A Proactive Recommendation System for Writing: Helping without Disrupting

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ABSTRACT

Motivation – Finding appropriate information while writing a scientific paper is essential, but also difficult and time consuming. A Proactive Recommender System (PRS) retrieves information relevant to the text being written, and presents it automatically. However, current PRSs overlook that writing is a demanding task, affected by interruptions. We look for those moments during writing where finding information is important and where proactive presentation interrupts least.

Our goal is to develop a PRS for professional writers that presents information non-intrusively and timely so as to minimize disturbing the writing process.

Research approach – Finding information is most needed during Reviewing and Planning. In two experiments we explore the effects of a PRS during these phases.

Findings – PRSs speed up writing and improve the quality of the text compared to situations where writers have to look for information actively.

Originality/Value – Our research will change the design of PRSs and enhance our understanding of complex cognitive tasks such as writing and how electronic information processing tools affect them.

Take away message – We can turn interruptions in complex cognitive tasks into an advantage in terms of time and the quality, provided that the interruption comes at the right time and the information offered is relevant and accurate. Future research should focus on precisely this: when are interrupts least disturbing and how to make PRSs more accurate and relevant.

Keywords

Proactive Recommender System, Information Seeking, Writing Stages, Planning, Editing, Interruptions

INTRODUCTION

Behind the process of writing professional documents lies a steady but intermittent need to check, validate, and add information. Search engines have become the primary tool for information access in both company-internal networks and the Internet. Still, broad keyword-based search is inefficient. Considerable time is spent interacting with low-precision search engines. The time in which the author is away from creating the document can have a negative impact on the total time spent, and on the eventual quality of the text. In addition, relevant information may be missed because the writer did not realize that the information exists and could be looked up. Furthermore, switching from the text editor to the search engine imposes extra demands on the user's cognitive capacities. A system that can relieve authors from explicit search and switching between applications by means of searching information accurately and recommending this information in a proactive manner would be most welcome.

PROACTIVE RECOMMENDATION SYSTEMS FOR WRITING

Proactive Recommendation Systems (PRSs) retrieve large quantities of documents, decide what available information is most likely relevant to the text being written, and offer that information without user requests. The decision about what information to offer is mainly based on the text that is currently being written, in combination with personal profiles and profiles of the working group to which the person belongs. Only a few PRSs have been specifically developed to support writing in professional settings. For example, the Remembrance Agent (Rhodes, 2000) suggests personal email and documents based on text being written. Watson (Budzik and Hammond, 1999) is another PRS that performs automatic Web searches based on text being written or read. IntelliGent™ is yet another PRS that proactively submits queries to a potentially large number of search engines and presents the retrieved information while the user is writing a document. A serious problem with all of these PRSs is that they are developed as search support tools and do not seem to take into account the specific characteristics of the task at hand. Writing professional documents is a complex and highly demanding task that can be seriously affected by any type of interruption from the environment.

An IntelliGent™ Proactive Recommender System

As a tool for research, we are performing experiments with IntelliGent™. The system proactively submits queries based on a broadly defined user profile in combination with what the user is currently typing or reading. The system presents the retrieved information to the user proactively and immediately. The results of the search are presented in a semi-transparent window

located in the bottom right of the screen (see Figure 1). The window contains URLs related to what the user is typing. As the user moves the cursor over the references, the URLs become fully visible and active. On clicking the required URL, the user accesses the corresponding paper from the digital library. The information in the window is changed depending upon the text that is being input and new queries are created. The information presented also changes as the user moves the cursor while reviewing previously written parts of the document, again on the basis of queries created from the text in the paragraph in which the cursor is located.

