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Comparing User Performance on an iPad to a 17" BackPad

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What will a truly large iPad be like? Will it have a touchscreen at the front, or will some other changes be forced by the sheer size of the device? We mocked up a working device using a 17-inch Macbook laptop screen. The device size was too large for us to comfortably hold with one hand while using the other hand for touch input, so we placed the touch pad at the back. Hence, we call our device a BackPad. In the first experiment, we compared user performance with our 17-inch BackPad and a normal iPad in game and typing tasks. The results on the game completion time and score were similar, and users liked our large screen, while time but not spelling errors were different in the BackPad versus the iPad. For the second experiment, we compared the front touchscreen versus the back trackpad user performance on same sized devices. Similar results to the first experiment were found on game completing time and score.

Keywords-component; 17-inch screen, back touchpad, natural interaction, typing task, game playing task, iPad, user study

I. INTRODUCTION

The Apple iPad is commonly used for reading news, magazines and textbooks, playing games, web browsing etc. [1]. The idea of a bigger screen with a pad at the back instead of a touchscreen arose due to the iPad's known issues regarding typing, playing game and reading on small screens, [2, 3, 4, 5, 6] and difficulties with touchscreens [3, 7, 8].

Reading on small screens obliges users to utilize smaller fonts in order to fit a page of their reading on the screen. A smaller font size due to low resolution and lighting conditions affects the reading process negatively [4] and it decreases accuracy [2]. If readers choose larger fonts, they have fewer words per page and must scroll the screen up and down/left to right many times in order to read a page [6].

Reading course materials on small screens is difficult. A user study [6] on students reading their course materials were conducted in London. In this work, the availability of text reading and editing software for PDA devices was examined. The results show that the portability of PDAs makes access to learning material easy but these devices have some limitations. They found it difficult to read their course materials on small screens, and they preferred to read on paper.

Typing speed on the small touchscreen devices is slower than typing on larger devices [5]. Hoggan et al. also experimented with different keyboard sizes [3]. They showed that novice and experienced subjects are slower in typing on small keyboards. In addition, novice participants have fewer corrected errors with the large keyboard. Typing phrases on touch screen devices has no feedback; it generally does not give any sense of touching keys under his fingers, which makes typing harder and slower than typing on a physical keyboard. They conclude that typing phrases on a physical keyboard is faster and has a lower error rate than touch screen typing [3].

In addition to typing, screen size has some effects on game playing. The larger screen size interests' users more but it does not change their score significantly. The keyboard size has an influence on game score, with lower scores the result of smaller keyboards [9].

A study [7] showed that using touchscreens make users' arms, fingers and wrists more fatigued than using a mouse. Another problem of touch screen devices is the friction between a user's fingers and the screen that may cause annoyance [8]. Also finding keys for typing texts on a small touch screen becomes harder when they are covered by the user's hand and some messages from applications are missed [10]. These problems might be resolved by placing the touch interface at the back of the device.

An experiment regarding holding PDAs showed most participants prefer to take the PDA device with two hands [11].

We introduce a device with new functionality. It has a large 17" screen and a touch pad is installed at the back of the device, hence we call it a BackPad. As we observed in our experiment, none of the subjects holds the device with one hand and presses the keys for applications with the other hand.

In this work, we focus on a user study comparing our 17-inch BackPad and the iPad with respect to typing and game playing task performance. We expect to reach a better performance and results in using the 17-inch BackPad for the two tasks. In addition we did another user study to compare the front touchscreen input of the iPad and the back input of our BackPad. To have a consistent factor for comparing input, we also designed a 10-inch BackPad and compared that with the iPad. We expect that back input would have better or same performance than front input in the larger device.

II. RELATED WORK

Scott et al. [12] introduced RearType, which uses the reverse side of the device to input text. The standard QWERTY keyboard is used at the sides at the back of the device to maximize screen available for showing output, and to eliminate the on screen keyboard which otherwise partially covers the display. Their results showed that there is no significant difference in performance between a touchscreen keyboard and RearType.

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III. FIRST USER STUDY

A. The BackPad Model and Description

In order to conduct a user study on the big screen device, we designed and developed a 17-inch BackPad. The device (Fig. 1) has a 17-inch nontouchscreen display (Fig.1.2) and a touchpad is installed at the back of the screen (Fig.1.4). The display we use is a semi-separated screen of a 17-inch Mac-laptop. We could not readily relocate the Mac-laptop touchpad so needed to use an extra touchpad. Participants (Fig.1.1) hold the screen with their hands and they use the touch pad at the back in order to move the cursor on the screen.

