Using Games to Practice Screen Reader Gestures

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Smartphones are shipped with built-in screen readers and other accessibility features that enable blind people to autonomously learn and interact with the device. However, the process is not seamless, and many face difficulties in the adoption and path to becoming more experienced users. In the past, games like Minesweeper served to introduce and train people in the use of the mouse, from its left and right click to precision pointing required to play the game. Smartphone gestures (and particularly screen reader gestures) pose similar challenges to the ones first faced by mouse users. In this work, we explore the use of games to inconspicuously train gestures. We designed and developed a set of accessible games, enabling users to practice smartphone gestures. We evaluated the games with 8 blind users and conducted remote interviews. Our results show how purposeful accessible games could be important in the process of training and discovering smartphone gestures, as they offer a playful method of learning. This, in turn, increases autonomy and inclusion, as this process becomes easier and more engaging.

1 INTRODUCTION

Smartphones changed the way people access information through services and how interactions with peers occur. While touch-based user interfaces can present significant accessibility barriers to blind or visually impaired users [9, 10], they created new opportunities for the development of ubiquitous assistive technologies. Nowadays, most smartphones come with built-in screen readers, such as Google Talkback[1] and IOS VoiceOver[2], which make smartphones generally accessible to blind people. However, for novice users, navigation and text-entry can be confusing and challenging to master [8–11, 15, 20], as it requires understanding the different gestures employed, often only overcome with the assistance of others [16]. Also, as users become acquainted, and more experienced using their smartphone, users do not necessarily become more 'expert' (e.g., aware of more efficient gesture shortcuts).

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[1]Google TalkBack. https://support.google.com/accessibility/android/topic/3529932?hl=pt&ref_topic=9078845 (Last visited on April 13th, 2021)
[2]IOS VoiceOver. https://www.apple.com/accessibility/ (Last visited on April 13th, 2021)

To interact accurately, touchscreen gestures must be performed according to a certain convention that has to be learned (e.g., speed, length, angular direction) [14]. Learning how to perform gestures correctly may be especially difficult for users with visual impairments. While sighted users may learn to perform gestures through observation of other users, video, in-application tutorials, or visual feedback provided from the applications, these are generally not available in accessible format [14]. Gestures are also not easily discoverable [17].

Prior work has investigated how to learn [14] and perform gestures on touchscreens [6, 9, 12]. Oh et al. [14] suggest that sonification and corrective verbal feedback can be useful for helping blind users to replicate a variety of gestures, such as taps, swipes, shapes, multistroke and multitouch gestures.

Similar to how the first computer games (e.g., Minesweeper) were designed to teach users to interact with personal computers [13], we envision mobile games as a means to practice and discover smartphone gestures. By embedding gesture discovery and practice into mundane interactions, through entertainment, one can enhance learning, performance tracking and system adaptation. Our focus is on smartphone use by blind users, specifically in the gestures involved in the use of Android's TalkBack.

2 TESTBED GAMES

Video games are mostly inaccessible, heavily relying on visual feedback. Audio games are games in which the user interface and game events use primarily sounds instead of graphics to convey information to the player [1–3, 21, 22]. We set out to design a set of mobile audio games that could enable gesture training and discovery for users of varied experience and expertise. The gestures used in each game mimic TalkBack's gesture recognition.

We created three games, each focused on practicing a gesture or set of gestures. In *Jump Rope*, a regularly timed sound cue of a rope hitting the ground is played and the player has to react in time and jump, by performing a double tap (used in TalkBack to activate a focused element). In *Rocket*, the player controls a spaceship and has to swipe left or right (used in TalkBack to navigate between items) to shift position between lanes, dodging enemies and catching bonus points. In *Goalkeeper*, the player is part of a soccer team and must defend penalties from the opposing team, by performing directional gestures (including left, right, up and down swipes, L-shaped, and back-and-forth gestures).

We purposefully designed games with short play sessions suited for mobile gaming and quick breaks. Importantly, we sought to design games where gestures could be intuitively linked with their game effect to facilitate understanding of its requirements of speed and precision. For example a double tap is associated with the user jumping rope, and each tap with lifting a foot. In such a way, the requirements of the close timing between taps becomes quickly apparent to enable the user to jump instead of tripping.

We used Unity to develop the prototypes and Amazon Polly web service to produce the speech used on menus and tutorials. Games are available at Google Play Store only in Portuguese[345].

3 PRELIMINARY STUDY

We conducted a remote user study with blind smartphone users. Participants had to play the three games and take part in a remote debriefing interview about their perspective on the games, smartphone usage, and gesture learning process. Our goal was to better characterize how games can be leveraged to potentiate training and discovery of touch-based gestures in smartphones.

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[3]Jump Rope. https://play.google.com/store/apps/details?id=com.FCUL.Corda
[4]Rocket. https://play.google.com/store/apps/details?id=com.FCUL.SpaceShooter
[5]Goalkeeper. https://play.google.com/store/apps/details?id=com.FCUL.GuardaRedes

Participants. We recruited 8 participants (P1-P8) aged 7-63 (M=36.8; SD=17.3). P3, age 7, participated under the tutelage of his father (F1), who also played the games, mediated, and participated in the interview. All participants are legally blind and screen reader users with the exception of the father, who is sighted.

Procedure. Each participant had access to the games for five days, and was asked to complete the tutorial and play at least 5 times each game. The games were embedded with logging capabilities collecting play sessions and game scores. After the five days, they took part in an audio-recorded remote interview of approximately 20 minutes. In the interviews, we delved into a conversation focused on the games, their potential for gesture teaching and training, and their experience with smartphone usage. The study was IRB approved by our school's ethics committee.

