Shake ‘n’ Tap: A Gesture Enhanced Keyboard for Older Adults

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Abstract
The need for text entry on smartphones and other touch-screen devices is key for many tasks and also a key factor in the usability of these devices. Physical and cognitive issues associated with age can aggravate the task of text entry for older adults. Technological exclusion due to low usability can present a significant problem both for social and ongoing business-related tasks with older adults. This paper investigates a new touch-screen keyboard design for older adults that combines the familiar QWERTY keyboard layout with physical gesture. User studies with older adults showed our keyboard reduced miss-taps, but was slower to use, and raised issues for further research.

Author Keywords
Older adults; text input; gesture keyboards.

ACM Classification Keywords
H.5.2 User Interfaces: Input devices and strategies.

General Terms
Human Factors; Design; Measurement.

Introduction
The developed world has an increasingly aging population: in the UK 17% of the population was over 65 years old in 2010 with a predicted growth to 23% by

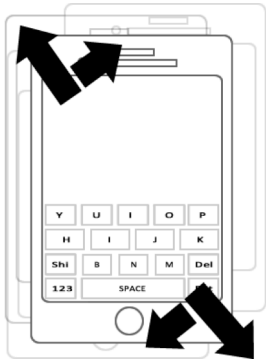


Fig. 1: Shake gesture for keyboard flipping on Shake'n'Tap



Fig. 2: Gesture keyboard input task. Shaking the device replaces the current half-keyboard with the other half.

2035 [7]. As the size of the older working age population rises, an increasing number of workers will want to continue to use mobile technologies for work into their 60s and beyond. Furthermore, many people will want to continue professional, social and lifestyle usage of mobiles into their late retirement as these technologies can lead to increased community involvement and personal independence. Unfortunately, however, the aging process can interfere considerably with mobile technology usage. For example, the normal aging process typically involves a decline in visual acuity together with a decline in working memory, selective attention, and motor control [1]. Even in their 40s many people can experience vision changes that affect their near focus, while from 60s onwards physical movements can be slower and less accurate [1].

Text is core to many interactions on mobiles such as emailing, social networking, instant messaging, searching etc. The majority of smartphones no longer have a physical keyboard but rely on on-screen touch keyboards. Text entry on these keyboards has been shown to be slower and more error-prone than traditional mini-physical keyboards (e.g. [2,4]), but they are popular as they permit full screen services and a larger reading area. While there have been numerous studies of text entry usage on touchscreens, to date there has been very little work studying the effects of aging on text entry, and none on modern touchscreen phones where diminutions in visual acuity, motor control and working memory are all likely to have an impact.

In this short paper we present an investigation into text entry using two touchscreen keyboards on mobile devices, one a standard QWERTY keyboard, the other involving the use of gesture. We focus on the results obtained for older users, here being defined as those users aged 50 years and over, but contrast this with younger users in the same study.

Keyboard Design

Our preliminary workshops with older adults highlighted that older users appeared more willing to adopt new keyboard layouts than younger users, largely due to their different experiences of and familiarity with QWERTY soft keyboards. We also identified a strong dislike of predictive text entry and "distracting" word suggestions. To increase the key size without the need for predictive texting and related dictionary-based models or slow multi-tapping, we designed a wide format keyboard where the standard and familiar QWERTY layout was spread across double the width of the screen (see Fig. 1). We were motivated to use gestures by previous studies on tilting text entry (e.g. [3, 10]) and research showing that older adults can perform familiar gestures more accurately than younger adults [9]. After testing various gestures we chose a simple shake gesture to swap the keyboard between halves of the QWERTY layout. Shake is a straightforward gesture to explain to participants and is instantly understandable. It has also been shown to be a gesture that comes naturally due to typical past user experience. A study by Ruiz et al showed that the shake gesture was frequently selected by participants to switch a device to its home screen, arguably due to their familiarity with "Etch-A-Sketch' [8].

As an example, input of the phrase *"batman wears a cape"* would require 19 taps on standard QWERTY, or 19 taps plus 8 side-swap shakes on our design. Although an increased number of inputs is required

with our keyboard, the layout has the benefit of larger target button areas, allowing both larger fonts and less precise tapping.