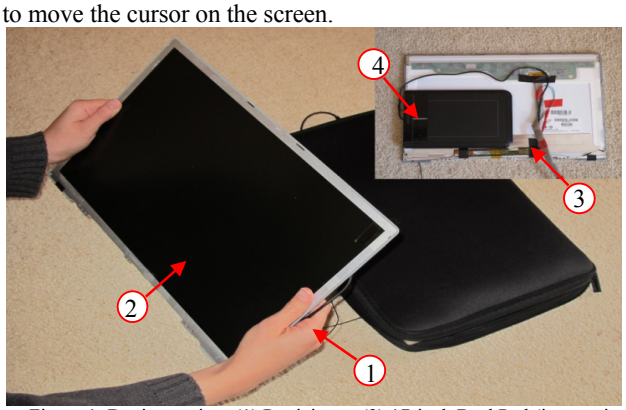

Figure 1. Device setting: (1) Participant, (2) 17-inch BackPad (i.e. semi-detached laptop screen), (3) Monitor cable, (4) Touchpad

The touchpad can be flipped for left handed or right handed use. Right or left handed users are a factor in positioning the touch pad. Although by changing the position of touch pad to the left of the screen, left handed users can participate in the experiment, we chose to limit the experiment to right handed users and left studying left-handed users for future work.

The positioning of the touchpad at the back of our device eliminates the hand covering part of the view problem of touchscreens [10]. The thumbs remain at the front to hold the device and cannot be used to touch the back touchpad. There is a potential issue with user performance with fingers behind the device. Wobbrock [13] found that the index fingers perform better at the front than at the back for complex gestures, and functions just as well as at the back for simple tasks.

B. Experiment

We have done the experiment on 16 subjects, considering the sequence of use of the devices, and the sequence of experiments; the tasks were typing and playing a game with two different devices.

We want a simple paragraph for the typing experiment. A paragraph from a children's storybook [14] was given to users to type in both devices. The paragraph complexity level is for a person who passed at least 6 years of education based on the Flesch-Kincaid Reading Ease method [15]. The Mac laptop has an onscreen keyboard [16] but it does not cover the whole width of screen so we installed the Big Screen Keys application [17] on the Mac laptop. The iPad was oriented horizontally to have more space for its onscreen keyboard.

We do not want external factors to affect the experimental results so we need two games on the iPad and Mac with similar interfaces. There are a large number of game applications for Mac laptop and iPad but only a few of them have very similar interfaces in both devices.

We used a game, which requires only a mouse / trackpad because there is only a touch pad at the back of our device and using keys or keyboard arrows is beyond the purpose of our paper. We chose the game 4 in a row [18] for a further reason; because it is easy to learn.

C. Participants

The sequence of using devices might affect the results. To avoid this, in our experiment half of the users first used the iPad then the big screen, and vice versa. Furthermore, in each of these, half of the subjects played the game first then went on to the second experiment; i.e. typing.

Sixteen students from a local university participated in the user study. The user study included 10 male and 6 female right and handed participants, ranging from 18 to 31 years of age (Mean = 23, SD = 3). All participants were regular computer users (Computer Science, Engineering and IT students).

A few participants often use iPad for playing-game and typing. Most of them have never used an iPad for typing. Fig. 2 shows previous use of an iPad and using it for playing games and typing for the 16 subjects who participated in the experiment.

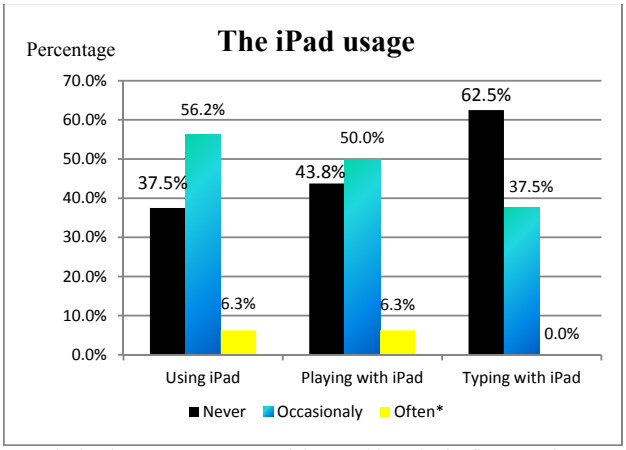

Figure 2. The iPad usage among 16 participant subjects in the first experiment, * Often is more than 1 hr/day

IV. SECOND USER STUDY

A. The 10-inch BackPad device Model and Description

In order to conduct this experiment we need to design a device with a 10-inch display and a trackpad at the back to compare it with 10-inch iPad with front (touch screen) input. The device (See Fig.4) has a trackpad at the back.