Data Analysis. Interviews were transcribed and analyzed, following an inductive thematic analysis, as proposed by Braun and Clarke [4]. We started by iteratively reading the data, and annotating recurring ideas. We generated a set of initial codes, which were then discussed among the authors and revised. Three researchers, in a remote call using a blank canvas, identified relationships, discussed examples (quotes and quantitative data), and rationalized themes.

4   RESULTS

Game sessions for *Jump Rope* lasted an average of 31 seconds (SD=15.7, MaxTime=125s), for *Rocket* for an average of 14 seconds (SD=14.3, Max=77s) and for *Goalkeeper* an average of 46 seconds (SD=19.2, MaxTime=105s). There were a total of 156 play sessions on *Jump Rope* (Min=4, Max=78), 197 for *Rocket* (Min=4, Max=62), and 192 for *Goalkeeper* (Min=2, Max=102). P3 was our most active participant with 208 play sessions, followed by P5 and P4 with 101 and 96, respectively. P6 had the least with only 15.

Discovery & Training. The games were regarded as a potential entry point for novice users to get acclimated with touch-based interaction, and an asset in training performance and discovering gestures that are unfamiliar. P6 mentioned how computer games are also important to novice users when learning to use the keyboard: "*[...] to start conceiving the mental image of the keyboard, there are games that encourage this. And here, I think it is the same*". In the words of P8, games can be "*a way for people to internalize information without thinking they are studying*". Similar to the games proposed, P8 mentions how analogies help, giving the example of how he usually explains swipes to other users: "*I usually say it's the gesture of... it's like a plane landing momentarily and getting up again. [...] Sometimes you need to find these strategies for the person to associate*".

Improving expertise. For experienced users, the games confronted their knowledge of more advanced ways of navigating on the smartphone: "*Users, even the most experienced, end up learning something*" (P2). For instance, while familiar with L gestures, P1 and P5 were unsure of their function in TalkBack. P4, in particular, suggested that future games could include more complex gestures, giving the example of left-right-down swipe to open the notifications, highlighting the discovery potential of the approach: "*Maybe those can be used in another game*".

Autonomy & Skill Development. F1 explained how he would introduce his son (P3) to more technologies and platforms by encouraging him to try applications and games, even when these are not totally accessible: "*The fact it explores his fine dexterity, sound perception, is what we are looking for.*". Similarly, F1 was pleased with the fact that the games developed in this study would also lead his son to feeling more autonomous when using the smartphone, and how he would show himself engaged, by spontaneously asking to play: "*These games, I noticed they were already an asset in the sense of exploring gestures and doing that with extreme ease*"; "*I simply start the game for him and then he goes to the options he wants [...] and keeps playing at will. [...] The fact he asks me at the end of the day, after school chores, [...] asks me to play the three games, it makes me happy*".

Learning transfer. Participants, being highly accustomed with navigating the smartphone with Google TalkBack, explained how intuitive the gestures felt to them, discussing how the training of gestures in the games can be important to interact with the smartphone outside the games. However, it was pointed out that the games do not help the user to understand their role in the navigation of the device. While the games comprise a compendium in which the function of the gestures in TalkBack is explained, most participants did not notice this menu. P1 suggested the explanation of the gestures should be highlighted: "*The only thing I would try to improve in the three games would be to put the explanation of the gestures in the menu*".

5   OUTLOOK

In our study, the possibility of using games as a method for practicing and discovering gestures was highlighted, particularly for less experienced players. For three participants (P3, P4 and P5) the games were highly engaging as evidenced by the over 90 individual play sessions. While this highlights the value of the games as an entertainment product, it also highlights their potential as a pervasive tool to boost and augment learning purposes.

The educational potential of games is recognized in industry and research, reflected in the increasing interest in serious games for education and training [5, 7, 18]. However, while purposeful games are designed to train or educate, most times they are not designed to actually be entertaining. Like the aforementioned example of Minesweeper, while not explicitly serious, was shown to be an effective tool to introduce the computer mouse to novice users [13]. Notably, Ludic Design for Accessibility highlights the central role playfulness has across various learning experiences of people with disabilities and how it can be leveraged in the design of accessible technologies [19]. Unlike gamification approaches that rely on incentives (e.g., badges, money) to achieve a specific goal, ludic design frames extended play as naturally enabling skill acquisition and long-term learning.

Our findings suggest that accessible mobile games, designed specifically for players to intuitively associate the gestures required with the game effects (i.e. using analogies to facilitate learning) are perceived to be effective tools for gesture training regardless of user expertise. In addition, if this type of games become intertwined and offered by screen reader providers they have the potential to monitor gestures allowing screen readers to dynamically adapt their recognizers and other customization options.

Our games were not able to clarify the relationship between the gestures that were practiced on the games and their function on Google TalkBack, thus having only an effect on the general knowledge about their use and not their concrete function. We realized how the learning transfer would be enhanced, if an explanation was more explicit in a menu, somehow embedded in the gameplay, or even if the mechanics were directly connected with the function of the gesture in TalkBack (for example, in a fighting game having the L gestures opening a list of contextual 'special attacks').

Games can be leveraged to promote repeated interactions which can lead to higher proficiency and autonomy with technology. We developed three games intended to represent and increase in difficulty and expertise of the touch-based gestures required. While we considered users from novice to experts, we did not consider other differences that we believe need to be further explored. A game to help children learn how to use TalkBack will be different from one that targets older adults who are picking up a smartphone for the first time. Games can be leveraged to lower the barrier to entry, and promote users to acquire new expertise that without it are hidden in advanced tutorials for screen reader use.

Our results showcase the potential of developing games purposefully and suggest that by designing and embedding this type of games with screen reader technology we can 1) lower the barrier to entry; 2) promote improving user expertise; and 3) monitor user gesture performance enabling dynamic (and automatic) personalization of screen reader features and touch recognizers.

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