Examining User Preferences in Interacting with Touchscreen Devices

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The introduction of touchscreen technology has remarkably changed how people interact with their devices. Users may adopt different methods of input depending on the type of device they are interacting with and the type of task being performed. In the present study, we collected data on users' preferences with regards to interface interaction, device position, and posture, while performing various tasks with four different touch screen devices: a touchscreen desktop, laptop, iPad or iPod Touch. Results indicated that users prefer touch over traditional input devices when performing more interactive tasks (ex: drawing, gaming). We also observed that the device position adopted by users may promote suboptimal flexion angles of the torso, neck and wrists. The information gleaned from this study contributes to the limited body of knowledge on the ergonomic implications of touch screen devices.

INTRODUCTION

The introduction of touch screen technology has changed how people interact with their devices in comparison to traditional input devices. Rogers, Fisk, McClaughlin and Pak (2005) found that different input devices were optimal based on age of the user and the type of task being performed. Users may also adopt different postures depending on the type of device they are using. For example, Shin and Zhu (2011) found that participants placed touch screen desktop PCs significantly closer when using the touch screen and also preferred the display to be lower and with more of a tilt than when using a traditional mouse and keyboard. The varieties of postures and types of input adopted when interacting with touch screen devices may have significant implications with regards to the ergonomic effects of touch interfaces (Muse, 2011).

Touch screen interfaces afford several advantages over traditional input devices (such as a keyboard and mouse) because gesturing can be mapped directly to the task and does not require the user to learn or remember commands, thereby reducing cognitive load (Mackenzie, 1995). In addition, Nielson, Störing, Moeslund and Granum (2004) found that gestures may be less likely to cause strain in the hand, arm or wrist due to reduction in external force required from holding a device like a mouse or stylus. However, other research suggests using touchscreen devices can result in greater muscle fatigue (Nielson et al., 2004; Shin & Zhu, 2011). In a similar vein, Young et. al (2012) observed that use of touch screen tablets in various tasks resulted in head and neck flexion angles deviant from the neutral posture defined by current ergonomic standards. Due to the fact that touch screen technology is relatively new to consumer products, current research is scarce (Muse, 2011). Furthermore, there are no design guidelines or standards developed for various touch screen devices such as tablets in comparison to current desktop and laptop computers (e.g. ISO-9241; ANSI/HFES 100; & CSA-Z412-M89; Young, et al., 2012). Therefore, additional research on the use of touch screen devices will provide valuable information for the development of new design guidelines and standards and promote a greater understanding of the ergonomic implications afforded by these devices. It is particularly important to investigate how people choose to interact with touch screen technology.

The purpose of the present study was to observe user behavior and preference touch screen device to perform various tasks on a touch screen device. Specifically, we were interested in the common postures adopted while interacting with the devices, the preferred method of interacting with the devices (i.e. using touch, stylus or keyboard accessories), and what position they preferred the device to be in (i.e. on the table, in the lap, etc.). The research is part of a larger study to examine the ergonomic implications of gesturing using well-established subjective and objective testing methods.

METHODS

Participants

48 participants were recruited for this study, 36 females and 12 males, ages 19 to 52 (M = 28.9). The majority of the participants were right handed (93.6%), 4.3% were left handed and 2.1% were ambidextrous. Recruitment was accomplished through a university participant pool and flyers posted around campus. Course credit or financial compensation of $25 was provided as incentive for participation. 12 participants were assigned to the desktop, 13 participants were assigned to the laptop, 15 participants were assigned to the iPad and 8 participants were assigned to the iPod.

Design

There were three independent variables in this study: The type of touch screen device used, the position of the device, and the type of task performed.

Touch screen device. Participants were randomly assigned to one of four touch screen devices (between subjects – 4 levels): iPad, iPod Touch, Laptop, and Desktop.

Position of device. Participants performed different tasks using the touch screen device assigned to them under 3 different conditions. The first two conditions required participants to adopt a specific position that varied by device. The third condition was a "Free Choice" condition, in which participants were allowed to adopt any position they wanted and were given the option of using an attachable device specific accessory at their discretion. (within subjects – 3 levels):

iPod - Sitting with device in lap/Standing/Free choice

iPad - Sitting with device in lap/Sitting with device flat on table/Free choice

Laptop - Tablet form, in lap/On desk, with screen declined and rotated 180-degrees to face participant/Free choice

Desktop – Upright/Declined (60-degrees)/Free choice

Type of task performed. Every participant performed four different tasks across all three positions (within subjects – 4 levels):

1. Emailing – Participants were instructed to respond to an email that consisted of questions that prompted continuous typing for the duration of task (e.g., “What was your favorite subject in school and why?). The questions differed across the three positions.
2. Browsing – Participants were instructed to browse the website Amazon.com to find products “for themselves or a gift for someone else.”
3. Drawing – Participants were instructed to replicate a series of basic line drawings of cartoon animals provided on a separate sheet of paper.
4. Gaming – Participants were instructed to play a puzzle game called “Bejeweled,” in which players gain points by creating a run of 3 or more identical gems by swapping adjacent gems.