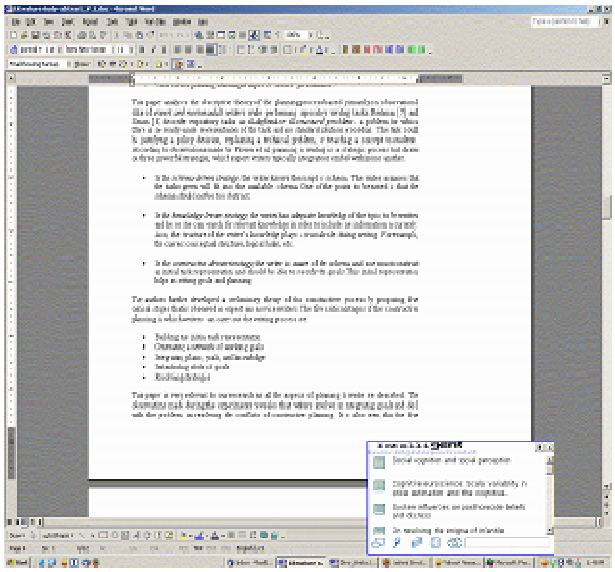

Figure 1. IntelliGent™ System for proactive information retrieval

Of course, to be helpful the retrieved information has to be precise and highly relevant to the written document, but also it should be presented in a non-intrusive and timely manner. If the way of presenting the information seriously interferes with the main task, users might stop using the system.

THE EFFECTS ON INTERRUPTIONS IN WRITING PERFORMANCE

Presenting information proactively, as IntelliGent™ does, can provide the user the opportunity to do a better job in less time (Maglio and Campbell, 2000). However, proactive presentation of information while writing can be considered as an interruption that imposes extra-task demands on user's cognitive resources. The effects of interruptions on the user's main task performance have being studied frequently (e.g. Bailey , Konstan and Carlis, 2000; Piolat, Kellog and Farioli, 2001, Zijlstra, Roe, Leonora and Kredit, 1999). For example, Bailey et al, (2000) used six tasks with different cognitive loads and two interruption tasks. They found a degradation on the time spent on task performance when interruptions where presented. The authors concluded that the cause of performance degradation is the additional time needed to resume the main task.

Summarizing, the presentation of information by a PRS may have a detrimental effect, because the additional task (i.e. to check if the offered papers are interesting to the writer) has specific demands and then there is the additional need to resume the original task at a later moment. This reorientation task requires the user to remember the status of the writing (i.e. to complete some argument in the text being written). Therefore, we investigated under what conditions the peripheral pop-up of IntelliGent™ distracts writers least from their main task. In addition, we investigated if interrupts caused by IntelliGent™ can still improve the quality of the final paper because it presents more complete and precise information.

THE STAGES OF WRITING

The need for a PRS might differ from one moment to another during the process of writing a document. Consequently, to optimally support professional document writing through a PRS it is necessary to explore the cognitive processes and stages involved in writing and the different effects that interruptions can have in these processes. To better understand the factors that play a role in the entire process of writing, we have adopted the writing model proposed by Hayes and Flower (1980). This model has been frequently validated and extended and it is still the most accepted model in writing processes (E.g. Piolat, Kellogg and Farioli, 2001). According to the model writing happens in three stages: Planning, Translating, and Reviewing. Planning involves retrieving and selecting information from the Long-Term Memory (LTM) and the Task Environment. Planning is divided into three sub-processes. *Generating* involves retrieving domain knowledge from LTM. *Organization* implies selecting the most useful material retrieved by the generating process, organizing it into plans and determining the sequence in which these topics will be writen. *Goal setting* involves the elaboration of criteria that allow the writer judging the appropriateness of the written text relative to the writing intentions. Planning precedes the formal writing or translation and continues occurring during the entire process. During the Translating stage information is taken from the LTM in accordance to the writer's plans and goals and is formulated into sentences. In the Reviewing stage the writer evaluates the relation between the text written so far and the linguistic, semantic and pragmatic aspects that would best serve the writing goal. Reviewing involves two sub-processes. *Reading* allows to detect errors or weaknesses and to evaluate the appropriateness of the written text in relation to the goals established during planning. *Editing* appears as a system of production rules that result in changes to the text.

Writing and Seeking for Information: an Initial Exploratory Study

To explore in which of the writing stages authors are most in need of additional information, Deshpande et al. (2006) performed an exploratory study with IntelliGent™.

