Visualizations encourage Uncertain Users to high Effectiveness

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ABSTRACT

Users have to handle a lot of information in order to fulfill their current task. For achieving an appropriate time and level of quality the users' motivation plays a key role. In this paper we present a user study which aimed to evaluate if the self-rated expertise of the subjects in their computer system skills has an impact on their task completion effectiveness using visualizations. The results reveal that regardless of the self-rated assurance of the users, no significant difference in the effectiveness of task completions using visualizations could be registered. Furthermore the participants indicate in the questionnaire that using visualization their individual satisfaction level had no significant differences when compared to the users' self-assurance levels. This indicates even users feeling not confident in interacting with computer systems they may feel confident in interacting with visualizations. Thus if visualizations are applied for tasks of information search and exploration, the user is encouraged to higher effectiveness.

Keywords: visualization, evaluation, effectiveness and satisfaction

1 INTRODUCTION

In the frequent interactions with computer systems users have to deal with a lot of information they have to interpret and apply to their current task. In order to fulfill these tasks in an appropriate time and level of quality the users' motivation plays an important role. There are several reasons why this motivation may decrease, one of which is the satisfaction and confidence of the user with the system.

User interface design guidelines propose principles which shall increase the comprehensibility and decrease potential frustration by unpredictable reactions of the system. But still unskilled users do not dare to try to click somewhere in order to retrieve the systems' reaction. They expect this could be a wrong action and in worst case harm the system. Or the user may not anticipate the systems' reaction correct and thus could not find the right action(s) to perform in order to fulfill his task. The overall result is the decreasing users' motivation.

In this paper we present a user study which aimed to evaluate whether the self-rated expertise of the subjects in their computer system skills has an impact on their task completion effectiveness using visualization technologies. The participants completed a questionnaire containing demographic aspects as well as items related to computer usage behaviors. The participants were divided into two counterbalanced groups so that they did not differ concerning frequency of search engine usage. Furthermore the participants were asked to complete another questionnaire to assess their self-assurance for their skills in working with computer systems. Therefore the COMA questionnaire, a subscale of the INCOBI questionnaire, had been used. Based on these outcomes the two groups were subdivided in significantly varying high and low COMA subgroups. In the main evaluation part the participants had to fulfill tasks in a group specific visualization cockpit. Thus in each of the demographically and usage-specifically counterbalanced group there were subjects feeling skilled (high self-assurance) and subjects feeling unskilled (low self-assurance). In the study the visualization cockpit, timestamps and actions were tracked. Afterwards we used the INTUI questionnaire to measure the intuitive effortlessness. Recent literature discusses the importance of the relationship between effortlessness and individual satisfaction (Orsinghe et al. 2011).

The results of the study reveal that independent of the self-rated self-assurance of the users there was no significant difference in the effectiveness of task completions using visualizations. Furthermore the users indicate in the questionnaire that using visualization their individual satisfaction level had no significant differences when compared to the users' self-assurance levels.

1.1 VISUALIZATION COCKPIT

The increasing amount of information is a well-known phenomenon in the

current information age (Keim and Mansmann 2008). Information Visualization aims to provide visualization techniques to present data in an efficient and effective way (Keim 2002; Nazemi et al. 2011). But the visualization of complex structures with various details en masse tends to result in visualization with reams of graphs, lines and icons. For this reason the usage of a single visualization is not adequate for all tasks or all users. It is necessary to combine different visualization techniques and reduce the complexity of information by splitting in different separated areas of visualization (Nazemi et al. 2010). For the evaluation in this paper two visualization cockpits had been used, consisting of the visualization SeMap, SemaSpace, concentric radial graph visualization and a text-based detailed view.

SeMap is a combination of the Shneiderman's Treemap and Treeview. The Semantic Map (SeMap) uses the two graphical metaphors, Treemap and Treeview, to combine the surpluses for a special case: the usage of annotated data and the implicit impartation of knowledge. Graphical primitives like color, order and size are used to communicate relevant information in a way the user can fast and proper percept it. Color indicates user specific relevance whereas the order and size are determined by a combination of user- and data-based relevance. Order arranges the most relevant element next to the selected element of the last row. SeMap is a visualization that visualizes the concepts and their hierarchy. It is possible to navigate through the hierarchy, where different graphical primitives indicate the relevance of the concept (Nazemi et al. 2009; Nazemi et al. 2010).

