The effect of Aging on Visual Attention Shifting in Collaborative Document Editing

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ABSTRACT

Many tasks, including driving, require frequent shifts in visual attention. Some visual shifting of attention is due to distraction from a secondary task, or from non-task relevant stimuli in the environment. Older people (e.g. over 60) are generally slower to react to stimuli and less skillful in learning to use new technologies. In this paper we are interested in studying the effect of age on the ability to shift visual attention in a task that involves computer use. An experiment is reported involving 10 participants, five who were over the age of 60 and five who were in their twenties and thirties. A collaborative editing task was carried out where participants, run one at a time, had to edit a document in real-time based on comments made by three research assistants (who were not participants for purposes of data collection). In one condition participants had to constantly shift their visual attention from a desktop computer they were using to a large shared screen where the research assistants made editing suggestions and used a laser pointer to indicate which part of the document (shown on the large shared screen) they were referring to. As expected, time to perform each editing task increased in the two-screen (vs. one screen) condition. However, the amount of slowing due to the use of two screens for the task was considerably greater for the older group. The results are interpreted in terms of the use of redesigned tools and technologies to assist older workers perform more effectively.

Keywords

Shifting, Executive Functioning, Visual Attention, Collaborative Editing, Aging Effects

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1. INTRODUCTION

We consider a collaborative document writing/editing task, where one person takes the role of scribe to edit a document according to edit suggestions provided by a group of editors using a shared presentation space (such as a large screen, or white board). For instance, in the process of revising a standard or regulation, the scribe might be responsible for listening to the edit suggests that are made and then editing the document accordingly using word processing software. In the task configuration considered in the research reported below, the editors identified the document location for their edits by using laser pointers, or by drawing notes on a white board, while the scribe worked on a desktop computer to incorporate the edits into the document. The use of the large shared screen required the editor to shift his/her visual attention between the shared screen/whiteboard and the desktop computer being used by the editor. We hypothesized that resulting shifts in visual attention would tend to increase the processing time for edits (causing lower productivity) and that this effect would be particularly pronounced for older people.

While the damaging effects of shifting attention (and the disproportionate effects for the elderly) have been shown in the past, previous studies[1] have tended to focused on specially constructed lab tasks that had little relation to real world tasks. In the study reported here we looked at the impact of visual shifting of attention on a fairly realistic collaborative text editing task. The ultimately goal of this research is to assist in understanding how detailed design of a task can impair or enhance the productivity of aging workers relative to the corresponding productivity of younger workers. Our particular interest is in how design of the task can increase or decrease productivity by requiring different amounts of visual attention shifting. "Guidance provided in this paper provide an example of how appropriate task design can potentially improve the productivity of older workers relative to the corresponding productivity of younger workers.

2. RELATED RESEARCH

The task of collaborative writing/editing has been of considerable interest in research on computer supported

collaborative work. Collaborative editing tools can be synchronous or asynchronous but in this research we are interested in synchronous editing where participants are co-located. Since older people are known to be more affected (than younger people) by distraction when reading[2], collaborative editing is an interesting task from the perspective of assistive technology for older workers.

The SASSE editor [4] was an early example of a synchronous collaborative editor, but it was designed to be used on individual desktops rather than on a co-located shared screen. Streitz et al. (1994) [5] described the DOLPHIN system for integrated meeting support. Dolphin was designed as a diverse system that could cover a wide range of usage scenarios. Of most relevance to the present discussion, research on DOLPHIIN examined meetings that used a standard text editor on an electronic whiteboard. "The group used only their standard text editor which was operated by a scribe using a keyboard from a distance while sitting at the table about 1.5 m (5 feet) away from the LiveBoard. The group created an outline of the next issue visible to all participants. The scribe got many instructions in terms of which content to note, which words to use including corrections of spelling errors but also on how to organize it (depth of indentation, etc.) and requests to reorganize the evolving structure. It was observed that in most cases the discussion stopped while everybody waited until the typing/editing on the public screen was finished." This early finding with the DOLPHIN system illustrates the general problem that when a scribe or moderator is making edits based on the instructions of a group of co-located people, and with reference to a large shared screen, he or she will have trouble keeping up with the contributions being made by the other team members.

Editing on a personal computer while receiving edit suggestions made with reference to a different shared screen requires the scribe to finish making the edit on her screen, switch her visual attention to the large screen, search for the location that is relevant to the current comment/suggestion, parse the edit requirement, and then switch her attention back to her local screen and make the edit. Thus much of the task difficulty and the resulting slow performance (where the work of the scribe lags behind the edit suggestions being made by others) is due to the cost of shifting visual attention between the screens.