The device's display is a USB Powered Portable Dual 13-inch External Monitor. The monitor is connected to a Dell Latitude laptop with a VGA cable. Since the display is 13-inch, we blacked the background of the screen and only used the 10-inch middle part of the screen. To make the experiment devices consistent, we extend the iPad size to 13-inch. A 13-inch board is fixed to the back of the iPad.

The 10-inch BackPad (865 gr) and the iPad (601 gr) weights are not equal. In addition to the display weight, we

have the trackpad (140 gr) weight for the 10-inch BackPad plus two trackpad AA batteries (24 gr each). To make the devices weights equal, we added an extra (442 gr) weight to the attached board of the iPad.

Figure 3. View of the 10-inch BackPad device from behind

We chose to place the trackpad at the right side of the 10-inch BackPad so it is only usable for right handed subjects. It could be flipped for left-handed subjects in future work.

B. *Experiment*

We used 16 different subjects from the first experiment but the sequences and the tasks was the same as the first experiment.

For the typing task, the same interface and same keyboard layout is used for both devices. Two different paragraphs with the same number of words (39) were chosen from children's storybooks for the typing task. We asked participants to not correct any errors they make. Auto capitalization, auto correction and keyboard sound feedback also are turned off in both devices. In this way, we would have the raw number of the errors users made.

One paragraph is used for the iPad typing task and a different one for the 10-inch BackPad typing task. We decided to have two different paragraphs [14, 19] to avoid learning affects in the experiment [20]. The first paragraph's complexity level is for a person who passed at least 6 years of education based on the Flesch-Kincaid Reading Ease method [15] for the iPad. The second paragraph is for a person with at least 8 years of education. Our participants were university students that already passed at least 12 years of education, so both paragraphs are 'easy' to understand.

In addition to the typing task, we have the "four in a row" game was chosen to be consistent with the first experiment. To have exactly the same interface for both devices, we prefer to use an html version of the game for the devices. (See Fig.4) The Four in a Row game [21] source code was customized to fit to both screen devices.

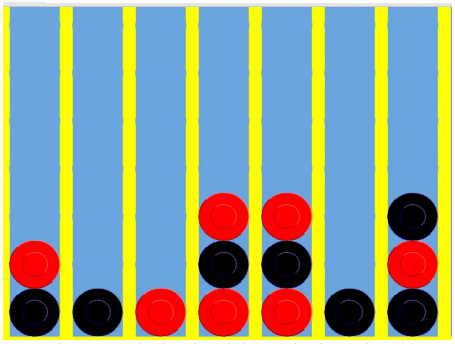

Figure 4. The iPad and the 10-inch BackPad
4 in a row game interface

C. *Participants*

Sixteen postgraduate students from a local university participated in the user study. The user study included 7 male and 9 female participants, ranging from 23 to 40 years of age (Mean = 26.6, SD = 4). Participants were right handed and regular computer users.

None of these participants group often uses iPads for playing-game and typing. Most of them have never used an iPad for typing. Fig. 5 shows previous use of an iPad and using it for playing games and typing.

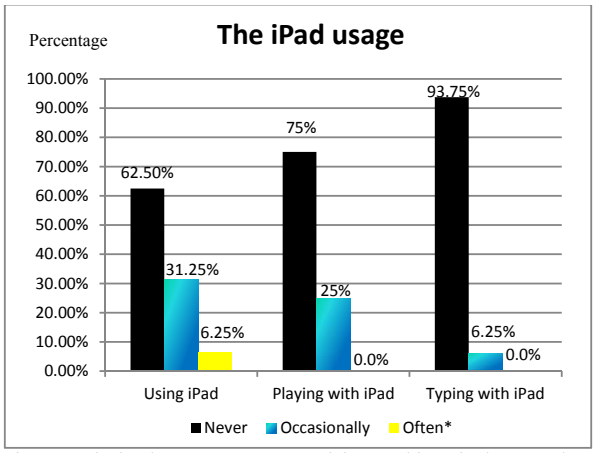

Figure 5. The iPad usage among 16 participant subjects in the second experiment, * Often is more than 1 hr/day

