Icon Design for Older Users of Project Management Software

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Abstract. Working in projects is an important part of many jobs in service industry. Due to their knowledge and experience project planning is often accomplished by older employees. Therefore, and with regard to the demographic change an integration of the needs of older employees into the work environment is required. Common to most IT-based systems, including project management software, is the use of icons. To investigate different icon sets in project management software, regarding age related differences, two studies were conducted. The first study aimed at investigating two different icon sets regarding execution times and eye movements in an applied setting. The second study consisted of a questionnaire where subjects had to map different icons to their corresponding functions and had to compare these icons regarding their intuitiveness. Results revealed that older users profit from an icon design which is low in complexity but no impact by different icon designs was found for younger users.

Keywords: Usability, icon design, human-computer interaction, project management, eye-tracking, age differences.

1 Introduction

Well-organized project planning and subsequent execution of the project plan is nowadays a central predictor for the success of a project and thus a main competition factor for companies. Since projects are often linked to high risks as they are highly complex and constrained by tight time schedules [1], the planning process is often supported by computers. Therefore, the number of software products which support project planning is growing. These project management software applications offer different functions (e.g. project scheduling, cost planning, resource assignment planning, quality management, documentation) and differ in their visualization and planning methods (e.g. network diagram, Gantt chart). To navigate through the system and to generate different functions most commercial off-the-shelf project management software applications use icons. An icon is a small picture or a graphical symbol, which provides an illustration of a function or file on the system. Such an icon should transmit information about its underlying function in an abbreviated, simplified form and should not depend on letters or words [2]. Especially software tools which are

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unfamiliar to the user benefit from a well designed icon structure as the ease of use is facilitated which enhances the acceptance and further use of the tool.

Since project management places many demands on a person, like professional, methodological, expertise and life experience, it is often accomplished by older employees. Due to age-related changes, the interaction with computers is often particularly straining for older employees. These changes include decreases of fluid cognitive abilities like abstract reasoning [3], mental speed and short term memory storage [4], perceptual impairments like vision [5] as well as impairments in performing complex motor activities [6] which may lead to longer movement times [7] and difficulties in performing computer mouse tasks [8]. Although different people experience these impairments at different points in time and to different degrees, older people in general must deal with these functional limitations [9].

The aim of the current studies was an age differentiated usability evaluation of two different icon sets within a project management software application. The two icon sets that were used differed in their appearance: Icon set A included very simple icons which only consisted of three colors and were designed flat, whereas Icon set B included icons that had a more realistic appearance in that the icons were more colorful and had a glossy surface that was supposed to simulate three-dimensional objects. Within the first study (study I) participants generated typical project management tasks with both icon sets and results were analyzed regarding execution times and eye movements. The second study (study II) consisted of an online questionnaire where at first subjects had to map icons of both sets to their corresponding function and at second had to give a rating of icon intuitiviness.

2 Literature Review

2.1 Icon Design for Aging Users

Interfaces using icons aim at reducing complexity for the user as the mental workload is decreased when the icons are designed properly [10]. Icons represent information for the user graphically because they express semantic information not through the use of words but via nonverbal cues. Because of impairments in cognitive and perceptual functions which can go along with the aging process, older users may have difficulties in information processing [11] and hence in interpreting icons. Until now little has been reported in the research literature about icon design for the elderly. Mertens et al. [12] investigated the graphical presentation of icons and it could be shown that among elderly, the use of photos compared to pictograms or clip art leads to a higher recognition rate. However, the study was conducted using a hardcopy questionnaire and not a real user interface. McDougall, de Bruijn and Curry [13] found out that two parameters which play a critical role when studying icon design are the concreteness and the complexity of icons. Concreteness in this context means how closely the icon resembles items in the real world and complexity refers to amount of visual detail depicted in the icon. Schröder and Ziefle [11] investigated the effects of icon concreteness and complexity on semantic transparency in younger and

older users of mobile devices. Results showed that concreteness of an icon has a significant effect on subject's confirmatory response per item and that this effect does not vanish with familiarity of the icon. For icon complexity there was no significant difference in subject's confirmatory responses but subjects had higher reaction times when complex icons needed to be processed instead of simple ones. Regarding age related differences an effect for the processing time was found but no effect of the icon design so that the authors recommend a uniform design approach.

To build on existing research by exploring age-related differences in the effects of concreteness and complexity two different icon sets were investigated in this study which differed in the level of complexity and concreteness. Current research was extended by using icons of a commericial off-the-shelf project management software and studying the usability of these icons in an applied setting and in a questionnaire.

