Toward Comparing the Touchscreen Interaction Patterns of Kids and Adults

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Abstract
Touchscreen interactions are increasingly more commonplace with the mainstream adoption of devices like the iPad and iPhone. Kids are using their parents' devices for entertainment, learning, and discovery, but the interactions have not always been designed with kids in mind. In this paper we discuss the results of our explorations of differences between children and adults on a dataset of touch- and gesture-based interactions. We find evidence for significant differences and discuss how these can be considered in design.

Keywords
Touch Interaction, Gesture Interaction, Mobile Devices

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors, Design

Introduction
The proliferation of mobile devices in the 21st Century has led educators and researchers to investigate methods of utilizing them to provide personalized learning environments, games, and entertainment. As

mobile devices have transitioned from single-purpose communication devices to multipurpose tools for creating, sharing, and discovering, their users have shifted downward in age from adults to children. Though many children use mobile applications to support their learning and entertainment, the devices and underlying interactions were not designed explicitly for children. Based on data comparing use of mobile touch interaction in children and in adults, we present evidence that there are key differences in how children acquire touch targets and make gestures. We believe these differences must be considered in order to design the most useful and usable touchscreen interactions for children, especially for learning-oriented systems.

Related Research

The usability of pen and finger input gestures has been studied on a variety of platforms, from PDAs and mobile devices [9], to Tablet PCs and tablet computers [7, 8], to tabletop and surface displays [3, 5, 6]. Most of this work has examined adult users only. While some of these works have included children as users, researchers did not focus on identifying differences between children and adult users of such devices [6]. Other work has investigated children without also looking at adults, making it difficult if not impossible to compare adults' and kids' interaction patterns [3, 5]. Read et al. have conducted a suite of experiments to understand the ways in which children use stylus and touch interaction for *handwriting* input and how that differs from adults (e.g., [4]). Other work with children and gesture or touch interaction has focused on tabletop surfaces or tangible user interfaces [3, 5], and it is unknown whether similar findings will transfer to finger input on smaller-screen mobile devices.

Prior research on children's interactions with *mobile* applications has found that each interaction mode (e.g., touch vs. gesture) posed different challenges for the young users. For example, gestures requiring a single down event followed by a move event in one coordinated movement were difficult, as the children tended to use multiple strokes to complete what is expected by recognizers to be a single stroke gesture, such as a square [2]. Second, the young users' ability to accurately touch smaller targets varied, which resulted in the need for larger interface icons, thereby reducing the amount of information that could be displayed on an already small interface [2]. These findings form a good foundation but must be extended.

Data Collection

We collected a dataset from eight children and six adults in order to identify differences in touch and gesture interactions between children and adults. The children, between 7 and 11 years old, and the adults completed touch and gesture tasks using mobile Android applications developed for this study. For touch tasks, the application displayed squares (targets) of 100x100 pixels, 60x60 pixels, 40x40 and 20x20 pixels, and participants were told to touch the target. The targets presented varied between the four sizes and in position on the 320x480 pixels interface. The fusion of target size and its screen position classified touches as being easy, medium, hard or very hard (see Figure 1). For example, a 40x40 pixels target in the upper left corner was classified as *hard*, whereas a 100x100 pixels target in the center of the interface was classified as *easy*. For gesture tasks, participants were asked to use their finger to draw gestures on the device screen. Gestures evaluated included letters (e.g., A or Q) and geometric shapes (e.g., squares or triangles).

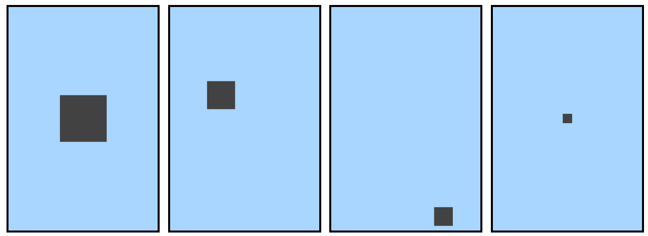

Figure 1: Easy, medium, hard and very hard targets.

Data Analysis

We have analyzed the dataset collected for characteristics of both touch and gesture interactions that differ between the children and the adults.

Gesture Generation

Figure 2 shows two typical example gestures from our study, one made by an adult (left) and one by a child (right). The child's gesture consists of 4 independent strokes, whereas the adult made the gesture in one smooth stroke. Furthermore, we determined that both the popular $N multistroke recognition algorithm [1] and the Microsoft Tablet PC recognizer are more accurate on gestures made by adults than by children in our dataset. For $N, a two-tailed paired-samples t-test indicates that the average recognition accuracy for each level of number of training examples is significantly lower for children than for adults ($t(9)=4.67$, $p<0.01$). We also found that children tended to generate gestures with more individual strokes than adults do ($t(128)=4.33$, $p<0.01$), which may be part of the reason the recognition accuracy is so much lower for children. Children also generate taller gestures ($t(128)=4.45$, $p<0.01$), more slowly ($t(128)=3.65$, $p<0.01$), and with less pressure per gesture ($t(128)=3.13$, $p<0.01$) than adults do.

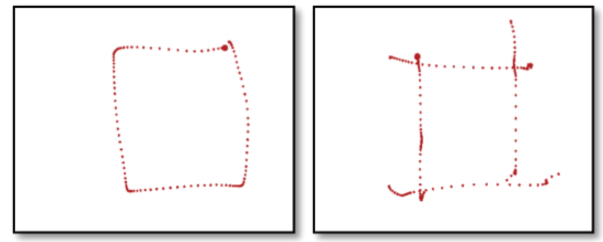

Figure 2: Examples of differences in gesture generation for adults (left) and children (right).

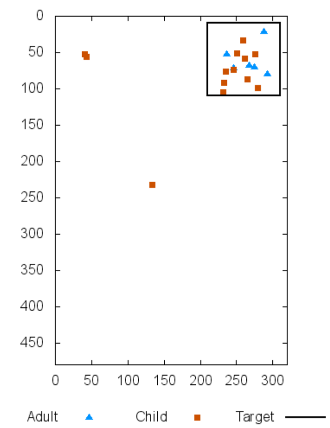

Figure 3: Examples of differences in touch target acquisition for children (squares) and adults (triangles).

Touch Target Acquisition

Figure 3 shows an "easy" target from the study and the positions of touches; in this typical case, more children (squares) missed the target than did adults (triangles). Over 43 touch targets varying in location and size, children's touches were not within the target 46% of the time, whereas adults only missed 32% of the time. Further analysis shows that both children and adults had the most difficulty with “very hard” targets, and while adults were most exact with the “easy” targets, children still showed relatively high levels of inaccuracy.

Discussion

Our data shows that key differences between kids and adults are present in touch target acquisition accuracy and gesture recognition accuracy, with potentially others yet to be discovered. We found that children tend to miss targets more often than adults, indicating a need for greater tolerance in location of touch corresponding to an onscreen target. We also found that modern recognizers perform worse on gestures made by kids than by adults, which may be partly due to children making gestures with inconsistent or unexpected numbers of strokes. This finding evinces a need for recognizers tailored to gesture features expected from children users. Based on our findings, we suggest that child-computer interaction designers relying upon touch and gesture interactions should take into account the inherent differences between the characteristics of child and adult touches and gestures. We intend to collect more data to ensure our findings are robust. With an understanding of these differences, designers can plan for them by modifying the recognizers or embedding error recovery strategies that are consistent with children’s interaction patterns.

Acknowledgements

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