Text Entry with the Apple *iPhone* and the Nintendo *Wii*

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ABSTRACT

We present an empirical study with 16 participants comparing text entry speeds and error rates on the Apple *iPhone* and the Nintendo *Wii*, both using onscreen keyboards. Over eight blocks, the average entry speed was 18.5 wpm for the *iPhone*, but only 9.2 wpm for the *Wii*. Error rates were 7.7% for the *iPhone* and 2.8% for the *Wii*. While the *Wii* fared very poorly compared to the *iPhone* on entry speed, its error rates were substantially lower. The lower error rates with the *Wii* were attributed to users' tendency to make slow and deliberate actions in controlling pointer position. An analysis of errors revealed that the majority of errors were on keys adjacent to the intended key. This was true for both devices.

Author Keywords

Text entry, keyboard, evaluation, onscreen keyboard.

ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces – evaluation/methodology.

INTRODUCTION

Text entry is an important aspect of human-computer interaction. While typically performed using a keyboard for desktop computing, on home entertainment systems or mobile devices users often work with an onscreen keyboard (a.k.a. virtual or soft keyboard). To enter text, the user selects the desired character from the onscreen keyboard using a finger or stylus, in the case of mobile devices, or a remote point-select device, in the case of home entertainment systems.

Onscreen keyboards can be hidden when not in use, thus freeing precious screen space for other purposes. Furthermore, an onscreen keyboard can dynamically change its layout and characters based on the task (e.g., a numeric keypad to enter a phone number, a QWERTY keypad to enter a name).

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This paper presents an evaluation of text entry on two recent and successful devices that use virtual keyboards: the Apple *iPhone* and the Nintendo *Wii*. Evaluating text entry on these devices is important since few evaluations of these devices exist, and little empirical research exists with on-screen keyboards in general.

iPhone Onscreen Keyboard

Touchscreens allow users to directly interact with an interface. Selection is accomplished by contacting the desired area of the interface with a stylus or finger. The *iPhone*'s touchscreen occupies almost its entire face: There is no other form of selection and no physical keyboard. Figure 1a shows the typical QWERTY form of the *iPhone* keyboard. (Additional layouts facilitate input of numbers, punctuation, and special characters.)

The *iPhone* keyboard provides animated and audio feedback. Each key has a popup animation effect when it receives focus and a sound is played when a key is selected. Figure 1b shows the popup animation effect.

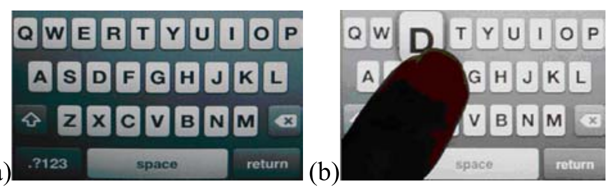
(a) (b)


Figure 1. (a) *iPhone* onscreen keyboard (b) popup animation when a key is selected.

Wii Onscreen Keyboard

Nintendo's *Wii* video game console has garnered much attention due to its controller, the *Wii Remote* (aka *Wiimote*). The *Wiimote* (Figure 2) uses an accelerometer to provide motion-based input for in-game actions. However, for pointing tasks, it uses an infrared camera. A series of infrared LEDs in a sensor bar (placed above or beneath the display) provide points of reference for the *Wiimote*. The onscreen pointer's location corresponds to the *Wiimote*'s orientation to the sensor bar, and consequently to the screen.

Figure 2: The *Wiimote*.

With Internet browser and instant messaging (IM) functionality, text entry is important on the *Wii*. It is performed using an onscreen keyboard (Figure 3). To enter text, users point the *Wiimote* at the desired character, and press the selection button ("A" on the *Wiimote*). Again, additional onscreen keyboards allow entry of numbers, punctuation, and special characters.

Figure 3: The *Wii*'s onscreen keyboard.

Related *Work*

Though evaluations of text entry on touchscreens exist, very few involve the *iPhone*. One exception is by Allen et al. [1] who performed a comparative study between the *iPhone* onscreen keyboard and the *BlackBerry* hard-key keyboard. Unfortunately, they do not provide any results in terms of text entry speed.

Hoggan et al. [3] present a study on the use of tactile feedback for a touchscreen keyboard. They compared text entry speed on a physical keyboard, an onscreen keyboard, and an onscreen keyboard with enhanced feedback. The results suggest that adding tactile feedback to the device increases entry speed. While tactile feedback is possible with the *Wiimote*, we were unable to control such feedback on the *iPhone*. Currently, there are no studies of the Nintendo *Wii* for text entry, although at least one study evaluated the *Wiimote* for gesture recognition [2].

In the following section, we describe our methodology to evaluate and compare *iPhone* and *Wii* text entry using onscreen keyboards. Our results are intended as a baseline from which follow-up design improvements and alternatives are empirically compared.

METHOD

Participants

Sixteen participants were recruited from the local university campus (9 male, 7 female; 2 left handed; mean age = 24.7 years). Four had previous experience with the *iPhone*, seven with the *Wiimote*. All were classified as novices, since they used either device less than five hours per week.