V. RESULTS

A. *First User Study*

The Paired T-test (2-tailed) showed a significant difference in time between typing in BackPad and iPad, T(15) = -10.6, P = 2.405e-08. Fig. 6 shows overall mean time for each device. It is clear that using BackPad for typing (Mean = 915.1, SD = 299.9) in the experiment on average participants take significantly more time than using an iPad (Mean = 118.9, SD = 33.1). But for spelling errors in typing the paragraph, the Paired T-test was done which shows no significant difference, T(15) =1.5, P = 0.1639, between the BackPad and iPad.

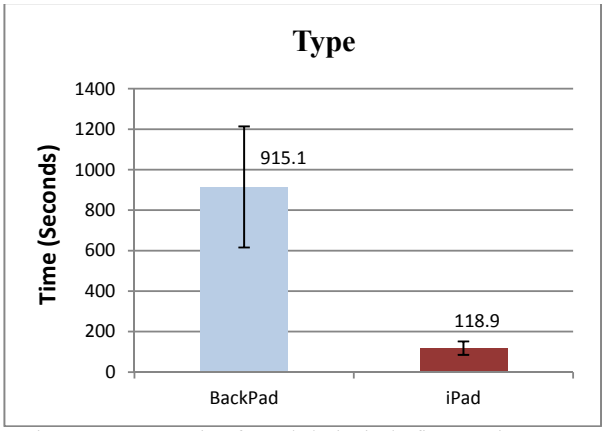

Figure 6. Mean type time for each device in the first experiment

In addition, the Paired T-test (2-tailed) for the time spent by participants on playing the game does not show any significant difference. This means that playing a game on the BackPad and iPad have similar results, T(15) = 0.7, P = 0.5185. Furthermore, the comparison of the mean of time spent, as illustrated in Fig. 7, shows that the results the participants achieved in using the BackPad (Mean = 79, SD = 61.2) for playing the game is the same as using the iPad (Mean = 65.2, SD = 40.0) in playing the game.

From the result of the Paired T-test (2-tailed) for the subjects' game in the experiment we found that there is no significant difference in their score between the BackPad (Mean = 0.4, SD = 0.5) and the iPad (Mean = 0.6, SD = 0.5), T(15) = -1.4639, P = 0.1639. The score for the game is counted as zero for losing the game and one for a win, with no draws.

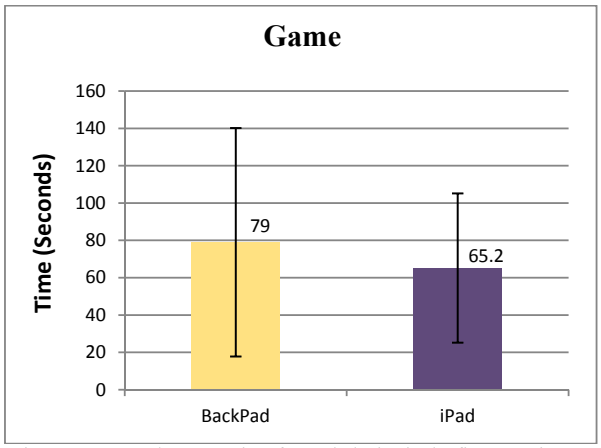

Figure 7. Mean play game time for each device in the first experiment

The results show that typing is slower on the BackPad but game playing is not. From participants' comments, we realized that they prefer to play game on the BackPad due to its big screen so the BackPad is more desirable for playing games.

We also surveyed participants to complement the quantitative measures we reported above. The questions in the survey are about "naturalness", "ability to play the game and type on the BackPad" and "complete the game and typing" in comparison to the iPad. Each question has a 7 points Likert scale from 1-Strongly Disagree to 7-Strongly Agree.

The results of questions from the survey regarding the experiment using the BackPad are represented in Fig. 8, which shows the results from the 16 participants.

