Self-Reported Preference, Ease-of-Use and Enjoyment of Traditional vs. Stylus Input for Children in a Brazilian Primary School

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ABSTRACT

We empirically compared traditional input using keyboard and mouse to the direct stylus input for 9 to 11 years old children in Brazil. These children performed a pointing, text-entry and drawing task using both input methods and self-report preference, ease-of-use and enjoyment in a paper questionnaire. Non-parametric within-subjects significance tests were used to analyze the collected data. Overall the children enjoyed the stylus more. The stylus was reported as easier to use, specifically for pointing and drawing tasks. The children preferred to use the stylus again, most convincingly for the text-entry task. Hence, a low-cost stylus and tablet could be a more suitable method than keyboard and mouse to allow interaction with PCs for children in Brazil.

Keywords: Stylus Tablet Keyboard Mouse Interaction Preference Ease Enjoyment

1. INTRODUCTION

Introducing alternative and additional ways of learning may improve young children's education. One option is the use of computers, which are now a common device in primary schools in Brazil. The Brazilian company Associação Brasileira de Informática (ABINFO) develops a low-cost transparent input-tablet and uses it in their digital desks in Project Alvorecer. Their device accepts input from a wired stylus and can be combined with a regular computer display to form a direct-input tablet. The more natural way of interacting with a computer via the tablet and stylus might provide an advantage to inexperienced computer users, and thus, make it more suitable for children. Therefore, the goal of this research is to empirically compare traditional input using keyboard and mouse to direct stylus input for children. This comparison was done based on preference, ease-of-use and enjoyment. We expected to find that children experience the stylus to be easier to use because of the similarity to the use of a regular pen. The reduced amount of effort can yield more enjoyment in performing a task and may lead to a preference to use the stylus again over traditional input devices. Indeed, when children have more fun, they are more inclined to return to an activity (Read, MacFarlane and Casey 2002).

Based on the literature, we expected that efficiency and effectiveness were unlikely to be reduced by a tablet and stylus. MacKenzie, Sellen and Buxton (1991) compared movement times and error rates of pointing and dragging for mouse, trackball and (input-only) tablet. They found that the stylus performs best for pointing tasks and that the mouse achieves the highest performance for dragging tasks. They argued that the stylus may achieve even better performance for different tasks such as drawing.

Based on the analogy with the research of Lindley and Rogers (2004), we expected that children can be more encouraged to collaborate when using tablet input. Lindley and Rogers observed a growing interest in the application of large interactive displays in several office and public locations. Their motivations included enhancing co-located collaboration, creating a sense of community, increasing awareness and invoking informal communication among collaborators.

The Tablet PC was found to be fun for users and not particularly slow to work on. Ozok, et al. (2008) studied user satisfaction and preference aspects of Tablet PCs with university students performing four common computer tasks. They compared the Tablet PC to a laptop PC and pen-and-paper. User satisfaction and preference were measured using questionnaires. Still, results from research with adults had to be used with care. Real end-users, namely children, should be the subjects in studies evaluating child-specific products. Hourcade, et al.

(2004) compared the performance of years old preschoolers to young adults in point-and-click tasks with a mouse. They found severe differences in ability to control the mouse between adults and preschool children. Specifically, age had a significant effect on accuracy, target reentry, and efficiency. Also, target size had a significant effect on accuracy and target reentry. The difference between the performance of children and adults was large enough to warrant user interface interactions designed specifically for preschool children.

2. METHODS

2.1 Experimental Design

Based on the knowledge found in literature we designed an experiment to compare the traditional input means to stylus input for typical computer tasks. The experiment had a 2x3 within-subject design based on two input modes (Traditional or Stylus) and three tasks (Pointing, Text-Entry, Drawing). All six conditions were evaluated in terms of preference, ease-of-use and enjoyment.

2.2 Setting

The experiment was carried out in a public primary school in Limeira - São Paulo, Brazil. A closed room with blinded windows was used. This room was familiar to the students, as they regularly take classes in that room. The experiment ran between 7 and 12 AM during teaching hours. A standard table and chairs from the school were used for the experimental set-up. The experiment was carried out with only the experimental leader (i.e. the first author) and two participants in the room at the time.