Apparatus

The experiment was conducted in a quiet lounge. An *iPhone* and a *Wii* console were used for the experiment. A Samsung *HL-T50765* television was used as display for the *Wii*. The *iPhone* firmware was modified to allow access to the file system. The *Wii* application was implemented using Adobe *Flash*, accessed using the *Wii*'s Internet channel.

Due to programming difficulties in capturing DELETE key events with the *iPhone*, we disabled error correction. These programming difficulties arose because of the poor documentation on some functions of the *iphone-dev* Toolchain.

Figure 4 and Figure 5 depict the applications. The topmost text area displayed the presented phrase, while the lower one displayed the transcribed text. The applications were designed with the same "look and feel". This included audio feedback ("click") on a key press event, distinct audio feedback ("beep") if the wrong character was entered, and a popup animation effect on a rollover event when a key receives focus.

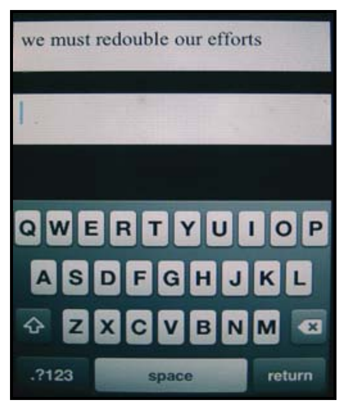


Figure 4: The *iPhone* application used for the experiment.

Figure 5: The *Wii* application used for the experiment.

Procedure

Participants were given basic instructions on how to enter text with each device, with a specific instruction to proceed "as quickly and accurately as possible". Because error correction was disabled, participants were also instructed to keep their input synchronized (i.e., aligned) with the presented text.

Participants sat during the study. For the *iPhone*, they used only one finger. For the *Wii*, each participant held the *Wiimote* with one hand, and used "A" for selection. The distance from the television was about two meters. A new phrase appeared each time the participant clicked the return key. The phrases were chosen randomly from a 500-phrase set [6]. Each study lasted approximately 45 minutes. Figure 6 shows the experiment setup.

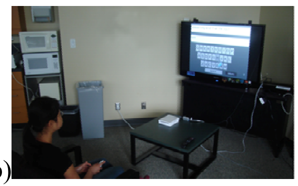
(a)  (b) 

Figure 6: Experiment setup (a) *iPhone* (b) *Wii*

Design

The experiment was a 2 × 8 within-subjects design. There were two independent variables: input device (*iPhone*, *Wii*) and block (1-8). Each block contained three phrases of text entry. The dependent variables were entry speed (wpm) and error rate (%). Participants were divided into two groups with the order of input devices counterbalanced to neutralize learning effects. In total, the number of phrases entered was 16 participants × 2 input techniques × 8 blocks × 3 phrases/block = 768.

RESULTS AND DISCUSSION

Performance

Figure 7 shows the results for entry speed. On average, participants entered text at 18.5 wpm (*SD* = 1.13) using the *iPhone* and 9.2 wpm (*SD* = 0.71) using the *Wii*. In relative terms, the *iPhone* was 102% faster than the *Wii* – a considerable difference. The effect of input device on entry speed was statistically significant ($F_{1,14} = 75.8$, $p <$ .0001).

The entry speed results for the *iPhone* were higher than other results reported in studies involving onscreen keyboards. Költringer and Grechenig [4] obtained an entry speed of 13.6 wpm using an onscreen keyboard on a graphic tablet, while Hoggan et al. [3] obtained an entry speed of 12.6 wpm using a Samsung *i718*.

The *Wii* entry speed is in line with other studies involving game controllers. Költringer et al. [5] obtained an average entry speed of 12.9 wpm using a Microsoft *Xbox 360* controller to enter text on an onscreen keyboard. But Wilson and Agrawala [9] obtained an average entry speed of only 6.5 wpm using an analog joystick on a Microsoft *Xbox* controller.

These results suggest that using a touchscreen to enter text is substantially faster than using a remote pointer-based technique such as the *Wii*. The reason for the significant difference is the directness of interaction for touch-based onscreen keyboards. Clicking a key using a *Wiimote*, on the other hand, requires more time per character. We attribute this to the user's need to attend or focus on the target key while maintaining stability in the hand in maneuvering the controller. This increases the selection and movement time for an onscreen keyboard when interacting from a distance with an indirect pointing device.

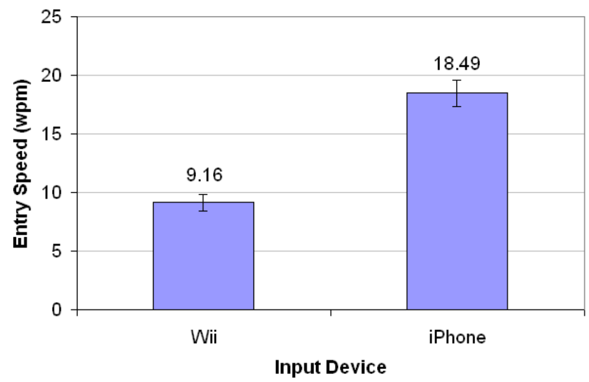


Figure 7: Entry speed vs. input device

Small improvements in the entry speed across the blocks were observed with both input devices (Figure 8). The effect of block on entry speed was significant ($F_{7,98} = 7.4$, $p < .0001$), even though there was a relatively small amount of text entered. Had a full longitudinal study been conducted, there likely would be more improvement with practice.

