Left vs. Right-Handed UX: A Comparative User Study on a Mobile Application with Left and Right-Handed Users

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Abstract. The demand for point-of-sale (PoS) applications, from public service kiosk to personal mobile devices, has drastically increased since the last decade. PoS applications are a demanding environment that requires the interface to be responsive, accurate and easy to use for anyone. Menus and navigation in applications have traditionally been on the left, but many application developers choose to put them on the right so that the content can have focus on the left. In left-to-right languages, people are used to reading from the left, and so objects on the left hand side get more attention than those on the right. Previous research has shown the benefits of right-handed use for touchscreen mobile phones in several angles, such as performance, usability and user experience. The goal of this study is to investigate the differentiating aspects of left or right-handed user experience through the use of a popular mobile PoS application in Turkey, *YemekSepeti*, on touchscreen mobile phones. More specifically, this study aims to evaluate the left and right-handed user experience on touchscreen mobile phones regarding an application, which was mainly designed to be used with a defined thumb. For this purpose, a qualitative mobile usability test based on a multi-method approach was conducted with a sample of 8 Turkish college students who defined themselves as iPhone users. The tests were conducted with a predefined smart phone: iPhone 4S. The participants were observed during the task executions and any additional data was collected by the thinking-aloud, eye tracking and video-recording of the participants. After completing the tasks, the participants were interviewed to have further understanding on their thoughts and actions. Findings support the notion that the usability of a touchscreen mobile phone was affected by both handedness and the layout of the applications in terms of entry speed, accuracy rate and inclusive touch interfaces.

Keywords: User Experience (UX), Handedness, Touchscreen, Mobile, Application.

1 Introduction

The spectrum of handedness is wide, diverse and challenging to comment on several counts of social and natural sciences. In the last decades, many scholars have made

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efforts to compensate the diversity based on handedness and support different fields with an inclusive access to technology, specifically to desktop devices. The same efforts, which have not yet been applied to touchscreen device accessibility is still in its spring. Touchscreen devices and their screen layouts along with the context of providing users to participate in a broader population may have been the main reason for this lack of accessibility and restricted user experience.

In our contemporary era, mobile phone touchscreens have been drastically replacing our traditional keypad devices. These interfaces and screen layouts reveal several challenges for mobile accessibility and usability for people of different handedness: they lack both the tactile feedback and physical stability assured by keypads, making it harder for people to reach at targets properly. This becomes commonfor whoever suffers from the lack of precision, such as left-handed users. These interfaces and devices offer several advantages over their adjustable settings, however. Especially, they can display different interfaces in the same surface and adapt to users' capabilities.

The ability to touch and manipulate content on the screen without any mediator provides an artless and attractive experience. In addition to this, the use of an adapted interface is an applicable alternative to mobile touchscreen devices, allowing the same interface to be used by different handedness. What is more, the customization of touchscreens makes the devices recoverable to the users' adaptive solutions, which fit better for each user's expectations and needs.

The reason why touchscreen devices have received such enormous success was that the big touchscreen entirely altered the interaction experience with mobile devices and the mobile applications [1]. Formerly, the main interaction approach between the device and the user was typically navigation based, meaning that the user needed to drive through the keyboard, the mouse orthe other input device in order to handle the screen controls. Instead of the ordinary approach, the new touchscreen smart phones offer the users with a pointing-based user experience, which enable the users to directly manipulate the on-screen objects by their finger [2].

The touchscreen devices came up with an excessive influence to the mobile application enterprises and developers. At the same time, the usability emerged as an important issue that should be improvedfor the new characteristics of features a touchscreen device could provide such as finger pointing.However, there is no reasonable information of the values concerning users' handedness. To be able to support the users with a flexible and adjustable interface, especially for the applications, it is needed to understand how users who are left or right-handed handle the same demands by using an application in their touchscreen mobiles.

This rapid innovation has brought a special intuitive way to the mobile device users, enabling the users to experience the touchscreens and accept this new technology fast. Similarly, the statistics approved this phenomenon of acceptance. According to the figures collected by COMSORE [3], the number of the touchscreen mobile users increased 59% from 2008 to 2009. The exponential adoption rate indicated that the touchscreen interaction required little or no learning curve forthe users. COMSORE [3] foresaw that the major user adoption of the touchscreen would come within time, and the touchscreen mobile device would certainly become the

future of the mobile world. As Takahashi [4] stated, the overall profit that the touchscreen could bring for the year 2017 will be $23.9 billion.