2.3 Equipment

On the table at which the participants performed the tasks, a 15 inch LCD display at a native resolution of 1024x768 was placed. The display was encased in a black metal frame. One of the glass input tablets was mounted in front of the display screen with a grey metal casing. The two casings were part of one of ABINFO's digital desks. A wooden vertical stand at each side kept the combination of devices under an angle of 36° from vertical.

An 800MHz PC with 128MB RAM running 'Linux Educacional'[1] was used to drive the software. No noticeable slowdowns or other nuisances between the input and the computer's response were found by the experimenters.

Between the edge of the table and the display a black QWERTY-keyboard with a Portuguese (Brazilian) layout was placed. Next to it on the right-hand side was a black 2-button scroll wheel mouse with common shape and size. No information about the handedness of the participants was registered because they worked in pairs and were allowed to move the input devices.

Next to the mouse a plastic stylus with a graphite core and tip was present. It looked like a regular pen or mechanical pencil. It was connected to a port at the top-right of the display case with a rubber-coated wire of approximately 1.5m that came from the back end of the stylus. Upon touching the tablet, a mouse-click was registered at the location of contact.

The display, mouse and keyboard together are referred to as the 'traditional setting.' The display and the stylus are referred to as the 'stylus setting.'

2.4 Participants

Children that attend the school on a daily basis were invited by the teachers to voluntarily participate in pairs in the experiment. Children were aged from 9 to 11 (N=48, M=10.4, SD=0.59) and were all local residents. Teachers described the children as coming from typical low-income families living in poor neighborhoods. Most of the children did not have a PC at home, and therefore, had limited experience in the use of computers. A stylus-based input for PC's had not been used in the school before. A short weekly class used basic typing and clicking interactions to play online educative games.

[1] Linux Educacional is a Debian-based operating system developed by Centro de Experimentação em Tecnologia Educacional (CETE) of the Ministério da Educação (MEC).

The school administration had an agreement with all parents/caretakers to allow research that was part of the Project Alvorecer.

2.5 Task

Participants were asked to perform all tasks in pairs, without any restriction as to how they worked together. First, a training was done in which they got familiar with the hardware. They created a digital drawing both with the mouse and with the stylus. They were asked to aim for about 3 minutes per drawing, but they were not really restricted in time.

Then two experimental stages followed, each with one of the input modes. In these stages, participants were presented portrait photographs of people with typical facial expressions. The participants were expected to associate the facial expression with one out of four predefined emotions, of which exactly one was correct. The four emotions (Happy, Sad, Scared, Angry) were chosen because they were considered to be basic and independent of cultural background (Ekman and Oster 1979). Six different input interactions resulted from combining the two input modes with the three input tasks (i.e. Pointing, Text-Entry and Drawing). When pointing, participants chose a word from the list of emotions and clicked or tapped on the displayed word. In the case of text-entry, participants had to type or write the right word in a white rectangular area. When drawing, participants were requested to draw the appropriate smiley in a white square. The layout and design of a participants' screen can be see in Figure 1. To exclude influences of performance of handwriting-recognition or computer vision software, a Wizard of Oz setup was used. The experimental leader judged the participants' input and classified it as one of the available answers or as unclear. After every photograph, feedback was given to the children about the correctness of their answer. This feedback was given after 3 seconds to avoid influences of the operator's reaction time. The orders of the two input modes and of the three input tasks per input mode were counter-balanced.

When all tasks were completed, a paper-based questionnaire was presented to the participants individually.

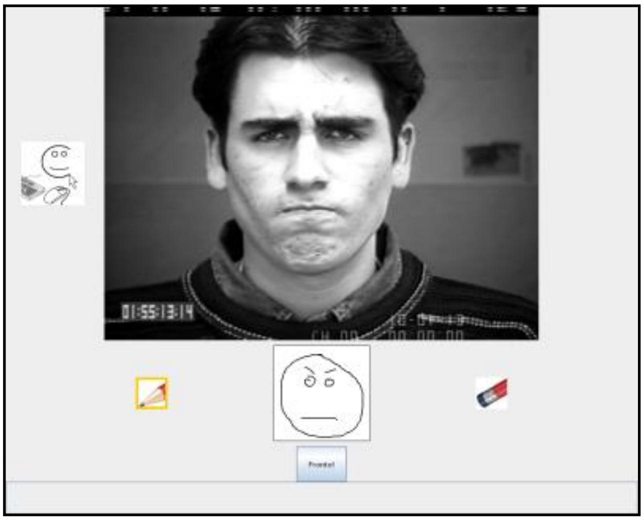

Figure 1: Typical screen content during an experiment session.