During two months researchers from the department of Language and Speech Technology at Radboud University (The Netherlands) used IntelliGent™

whenever they were using MS-Word. The Scopus® database was linked to IntelliGent™ as the source for information. To investigate if there were different information seeking needs during the different stages of writing, several interviews and questionaries were done. Also the issues of efficiency, effectiveness, and overall satisfaction working with IntelliGent™ were explored.

The main results of the study show that, as the user shifts between the stages of writing, information requirements differ. In most cases, participants were not aware of doing any planning before starting the translating stage. However, in all cases, they found that the most important moment to search for information is before translating starts. When asked if they also looked for new information during translating and reviewing, participants claimed not to do it frequently and only when it appeared that better justification of their ideas was needed. These results are similar to the ones described by Dansac and Alamargot (1999).

Furthermore, participants perceived that the system often presented information at an inopportune moment, interrupting their writing. As a consequence, some users simply ended up stopping using IntelliGent™.

Summarizing, it is important to explore not only the moments of writing in which presenting proactive information is more relevant, but also to know when it is appropriate to interrupt the writing task. Based on these results we performed two experiments in which the effects of presenting information by IntelliGent™, during the stages of Planning and Reviewing, the moments in which finding new information seem to be more relevant, were studied in more detail.

EXPERIMENT 1: PRESENTING PROACTIVE INFORMATION DURING EDITING TASKS

We started by exploring the Reviewing stage. During this stage writers read and edit their written text whenever errors or weaknesses are detected in the text. In this stage writers normally look for new information in order to correct and/or justify written ideas.

To explore the effects of presenting proactive information, we asked participants to perform two different editing tasks: spelling corrections and filling in requested information. These two tasks are similar to the ones described by Iqbal et al, (2005).

Method

Subjects. Twenty students from the Radboud University (Nijmegen) and randomly chosen, participated in the experiment. All participants met the following criteria: (a) Familiarity using MS Word and Internet Explorer (b) working knowledge of English, and c) they have never used IntelliGent™.

Design. Two independent variables were manipulated within subjects: the editing task category and the information seeking conditions.

Editing Tasks. Participants performed two different editing tasks:

1. Spelling correction task. Participants corrected texts containing the misspelled names of three Indian personalities. The texts were divided into three paragraphs and presented in MS-Word with the misspelled names underlined with coloured wriggles (see Figure 2).

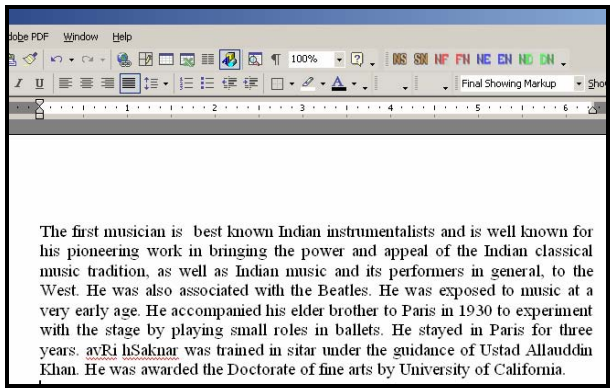

Figure 2. Spelling correction task

2. Filling the blanks task. Participants were given texts on various topics. The task consisted in filling in the gaps with the correct word (one gap per each of the three paragraphs included in one text). For example, in the sentence "the Baby Boomers are often referred to as the _____ generation as they are still in a phase of life where they are not only taking care of their kids but also their parents", the correct answer was the word "Sandwich" (see Figure 3).

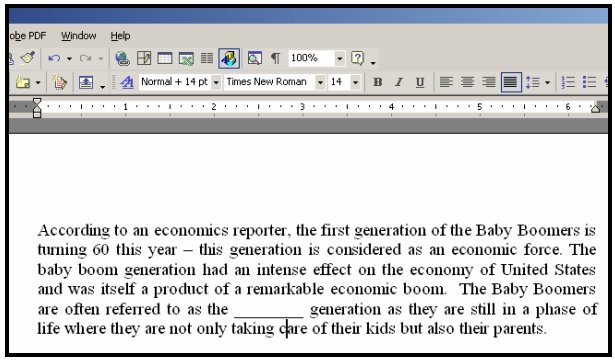

Figure 3. Filling de blanks task

Information Seeking Conditions. Three different options were presented:

1. Proactive presentation of related information. When performing the editing tasks, the PRS IntelliGent™ presented texts containing the correct answer for the editing task.

