen, A. (2000), 'The information-seeking practices of engineers: searching for documents as well as for people', *Information Processing and Management (IPM)* **36**(5), 761-778.

Hurlock, J. & Wilson, M. L. (2011), Searching Twitter: Separating the Tweet from the Chaff, *in* 'Proceeding of the Fifth International AAAI Conference on Weblogs and Social Media (ICWSM)'.

Ingram, M. (2011), 'New Twitter Search Is Nice, But Still Needs Work', *http://gigaom.com/2011/06/01/new-twitter-search-is-nice-but-still-needs-work/ Last Accessed 7th October, 2012*.

Ingwersen, P. (1992), *Information retrieval interaction*, Taylor Graham.

Jansen, B. J.; Booth, D. L. & Spink, A. (2008), 'Determining the informational, navigational, and transactional intent of Web queries', *Information Processing and Management (IPM)* **44**(3), 1251--1266.

Java, A.; Song, X.; Finin, T. & Tseng, B. (2007), Why we twitter: understanding microblogging usage and communities, *in* 'Proceedings of the 9th WebKDD and 1st SNA-KDD 2007 workshop on Web mining and social network analysis', pp. 56--65.

Joachims, T.; Granka, L.; Pan, B.; Hembrooke, H. & Gay, G. (2005), Accurately interpreting clickthrough data as implicit feedback, *in* 'Proceedings of the 28th annual international ACM SIGIR conference on Research and development in information retrieval', ACM, New York, NY, USA, pp. 154--161.

Kellar, M.; Watters, C. & Inkpen, K. M. (2007), An exploration of Web-based monitoring: Implications for design, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)', pp. 377-386.

Kim, S. & Soergel, D. (2005), 'Selecting and measuring task characteristics as independent variables', *Proceedings of the American Society for Information Science and*

Technology **42**(1).

Kuhlthau, C. C. (1991), 'Inside the search process: information seeking from the user's perspective', *Journal of the American Society for Information Science* **42**(5), 361-371.

Lake, C. (2012), 'Twitter Search sucks, so why not use Topsy?', *econsultancy, http://econsultancy.com/de/blog/10826-twitter-search-sucks-so-why-not-use-topsy, Posted 04 October, last accessed 7th Oct, 2012*.

Landis, R. J. & Koch, G. G. (1977), 'The measurement of observer agreement for categorical data', *Biometrics* **33**, 159-174.

Lee, U.; Liu, Z. & Cho, J. (2005), Automatic identification of user goals in Web search, *in* 'Proceedings of the 14th international conference on World Wide Web (WWW)', ACM, New York, NY, USA, pp. 391--400.

Li, Y. & Belkin, N. J. (2008), 'A faceted approach to conceptualizing tasks in information seeking', *Information Processing and Management (IPM)* **44**(6), 1822--1837.

Lin, J. & Mishne, G. (2012), A Study of "Churn" in Tweets and Real-Time Search Queries, *in* 'Proceeding of the 6th International AAAI Conference on Weblogs and Social Media (ICWSM)', pp. 503-506.

Marchionini, G. (2006), 'Exploratory search: from finding to understanding', *Communications of the ACM* **49**(4), 41--46.

Marchionini, G. (1989), 'Information-seeking strategies of novices using a full-text electronic encyclopedia.', *Journal of the American Society for Information Science* **40**(1), 54--66.

McFedries, P. (2007), 'Technically speaking: All a-twitter', *Spectrum, IEEE* **44**(10), 84--84.

Mishne, G. & de Rijke, M. (2006), A study of blog search, *in* 'Proceedings of the 28th European conference on Advances in Information Retrieval (ECIR)', pp. 289--301.

Morris, M. R.; Teevan, J. & Panovich, K. (2010), What do people ask their social networks, and why?: a survey study of status message behavior, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)', pp. 1739--1748.

Morville, P. (2009), *Ambient findability: What we find changes who we become*, O'Reilly Media, Inc..

Pak, A. & Paroubek, P. (2010), Twitter as a Corpus for Sentiment Analysis and Opinion Mining, *in* 'Proceeding of the 7th international conference on Language Resources and Evaluation (LREC)'.

