M. Koch, A. Butz & J. Schlichter (Hrsg.): Mensch und Computer 2014 Tagungsband, München: Oldenbourg Wissenschaftsverlag, 2014, S. 319-322.

# Evaluating user preference on touch screen tablets by a complex tapping task with multiple targets

Thorsten Stark[1], Stefan Schade[2], Melanie J. C. Stade[3]

Informatik und Medien, Beuth Hochschule für Technik Berlin[1]
Psychologie Neuer Medien und Methodenlehre, Technische Universität Berlin[2]
Kognitionspsychologie und Kognitive Ergonomie, Technische Universität Berlin[3]

**Abstract**

The aim of this study was to investigate objective data indicating preferred areas of a touch screen tablet. Participants had to tap one of several colored targets arranged in theoretical sections. We assume that the sections with the highest number of touches indicate preference and "comfort zones". We found that the middle right section is the most preferred area on the tablet screen regardless of tablet orientation (portrait vs. landscape) and posture (single vs. both handed).

## 1 Introduction

With the prevalence of personal digital assistants (PDAs) and smartphones several studies in the past decade have been conducted to evaluate target positions and sizes for one handed thumb tapping on mobile small screen devices. In general, participants were instructed to hold their devices with one hand and use the thumb of the same hand for tapping targets varying in size and position. However, results of previous studies dealing with small screen devices could not be transferred to heavier and larger touch screen based tablet computers because (1) these devices are not held and used with the same hand, (2) people use the index (or middle) finger and thumb of their preferred hand as well as the thumb of the non-preferred hand, and (3) tablets are used in different orientations. Furthermore, the referred studies measured "preference" of target positions by (debatable) subjective ratings of participants in post-session questionnaires (e.g., Perry 2008). In addition, previous studies with a single-target/single-tap task approach did not consider that in real life scenarios there is usually more than one possible target available. Moreover, the interaction between user and tablet is an interplay between perception and reaction. Experiments with single-target/single-tap tasks did not consider visual search, information processing and attention allocation of the real world. Finally, in case of tablets only one posture (landscape, both

handed) was analysed (e.g., Odell et al. 2012, Oulasvirta et al. 2013). Thus, we chose an alternative approach to investigate whether preferred areas exist on tablet computers and how these preferred areas correspond to tablet orientation and posture. We assume that users have preferred areas (*"comfort zones"*) on the screen and that these areas can be reached with a minimal amount of physical effort. For example, Young and colleagues (2012) showed that normal tablet usage causes a greater head and neck flexion especially compared with desktop computer usage. Contrary to previous approaches, we want to investigate the preference of different areas of the tablet computer based on objective tapping parameters (number of touches) in different conditions. Identifying comfort zones of tablet usage may help to establish new guidelines for designing tablet computers in order to reduce the amount of uncomfortable postures and gestures.

# 2 Methods

*Participants.* Overall twelve right handed subjects between 13 and 14 years of age (mean age=13.7; sex=4 female) of a German grammar school participated in the experiment. All participants received a standardized instruction, were unaware of the purpose of the experiment, and reported having normal/corrected-to-normal color vision and visual acuity. *Apparatus and stimulus.* For the experiment a mobile tablet computer by Apple (iPad 3; 2048×1536 Pixel; Apple A5X 1GHz dual-core, 1024MB RAM; see Figure 1, left) was used. Figure 1 (middle) illustrates an example screen in one experimental trial. On the 9.7" screen 54 grey discs were equally spaced on a virtual matrix in every trial. All discs were displayed with a radius of 44 pixels.

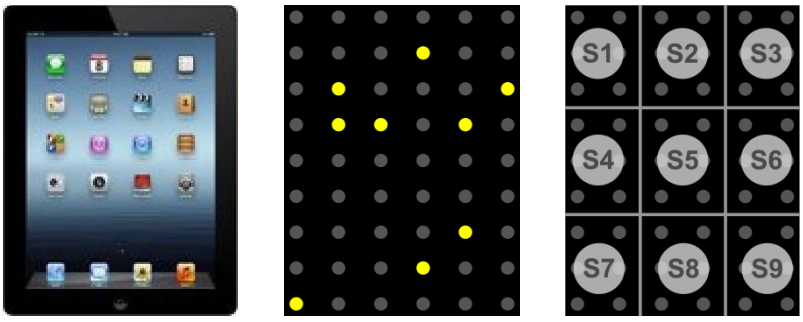


*Figure 1: Left: mobile table computer (Apple iPad 3) in portrait orientation used in the experiment. Middle: example screen in one trial (portrait orientation). Right: Sectioning of the screen into nine (invisible) sectors for analysing preferred screen regions.*