Methodology

We conducted a user study to investigate use of the QWERTY and Shake'n'Tap keyboards. We initially recruited 124 participants through our standard mailing list and forum recruitment procedures for user studies. Unfortunately, this did not result in enough older adults. To compensate we liaised with our University's Centre for Lifelong Learning to increase the numbers of older participants and recruited a further 23 participants in the 50+ category, bringing the total number of participants to 136.

Our study was based around a standard text entry study methodology using the MacKenzie and Soukoreff phrase set [6] that was designed to give short memorable phrases (e.g. see Fig. 2). Participants were initially presented with a standard QWERTY layout and given some practice time until they felt comfortable. After this they moved on to enter 10 timed phrases (randomly selected from two blocks). They were then shown the Shake'n'Tap keyboard and repeated the practice and timed tasks. In line with previous text entry studies, we did not counterbalance due the ubiquity of the first input method. After each set of task phrases the participants provided subjective feedback through a series of on-screen questions (using 5 point Likert scales). The two key measures of success of a text entry method are speed and accuracy. For timed tasks, times were recorded from first key press to last key. Accuracy was calculated using Levenshtein edit-distance, removing the artificial entry constraint of forcing participants to maintain perfect accuracy [5] and allowing us to investigate both corrected and uncorrected errors in reasonably natural typing. Each key tap location was also recorded for later heat-map analysis.

Our experimental keyboard was implemented in HTML5, using standard accelerometer access for shake detection and a canvas for drawing the keyboard. We chose HTML5 to support platform portability, though all tests were conducted on iOS devices. Input was logged to a PHP/MySQL Server.

Results

Fig. 3 shows that the average number of incorrect key-presses during the input tasks was lower for Shake'n'Tap than the standard layout. The difference is statistically significant for the 18-29 and 50+ groups. This observation is also shown by the heatmap of key press errors screen coordinates (Fig. 4), where the Shake'n'Tap keyboard shows fewer off-key taps. The heatmaps highlight that often errors occur due to users inadvertently registering touches inbetween keys.

Despite the difference in incorrect key-presses, Fig. 5 shows that the accuracy of the final entered phrases is similar for all groups ($p>0.05$, paired t-tests per age group). For the 50+ group, the number of incorrect key presses was almost double using the standard QWERTY keyboard: while the final phrase accuracy was similar, the older adults made less corrections as they typed with Shake'n'Tap.Fig. 6 shows that task completion time grew with age but that the Shake'n'Tap keyboard was consistently slower - paired T-tests confirm this ($p<0.01$ for all age groups). However, the difference is less extreme for the older adults group.

