Investigating Drag and Drop Techniques for Older People with Cognitive Impairment

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Abstract. Graphical user interfaces and interactions that involve pointing to items and dragging them are becoming more common in rehabilitation and assistive technologies. We are currently investigating interaction techniques to understand point-select-drag interactions for older people with cognitive impairment. In particular, this study reports how older perform such tasks. Significant differences in behavior between all of the interaction techniques are observed and the reasons for these differences are discussed according the Mini Mental Score.

Keywords: Human Computer Interaction, Older subjects, dementia, evaluation.

1 Introduction

Older people with cognitive impairment are a challenging user group to study the human computer interaction. Because of the increased invasion of computer and portable devices in world and the demographic "ageing" of people, there is a need for usable interface that promotes accessibility and usability for older people. Another effect of the demographic shift towards an ageing population is a growing number of people with dementia. Current estimates put the numbers of people with dementia at around 25 million worldwide but this is predicted to rise to 114 millions [16].

The majority of people with dementia are over 65, and most likely have Alzheimer's disease, cerebrovascular disease or a combination of both [14].

Graphical user interfaces and interactions that involve pointing to items and dragging them are becoming more common in rehabilitation and assistive technologies. It is why there is an important need to study computer pointing devices for older people with cognitive impairment.

While many studies have examined age-related declines in motor control trough experimental observations showing that older people have slower movement times and greater difficulty producing fine motor adjustments [2]. Many studies have also looked at the effects of ageing on computer interaction [1], [3], [4], [5], Chaparro & al [5] have investigated age-related differences using these two devices (e.g. mouse and trackball). The results showed that older people moved more slowly than younger adults by two groups of adults (younger < 40 years of age and older > 65 years older).

J.A. Jacko (Ed.): Human-Computer Interaction, Part IV, HCII 2011, LNCS 6764, pp. 530–538, 2011.

Another point is that no age differences were found in movement time or variable error between the two devices. Smith & al. [4] have also examined age differences in the performance of basic computer mouse device. Differences in performance due to age were found for complex tasks (clicking and double-clicking).

Many approaches in the mainstream human-computer interaction community have been proposed to ease pointing tasks on computers, although few have been directed at older adults [e.g. 3, 6, 7, 8, 9 & 10]. However, these essentially aim to improve point and click interaction, using familiar pointing devices, such as the computer mouse, which manipulate an on-screen pointer.

One of the key challenges in developing computer accessibility is finding some easy and effective means of interaction. This is even more necessary in the process of designing interactive systems that could rehabilitate them such serious games, memory aids, history books, etc.

A major point from reported above is that older subjects take longer to realize selections, and require a greater proportion of time and a higher number of corrective movements to reach the targets with the same level of accuracy as younger subjects. So, compared with younger users, older subjects can have greater difficulty to perform the aiming, clicking, and movements required to point-select-drag interactions.

Therefore, the goal of this study is to investigate how older people with cognitive impairment respond to different drag and drop interaction techniques. This ongoing study will present our experiment and Mini Mental State group differences in movement time, movement distance and mean number of mistakes.

2 Experiment

This experiment studies three interaction techniques to select and to move an item to another one with a mouse. The aims of this experiment are to:

- Analyze performance differences between older subjects without cognitive impairment and with cognitive impairment;
- Identify and analyze factors that can explain any preference or better efficiency observed between these interaction classes.

2.1 Materials

The experiments were conducted on a Satellite Pro A200Toshiba laptop with a 15 inch widescreen, 1024*768 TFT display. An optical computer mouse was used as an input device. The right button was deactivated. The mouse was selected to be representative of an input device that would be typical for personal use. A hand cursor was preferred as a good metaphor.