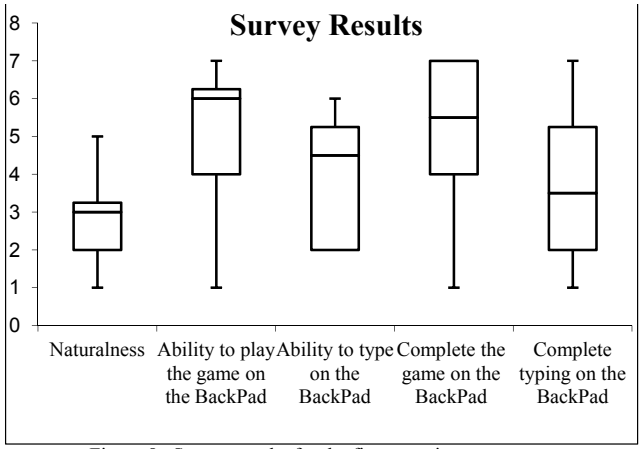

Figure 8. Survey results for the first experiment
(7- point scale: 1 – Strongly Disagree to 7 – Strongly Agree)

Users did not on average find the device natural on first use, but were very able to play the game on the device. The survey results in general support our quantitative results.

B. Second User Study

The Paired T-test (2-tailed) showed a significant difference in time between typing at the back and at the front in the iPad, T(15) = -12.0, P = 4.333e-09. Fig. 9 shows overall mean time for each device. It is clear that typing at the back (Mean = 466, SD = 125.9) in the experiment on average participants take significantly more time than typing in the iPad (Mean = 144.4, SD = 31.0). For spelling errors in typing the paragraph, the Paired T-test was done which shows a significant difference, T(15) = -2.4, P = 0.02985, between the back and front.

In addition, the Paired T-test (2-tailed) for the time spent by participants on playing the game does not show any significant difference. This means that playing a game on the back 10-inch device and iPad have similar results, T(15) = -1.6, P = 0.1257. Furthermore, the comparison of the mean of time spent, as illustrated in Fig. 10, shows that the results the participants achieved in playing game by using back trackpad (Mean = 45.8, SD = 18.9) is the same as using the iPad (Mean = 61.6, SD = 41.4).

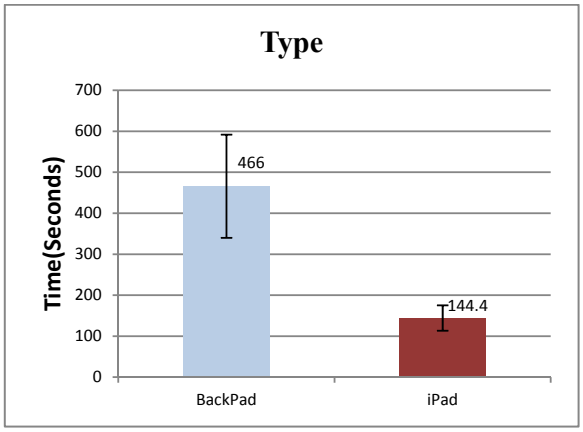

Figure 9. Mean type time for each device in the second experiment

From the result of the Paired T-test (2-tailed) for the subjects' game in the experiment we found that there is no significant difference in their score between the Back 10 inch (Mean = 0.44, SD = 0.5) and the iPad (Mean = 0.38, SD = 0.5), T(15) = -0.4, P = 0.7183. The score for the game is counted as zero for losing the game and one for a win. It should be noted that there are no draws in the second experiment. We asked participants to play again if that happened.

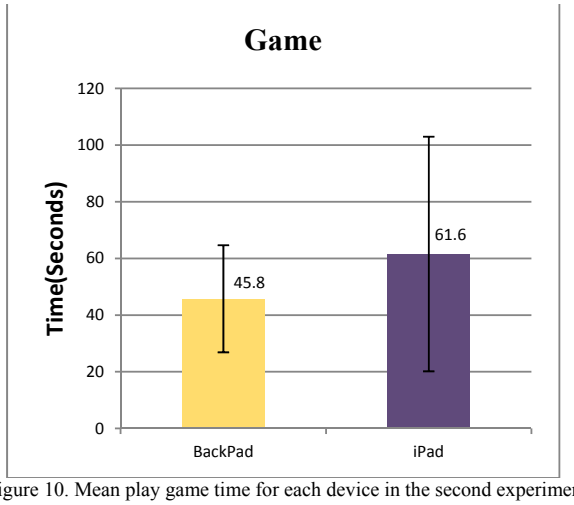

Figure 10. Mean play game time for each device in the second experiment

We also surveyed participants to complement the quantitative measures we reported above. The questions in the survey are the same as first experiment and about "naturalness", "ability to play the game and type on the Back 10-inch" and "complete the game and typing" in comparison to the iPad. Each question has a 7 points Likert scale from 1-Strongly Disagree to 7-Strongly Agree.

