Analyzing the influence of Language Proficiency on Interactive Book Search Behavior

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Abstract
English content still dominates in many online domains and information systems, despite native English speakers being a minority of its users. However, we know little about how language proficiency influences search behavior in these systems. In this paper, we describe preliminary results from an interactive IR experiment with book search behavior and examine how language skills affect this behavior. A total of 97 users from 21 different countries participated in this experiment, resulting in a rich data set including usage data as well as questionnaire feedback. Although participants reported feeling language constraints, a preliminary analysis of native and non-native English speakers indicate little to no meaningful differences in their search behavior.
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1 Introduction

Despite only a quarter of the world's Internet users having English as their native language, English-language content still dominates the Web[1]. This discrepancy suggests that overcoming these language barriers by, for instance, supporting multilingual information access is essential. Books are another example of a domain where this is important: book content is often unique and usually unavailable in multiple languages in parallel.

The potential impact of a searcher's language skills on their search success largely remains an open question. We aim to provide a preliminary answer to this question in the context of the Interactive Social Book Search (ISBS) task, an interactive IR experiment focused on problem of book search in a collection of 1.5 million English book records using a heterogeneous group of 192 test subjects. The aim of this paper is to explore possible differences between native and non-native English speakers in the form of the following research question:

RQ What differences in book search behavior, if any, are there between native and non-native English speakers?

The structure of this paper is as follows. We start in Section 2 by describing the most important related work on the effect of language skills on search behavior and preferences. We provide a short overview of the ISBS experimental setup in Section 3. Differences in search behavior between native and non-native English-speaking participants are presented in Section 4. Section 5 discusses the results and concludes this paper.

2 Background

Most of the past work on multilinguality IR has focused on cross-language information retrieval; Nie (2010) provides a good overview of the state-of-the-art. However, a handful of studies have investigated information access behavior by users in relation to their language skills. Previous research comparing native and non-native speakers has indicated differences in search and browsing behavior. Initial results from a study by Józsa et al. (2012). identified a variety of factors that influence foreign language search. They conclude that in-depth search strategies work better compared to cursory search strategies, and that they allow searchers to achieve the same success rate in a foreign language as in their native language. Another study found that non-native speakers tend to spend more time searching and that they more frequently reformulate queries (Chu, Józsa, Komlódi, & Hercegfi,

[1]Available at http://www.internetworldstats.com/stats.htm, last visited on October 5, 2015.

2012). With respect to content inspection, native speakers spent more time on interacting with the search results (Józsa et al., 2012).

3 Methodology

Our investigation of book search behavior is in the context of the interactive IR experiments run as part of the ISBS task at CLEF 2015[2]. The overall goal of the ISBS task[3] is to investigate how book searchers behave at different stages of the search process. All research teams participating in the ISBS task used the same experimental book search setup, but recruited their own test participants. The data collected on the shared pool of 192 participants was then made available to all teams.

3.1 Search interface

The experimental setup of the ISBS task included two interfaces: (1) a standard Web search interface, and (2) a multi-stage interface, designed to support searchers by taking the different stages of the search process into account. The standard interface implemented a search box, a traditional results list, and faceted search functionality that participants were likely to be familiar with as seen in Figure 1. The default components are shown in the left half of the screen; the right half contains the search history as well as the bookbag, which participants could use to save relevant results. In this paper, we only report on the subset of experiments with the standard interface, as these are most likely to be relevant for digital library search engines. Participants were asked to complete two search tasks: a focused, goal-oriented task and an open, non-goal task. Participation were assigned both tasks, but in random order to avoid fatigue and learning effects.