The 9.7" screen was divided into an imaginary three-by-three grid resulting in nine possible tapping sectors, each containing six discs (Figure 1, right). In every sector (S1 to S9) one of the grey discs turned into one of five target colors, while the remaining discs left grey. The targets were spaced at intervals of about 1.6° visual angle (horizontal and vertical) with an assumed viewing distance of 50 cm. The distance to the edge was about 0.46° visual angle for each exterior target position in both format conditions. *Task, procedure and design.*

Participants were instructed to tap one of the nine colored targets as fast and accurate as possible. We realised a two-by-two repeated measures design consisting of the factors *tablet orientation* (portrait vs. landscape) and *tablet posture* (single handed vs. both handed). In single hand posture the tablet is held with the non-dominant hand while the tapping task was performed with the dominant hand. In both handed postures the tablet is held with both hands while the display was tapped with the thumbs (100 trials per condition with varied condition sequence). The nine targets (one per sector) were colored for 1.000 ms or until participants touched a colored target. After 1.000 ms or as success feedback, all 54 target positions were displayed in grey for 1.000 ms (darker grey in case of success). The experiments were performed sitting in a darkened room with low level of brightness.

| | both handed | single handed |
|---|---|---|
| portrait | 1.00 7.43 7.86<br>2.60 38.36 24.30<br>8.75 12.10 16.86 | 2.33 1.50 3.38<br>14.40 11.10 37.75<br>5.57 4.86 23.90 |
| landscape | 1.00 4.86 6.75<br>1.25 27.82 31.58<br>3.00 11.00 14.73 | 1.25 2.00 9.38<br>14.11 3.60 47.17<br>4.20 2.50 19.25 |

*Figure 2: Heatmaps for all conditions indicating the mean absolute numbers of target taps by coloring from white (small numbers) to black (high numbers).*

# 3 Results

The dependent variable was the *target hits*. Figure 2 illustrates the mean number of target taps by heatmaps indicating the comfort zones for the four conditions of the experiment. The descriptive analysis shows that users preferred – as expected – sectors on the right side of the tablet irrespective of the tablet orientation. In the both handed posture it seems that there is a

tapping shift of the comfort zone to the centre of the screen although subjects were free in tapping.

# 4 Prospect

Several questions are relevant in the interaction between users and mobile devices:

1. How do visual stimuli on the screen, physical parameters of the user and surrounding distraction influence changings of the comfort zones?
2. Is there a left shift of comfort zones for left-handed subjects?
3. How does the tablet usage interact with eye tracking parameters?
4. How does a more realistic setting including movement and other subpopulations (e.g., elderly people, users with physical or psychological disorders) influence the mobile device usage?
5. What are implications for designing user-friendly devices, e.g. individual layout adjustment?

**References**

Odell, D., & Chandrasekaran, V. (2012). Enabling comfortable thumb interaction in tablet computers: a Windows 8 case study. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 56(1), 1907–1911. doi:10.1177/1071181312561278

Oulasvirta, A., Reichel, A., Li, W., Zhang, Y., Bachynskyi, M., Vertanen, K., & Kristensson, P. O. (2013). Improving Two-thumb Text Entry on Touchscreen Devices. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 2765–2774). New York, NY, USA: ACM. doi:10.1145/2470654.2481383

Perry, K. B., & Hourcade, J. P. (2008). Evaluating One Handed Thumb Tapping on Mobile Touchscreen Devices. In Proceedings of Graphics Interface 2008 (pp. 57–64). Toronto, Ont., Canada, Canada: Canadian Information Processing Society.

Young, J. G., Trudeau, M., Odell, D., Marinelli, K., & Dennerlein, J. T. (2012). Touch-screen tablet user configurations and case-supported tilt affect head and neck flexion angles. Work, 41(1), 81–91. doi:10.3233/WOR-2012-1337

**Kontakt:**

stark@beuth-hochschule.de[1]; stefan.schade@tu-berlin.de; melanie.stade@tu-berlin.de

[1] The work of Thorsten Stark was supported in part by the ERDF funded R&D project MoMo of Berliner Senatsverwaltung Bildung, Jugend und Wissenschaft, Project no.: EFRE 20072013 2/51.