SemaSpace is a visualization of knowledge spaces supporting different aspects, e.g. thematic, co-occurrences, spatial, clusters, or configurable domain-specific representations. It provides different knowledge domains (ontology concepts) visualized as circles containing the instantiation of the knowledge domain as smaller circle. SemaSpace offers a sophisticated way to explore knowledge spaces. It offers concepts and related knowledge items to them as factual knowledge and interrelation between knowledge spaces. Awareness knowledge is acquired, when the user explores knowledge spaces and makes decisions to follow different branches or chooses alternative branches in the visualization. Users can also reorganize the visualized knowledge spaces to put the important or relative knowledge spaces in the focus just like working on the desktop (Nazemi et al 2010; Bhatti 2008).

1.2 EVALUATION METHODS FOR VISUALIZATIONS

To design computer systems making people with high self-assurance and a high frequency of computer usage feel confident and comfortable while working with them seems not to be a challenging task. But if people with low self-assurance and low usage frequency are in the same target audience, the design process becomes more difficult. It is in the interest of users and designers to generate computer systems that encourage high and low self-confident users to high effectiveness and satisfaction. Therefore, it is important to evaluate new computer systems with regard to their fitness for both high and low self-confident users using appropriate

evaluation methods.

The COMA questionnaire is a subscale of the INCOBI (Richter et al. 2009) that is an instrument for the assessment of attitude towards and competence with the computer. The COMA subscale is a very useful and accurate tool to measure the self-confidence of users working with computer systems. Therefore the COMA questionnaire is used to collect self-assurance data to assign the participants into high and low self-assurance groups.

Another influential factor in the interaction with computer systems is whether users perceive the system as being intuitive and satisfying. Even if a system facilitates to solve tasks effectively it might be designed not intuitively, thus the interaction with the product is perceived as complicated, unforeseeable or inefficient. A lack of intuitive interaction might lead to dissatisfaction. As a result users may avoid using the system or may not feel comfortable in working with it. Therefore it is very important to evaluate, how intuitive users perceive the interaction with a computer system. The INTUI questionnaire (Ullrich & Diefenbach, 2010a,b) is a measurement tool to collect data on how intuitive the interaction with computer systems and software is assessed by users. It contains the subscales Effortlessness, Gut Feeling, Magical Experience and Verbalizability.

A third dimension is the users' presence Immersion or immersive tendencies. This dimension describes the state of presence the user is in while interacting with the computer system. If a user easily shifts his or her attention from the actual physical to the computer system environment, he has a high degree of immersion and is able to focus and be aware of the entire task in contrast to a user with low presence (Fontaine 1992). Especially in the interaction with new software, higher attention to the task and a more detailed overview on the characteristics of the application is important. The attention facilitates more immersive users to solve the given tasks better than users with low presence. The ITQ (Immersive Tendencies Questionnaire, Witmer and Singer, 1998) measures immersive tendencies on the subscales tendency to become involved in activities, tendency to maintain focus on current activities and tendency to play video games.

To evaluate the computer system a typical scenario of usage is necessary. The evaluation setting should be as realistic as possible, in order to observe a test users experience very similar to a real users experience. Therefore specific tasks are generated that users typically solve using the system.

2 EVALUATION SETTING AND PROCEDURE

The participants were tested simultaneously, each seated in front of a Windows 7 PC with a LG 22'' Monitor, the visualization cockpit was prepared including an individual participant ID. 18 subjects (w=14), all students with major in psychology at the Technische Universität Darmstadt, with a median age of 23 years participated in the experiment and received course credits for their participation.

At first, all participants completed the COMA questionnaire of eight items concerning the self-confidence in using a computer system. Based on the results of

this questionnaire two groups of each nine persons were generated by median split, see Figure 1.