Materials

The touch devices used in this study were:

1. 8 GB Apple iPod Touch (iPod), iOS 3.1.2, with a 3.5 inch (diagonal) display
2. 32GB Apple iPad 1 (iPad), iOS 4.3.3, 9.7 inch (diagonal) display
3. HP Elitebook 2740p Tablet PC (Laptop), with a 12.1 inch (diagonal) display
4. HP Touchsmart 610 PC series (Desktop), with a 23 inch (diagonal) display.

A Logitech webcam was to capture video of the participants’ posture and behavior. Motion capture markers were placed on the right side of the participant’s body in order to assist in measurement of flexion angles. Surface Electromyography, (sEMG) was used to evaluate muscle activity throughout the study. Additionally, participant’s physical fatigue and body discomfort was self-reported via a short questionnaire and a modified body discomfort diagram, BDD (Cameron, 1996).

Procedure

Participants were required to perform all of the tasks (Emailing, Browsing, Drawing, and Gaming) for five minutes each in all three positions, resulting in a 20-minute session per position. The orders of the first two positions were counterbalanced and the third condition was always the “Free Choice” position. At the end of each 20-minute session the participants were required to complete a short questionnaire and the modified body discomfort diagram, BDD (Cameron, 1996) in order to collect subjective data on fatigue and body discomfort.

The present study focuses solely on the “Free Choice” condition. In this condition, participants were informed that they were allowed to adopt any position they wanted and were given the option to use various input devices such as: a wireless keyboard and docking station for the iPad and iPod, a wireless keyboard and/or mouse for the desktop, and the keyboard and touchpad, or stylus, of the laptop. The researchers reviewed video footage of the free choice session, independently collecting data for analysis based on the measures identified for the study.

Measures

Three dependent variables were calculated using the videos of the participants during the free choice session:

Interface Interaction. Researchers noted whether participants used touch only, no touch (i.e. they only used the device specific accessory), or touch and the accessory to measure the type of interface interaction chosen for each task across devices.

Posture. Participant’s posture was subdivided into three categories: Neck, Torso and Wrists. Researchers independently rated these three categories as either “Optimal” or “Suboptimal” for each task performed by the participant in the free choice position. Posture was rated as “Optimal” if the researcher judged the angle of the specific body part to be in accordance with ANSI recommendations for neutral posture and current ergonomic standards. If the angle of the body part was deemed by the researcher to deviate significantly from the neutral posture it was rated as “Suboptimal.”

Device Position. All the device positions used by participants were identified and were coded in to 5 specific positions:

1. Desk inclined
2. Desk declined
3. Desk flat
4. Lap
5. Chest level

RESULTS

Interface Interaction

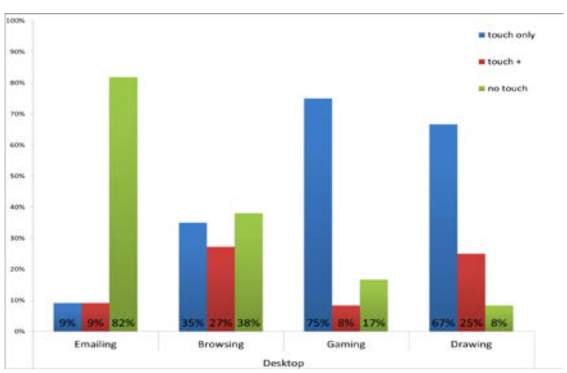

Figure 1. Percentage of participants who interfaced with the desktop using touch only, no touch (i.e. accessory only) or touch+ (i.e. touch and an accessory) across tasks

Desktop. A majority of participants (82%) opted to use the keyboard and mouse accessory when performing the emailing task on the desktop. Figure 2b shows a participant using the desktop with keyboard and mouse accessory. In contrast, most participants used touch only while performing the gaming and drawing tasks. Figure 2a illustrates the use of touch only on the desktop in the reclined position. Refer to Figure 1 for a complete breakdown of the method of interface interaction for participants using the desktop.