1.1 Statement of the Problem

Touchscreen has been highly adopted on different mobile or desktop devices for several years. Despite this, a certain amount of people has still defined themselves as an opposing view to get used to using the touchscreen devices.

SaschaSegan[5]defined the reasons of why some people could not adapt themselves to the touchscreen user interface, as they criticized the low feedback of the tap-based onscreen objects, and they believed that the new user interface cause them to go through additional learning process therefore reduce the productivity of the mobile phone. Additionally, they complained that the virtual software keyboard require much more time, skills and patients to use when compared to the ordinary hard keyboard, furthermore, the soft keyboard generally occupies a large portion of the screen space hence block some important information away from the users [5].

User experience on mobile devicesmay be affected by whether the person using them is right handed or left-handed. A touchscreen mobile device is one area where the users probably want to consider such details, as the developers should have considerations of the persons' hand physically blocking the view on the screen. In this sense, user research is critical in understanding user needs and expectations in screen interaction due to handedness. When relating to any use of touchscreen, the pun intended question to ask should also be what the user's expectation and preference is.

Touchscreen supporters indicated that the touchscreen as a gesture-based technology was an extraordinary innovation, and the modernization from normal screen display to the touchscreen is irresistible. However, the design of the user interface of the touchscreendevices has also direct impact on mobile user experience. Since the user interface is defined as the main intermediary between the user and the touchscreen, [6] therefore, the user interface on touchscreen device is a double-edged sword, at one hand, it could support and enrich the user experience, alternatively, it might also confuse the user and leave them with some serious difficulties during their experience.

1.2 Purpose of the Study

Strong evidences have shown the benefits of right-handed use for touchscreen mobile phones because menus and navigation in mobile applications have been on the left generally. Hence, the content can have focus on the left. However, there is only a very limited number of studies that focused on the impact of handedness in mobile user experience. In this context, this paper focuses on the differentiating aspects of left or right-handed user experience through a PoS application and aims to contribute to the relevant literature.

We found it worth nothing, that an application in a touchscreen device – especially a mobile, one-hand operated touchscreen device – is not always operated by means of the user's dominant hand [7]. Most of the population is right-handed. Furthermore,

there is a certain physical dimension not to be overlooked: Several studies [8] have found that users prefer to interact near the center of the touchscreen, thus avoiding extreme flexion and extension of the thumb.

The main lines of carrying out such a defined research are to determine design inconsistencies and usability problem areas within the user interface, to see potential sources of error, to exercise the application under controlled test conditions with representative users and to establish baseline user performance and user-satisfaction levels of the user interface for the application regarding an effective, efficient and well-received user interface.

2 Research Methodology

In the light of the purpose of the study described above, below are the two research questions of the study:

Research Question 1: What are the user expectations due to handedness towardstouchscreen-based mobile devices?

Research Question 2: What are the factors that affect or enhance different handed user experiences?

This qualitative study adopted a multi-method approach. Data was collected by different data collection techniques such as background questionnaire, behavioral data including retrospective probing and a final debriefing interview.

The test procedure was divided into three phases. After the completion of a pre-test questionnaire on users' demographics and prior device usage, the participants

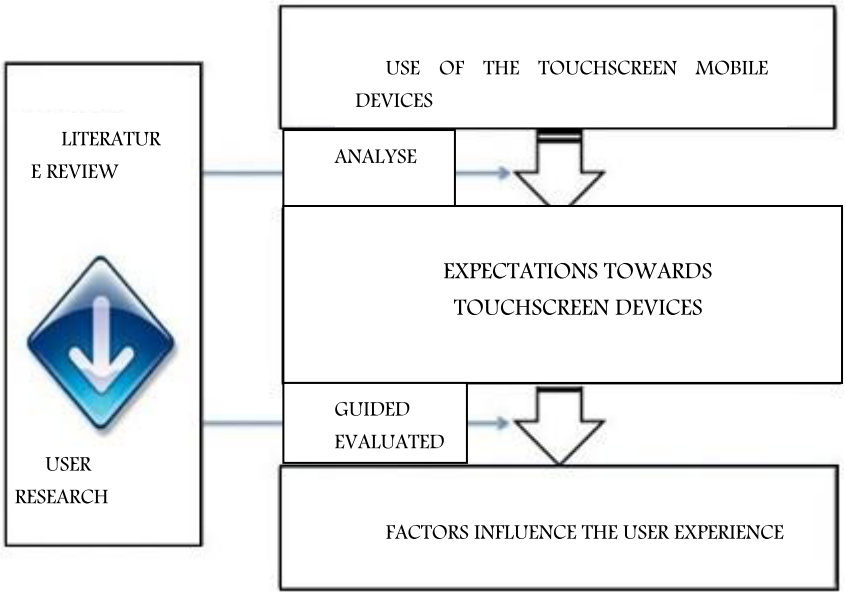


Fig. 1. The Concept Map (based on Previous Researches)

performed the discrete target phase, namely execution of selected key tasks on a pre-defined touchscreen device, followed by a final interview. The tasks were evaluated by both speed and accuracy of task completion. The total session time was approximately 30 minutes.