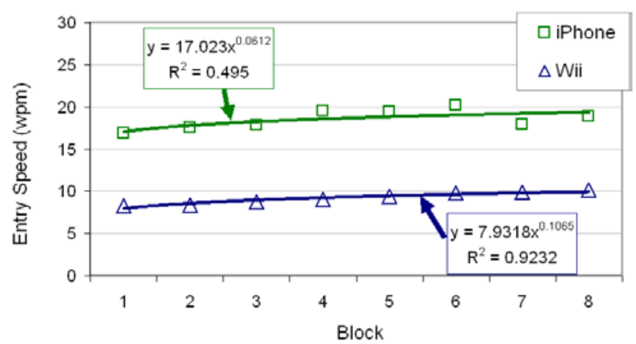


Figure 8: Entry speed vs. block

One possible factor that affects improvement over blocks is the size of the keys. To explain this, we had a closer look at the types of errors for both devices.

Error Rate

Figure 9 displays the results for error rate. The error rate for the *iPhone* was 7.7% (*SD* = .85), while the error rate of the *Wii* was only 2.8% (*SD* = 0.41). With such a dramatic difference, it is no surprise that the effect of input device on error rate was statistically significant ($F_{1,14} = 15.4$, $p < .005$). The error rate for the *iPhone* is higher than the 4.1% error rate reported by Költringer and Grechenig [4].

The effect of block on error rate was not statistically significant ($F_{7,98} = 0.79$, ns).

The high error rate can be explained by analyzing the keys that had more errors. Given the procedure of maintaining synchronization of the presented and transcribed texts, it was relatively easy to analyze errors "by key". For both devices, the top ten keying errors were on adjacent keys. The top five for the *iPhone* were O→P, I→O, E→R, T→Y, and N→M (50.3% of all errors), and for the *Wii*, O→I, L→K, A→S, E→R, and M→N (29.2% of all errors).

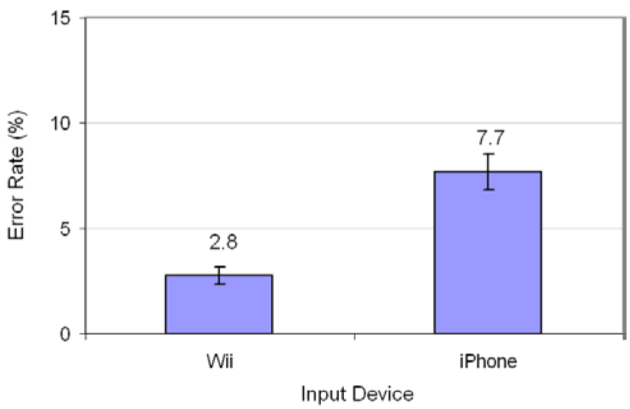


Figure 9: Error rate vs. input device

The size of the keys could be a factor that affects error rate and entry speed over blocks. The keys on the *iPhone*'s onscreen keyboard are 5 mm high × 4 mm wide. The spacing is only 1 mm. This is small considering the size of the human fingertip. Perry and Hourcade [7] presented a study involving tapping targets of different sizes with a touchscreen. They found that the target size had a statistically significant effect on the accuracy. A target of size 5.8 mm had only 79.8% accuracy. Wigdor et al. call this the "fat finger problem" [8]. These results could explain why the error rate remains the same over blocks and the entry speed does not improve over blocks on the *iPhone*. Each time a participant enters text, he/she has the same chance of hitting an adjacent key due to the small size of the keys and the small spacing between them.

Most of the errors for the *Wii*, although on adjacent keys, were randomly located on the keyboard. One possible explanation is that in using the *Wiimote*, participants had more precision in selecting the desired key, since they invested more time finding the desired key and checking if that key was correct by observing the rollover effect. That is why error rates were low – they are a bi-product of the slow entry speed overall!

Following testing with each device, participants were asked to provide a Likert scale response to two assertions: "The device is easy to use" and "I can adapt easily to the device". Interestingly enough, participants gave the *iPhone* only a slightly better rating on both questions, despite their ability to enter text at twice the entry speed than with the *Wii*. Evidently, participants considered text entry with the *Wii* "fun", almost game-like.

CONCLUSION

In general, the *iPhone* onscreen keyboard was much faster than the *Wii* onscreen keyboard. This work is important since there is little research on these types of keyboards. This is particularly true for the *Wii*, which is novel, greatly hyped, but short on evaluations. Future work is intended to more thoroughly investigate learning over extended sessions of practice and to involve different devices using onscreen keyboards.

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Contribution and Benefits

We present the first empirical evaluation comparing text entry on the Apple *iPhone* and the Nintendo *Wii* using on-screen keyboards. Entry is substantially slower (<10 wpm) with the *Wii*.