2.2 Eye-Tracking Metrics

Research has shown that eye-tracking measures can be used to detect usability problems in various contexts [14-16]. A number of eye movement metrics have been used to measure usability [16-17]. The mean fixation duration is one eye movement parameter that is often analyzed in usability studies. According to Goldberg and Kotval [14] longer fixation durations are an indicator for the difficulty to extract information from a display.

Concerning age differences in mean fixation durations most studies report higher mean fixation durations for older subjects. When analyzing navigational behavior on web pages, for example, Fukuda and Bubb [18] found that subjects aged between 62 and 74 years had longer fixation durations than younger participants aged between 17 and 29 years. Moreover, Hill et al. [19] investigated computer expertise when using the web within older subjects (70-93 years) and found that older novices had significant higher mean fixation durations than older experts.

Studies from other fields also address the effect of aging on eye-tracking metrics. In reading studies higher fixation durations were often found for older subjects [20-21]. However, there are also few studies that report no age differences regarding the fixation durations. Veiel et al. [22], for example, investigated age differences in the perception of visual stimuli and found no age difference regarding the fixation durations.

In line with these studies we used the mean fixation durations as dependent variable of the eye movements. Because the icons were arranged in the menu part of the software we furthermore analyzed the relative amount of fixation durations in menu parts.

3 Method

Dependent variables in study I were the execution time, the mean fixation durations and the relative amount of fixation durations in the menu area. Study II was analyzed

regarding errors made in a mapping task and regarding ratings in intuitiveness for the two different icon sets as dependent variables. Icons were selected from an existing commercial project management software and differed regarding their complexity and concreteness. Table 1 shows the icons of both sets used in this study. Icon set A consisted of very simply icons which were low in complexity and concreteness since the icons only consisted of three colors and were designed in bi-dimensional space. Icon set B included icons that had a more realistic appearance in that the icons were more colorful and had a glossy surface that was supposed to simulate three-dimensional space and was therefore rated as being high in complexity and concreteness.

Table 1. Icon sets investigated in the study

Meaning	Icon set A	Icon set B
Save		
Reload		
Undo		
Redo		
Settings		
Progress evaluation		
Insert activity		
Delete		
Upgrade		
Degrade		
Collective task		
Type of task		
Critical		
Done		
Started		
Relationship		
Zoom out		
Zoom in		

3.1 Participants

Altogether 10 subjects participated in study I and a sample of 19 subjects in study II. Subjects were divided in two age groups. In study I age ranged from 29 to 37 years in the younger age group (mean=32.00, SD=3.08) and from 43 to 60 in the older age group (mean=52.40, SD=7.13). In study II subjects in the younger age group were between 21 and 38 years old (mean=30.55, SD=4.80) and between 42 and 56 in the older age group (mean=49.25, SD=5.06). All participants had experience with project work and project management software but were not familiar with the design of the icons used in the study.

3.2 Apparatus

The experiment was conducted at a 22”-inch LCD TFT-widescreen-monitor. Eye movements were measured during the task using a Tobii X120 eye tracking system. Fixation durations were measured according to data typically found in the literature for usability studies, e.g. [16-17]. With regard to these studies the mimimum time for a fixation was set to be at least 100ms and the eye-in-head position had to be in a threshold of dispersion of about 2°.

3.3 Procedure and Task

Study I was conducted in a laboratory where subjects were seated in front of the monitor with a viewing distance of 500 mm. After calibrating the eye-tracking system, the subjects executed the tasks using the software with icon set A. This procedure was repeated for the software with icon set B as well. The representation of the icon set was permutated. The task consisted of typical steps (subtasks) when developing a project plan. Table 2 gives an overview of the nine sequential subtasks.

Table 2. Specification of the task

Subtask 1	Generate a new project plan
Subtask 2	Create five new activities and change duration of the activities
Subtask 3	Insert two new activities, change duration and level of the activities
Subtask 4	Insert four new activities, change duration and level of the activities
Subtask 5	Link activities
Subtask 6	Insert new milestone and link it to activity
Subtask 7	Insert new milestone and link it to activity
Subtask 8	Insert new milestone and link it to activity
Subtask 9	Assign responsible person

Study II was conducted using a questionnaire which could be completed online. In the first part of the questionnaire subjects had to map icons to their underlying function. Therefore, icons were arranged in blocks of 6 icons plus one icon which had no corresponding function serving as control item to make possible contradictions visible. In the second part of the questionnaire subjects had to rate icons according to their intuitiveness. Thereby, a function was given and subjects could choose between three answer options: Icon of set A, icon of set B and as a third option subjects could indicate whether the icon of set A or set B makes no difference to them.