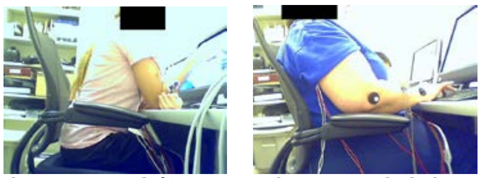

Figure 2a-2b. Participant (left) using touch screen with desktop in declined position and participant (right) using keyboard accessory.

Laptop. Participants used either touch only (46%) or an accessory only (54%) to complete the emailing task. Participants primarily used touch only or both touch and an accessory to complete the gaming and drawing tasks. Figure 3b shows a participant using the stylus and touch screen with the laptop.

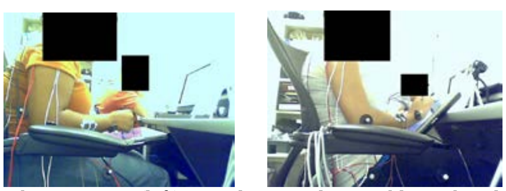

Figure 3a-3b. Participant (left) using laptop in lap as tablet with stylus and participant (right) using both touch and stylus with laptop in lap as tablet.

Interestingly, a majority of the participants used touch only to complete the gaming task, but preferred to use a combination of touch and an accessory (stylus) to complete the drawing task. Figure 4 shows a complete breakdown of the method of interface interaction across tasks for participants using the laptop.

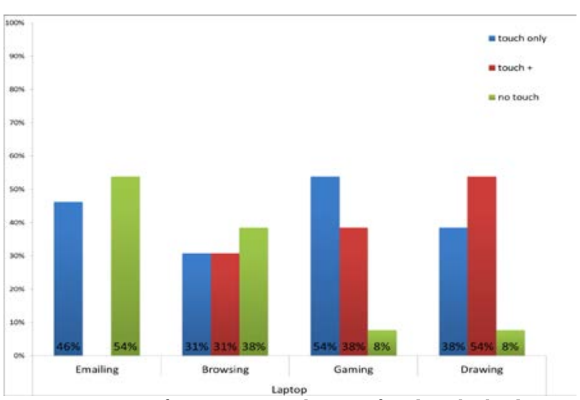

Figure 4. Percentage of participants who interfaced with the laptop using touch only, no touch (i.e. accessory only) or touch+ (i.e. touch and an accessory) across tasks

iPad. Participants used either touch only or touch and an accessory to perform the emailing task. Figure 5a shows the use of touch only and Figure 5b shows use of the dock and keyboard accessory with the iPad. Most participants used touch only when performing the browsing, gaming and drawing task. Figure 6 shows a complete breakdown of the method of interface interaction across tasks for participants using the iPad.

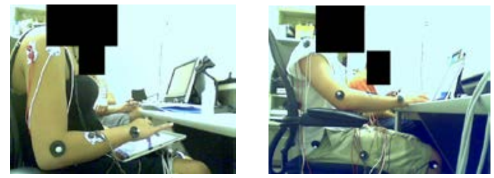

Figure 5a-5b. Participant (left) using iPad in lap with touch and participant (right) using iPad on desk with dock and keyboard accessory.

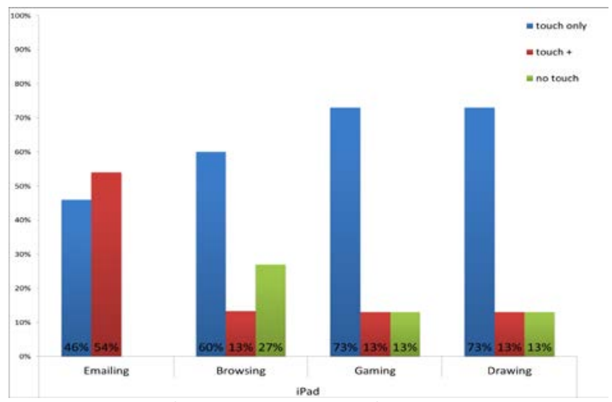

Figure 6. Percentage of participants who interfaced with the iPad using touch only, no touch (i.e. accessory only) or touch+ (i.e. touch and an accessory) across tasks.

iPod. 100% of participants only used touch only to interact with the iPod for all tasks.