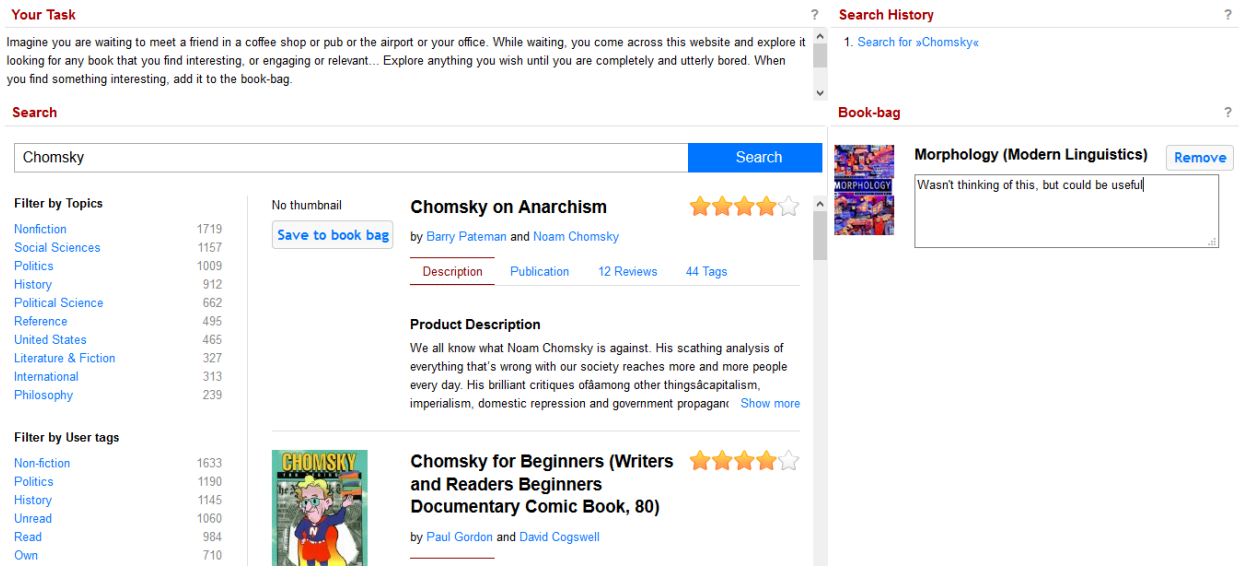

Figure 1: Standard search interface used in the interactive book search experiments.

The underlying search engine contained an index of 1.5 million English-language book records from the Amazon/LibraryThing book collection (Beckers et al., 2010). In order to explore differences in search behavior between native and non-native speakers we have used (1) data on participant responses from a questionnaire to differentiate between native and non-native English speakers, (2) log data to describe and analyze user interaction in relation to time, queries, depth of results inspection, and (3) bookbag data to analyze participants' use of it.

[2]Available at http://clef2015.clef-initiative.eu/CLEF2015/, last visited October 5, 2015.
[3]See Gäde et al. (2015) for a more detailed overview of the ISBS task.

3.2 Participants

A total of 192 participants were recruited from different research teams within Europe, of which 97 used the standard search interface. These 97 participants came from 21 different countries and participants' mother tongues included 18 different languages. We defined native speakers of English as those who either had English as their mother tongue or as their home language. According to this definition, 23 participants of the 97 focus participants (23.7%) are native speakers and the remaining 74 participants are non-native speakers (76.3%). Of the 97 participants, 67.0% were female and 33.0% were male.

4 Results & Analysis

4.1 Time

One aspect of search behavior where language profiency has been shown to have an influence is the time spent searching (Chu et al., 2012). We first investigated whether there were any differences between native and non-native speakers' search behavior on the time spent on the two different types of task. Results show that non-native speakers (M = 0:15:20.29) spent more time on the focused task than native speakers (M = 0:11:06.29). This difference was statistically significant according to an independent-samples t-test ($t(104.714) = 2.78$, $p < .01$), with equal variances not assumed ($F = 4.62$, $p < .05$), confirming the work by Chu et al. (2012). On the open task, non-native speakers also spent more time (M = 0:10:16.97) than native speakers (M = 0:07:49.04), but this difference was not significant according to an independent-samples t-test ($t(190) = 1.14$, $p = .25$).

In addition, we looked at time in relation to fatigue. On average, people spent more time on a task if it was the first one they performed. If participants started with the focused task, they spent more time on the focused task (M = 0:16:17.15) than if they started with the open task followed by the focused task (M = 0:12:44.75). This difference was statistically significant according to an independent-samples t-test ($t(146.605) = 2.26$, $p < .05$), with equal variances not assumed ($F = 4.25$, $p < .05$). Likewise, if participants started with the open task, they spent more time on the open task (M = 0:09:52.61) than if they started with the focused task followed by the open task (0:09:21.26). This difference was not significant, however, according to an independent samples t-test ($t(191) = 0.27$, $p = .79$). Factorial ANOVAs showed no significant influence of language proficiency on the fatigue they experience due to task ordering for either task.

We also performed a temporal analysis of how user actions were distributed across a normalized session timeline, which could uncover differences in terms of when users perform specific actions, such as querying or selecting facets. By using Kernel Density Estimation (KDE), we can estimate the likelihood of different actions taking place during a session. Figures 2 and 3 show the action-time KDEs for the queries issued during a session. They show relatively few differences between native and non-native speakers and independent samples t-tests showed them not to be statistically significant for both tasks.

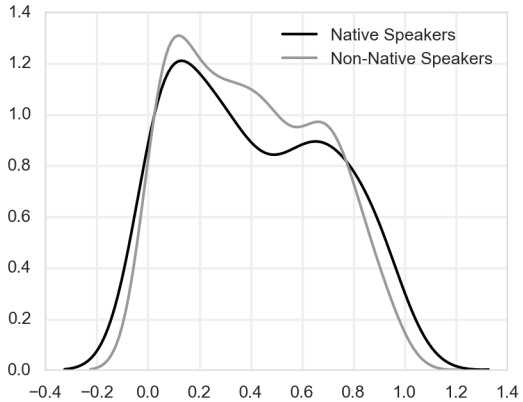

Figure 2: Action-time KDEs for the queries issued by native and non-native speakers on the focused task.