2.2 Tasks

Study participants (Fig.2) have been asked to perform some serial pointing and moving tasks (Fig.1). They have been asked to select the item (the piece of sugar) and to put it in the middle of the cup of coffee. The size of sugar is 57 x 38 pixels. The distance between the sugar center and one cup of coffee is 406 pixels. Three modes of the “drag and drop” interaction techniques have been defined:

Fig. 1. Exercise view

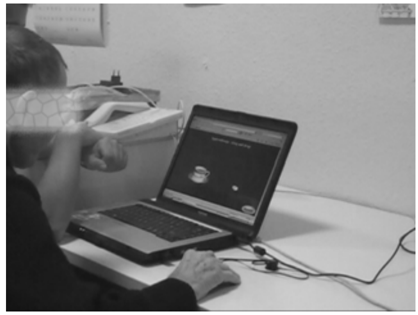

Fig. 2. A subject doing the exercise

- **Clicking Interaction** (CL)**:** The subject selects the sugar by clicking it, moves the cursor to the coffee cup top, and clicks in the area of the coffeethen the piece of sugar is falling down;
- **Dragging Interaction** (DR)**:** The subject selects the sugar by clicking it, maintains the pressure on the mouse button until the cursor is over the cup of coffee, then release the button and the sugar is falling in;
- **Clicking and Magnetization Interaction** (CAM)**:** The subject selects the sugar by clicking it, then the sugar is automatically attached to the cursor; he moves the cursor over the cup of the coffee, and the sugar is falling in automatically.

For this experiment, the size of the sugar target and the distance between the sugar and the cup of coffee is fixed. A sound feedback is playing to inform that the sugar is taken by "hands" during the clicking action. A splash sound is playing when the piece of the sugar is falling down in over the coffee.

2.3 Experimental Design

The study utilized a split design with task (CL, DR and CAM).

2.4 Procedure

Participants sat approximately 60 cm from the screen with the mouse positioned for right-hand use as default configuration. Participant sessions involved a set of training and trial computer sessions followed by a semi-structured questionnaire.

The training phase consisted in: firstly, describing the run of the mouse (moving and clicking principles) to encourage familiarity with the device, secondly doing the exercise with each "drag and drop" interaction technique. We have considered that the technique was mastered when the subject was capable of using it without any comment or help from the experimenter. This was followed by the experimental session. On the display, participants viewed a sugar piece and a cup of coffee. The task involved moving the cursor to the sugar piece and then to the cup of coffee according the "drag and drop interaction". Each participant performed a total of nine trials (3 trials per each task). Tasks were counterbalanced.

The session trial is considered succeeded when the nine trials were The questionnaire was designed to complement the movement behavior and to address issues such as computer expertise, preferred interaction technique, difficulties of computer use, etc.

2.5 Participants

Physicians' geriatrics division of the Center Hospitalize Universities de Toulouse recruited 97 subjects, aged over 65 years with and without Alzheimer's disease. All these subjects have accepted to participate to the experiment. The Mini Mental State (MMS) examination was made by an geriatric doctor in Alzheimer disease.

They were classified into 5 groups according to their cognitive impairment dementia estimated on the MMS [12] We have used the Feldmann and Woodward's distribution [11] which consists into five intervals.

Subjects cannot understand the instructions or cannot communicate, have not been recruited by doctors

Table 1. Participants according to MMS and success

MMS	<10	[10-14]	[15-20]	[21-26]	[27-30]
Number of subjects	8	16	19	26	28
Failure (F) and Achievement (A)	7F/1A	7F /9A	9F/10A	3F/23A	1F /27A

The table 1 confirms more the MMS is low more the subjects were forced to withdraw the exercise (7/16 in the [10-14] and 78 in the [0-9] intervals.

3 Results

In this study, we have not considered the class of MMS <10 because one subject was successful exercises. The results were not significant for this class.

The time, the distance as well the mistakes were analyzed for differences between MMS intervals and techniques interaction. The figures in this section show mean values for each group and interaction techniques, with bars showing the standard deviation.