The research focused on the use of a mobile application on a touchscreensmartphone by users of different handedness.The screen interaction was analyzed through basic gestures such as holding, tapping, crossing, sliding, scrolling down and up by using a touch-based terminal device.

3 User Study

3.1 Sample

8 college students (4 left-handed and 4 right-handed) aged between 18 and 28 (median = 25) from different universities voluntarily participated in this experiment. Participants were classified as being left or right-handed by self-reporting on handedness. They all gave informed consent before the start of experiment and reported any physical or health problems involving their hands or fingers.

The participants were expected to complete a set of representative task scenarios presented to them in an efficient and timely manner, and to provide feedback regarding the usability and acceptability of the user interface. The participants werealso expected toparticipate a debriefing post-test interview. The participants had similar experience on using iPhone and its applications, but not the application, which was chosen as the test medium.

3.2 Test Device and Medium

A personal mobile device (iPhone 4S, 64Gb) was used for the usability test. The mobile application chosen for data collection was *YemekSepeti (Food Basket)*, whichis a food delivery portal of Turkey (Fig. 2). The application provided a virtual

Fig. 2. The Display of the Application

keyboard with automatic spell checking and correction. The users have an opportunity to alternate characters with accents that can be typed from the keyboard by pressing the letter for 2 seconds and selecting the alternate character from the pop-up. The device has a resolution of 640x960 at 326 ppi. The touchscreen mobile device was positioned on a worktable and its center was at a favorable height from the floor, at which all participants could respond comfortably in a standing posture.

3.3 Procedure

Participants took part in the usability testconducted in the fully equipped "Interactive Media Lab" at GalatasarayUniversityinIstanbul, Turkey. An iPhone 4S with the mobile application and supporting testing software was used in a typical lab environment. The facilitator seated in the lab monitored the participant's interaction with the mobile application. A person, acting both as note takerand data logger, monitored the sessions in the observation room, connected by video camera feed. The test sessions were recorded via eye-tracking glasses and a camera in the lab.

The tests were carried out in three stages for each participant; namely, a pre-test questionnaire, task execution and a post-test interview. Participants completed a pre-test demographic and background information questionnaire based on each participant's use of mobile phones and system or user-installed applications. The answers based on their experiences helped us specify each participant's familiarity with mobile technology.

Two tasks were given to each participant during the task execution stage. The first one may be titled as "Being a New Member". In this task, the "New Member" button is placed on the right top. When the participant selects it, a form is seen on the screen to fill in. The form is right justified and there is no in-line text. If the participant does not thumb in the middle of each line, the form is not ready for keyboard input. The second task was based on "Ordering a Meal" by choosing a section ("cuisine, district and restaurant" or "meal, district and price range"). Each participant was asked to find the closest Chinese Restaurant to give an order for Manhattan Roll and Coco Cola.

Each participant was asked to "think-aloud" and the audio data was recorded during the execution of each task. The facilitator observed and entered user behavior, user comments, and system actions by the testing software.

Each scenario required that the participant obtained and input specific data that would be used in course of a typical task. The scenario was completed when the participant indicated the scenario's goal has been obtained (successfully or not) or the participants were not aware that the task goal is incorrect or incomplete. After all task scenarios wereattempted, a final post-test debriefing interview was realized to get complementary data concerning user attitudes and satisfaction toward the mobile application. The length of the whole test lasted approximately 30 minutes, privately with each of the participants.

4 Results

Our goal is to understand and relate the capabilities of both user populations (e.g. left-handed and right-handed) when using different hands and fingers. The results were

presented by highlighting their main similarities and differences considering each task, target size and interaction area. We believe that the findings that were provided by this studymight enable designers and developers to predict how both left and right-handed users will perform in using mobile applications in touchscreen devices. Table 1 below presents a summary of findings.