2.6 Stimuli

A subset of 40 images from the Cohn-Kanade AU-Coded Facial Expression Database (Kanade, Cohn, and Tian 2000) was used. The subset was balanced in gender and in the four emotions used in this experiment. For every task at least one image for each emotion was selected. The associated emotions were found with a survey in The Netherlands. For all images used, at least 80% (*N*=13) agreed on the emotion out of the list of four best fitting the image.

2.7 Measures

For our experiment we used self-report through the means of paper questionnaires. The questionnaires were based on a toolkit for children (Read 2008) and two types were used. For one type, participants received a set of symbolic cards. One set represented the two input modes, another set represented the six combinations of input mode and tasks. Participants were asked to sort the cards from easy-to-do to hard-to-do and from boring-to-do to fun-to-do on separate survey sheets. For any combination of two cards, a binary value could then be derived (note that equal ranks are impossible); either card X was ranked higher than Y, or the other way around. Binomial tests with a test proportion of 0.5 were performed on these values to compare two input modes or input tasks.

Participants answered the question 'Would you like to do it again?' with Yes, Maybe or No for the two input modes and the three input tasks. The input values Yes, Maybe and No were translated to scores of 3, 2 and 1 respectively, which were then used in Sign tests to compare the two input modes for each of the input tasks. Because the children participated in a session as a pair, their data cannot be treated as independent. Therefore each pair of data was randomly divided over two separate data sets (N_1 and N_2) and each data set was analyzed separately resulting in a p-value for each group (p_1 and p_2). A more advanced statistical test might provide more detailed information, but was considered out of the scope of this paper. All statistical analyses were done at a significance level of 95% (α=0.05).

3. RESULTS

3.1 Enjoyment

Binomial tests were performed on the binary variable "More fun" that indicated whether the stylus input mode was considered as more fun compared to the traditional input mode (Table 1). From the test on overall enjoyment, significantly more fun was experienced in stylus input mode (N=24, p_1=0.064, p_2=0.023).Studying the tasks separately, no significant effect was found for the pointing task (N=24, p_1=0.152, p_2=0.307), the text-entry task (N=24, p_1=0.839, p_2=0.064) or the drawing task (N=24, p_1=0.064, p_2=0.064).

			N_1	N_2
More Fun	Overall	Traditional	7	6
		Stylus	17	18
	Pointing	Traditional	8	9
		Stylus	16	15
	Text-Entry	Traditional	11	7
		Stylus	13	17
	Drawing	Traditional	7	7
		Stylus	17	17
		Total	24	24

Table 1: 'Fun to do' results.

3.2 Ease of use

Binomial tests were performed on the data that represented whether participants judged one input mode to be harder to use than the other. Based on the data of Table 2, we can conclude that participants indicated that overall the traditional input mode was significantly harder than the stylus input mode (N=24, p_1=0.023, p_2=0.002). More particularly, both pointing (N=24, p_1=0.023, p_2=0.064) and drawing (N=24, p_1=0.023, p_2=0.152) were significantly easier with the stylus. No significant effect was found for the text-entry task (N=24, p_1=0.541, p_2=0.064).

			N_1	N_2
Easier	Overall	Traditional	6	4
		Stylus	18	20
	Pointing	Traditional	6	7
		Stylus	18	17
	Text-Entry	Traditional	10	7
		Stylus	14	17
	Drawing	Traditional	6	8
		Stylus	18	16
		Total	24	24

Table 2: 'Easy to do' results.

3.3 Preference

Sign tests were performed on the data representing the participants' desire to do the task again (Table 3). These tests revealed that overall the participants preferred to use the stylus input mode again rather than the traditional input mode (N=24, p_1=0.013, p_2=0.180). More particularly, they preferred to do the text-entry task in the stylus input mode rather than in the traditional input mode (N=24, p_1=0.143, p_2<0.001). No effect in preference was found for the pointing (N=24, p_1=0.146, p_2=0.581) or drawing (N=24, p_1=0.424, p_2=0.804) task.