3.1 Average Time for the 3 Interactions Techniques

This parameter is the time to move the sugar in the coffee. One major significant (Fig.3) result is that the duration factor is significantly different for the three interaction techniques: the DR duration is much longer than this CAM and CL (CL=16 s, DR=19 s and CAM=6 s). This result is independent of the age.

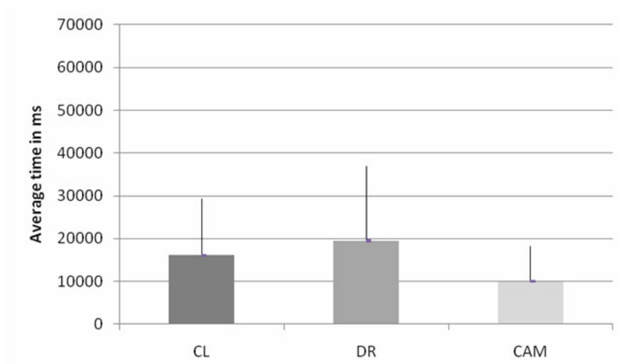

Fig. 3. Average time for using of the 3 interactions techniques

Another important result is that the duration increase is correlated to the decrease of the Mini Mental Score (MMS) for CL and DR (Fig.4). We observe also large behaviour variability for all MMS class.

CAM (Fig.4) duration is not also dependant of the MMS. From the empirical observations, we identify several difficulties with mouse, such as losing the cursor and bad control in moving with DR.

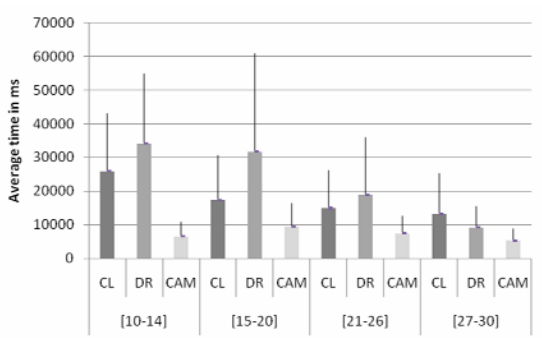

Fig. 4. Average time for using of the 3 interactions techniques according to MMS

3.2 Average Distance of Cursor for the 3 Interactions Techniques

This parameter is the distance to move the sugar in the coffee. This result (Fig.5) showed this distance is more important for DR and CL than CAM.

The Fig.6 showed that the distance increase is correlated to the decrease of the Mini Mental State (MMS) for CL and DR. We observe also large behavior variability for all MMS class. CAM distance does not vary according to the MMS.

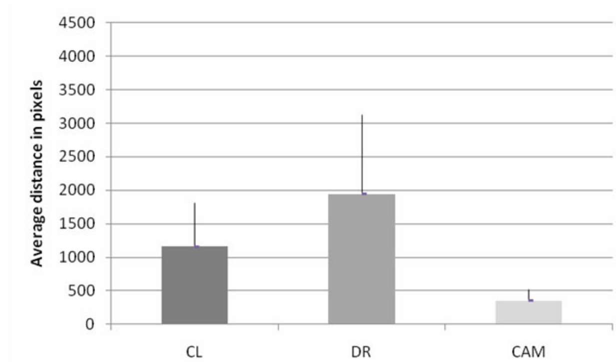

Fig. 5. Average distance of cursor for the 3 interactions techniques

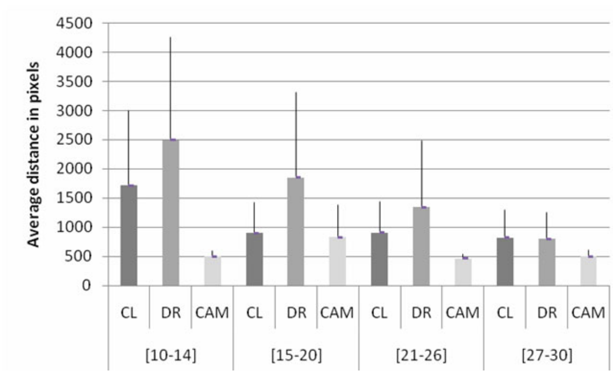

Fig. 6. Average distance of cursor for the 3 interactions techniques according to MMS