2. Proactive presentation of not related information. When performing the main task, the PRS IntelliGent™ presented texts about a completely different topic and consequently, did not contain the correct answers for the editing tasks.

3. No presentation of proactive information. Participants performed the editing tasks without the presence of IntelliGent™. In this condition, participants were encouraged to do active searches of information in order

to perform the editing tasks properly (i.e. using search engines).

Procedure. Each subject edited a total of six texts each of then containing three items to edit (one per paragraph). Three texts contained spelling errors and the rest contained gaps to fill in. Prior to starting each editing task, the experimenter gave a verbal description of the task. In each editing condition, participants worked with one text without being interrupted and the other two texts where interrupted by the presentation of proactive information, related or not related, that appeared as soon as the cursor was placed on the underlined wriggled word or the blank. The presentation order of the editing tasks and the information seeking conditions were counterbalanced across all subjects.

IntelliGent™ appeared in the right low corner of the screen and participants were asked to click on the link presented. Upon clicking the link, a text appeared and participants were asked to read it. Half of the cases participants were presented with text containing the answer to perform the editing task properly. In the not related conditions participants were interrupted with the presentation of a text whose content was not related to the main task. After each editing task was performed, participants were asked about the perceived quality of their performance in a questionnaire based on a 5-point Likert scale. The duration of the experiment was about one hour depending on the subjects reading and information seeking skills. The experiment sessions were recorded using Camtasia Studio Software.

The Dependent variables were: 1) Time on Editing Task. 2. Time on Information Seeking and, 3) Quality of editing task performance.

Results

Time on Editing Task

The time on editing tasks was measured as the amount of time needed to complete the editing task (in seconds); this measure did not include the time spent on seeking information.

We did not find significant differences in time as a function of the editing task (spelling corrections vs. filling the blanks) $F(1, 19)=1.59$, $p=0.22$ or as a function of the information seeking condition (Related proactive information, Non-related proactive information and No information) $F(2, 38)=0.85$; $p=0.43$. The interaction between type of task and information seeking conditions was also not significant $F(2, 38)=0.69$; $p=0.51$. Table 1 shows the averages per condition. From these results we can conclude that there are no differences in time between the tasks of filling in the blanks and spelling corrections in any of the manipulated information seeking tasks conditions.

Table 1. Average and standard deviation (between parentheses) of time performance of the editing tasks according to the information seeking condition.

	Related	**Non related**	**No interruption**
Spelling errors	37.73(11.05)	38.89(14.23)	46.53(25.74)
Filling blanks	46.48(25.05)	46.65(19.84)	46.83(23.21)

Time on Information Seeking

The amount of time spent searching/checking new information was measured in seconds.

We did not find differences in information seeking time as a function of the editing task $F(1, 19)=2.05$, $p=0.17$.

We found differences as a function of the information seeking condition $F(2, 38)=64.34$; $p<0.00$. Comparisons showed significant differences between the conditions of No information (average=144.99) and Non related (average=172.35) with a $t(19)=2.04$; $p<0.05$. Differences between no information (average=144.99) and related (average=35.54) were also significant $t(19) =7.99$; $p<0.000$. These data indicate that participants took more time seeking information in the non-related and no information conditions, and this time was bigger when non-related information was presented by IntelliGent™.

The interaction between the task type and information seeking condition was not significant $F (2, 38) =2.90$; $p=0.07$ (See Table 2).

Table 2. Average and standard deviation (between parentheses) of time on information seeking tasks as a function of the main task and the information seeking condition.

	Related	**Non related**	**No interruption**
Spelling errors	30.0(16.5)	198.2(81.6)	152.6(74.4)
Filling blanks	41.08(21.8)	146.49(69.9)	137.0(78.37)

Quality on Editing Task Performance

Task performance was measured in one scale from 0 to 1. Tasks finished with the correct answer scored 1.