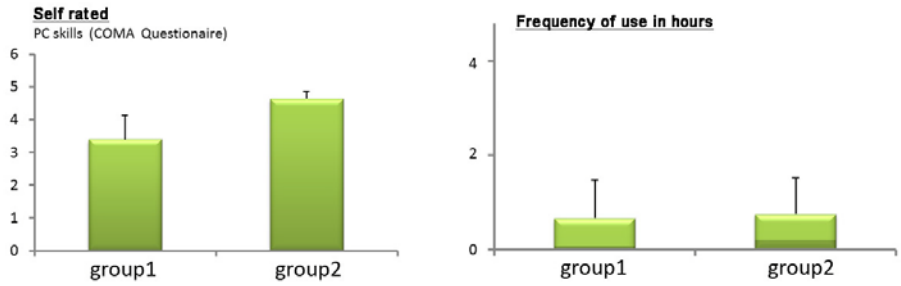

Figure 1 Left: participants self-confidence of c omputer system usage. Right: frequency of computer system usage in hours.

Afterwards, the participants completed the ITQ with 29 items on the subscales tendency to become involved in activities, tendency to maintain focus on current activities and tendency to play video games.

In the main part of evaluation the participants were instructed to solve typical search and exploratory tasks with the SemaVis system (Nazemi et al. 2011). Therefore, 25 questions concerning life data of different well known psychologists were generated. The participants were instructed to answer as many questions as possible only by means of SemaVis within 25 minutes. The questions were asked in English language to fit to the English data provided by the database. The short answers, e.g. date and place of birth, nationality or religion, should be written down on a sheet of paper, on which the questions were presented.

Both groups used SeMap and the text-based detail view giving information on the search results. Another type of visualization, either concentric radial graph visualization, a network visualization for exploring linked information (Figure 2), or SemaSpace (Figure 3), was randomly chosen and used by the participants. SeMap visualization was placed at the left top of the page, SemaContent at the right top of the page. The concentric radial graph visualization respectively SemaSpace was placed at the bottom of the page. Icons, other visualization types and adaptive functions of SemaVis were deactivated. It had been ensured all questions could be answered using the displayed information in either the text-based detail view or the concentric radial graph visualization respectively SemaSpace, so both types of visualizations had to be used.

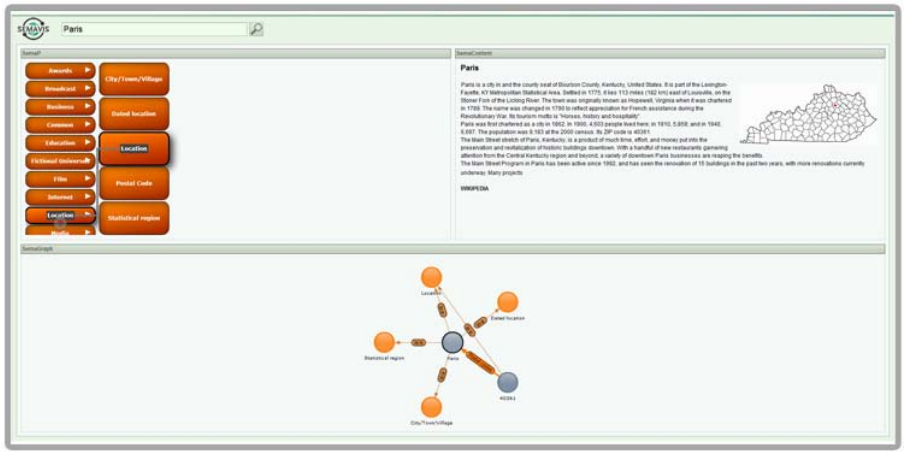

Figure 2 Evaluation scenario 1: SeMap visualization, text-based detail view and concentric radial graph visualization juxtaposed to a visualization cockpit.