The results of questions from the survey regarding the experiment using the Back 10-inch are represented in Fig. 11, which shows the results from the 16 participants.

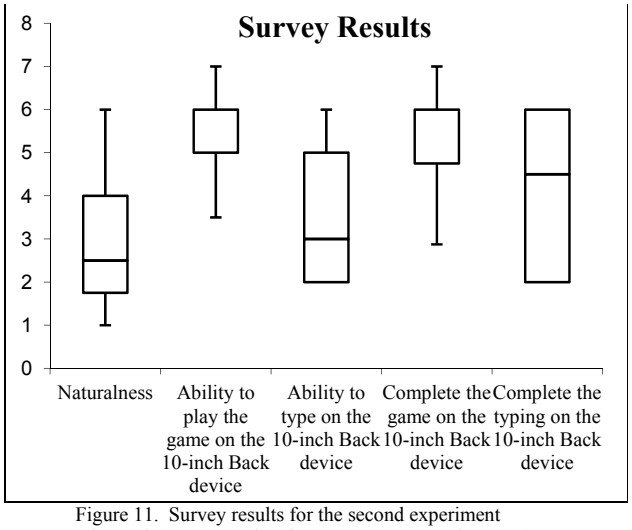

Figure 11. Survey results for the second experiment
(7- point scale: 1 – Strongly Disagree to 7 – Strongly Agree)

Users again did not on average find the back natural on first use, but were very able to play the game on the device. The survey results in general support our quantitative results.

Discussion

The idea of this paper is to introduce a new device; 17-inch BackPad. The 17-inch BackPad has a 17-inch screen and a trackpad at the back, which is compared to the iPad. The iPad screen size is 10-inch wide and it has a front touch screen input. The devices; 17-inch BackPad and iPad have two different factors to compare; screen size and input.

Three tests are needed to complete this comparison; i) comparing 17-inch screen versus 10-inch screen, ii) comparing front input versus back input and iii) comparing the 17-inch BackPad and the iPad. The screen size comparison test between 56-inch, 13-inch and 2-inch screens was done before by Reeves et al. [22]. The authors found the greatest skin conductance, highest level of arousal and highest heart rate in the 56-inch screen that is the larger screen was best. We can reasonably assume that this holds for 17-inch over the 10-inch, which was supported by our qualitative results.

Two other tests for comparing the front and the back input and comparing the 17-inch BackPad and the iPad are done. The front and back experiment is done with two different tasks; typing and playing game. A significant difference was found between front and back typing. Typing in the front was faster than typing at the back. However, there is no significant difference between game playing in the 10-inch Backpad and the iPad.

In addition, comparison between the 17-inch BackPad and the iPad is completed by two tasks. From 16 participants data results, no significant difference discovered while users playing the game. In the other hand, typing was faster in the iPad than the 17-inch BackPad. The 17-inch BackPad is not comfortable for tying but from participants' comments, it the 17-inch BackPad was more desirable for playing game.

It should be mentioned that since we wanted to examine the same tasks in both comparisons; comparing the 17-inch BackPad with the iPad and comparing front touchscreen iPad

and the 10-inch, we did two separate experiments to avoid learning and fatigue [20].

I. Conclusion

We presented two user studies comparing typing and playing game tasks performed on our 17-inch non-touch screen BackPad device and on a 9.7-inch touchscreen iPad and on our 10-inch nontouch screen Backpad and 9.7-inch touchscreen iPad. From the results of both objective and subjective measures from the first experiment, we demonstrated that typing with iPad is significantly faster than the 17-inch BackPad. The participants play the game with iPad as fast as the 17-inch BackPad, without any pre-training. In addition, their score in the game is the statistically no different from the 17-inch BackPad, and they mentioned that they are more interested in playing games with the 17-inch BackPad in their comments. Therefore, the 17-inch BackPad is a desirable device in order to play games.

In addition, from the second experiment's objective and subjective results on our 10-inch Backpad and the iPad with front touchscreen, we demonstrated the same results as the first experiment. There is no significant difference in game score between back and front input and front typing is significantly better than back typing. This work is useful regarding designing new PDAs. Future directions include experiments with use of external keyboards in any typing tasks, and with BackPads intermediate in size, for example with 13 or 15-inch screens.

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