			N_1	N_2
Preference	Overall	Traditional	2	4
		Stylus	12	10
		Tie	10	10
	Pointing	Traditional	3	5
		Stylus	9	8
		Tie	12	11
	Text-Entry	Traditional	5	1
		Stylus	12	17
		Tie	7	6
	Drawing	Traditional	5	7
		Stylus	9	9
		Tie	10	8
		Total	24	24

Table 3: Preference results.

4. DISCUSSION

There were some limitations to this study that might have affected our results. The location of the experiment had some disadvantages such as daily changing decoration of the room and annoyance by external noise. Twice data had to be discarded because of announcements over the school speaker at high volume lasting for over 30 minutes. Despite the reduced control, the setting provided a realistic environment, which helped to observe the children's behavior in a natural setting. Four pairs of participants had trouble drawing with the mouse. Once we even decided to finish the experiment already during the training. In general, when using the stylus, some non-existent movement of the stylus was registered leading to unintended input. Regularly this led to delays and nuisances for the participants. Possibly such erratic behavior was fun for the children at first, but we believe this would wear off during the training phase, on which the data analysis was not based. We argue that biases in the data due to imprecise input of the stylus were in favor of the traditional input mode. This particular stylus and tablet are still being developed, implying that its usage can be further improved. During the experiments a more accurate version became available that also allows non-click control when hovering over the tablet. This technological improvement was not included in the experiment, and so the differences between stylus and traditional input mode are only expected to increase over time.

The stylus input mode overall was found to be more fun. This means that children can be more motivated. Although the data was favored towards the stylus for all tasks, for the separate tasks no significant effect of the input mode on the 'Fun to do' variable was found. This came as a surprise because reactions from participants seemed to indicate that they enjoyed using the stylus more. Examples were utterances such as 'oh that's nicer' when switching to the stylus, or requests to use the stylus instead of the mouse. Including more children in the experiment might help to establish whether there is an effect of input mode on experienced fun. It is also worth investigating whether other measurement tools than the one used here are more sensitive for measuring enjoyment. It should also be noted that the latest improvements in the stylus and tablet reduce nuisances, and as such are expected to increase fun.

The children had limited experience with PC usage, so no strong bias due to habituation was expected for either input mode. Selecting the stylus as an easier input mode can be an indication that the device reduces efforts in learning how to handle hardware, which thus allows more effort to be spent on the task at hand, such as educative tasks. Especially, pointing and drawing are found to be easier with a stylus than with a mouse. The stylus changes these interactions from indirect to direct input making them similar to motor skills that are already developed (Smith, Cowie and Blades 2003). As a consequence, it may cost less effort for the children to use the computer, and so they can focus more on the learning itself. No difference in ease-of-use is found between typing on a keyboard and writing with the stylus. We argue that this is because participants had some difficulties with both input modes. When typing, this is reflected by nonsense answers (e.g. 'ffffff' or nothing at all). When writing, this is apparent from unfinished input. A more accurate stylus should make it easier to write. Perhaps also the unusual angle for writing on the tablet compensates for the advantage of being similar to regular writing on paper. In that case a horizontal setup would be more likely to be easier to use. Furthermore, we expect differences in ease of use between both input modes to show up for entering longer texts. This needs to be proven in further research.

The preference of participants to use the stylus again rather than the traditional input mode can be explained by the more natural interaction and possibly a higher level of general satisfaction. The findings of Read (2008) that more fun leads to a stronger desire to do an activity again is supported by our results. Our findings imply that children will be more likely to return to a task with the stylus, and as such this can improve their ability to learn in an educational context. We expect that when the stylus technology further improves, children will even show a stronger preference for the stylus. The observation that the preference for the stylus was mainly found for the text-entry task, while for this task the stylus was not selected as giving more fun or being easier to use, might imply that other aspects of the stylus determine its preference.

5. CONCLUSION

Compared to traditional interaction with keyboard and mouse, the low-cost stylus and tablet are shown to be a more suitable method to interact with a PC for primary school students in Brazil, because of its enjoyment, ease of use and preference for a number of specific computer tasks. Children seem to be more inclined to use the stylus again instead of the traditional input mode. Possibly this can lead to a reduced threshold for educative activities. When the stylus technology is further improved, the tendencies found in this study are expected to become even more pronounced.

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