Table 1. A Summary of Findings

Participant	Age	Experience	Handedness	Used Fingers	Attitude	Duration
1	26	< 5 years	left-handed	both thumbs	Seems quite easy to use both	32 min.
2	28	> 1 year	right-handed	right thumb	Difficult to use both (and P2 quitted)	39 min.
3	24	< 5 years	right-handed	right thumb	Easy to use the mobile device, but hard to use the application	26 min.
4	24	< 5 years	left-handed	both thumbs	Easy to use both	21 min.
5	25	< 5 years	left-handed	left thumb	Difficult to use, but dare to try	27 min.
6	23	< 5 years	left-handed	left thumb	Simple, but not easy to use both	31 min.
7	28	< 5 years	right-handed	right forefinger	Hard to use both	28 min.
8	28	< 5 years	right-handed	right thumb	Comes naturally to me	23 min.

4.1 Discussion

This study has two main focuses; one is to understandthe user expectations due to handedness towards a touchscreen mobile devicewhile the other is the handedness factor that may possibly affect the user experience on the mobile applications in touchscreen applications. The data was collected through a multi-method qualitative usability test. The participants were observed during the task executions and additional data was collected by the “think aloud” procedure, eye tracking and video recording of the participants. A short debriefing interview was also made to gain a detailed insight into the user experience.

According to Renner & Taylor [9], the success of the data analysis largely depends on the fully understanding of the data, in terms of the qualitative analysis, in which the data are mainly linguistics and recorded videos and researchers are required to respectively read and visualize the whole sections of the tests.

4.2 Screen Interaction through Gestures due to Handedness

Left-handed. Considering *Tapping* and *Scrolling Down* and *Up*, there was an effect of handedness on task scenarios. Some multiple comparisons post-hoc test found essential differences between even two left-handed users. 2 of the participants used their thumbs to tap, 1 completed the task with forefinger and 1 did it with both hands.

Right-handed. There was statistically significant different in Task Scenarios depending on handedness for tapping. All the participants used their right thumbs to complete the whole tasks.

Differences and Similarities. Regarding each interaction technique, tapping seems to be the most similar between user populations. Particularly, both perform properly and achieve similar accuracy results. The main difference between these two types of users lies in the hold of the touchscreen device. According to the design of the defined application, the target areas on different locations on the touchscreen allowed us to compare the performance of right-handed and left-handed. As Shneiderman[10] stated, a specific disadvantage when using a touch screen is that the hand of user might obscure the screen. For the acts labeled among 4 different participants (Table 2), the buttons in the application are placed at the edges and the bottom of the screen and the participants' hands do not obscure the parts of the screen so that most of the participants could easily find the buttons to achieve task. However, the button "New Member" was placed on the right edge, and left-handed participants needed to tilt and use their right forefinger to reduce finger fatigue. For both handednesses, the upright buttons should be installed at a lower position. The participants, who could not find the buttons as easy as the others, had an opportunity to see the buttons clearly, but checked other edges. Table 2 below presents eye-tracking outputs for screen interaction that overlap and differentiate due to handedness.

Tapping. Tapping is the first interaction technique the participants have experienced. Tapping has shown itself to be the one with less resemblance between left and right-handed persons. This act presented the lowest error rate for both user populations, and accuracy began to converge in a way.

Scrolling Down and Up. This gesture was chosen as a proof for middle of the screen consistency. Both user populations can use all the interaction techniques with similar accuracy. Neither for left-handed or right-handed participants experienced a significant error, but a low effect for reading the required texts to type the information.

Among the tasks, "New Member" was placed on the right top. When the participants thumbed on it, a form was seen on the screen to fill in. The form was right justified and there was no in-line text. For the second task, which is "Order a Meal", two different pathswere offered to order a meal, namely two different search sections, which are symbolized by the "magnifying glass" and "fork/knife" icons. Both user populations have chosen different paths due to handedness issues. Some of the participants used their thumbs and other used their forefingers. Those who used their thumbs were more likely to face some handedness issue (Fig. 3).

Table 2. Eye Tracking Outputs for Screen Interaction due to Handedness

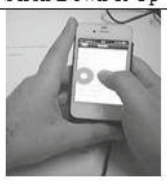
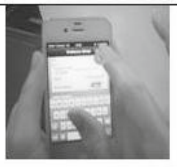
P. No.	Sliding	Tapping	Data Entry	Scroll Down & Up
P1 (left-handed)				
P3 (right-handed)				
P6 (left-handed)				
P7 (right-handed)				

Fig. 3. The Screenshots of "New Member" and "Order a Meal" Keys, respectively

4.3 Reach Restrictions

A main difference between user populations is their thumb-use to reach far-away target spaces. Left-handed users have greater difficulties to tap the targets with their left thumb, thus resulting in lower accuracy rate for trials. Conversely, right-handed users did not have such difficulties, however when the target space are on the left, they faced some difficulties and decided to use the touchscreen mobile device with their two hands. To activate the target spaces, the participants should always thumb in the middle of the lines. This might be due to the restrictions with the physical edges and legibility, preventing users to fully land their thumbs or forefingers on the target spaces.