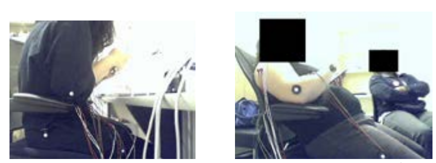

Figure 7a-7b. Participants holding iPod at chest level to perform tasks

Posture

Desktop. Participants maintained optimal posture with regards to neck angle throughout all the tasks when using the desktop. Some participants (less than 35% for each task) shifted their torso to a suboptimal posture by either leaning forward or back in their chair while performing the tasks. Figure 2a shows a participant with suboptimal posture of the torso from leaning forward while using the desktop. Wrist posture was rated suboptimal for a majority of participants when performing the gaming task (75%) and drawing task (83%) on the desktop. Figure 8 shows the percentage of participants with suboptimal ratings of neck, torso and wrist posture during each task by device.

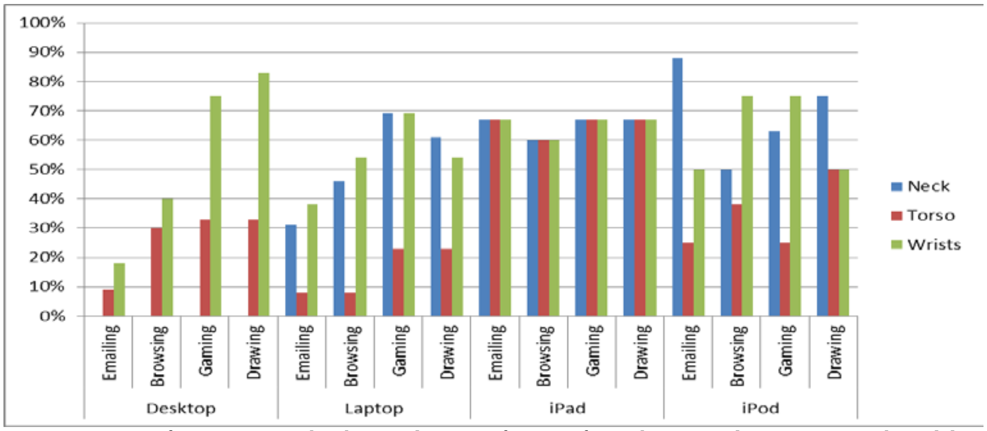

Figure 8. Percentage of participants with suboptimal ratings of posture for neck, torso and wrists across tasks and devices.

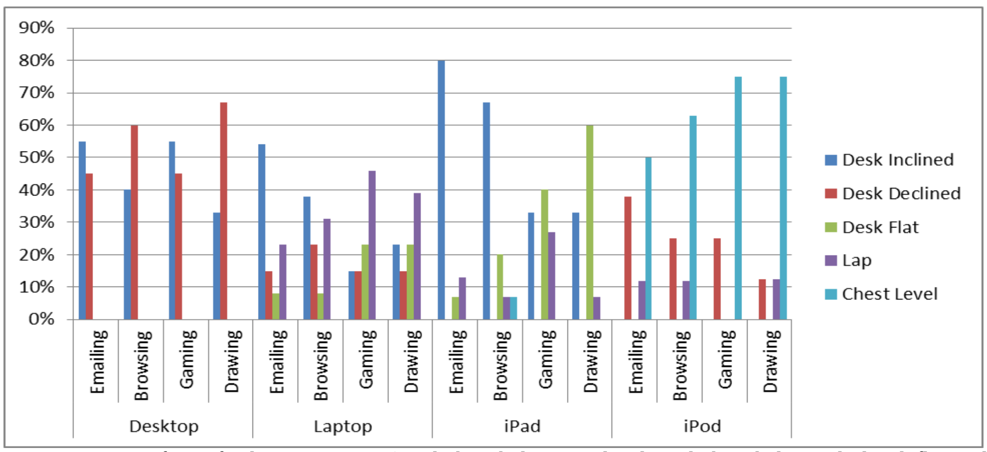

Figure 9. Percentage of specific device positions (On desk with device inclined, on desk with device declined, flat on desk, device in lap, or device held at chest level) participants adopted across tasks and devices

Laptop. A majority of participants maintained optimal posture of the torso across the four tasks. More participants had suboptimal wrist posture than neck posture while performing the emailing and browsing tasks. In contrast, more participants held poor neck posture than wrist posture when performing the drawing task. More than half of the participants held suboptimal wrist and neck posture while performing the gaming and drawing tasks.

iPad. Overall posture was rated the worst for participants using the iPad when compared with the other devices. A majority of the participants adopted suboptimal postures of the neck, torso, and wrists for all four tasks.

iPod. Similar to the laptop, more participants had suboptimal posture for the wrists and neck than the torso across all tasks. Most of the participants adopted a suboptimal neck posture when performing the emailing, gaming and drawing task. Furthermore, a majority of the participants had suboptimal wrist posture when performing the browsing and gaming tasks.