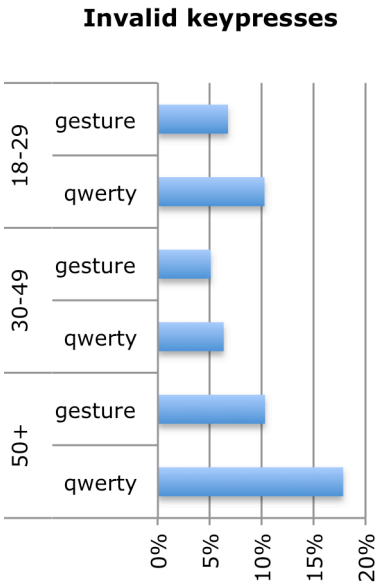


Fig. 3: Percentage of invalid keypresses

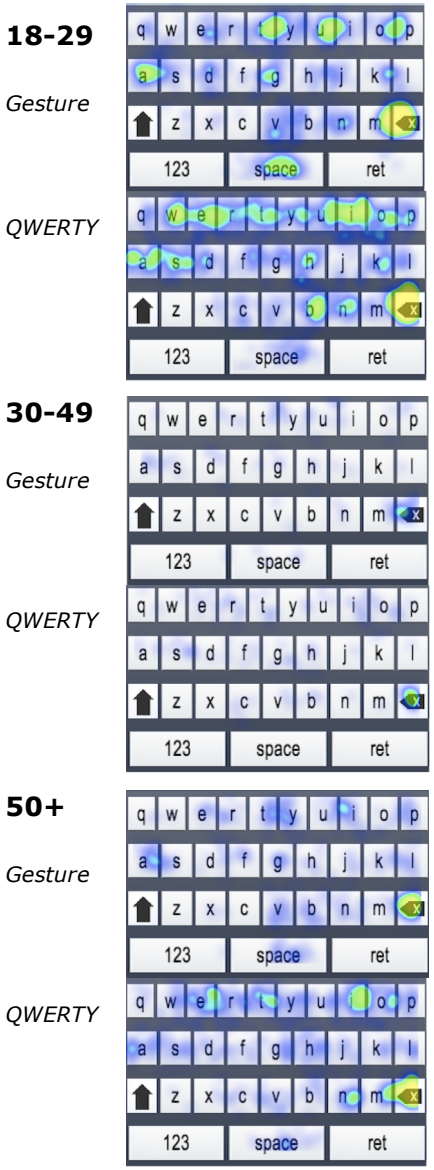


Figure 4: Invalid keypresses heatmap for the Gesture Keyboard

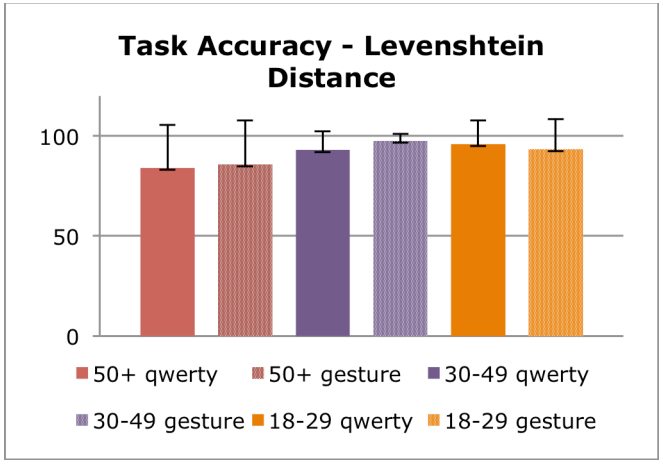


Fig. 5: Average task accuracy (Levenshtein distance)

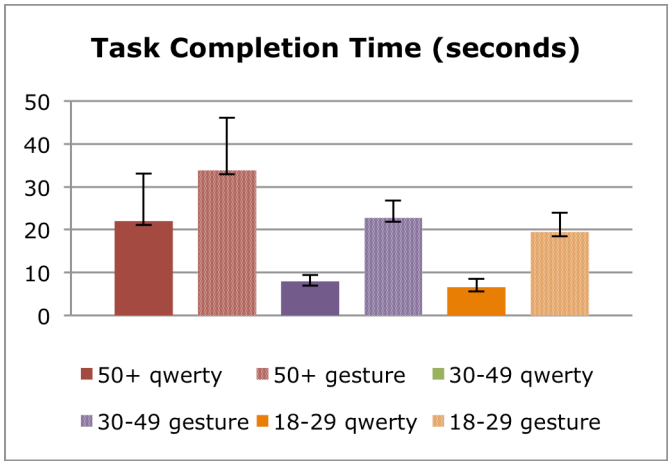


Fig. 6: Average task completion times

Participants were observed to carry out the gestures in a variety ways: a sharp shake with a forward motion; a side to side shake; a tilt of the device slowly left to right with a wrist turning action; and one participant turned the device close to 90° (which triggered the screen to auto-rotate). Those who used single finger text entry tended to perform the gesture using the same hand that they used to hold the device while entering text. For those using two thumbed text entry (2 participants) were observed to use both hands to hold the device as it the gesture was performed.

Subjective feedback is summarised in Fig. 7. Desktop touch-typists tended to state familiarity as the reason for their preferring QWERTY over Shake'n'Tap. While fewer participants favoured the Shake'n'Tap keyboard over the QWERTY keyboard, nearly all participants said that they learned to use it quickly and that towards the end of the study session they were no longer thinking about where the letters were, they just somehow "knew" which screen to be on in order to find the correct letter. A few said they were surprised by how quickly they got used to using the gesture after initial doubts and concerns when it was first demonstrated. Interestingly, the one participant who had not used a mobile phone before indicated a preference for the Shake'n'Tap keyboard, though he was certainly familiar with QWERTY on PCs and other non-mobile devices. Several participants regretted the absence of predictive texting in the application, however there were more who said they were relieved to see that they were not required to use predictive texting as they found it to be unhelpful in normal use.