Executive function capability is known to decline with age in general, and there is a strong age-related decline in shifting ability in particular [6].Heaton et al. [7] showed that performance on the Wisconsin Card Sort Test, in which attention shifting is required [8] declines with age. Using 899 individuals aged 6.5-90 years, they reported a quadratic effect for age on all WCST measures. They found a significant improvement in WCST scores from ages 6.5 to approximately 19 years, with little change over ages 20-50 years, and then modest decline over following decades followed by a relatively sharper decline in performance after 60 years.

Older adults also perform more poorly in tasks that require attending and responding to multiple sources of information [9]. Thus collaborative editing with a large shared screen where a moderator makes edits based on the recommendations of co-located others is likely to be a more difficult task for older people due to the demands of shifting visual attention between screens.

3. Research Questions and Hypotheses

We addressed the following two research questions.

1) Do older (vs. younger) participants take longer to carry out a collaborative editing task ?

2) Will reduction in visual attention shifting using a single screen implementation of the task provide more benefit to older (vs. younger) participants in a collaborative editing task?

To examine the research questions above, we tested the following hypotheses.

H1) Older participants take longer time than younger participants to carry out an editing task.

H2) When the task requires less visual shifting, the task completion time advantage of younger participants will be significantly reduced.

4. EXPERIMENT

4.1. Experimental design

We conducted an experiment to examine the effect of visual shifting on document editing speed by age.

The experimental design was 2 x 2 mixed design with age is a between participants variable (younger vs. older) and type of supporting technology as a within participants variable (one-screen task vs. two-screen task, as explained below). We measured time to complete the task as the dependent variable.

In the two-screen condition, the scribe sat at a desktop computer while three people provided him or her with a pre-scripted set of edits to carry out. The three people pointed to where the edit should be made by shining a laser pointer on the large screen. This design required the scribe to look away from the desktop screen being edited, and to view the large screen which was the focus of the editing instructions being provided.

In the one-screen condition, the scribe was provided with a new application designed to run on the desktop screen. This application showed where the editors were pointing in the document with reference to their edits. This application removed the need to keep shifting visual attention to the second (large) screen. A video camera was used to capture the moving images of the pointers on the projector's screen. The images were sent to the computer to extract the pointers' coordinate on the screen. The pointers' coordinates were then converted and sent to the screen of the document editor, as shown in Figure 2. When using the one screen application the editor not need to shift his/her visual attention between screens.

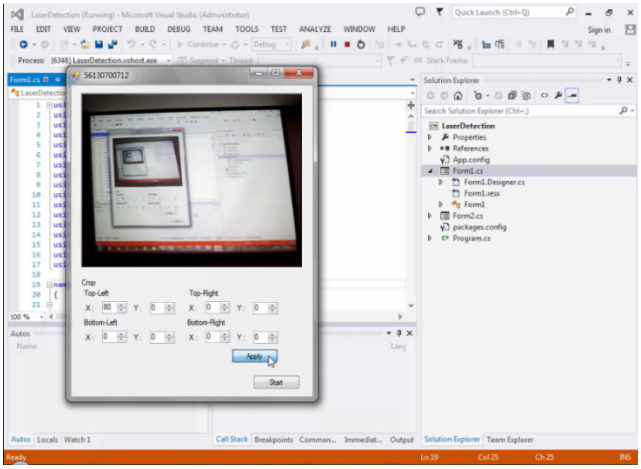

Figure 1 A screen shot of the application that capturing the projector's screen.

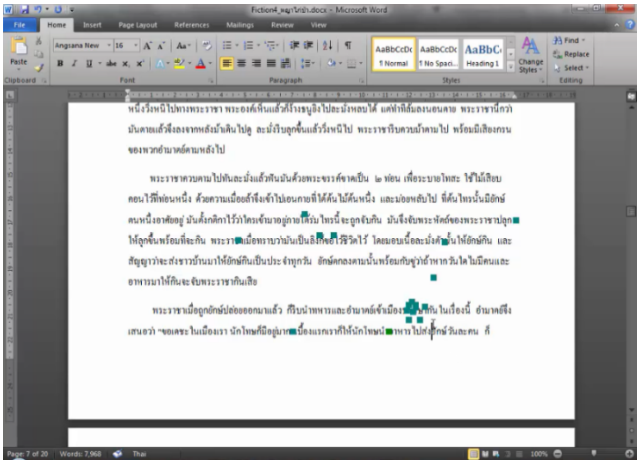

Figure 2 Sample of screen shot of the duplication of pointer red dot

4.2. Participants

Ten participants participated in the experiment individually. Five of the participants were from 27 to 32 years old (younger group; Mean=29.4 years, SD=2.1) and five of the participants were from 60 to 65 years old (older group ;Mean=62.4, SD=1.8). .All of the participants were native Thai speakers and the task was conducted in Thai.