4.4 Perceived Difficulty

When the themes were tried to be categorized, the participants (without an eye to following up their handedness) could be classified into two groups, one of which stated that the touchscreen user experience were decent and cozy while the other group mentioned their user experiences as the one which was poor, bad and ungrateful. Only one participant could not complete the task and decided to call the support line concerning the application s/he used in the test.

As the majority feedback from the view of both user experiences, some of the participants indicated that the mobile application in the touchscreen mobile device be changed into more friendly design, therefore they would not have a chance to guess the "Search" button as the logo of the product. As P2 explained that s/he often felt lost when using the touchscreen application because s/he could not see what was written on the screen while typing on the keypad. Although the other one completed the tasks without having any error, s/he got confused while using the application and asked himself/herself some questions "*I cannot decide which one is useful for me now, but I should try this one to see the further pages*." Questions emerged not only because of their handedness but also because of the usability issues observed in the application.

5 Conclusion

The touchscreen mobile devices became excessively popular, and the increasing number of people started using and getting familiar with the features of any kind of touchscreen mobile devices. In this context, investigation of the mobile user experience became vital for the developers and designers. It is evident that these user-centered studies could enable the researchers and designers to develop more user-friendly applications. However, among various user groups, there is only a limited number of study addressing users who use different hands for screen interaction.

This study aimed to evaluate the mobile user experience in a meal ordering mobile app in Turkey, namely*YemekSepeti (Food Basket)*, with a sample of 4 left-handed and 4 right-handed users. Our goal was to show the main differences and similarities between these two distinguished populations based on their handedness, and also compare their interaction techniques under the same circumstances. As we have been

able to get from the behavioral data collected via eye-tracking equipment, the participants are similar on tapping because they use their defined fingers to tap and they perform in an accurate way because of their inherited handedness. The main difference is just based on the hold of the device and use of thumb or forefinger.

Generally, based on this conducted research, it is observed that the limitation of the touchscreen mobile devices would affect the user experience. More specifically; the mobile device users are not provided with appropriate features to use it in a simple way with his/her born-defined handedness. These limitation issues also include the low accuracy of the pointing experience, especially among the left-handed users. According to the results of this study, the right-handed users were quicker and more accurate when the targets were placed in the lower-right part of the screen. However, the left-handed performed their best when the target buttons were placed in the lower-left part. Compared both users based on the upper parts of the screens, the restrictions were only confirmed for the buttons positioned opposite to their handedness.

Further research could include tests with larger user groups and eventually the design of an interface that can be adapted according to user needs concerning interaction technique, target area and position of the menu and navigation on the screen.

References

1. Waloszek, G.: Interaction Design Guide for Touchscreen Applications. SAP Design, Newtown Square (2008)
2. Morris, J.: Android User Interface Development - Beginner's Guide. Packt Publishing, Birmingham (2011)
3. comScore.: Touchscreen Mobile Phone Adoption Grows at Blistering Pace in U.S.During Past Year. comScore, Inc., Reston (2009)
4. Takahashi, D.: Touchscreen market growing 10 times faster than other displays. VentureBeat (2011), http://venturebeat.com/2011/08/17/touchscreen-market-growing-10-times-faster-than-other-displays/ (retrieved January 3, 2014)
5. Segan, S.: Why I Hate Touchscreens (2009), http://www.pcmag.com/article2/0,2817,2337575,00.asp (retrieved January 1, 2014)
6. Weiss, S.: Handheld Usability. John Wiley & Sons, Ltd., New York (2002)
7. Silfverberg, M., MacKenzie, I.S., Korhonen, P.: Predicting Text Entry Speed on Mobile Phones. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 9–16 (April 2000)
8. Perry, K.B., Hourcade, J.P.: Evaluating One Handed Thumb Tapping on Mobile Touchscreen Devices. In: Proceedings of Graphics Interface, vol. 322, pp. 57–64 (May 2008)
9. Renner, M., Taylor, E.: Analyzing Qualitative Data. Sheboygan, Wisconsin (2003)
10. Shneiderman, B.: Touch screens now offer compelling uses. IEEE Software 8(2), 93–94, 107 (1993)