Device Position

Desktop. Participants could choose to have the desktop at an upright position or a declined position. Figure 2a shows the desktop in the declined position. More participants preferred the desktop to be in the declined position when performing the browsing (60%) and the drawing tasks (67%). In contrast, a majority of participants preferred the desktop to be in the upright position when performing the emailing (55%) and gaming tasks (55%). Figure 9 shows the percentage of participants adopting specific device positions during each task by device.

Laptop. Most participants preferred to use the laptop in the normal orientation on the desk (desk inclined) when performing the emailing (54%) and browsing (38%) tasks. For the gaming and drawing tasks, participants preferred to position the device on their laps in tablet form (46% for gaming and 39% for drawing). Figures 3a and 3b illustrate participants using the device in tablet form in the lap.

iPad. For the emailing and browsing tasks, most participants preferred to position the iPad on the desk using the iPad dock (desk inclined). Figure 5b shows a participant using the iPad in the "desk inclined" position. Participants preferred to place the iPad flat on the table when performing the gaming (40%) and drawing (60%) tasks. A small percent of participants also positioned the iPad in their laps for each task.

iPod. A vast majority of participants preferred to hold the iPod at chest level when performing the tasks, particularly for the gaming (75%) and drawing (75%) tasks. Figures 7a and 7b illustrate the "chest level" position with the iPod. Some participants also placed the iPod on the desk, holding the device upright at a declined angle (desk declined). In addition, a small percent of participants placed the iPad in their lap while performing the emailing, browsing and drawing task.

DISCUSSION

Interface Interaction

Most participants preferred to use touch (or a combination of touch and an accessory) when performing the gaming and drawing tasks across all the devices. Not surprisingly, users were likely to use an accessory when performing the browsing and emailing tasks, especially when using the desktop and laptop. Interestingly, at least one user utilized touch for all tasks across all devices. That is, there was no task in which none of the participants used the touch screen when performing the task.

Posture

Many of the participants using the touch screen desktop were observed with suboptimal wrist posture, compared to posture of the neck and torso. This finding is likely due to the angle of the display, which required participants to angle their wrists accordingly in order to perform the tasks using the touch interface. Participants who used the laptop tended to adopt poor posture of neck and wrist, particularly for the gaming task. These results may be attributable to the participants' preference regarding device position. Many of the participants chose to use the laptop in tablet form, placed in the lap. This position forced the participant to look down at the display, resulting in suboptimal neck and wrist flexion angles. In addition, some participants placed the laptop (in tablet mode) flat on the table, requiring them to lean forward and look straight down at the display.

Overall, the iPad and the iPod yielded the most suboptimal postures from participants compared to the desktop and laptop. This is likely due to the fact that the devices are smaller (particularly the iPod), allowing the user to hold the device in different positions while performing the tasks, resulting in suboptimal wrist flexion angles. Furthermore, the smaller size may have affected the participant's view of the display, leading them to adopt suboptimal postures in order to perform the tasks. Indeed, a majority of the participants using the iPod held the device up at chest level in order to see the display better while performing tasks.

Device Position

Preference for device position varied across tasks and devices. Participants who used the desktop preferred to have it in the declined position when performing the browsing and drawing tasks, and preferred it in the upright position when for the emailing and gaming tasks. When using the laptop, most participants preferred to have the laptop in the tablet orientation and placed in their lap when performing the gaming and drawing tasks. They preferred to use the laptop in normal orientation on the desk for the emailing and browsing tasks. Most participants using the iPad preferred to have the device flat on the desk when performing the gaming and drawing tasks. This difference in position preference between the iPad and laptop was surprising, as the laptop when used in tablet form is very similar to the iPad. Most of the participants who used the iPod preferred to hold it at chest level. This position was likely maintained due to the small viewing size of the iPod's display.

Limitations

There are several inherent limitations within this study that should be addressed. First, participants were attached to electrodes from the EMG machine which may have interfered with the participant's mobility and comfort. This may have limited potential postures and device positions. Likewise, the presentation of the free choice session was always the last in a series of three sessions, which took approximately 20 minutes each to complete. It is possible that participants may have suffered from fatigue effects. Furthermore, assessment of the results may have produced an inter-rater reliability conflict. The videos were reviewed and rated by an individual researcher per device.

Conclusion

In general, the results of this study illustrate the various interaction methods, postures, and device positions that users choose to adopt when interacting with touch screen devices. We found that participants preference regarding input methods, device positions and postures varied depending on the type of task being performed and type of touch screen device used. The information gleaned from this study contributes to the limited body of knowledge on the ergonomic implications of touch screen devices.

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