The older group were retired teachers and government officers. The participants had worked with and had been familiar with computer use and editing Word documents for many years. The young participants were recruited from a private company. They all use a computer and word processing software (MS Word) daily.

4.3. Apparatus

A desktop computer, a monitor, a projector, a projection screen, a video camera, and three red laser pointers were used in the experiment (Figure 3).

The video camera was used to capture the projector screen and movement of the laser pointers. The three laser point positions were then sent to the scribe's computer and annotated on the screen.

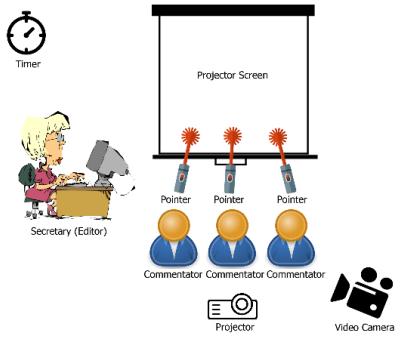

Figure 3 Experimental setting

4.4. Task and procedure

A participant took the role of scribe while three research assistants played the roles of editors who asked for changes on the documents based on a pre-defined script of edit changes**.** The target document was projected on to a large screen in the experimental room and was also shown on a computer display in front of the scribe**.** The commentators instructed the scribe (participant) to correct errors in the document, pointing to the projected screen with laser pointers to indicate where the changes were to be made.

The two target documents used in the study were two-page meeting reports that each had approximately 20 errors per page for a total of around 40 errors per document. Each participant saw one of the two documents in the one screen condition and the other document in the two-screen condition.

The participants first carried out the editing task using the two screen method, and then carried out the task again using the one screen application. Note that all participants used the two screen condition first followed by the one screen condition. Our reasoning for using this fixed ordering of the conditions was that we wanted to simulate the targeted use case where an assistive technology was added to the workplace to improve the performance of older workers.

5. RESULTS

Figure 4. shows the mean task completion time (in minutes) and associated 95% confidence intervals **(error bars),** by number of screens and age group.

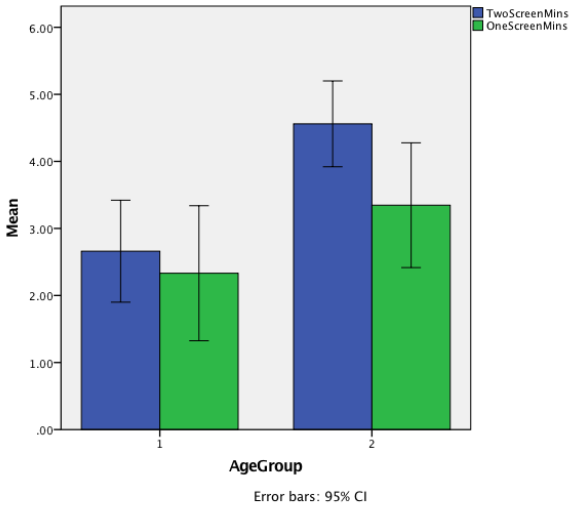

Figure 4 The mean task completion time and standard errors by display condition age group) 1 =younger, 2 =older(

Mixed Analysis of Variance was carried out with Number of Screens as the within subjects factors and Age Group as the between subjects factor. There was a significant interaction between age group and number of screen ($F [1,8] = 7.79$, $p<.05$). As can be seen in the figure 4, the older group is generally slower in performing the task and this is especially true in the two screen condition ($p< .05$). This supports our first hypothesis (H1). However, the significant difference in task completion time between age group diminished as the reduction in time taken after switching to the one screen condition was greater for the older group as indicated by the significant interaction effect in the ANOVA analysis (H2).

6. CONCLUSIONS

Both of our hypotheses were supported in the experiment. Older participants took longer to perform the collaborative task than younger participants. However, in the one screen condition the older group could carry out the editing task with less visual attention shifting, and the gap between their performance and the performance of the younger group narrowed, as confirmed by the significant interaction effect. Our results show how age-related performance decrements, that have an impact on the productivity of workers, can be reduced through appropriate redesign of the task.

Visual attention shifting is required in many tasks including driving and machine operation as well as document editing, and it will selectively impair the performance of older workers. Thus there are many opportunities to improve the relative productivity of older workers by redesigning the task using appropriate technological support.

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