Palen, L. & Salzman, M. (2002), Voice-mail diary studies for naturalistic data capture under mobile conditions, *in* E. Churchill & J. McCarthy, ed., 'Proceedings of the 2002 ACM conference on Computer supported cooperative work (CSCW)', ACM Press, New York, NY, USA, pp. 87--95.

Rushe, D. (2013), 'Twitter IPO: social media company looks to raise $1bn in public share sale', *Guardian News Online: http://www.theguardian.com/technology/2013/oct/03/twitter-ipo-share-sale. Last accessed on 21.11.2013*.

Russell-Rose, T. & Tate, T. (2012), *Designing the search experience*, Morgan Kaufmann.

Shin, Y. (2013), 'New Twitter search results', *Twitter Engineering Blog - http://engineering.twitter.com/2013/02/new-twitter-search-results.html last accessed on February 13th, 2013*.

Soboroff, I.; McCullough, D.; Macdonald, C.; Ounis, I. & McCreadie, R. (2012), Evaluating Real-Time Search Over Tweets, *in* 'Proceedings of the 6th International Conference on Weblogs and Social Media (ICWSM)'.

Sohn, T.; Li, K. A.; Griswold, W. G. & Hollan, J. D. (2008), A diary study of mobile information needs, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)', ACM, New York, NY, USA, pp. 433--442.

Sriram, B.; Fuhry, D.; Demir, E.; Ferhatosmanoglu, H. & Demirbas, M. (2010), Short text classification in twitter to improve information filtering, *in* 'Proceedings of the 33rd international ACM SIGIR conference on Research and development in information retrieval', pp. 841--842.

Strauss, A. & Corbin, J. M. (1998), *Strategies of Qualitative Inquiry*, Sage Publications, chapter Grounded Theory Methodology: An Overview.

Strauss, A. & Corbin, J. M. (1990), *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, SAGE Publications.

Teevan, J.; Adar, E.; Jones, R. & Potts, M. A. S. (2007), Information Re-Retrieval: Repeat Queries in Yahoo's Logs, *in* 'Proceedings of the 30th annual international ACM SIGIR conference on Research and development in information retrieval', ACM, New York, NY, USA, pp. 151--158.

Teevan, J.; Ramage, D. & Morris, M. R. (2011), #TwitterSearch: A Comparison of Microblog Search and Web Search, *in* 'Proceedings of the fourth ACM international conference on Web search and data mining (WSDM)', ACM, New York, NY, USA, pp. 35--44.

Thelwall, M. & Hasler, L. (2007), 'Blog search engines', *Online Information Review* **31**(4), 467 -- 479.

Toms, E. G.Kelly, D. & Ruthven, I., ed., (2011), *Interactive Information Seeking, Behaviour and Retrieval*, Facet, chapter Task-based information searching and retrieval, pp. 43-60.

Toms, E. G.; O'Brien, H.; Mackenzie, T.; Jordan, C.; Freund, L.; Toze, S.; Dawe, E. & Macnutt, A. (2008), Focused Access to XML Documents, *in* Norbert Fuhr; Jaap Kamps; Mounia Lalmas & Andrew Trotman, ed., , Springer-Verlag, Berlin, Heidelberg, pp. 359--372.

Vakkari, P. (1999), 'Task complexity, problem structure and information actions: Integrating studies in on information seeking and retrieval.', *Information Processing and Management (IPM)* **35**, 819-837.

Vieweg, S.; Hughes, A. L.; Starbird, K. & Palen, L. (2010), Microblogging during two natural hazards events: what twitter may contribute to situational awareness, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)', ACM, New York, NY, USA, pp. 1079--1088.

Whittaker, S.; Jones, Q.; Nardi, B.; Creech, M.; L.Terveen; Isaacs, E. & Hainsworth, J. (2004), 'ContactMap: Organizing Communication in a Social Desktop', *ACM Transactions on Computer Human Interaction* **11**.

Wildemuth, B. M. & Freund, L. (2009), Search tasks and their role in studies of search

behaviors, *in* 'Third Annual Workshop on Human Computer Interaction and Information Retrieval'.

Wilson, M. L. & Elsweiler, D. (2010), Casual-leisure Searching: the Exploratory Search scenarios that break our current models, *in* '4th International Workshop on Human-Computer Interaction and Information Retrieval'.