We found significant differences as a function of the editing task $F(1, 19)=23.53$, $p<0.00$. Also were significant the differences between information seeking conditions $F(2, 38)=10.23$; $p<0.00$. The interaction between type of task and information seeking conditions was also significant $F(2, 38)=3.38$; $p=0.04$. Table 3 shows the averages per condition.

Table 3. Average and standard deviation (between parentheses) of quality on task performance as a function of the main task and the information seeking condition.

	Related	**Non related**	**No interruption**
Spelling errors	1(0)	0.92(0.18)	0.93(0.14)
Filling blanks	0.97(0.10)	0.79(0.25)	0.67(0.26)

Pairwise comparisons showed significant differences between both editing tasks ($p<0.00$). Participants performed the task of editing spelling errors better that

the task of filling the blanks. Similar results have been found by Ibqal et al (2005). The related condition was significantly different to both non related and no interruption conditions (both $p<0.001$).

Discussion

The main results of this experiment show that the presentation of proactive information by IntelliGent™ does not seriously impair the time performance in editing tasks in comparison with the conditions in which the user was not interrupted by the system. Furthermore, the time spent in looking for new relevant information was less when the PRS presented relevant information than in the cases in which participants had to search for the information actively. The information seeking time was even bigger when non relevant information was presented proactively. In this case, after assessing that the information by the PRS could not help in performing the editing task, participants started an active search. The quality of the editing tasks was also improved by the presentation of proactive relevant information.

EXPERIMENT 2: PRESENTING PROACTIVE INFORMATION DURING PLANNING TASKS

Planning involves creating and organizing ideas, and setting goals during composition. Similar to Dansac en Alamargot (1999), Deshpande et al, (2006) found that this is the most important moment for looking to new relevant information.

In order to simulate the stage of Planning, we used a procedure similar to the one described by Berninger et al. (1996). Participants were told that they had to write small essays about different topics but before they had to plan and write an outline of the major points of the text with supporting details and the order in which they would be introduced.

Method

Subjects. Thirty-two students from the Radboud University (Nijmegen) and randomly chosen, participated in the experiment. All participants met the following criteria: (a) Familiarity using MS Word and Internet Explorer (b) working knowledge of English, and, c) they have never used IntelliGent™.

Design. The information seeking conditions were manipulated within subjects. Four different options were presented: 1) without extra help, 2) with the option of getting information by actively searching information in the Web (active search), 3) with presentation of proactive relevant information by IntelliGent™ 3) with presentation of no relevant information by IntelliGent™

Procedure. Participants were asked to write in a MS Word document a planning outline about different topics. They had to write the major points they wanted to make with supporting details indicating the order in which they would be introduced.

Before starting the planning tasks participants were asked about the previous knowledge they had about the different topics they had to write about. The selected topics were about activities or requirements needed in order to reach a specific goal (for example, what are the requirements to import a car to USA?). None of the participants reported high knowledge about any of the topics.

Participants wrote 4 planning outlines, one per condition. The presentation order of the planning tasks was counterbalanced across all subjects. Participants had to finish every condition in less than 10 minutes, and it was mandatory to write at least four points in every planning. Participants were not allowed to copy and paste text from other documents. The experiment sessions were recorded using Camtasia Studio Software.

We measured 1) total time on planning, 2) the amount of time spent on searching/checking new information and, 3) the text quality as a function of the number of correct written ideas (activities or requirements).

Results

Time on Planning Task

There were significant differences in time on planning as a function of the information seeking condition $F(3, 90)=2.71$, $p<0.05$ Table 4 shows the averages per condition. Pairwise comparisons showed that the average time in the condition in which participants could not search for information was significantly higher than the conditions no relevant and active search (both $p<.02$). A trend with the relevant condition was also found ($p<.06$). No other comparison was significant. When no option to search is given participants tend to spend more time planning than in the rest of the conditions.

Table 4. Average and standard deviation (between parentheses) of time performance of the planning tasks according to the information seeking condition.

No search	Active Search	Relevant	No relevant
400.68(148.6)	338.42(102.8)	341.13(104.9)	336.9(151.7)

Time on Information Seeking

We did not find differences in information seeking time $F(2, 54)=1.67$, $p=0.19$.