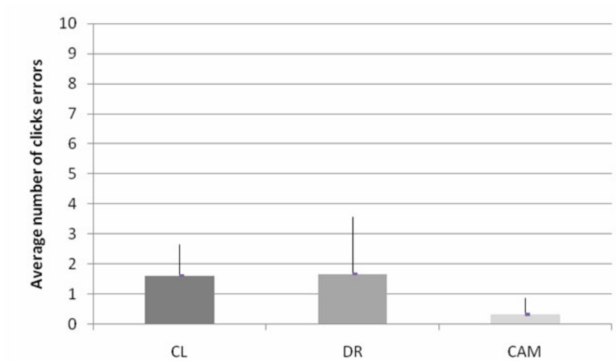

Fig. 7. Average number of clicks errors for the 3 interactions techniques

3.3 Average Number of Clicks Errors for the 3 Interactions Techniques

The numbers of clicks errors are the supplementary clicks during the move of the sugar in the coffee. This result (Fig.7) showed these clicks errors are more important for DR and CL than CAM.

The Fig.8 showed that the clicks errors increase is correlated to the decrease of the Mini Mental Score (MMS) for CL and DR. We observe also large behavior variability for MMS [10-14] and [15-20]. The clicks errors of CAM do not vary according to the MMS. We observe a small variability.

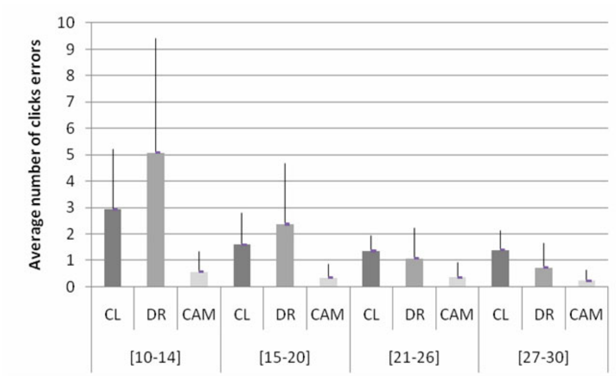

Fig. 8. Average number of clicks errors for the 3 interactions techniques according to MMS

4 Discussions

The CAM interaction is well appreciated because the technique represents well the natural actions (taking and moving). It is a good metaphor. The DR was rejected by subjects because it requests too much workload: this fact can be explained because two simultaneous processes (moving and pressure) are involved in the task.

When the subject was falling in one of the part of exercise (clicking or moving with or without pressure), he/she developed two main behaviours: one is asking help (for instance, can you show me, can you explain me, what do must do now?), another is doing with hand as he/she would have done in a real world.

In the results we note that the MMS has an important role on the use of DR technique and CL technique. Regarding the DR, it requires the user to perform two simultaneous actions moving and clicking. On CL, it has the disadvantage of moving the object automatically. This disturbs users because in reality objects do not move alone. However, we note that MMS varies very little on the CAM technique. In fact, it behaves as an aid to move the object that is hooked to the cursor. We note that, whatever the MMS, the distance travelled (average 570 pixels) the cursor is very close to the shortest distance between sugar and coffee (406 pixels).

5 Conclusion and Future Works

This paper has focused on presenting the experiment on point-select-drag interactions. One of the most important points is that the pointing interaction technique has an important impact on the cognitive activity of the subject. We noted that the CAM technique is the more adapted because the MMS varies little. We plan to model the tasks (move, click) of the older people with cognitive impairment. This model allowed to design and to evaluate IHM for them.

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