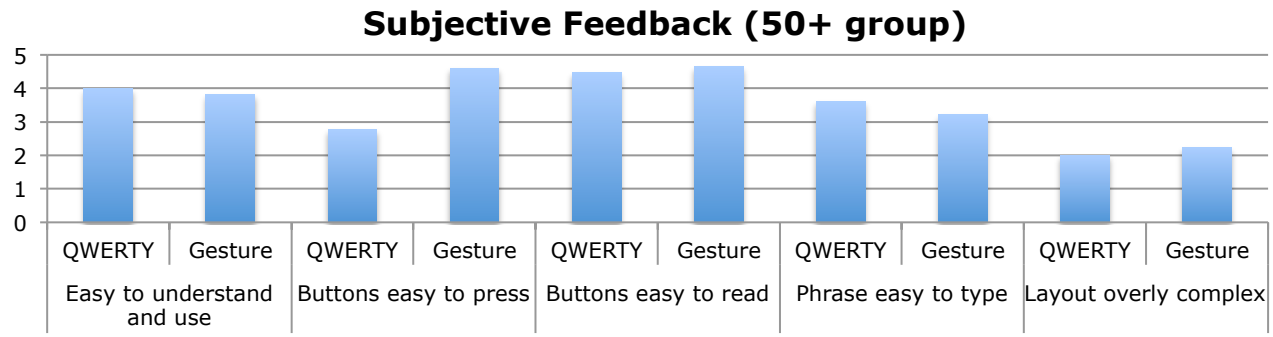


Fig. 7: Subjective feedback from the older adults (50+) group

Around half of the participants suggested making the device more sensitive to the shake gesture as they felt that the action currently required to carry out the gesture successfully was fairly vigorous.

Discussion

In this short paper we set out to design and evaluate a gesture based keyboard, that allows for larger key targets, in order to help older adults with accurate typing. In line with previous studies, our results showed that users were keen to complete input tasks accurately. With QWERTY keyboards, users were more prone to errors and the heat-maps show fewer areas of erroneous taps for the larger keyed keyboard. We also saw considerable use of the backspace key, as users strived to achieve the desired accuracy. The Shake'n'Tap keyboard succeeded in helping users type in more accurately, albeit at the expense of input speed. We expected, given the requirement for additional input due to the shake, that task times would be longer. For older adults, despite the longer task times with the Shake'n'Tap keyboards, subjective feedback did not indicate a preference for any of the two keyboard types. We did receive several comments regarding their willingness to learn to use the gesture keyboard style and confidence that their performance would increase with more practice. After refinement of the shake gesture and implementation as a full IME, we hope to conduct a further field trial that will allow users to take advantage of the Shake'n'Tap keyboard in real-life tasks, as part of longitudinal studies.

Another significant finding is the confirmation that text input is a significant problem for older adults. Our keyboard design is not optimal. However, it provides valuable insight at designing input methods for older adults. Our work shows that for this age group, multimodal interaction based on physical gestures is a viable option that deserves further exploration. Through the process of participatory design, we will, in the near future, investigate alternative designs involving physical and touch gestures as well as further investigate the speed / accuracy trade-off with this group and issues raised concerning predictive input / word suggestions.

Conclusions

Text input is core to much of our interaction on mobiles. In this study we confirmed that older adults are slower and less accurate entering text than younger adults: while many users find text entry on mobiles frustratingly inaccurate and slow, this is worse for older adults. Our study investigated the use of a double-width keyboard with a simple gesture to flick between sides of the keyboard. This provided larger target areas and was shown to result in significantly fewer mistypes by older adults. While younger users expressed a strong preference for the standard QWERTY layout, older users were more balanced between the two and found the larger keys easier to use.

Our initial design goal of avoiding predictive text and dictionary-based methods needs further investigation as this study gave contradictory feedback - some missed predictive technologies while some welcomed its absence. The studies also raised some methodological issues: there is long debate in mobile interface design as to whether laboratory based evaluation is valid. While our "quiet location" based studies gave valuable insights, issues concerning error correction strategy may be better evaluated in more natural locations. We plan to develop further prototypes in collaboration with groups of older adults with the aim of developing keyboards that can make a real difference to the input performance of an increasingly large percentage of the population.

Acknowledgments

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