Table 5. Average and standard deviation (between parentheses) of time on information seeking tasks as a function of the information seeking condition.

Active Search	Relevant	No relevant
233.39(101.7)	200.86(98.3)	185(133.4)

Quality of the Planning

The quality of planning was measured by the number of relevant ideas written in the text. The quality of the task was scored in a scale from 0 to 10.

There were significant differences between conditions $F(3, 93)=10.46$, $p<0.00$. Pairwise comparisons showed that the relevant condition was significantly better than the rest (all $p<0.00$) and the conditions no search, google and no relevant were no significantly different between them.

Table 6. Average and standard deviation (between parentheses) of quality on task performance as a function of the information seeking condition.

No search	Google	Relevant	No relevant
4.05(2.2)	4.33(1.7)	6.52(2.1)	4.18(1.6)

Discussion

The main results of this second experiment again indicate that the presentation of proactive information by IntelliGent™ does not seriously impair time performance during planning. Although the difference in time performance on planning in the condition with the proactive relevant information does not greatly differ in comparison to the other conditions, it is also true that the quality of the task is significantly higher in the relevant condition than in the rest. In other words, we found a trade-off between time and quality. In the condition in which relevant information was presented proactively, writers did not spend less time performing the task but the quality of the task was significantly better meaning that they wrote more correct ideas in their planning than in any of the manipulated conditions.

We expected participants to spend less time seeking for new relevant information in the condition in which proactive relevant information was presented, but we did not find significant differences between conditions. The cause of these results can be the fact that in the no relevant condition a considerable amount of participants (11) did not look for extra information even when they were aware that the information presented by the PRS was not helping to improve their planning. As a result of this behaviour, the quality of their planning in this condition was considerably low.

CONCLUSIONS: THE CHALLENGES FOR A PROACTIVE RECOMMENDER SYSTEM FOR WRITING

Proactive Recommender systems such as IntelliGent™ retrieve and decide which available information is most likely relevant to the text being written, and present it without user intervention. However, the structure of the writing process has a large impact on the ways in which a PRS should interact with the user. In this paper we present two experiments in which the effects of presenting proactive information during the tasks of planning and editing are studied. The experiments presented here show that the presentation of proactive information by a PRS do not seriously impair time performance and improve the quality of the product in editing and planning tasks. From these results, we would like to consider several challenges in order to design an appropriate PRS for writers.

The Planning Challenge

Most of the planning occurs before any substantial writing is done. Although a writing strategy that involves explicit planning is often recommended in formal writing courses, few writers seem to do it. The challenge to designers is to make the PRS so effective and powerful that professional writers experience the added value of adhering to a strategy that involves explicit planning. In other words, the PRS should be able to motivate users to change their writing procedures in such a manner that the system can help them to find information in the appropriate moment. For example, if users would make their writing plans explicit by typing section headers and short summaries of what should go into each section before they set out to create the full text, a PRS might be in a much better position to search for potentially relevant information. The big benefit to writers would be that they receive recommendations in a proactive manner, shortening considerably their task of seeking for information, and minimizing the risk of missing essential information.

The Challenge of Interrupting but not Disrupting

Proactive information recommendation does interrupt the ongoing writing tasks, but when the information presented is really relevant, the quality of the written text seems to improve.

In addition, we are investigating several issues related to the interface of the PRS. The goal is to design the interface and interaction procedure in such a way that it is easy for writers to observe that potentially relevant information has been retrieved, while at the same time it is easy to ignore the messages of the system if they are involved in a part of a task that would be difficult to resume after having been interrupted.

The Challenge of an external Long-Term Memory

Finally, one of our goals is to develop the PRS in such a way that it can be used as an addition to the writer's neural Long-Term Memory (LTM). So far, virtually all writing research has been conducted in settings in which the LTM from which participants could 'get information' was limited to their own brain (e.g. Olive, 2004). The advent of extremely powerful search systems will have a large effect on the way people will consider and use LTM. In the future it may be more important to know how to find information than to memorize information in the first place. Also information retrieved in the form of documents or text snippets may have a different impact on how one decides to organize the information in a coherent text than when the information is retrieved from one's own experience.

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