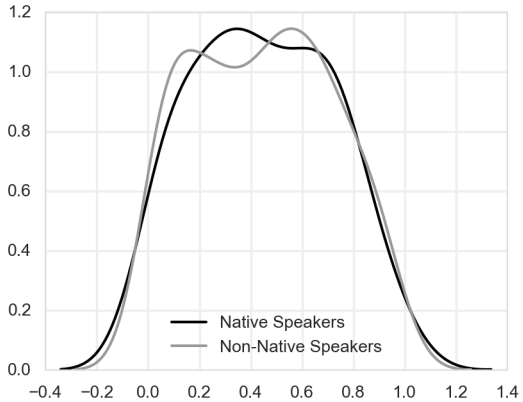

Figure 3: Action-time KDEs for the queries issued by native and non-native speakers on the open task.

Finally, we looked at facet selection by users on the two different tasks in Figures 4 and Figure 5. Here, there is an interesting (albeit statistically not significant) difference: on the focused task, non-native speakers are more likely to start using facets than native speakers to filter their search results, perhaps as a proxy for active query reformulation. The opposite happens on the open task, but we do not have an explanation for why this is the case. Overall, the temporal analysis also shows no meaningful effect of language proficiency on search behavior.

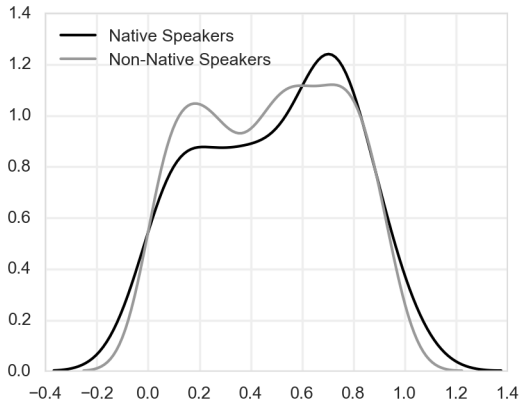

Figure 4: Action-time KDEs for the facets selected by native and non-native speakers on the focused task.

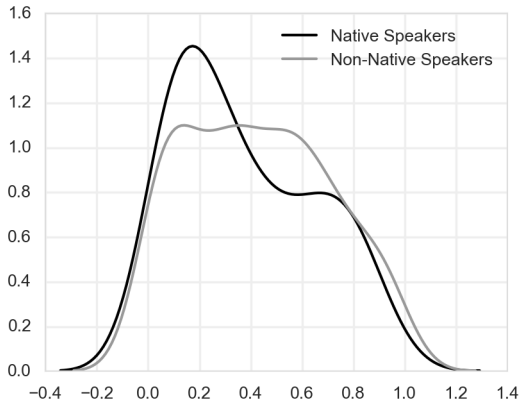

Figure 5: Action-time KDEs for the facets selected by native and non-native speakers on the open task.

4.2 Interaction

Another dimension of our analysis focused on the users' interaction with the search functionality. For instance, it is not unlikely that a lower English proficiency would cause searchers to attempt multiple query reformulations to achieve the same results as native speakers. While non-native speakers do formulate more queries on average (M = 12.17) than native speakers (M = 10.88), this difference was not significant according to an independent-samples t-test ($t(190) = 1.08$, $p = .28$). In contrast, one could expect native speakers to be better able to formulate longer, more precise queries due to their increased command of English. Native speakers did submit longer queries on average (M = 1.91) than non-native speakers (M = 1.85), although this difference was not significant either according to an independent-samples t-test ($t(190) = 0.53$, $p = .59$). We also extracted the average number of inspected results for each user from the log-data. Results show no significant difference between native (M = 29.37) and non-native (M = 27.43) speakers of English in the number of results inspected according to an independent-samples t-test ($t(190) = 0.57$, $p = .57$).

Finally, we looked at whether native and non-native speakers used the bookbag functionality differently. In the open, non-goal task participants were asked to add interesting books to the bookbag and add a note explaining why they selected each of the books. In the focused, goal-oriented task participants were asked to select a book for each of five sub-tasks and add an explanatory note. The results showed no significant difference between native (M = 8.08) and non-native (M = 8.34) speakers of English in the number of books added to their book bag according to an independent-samples t-test ($t(190) = 0.47$, $p = .64$).

5 Discussion & Conclusions

In this paper we have presented preliminary results on differences in search behavior between native and non-native English speakers in the context of interactive social book search. Earlier studies have indicated differences in search behavior between native and non-native speakers. However, in general the results show surprisingly few differences between native and non-native speakers of English. The results show that non-native speakers spent more time on both the focused and the open task than the native speakers, which corresponds to earlier findings by Chu et al. (2012). No significant differences were found in relation to number of queries, query length, depth of results inspection, or number of books added to the bookbag.The surprisingly few differences indicate that

language proficiency may not be a big problem in the context of interactive social book search, perhaps because many users are accustomed to searching for books on English language websites. A possible explanation for our findings may be that the majority of our users possess acceptable foreign language skills, in particular in English as second language. Future research could take individual language groups and their preferences into account. For example, Gäde (2014) proposed country profiles for digital library search based on language-specific behavior. Furthermore, other user characteristics, such as education level or age, might play an important role and should be investigated in more detail.

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