3.4 Statistical Analysis

To analyze the data of study I statistically repeated measures analysis of variance was used. The age of the participants served as a between-group factor. Study II was analyzed using two-way ANOVA with age group and icon set as independent variables. Furthermore, a correlation analysis was used to investigate whether there is a relationship in the rating of intuitiveness and the performance in the mapping task. Because data for the correlation analysis were not measured at the interval level, correlation coefficients were calculated using Spearman's rho. According to Cohen & Cohen [23] effect sizes can be classified into small (r=.10), medium (r=.30) and high (r=0.50). The level of significance was set to $\alpha = 0.05$.

4 Results

4.1 Execution Times

To analyze the execution time similar subtasks were analyzed by combining the data. The analysis of the execution times resulted in significant main effect for the age group for subtasks 2-4 "Insert two new activities, change duration and level of the activities" ($F(1,8)=11,224$; $p=0,010$) and for subtasks 6-8 "Insert new milestone and link it to activity" ($F(1,8)=7,008$; $p=0,029$). In both tasks participants in the older age group needed significantly more time to execute the tasks than participants in the younger age group. For the main effect of the icon set as well as for the interaction effect between age group and icon set no significant effects were found.

4.2 Mean Fixation Durations and Relative Amount of Fixation Durations in Menu Parts

Mean fixation durations and the relative amount of the fixation durations in the menu part could not be analyzed with regard to age differences because data of the older age group were insufficient. This may be attributed to the problem of droopy eyelids. Droopy eyelids of participants when using eye-tracking metrics cause data loss because the eyelids or the eyelashes cover the pupil in specific gaze directions. The problem of droopy eyelids is a matter of individual differences and it grows with the age of participants [24]. Consequently, this might have been the case with data collected in this study.

Regarding the mean fixation durations no significant effect was found for the icon set when analyzing the graphical user interface as a whole. In order to investigate for which icon set more time was spent fixating it, the relative amount of fixation durations in the menu part where the icons are arranged was analyzed. Data revealed no significant effect when looking at the differences between the two icon sets when the mean fixation durations in the menu part were analyzed.

4.3 Questionnaire

The first part of the questionnaire was analyzed by measuring the performance in the mapping task for each icon set. Results indicate that subjects in the older age group made more errors with icon set B compared to subjects in the younger age group ($F(1,34)=8.816$; $p=0,005$). No age effect was found for icon set A.

When analyzing the second part of the questionnaire scores revealed that there was no significant difference in the intuitiveness ratings for one icon set or the other. To analyze whether intuitiveness ratings of the subjects are linked to the errors they made in the first part of the questionnaire a correlation analysis was conducted. According to the classification by Cohen and Cohen [23] a medium to high effect size was found for icons which were rated as being low in intuitiveness and errors made in the mapping task $r=.429$.

5 Discussion

The aim of the study was an age-differentiated analysis of two icon sets. The investigation of the execution times resulted in a significant main effect for the age group for two of the subtasks. In both tasks participants in the older age group needed significantly more time to execute the tasks than participants in the younger age group. This effect may be attributed to declines in perceptual and cognitive processes [3,4] like the hand eye coordination which may have an influence in this study because participants performed the tasks with a computer mouse. Regarding the execution time no effects were found for the icon set. So the complexity and the concreteness of the two investigated icon sets make no difference in accomplishing the subtasks used in this study. However, a tendency for the older age group was found in the scores to have shorter execution times when working with icon set A.

Results of eye-tracking data analyzed by means of fixation durations of the interface as a whole and the relative amount of fixation durations in menu parts did not differ for the two icon sets. As the fixation duration is assumed to be an indicator of the difficulty to extract information from a display it can be concluded that the design of the icons used in this study has no effect on the ability to extract information. Unfortunately, we were not able to investigate eye-tracking data with regard to age differences because we had difficulties in collecting data from older subjects. In future research we are trying to improve the measuring procedure so that an age differentiated analysis will be possible.

When analyzing the questionnaire results revealed that older subjects had more difficulties in the mapping task when working with icon set B. Together with the tendency for the older age group to have shorter execution times when working with icon set A this could lead to the conclusion that the older age group performs better with icons that are not high in complexity and concreteness. An explanation for this finding might be that the older age group already used to work with rather simple icons in the past since they grew up with early computers which used such an icon design in comparison to the younger age group, which showed no tendency for one icon set or the

other. Regarding the intuitiveness scores results showed that fewer errors were made in the mapping task with the icon set which was rated as being higher in intuitiveness. This finding is in accordance with existing literature [2] and shows that icon design places a crucial role in human-computer interaction.

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