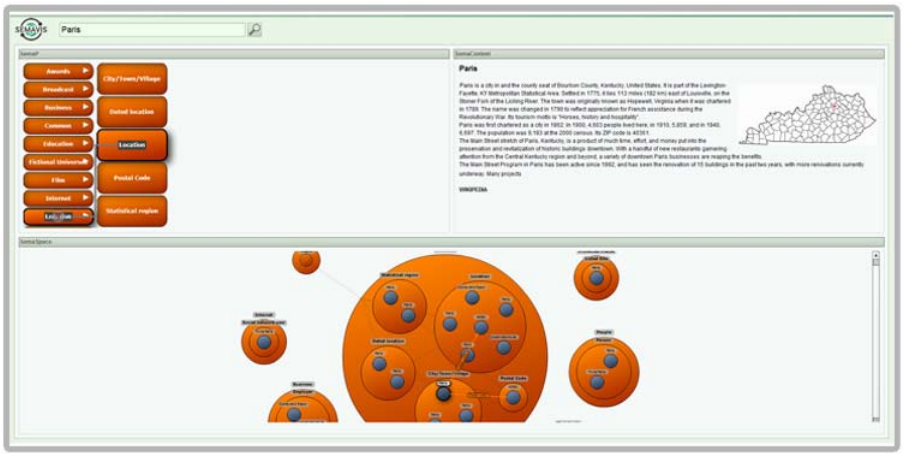

Figure 3 Evaluation scenario 2: SeMap visualization, text-based detail view and SemaSpace juxtaposed to a visualization cockpit.

Usage data such as timestamp, action (left-click, right-click, double-click), applied visualization, information and data type were tracked during the period of search.

At the end the participants were asked to complete the INTUI questionnaire. The INTUI measures intuitive interaction containing 16 seven-point semantic differential items on the four subscales *Effortlessness*, *Gut Feeling*, *Verbalizability*, and *Magical Experience*.

3 EVALUATION RESULT

The self-assessed self-assurance of both groups differed significantly. The overall mean of correct answered questions was 11.61 with 9.98 for the low self-assurance (LSA) group and 13,33 for the high self-assurance (HSA) group. A MANOVA was conducted to examine the effect of LSA resp. HSA (independent variable) on the number of correct answered questions and the INTUI scales (dependent variables).

The MANOVA revealed a significant main effect of LSA resp. HSA on the INTUI subscale verbalization, $F(1,16)=5.699$, $p=.03$, with a mean of 3.53 for the LSA group and a mean of 4.89 for the HSA group.

There was a significant correlation between the frequency of computer use and self-rated self-assurance of users (r=.58**), see also Figure 1.

There was no significant main effect of LSA resp. HSA on the number of answered questions. The results were tested on correlations. There was no significant correlation between the self-rated self-assurance of the users and the number of answered question (r=.43), see Figure 4.

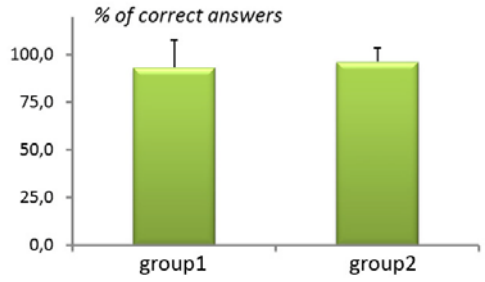

Figure 4 Percentage of correct answered questions in the groups.

5 CONCLUSIONS

In this paper a user study was presented which depicts that regardless of the self-rated self-assurance of the users no significant difference in the effectiveness of task completions in using visualization technologies can be registered. Furthermore the users indicate in the questionnaire that using visualization their individual satisfaction level had no significant differences compared to the users' self-assurance levels. This indicates even if users feeling not confident in interacting with computer systems, they may feel confident interacting with visualizations. Thus when applying visualizations for tasks of information search and exploration the user is encouraged to high effectiveness.

The satisfaction with the usability of the visualization measured on the subscales

effortlessness, gut feeling, verbalizability, and magical experience is not related to the degree of self-assurance. This illustrates also users with low computer experience are encouraged to use visualization to fulfill tasks on information search.

These results indicate that even if users do not feel confident in interacting with computer applications, they may feel confident with visualizations. Visualizations seem to be an appropriate way to encourage high and low self-confident users to fulfill tasks of information search with the same high degree of effectiveness and satisfaction. The results of the evaluation indicate that even users feeling not confident in their interaction with computer systems are able to solve specific information search tasks as efficient and satisfied as their high-confident colleges.

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