

# Perceptions of Mobile Device Authentication Mechanisms by Individuals who are Blind

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## ABSTRACT

This paper describes an exploratory study focusing on the methods of mobile authentication currently utilized by individuals who are blind. Perceptions of security are discussed, along with the trade-offs with usability and accessibility. A tactile aid for a mobile authentication interface was introduced to participants to obtain preliminary feedback on its design. The aid was found to offer promise for supporting orientation, which could be used support novice users, and provide assistance when the mobile device must be used privately in public spaces.

## CCS Concepts

CCS → Human-centered computing → Accessibility → Empirical studies in accessibility.

## Keywords

Authentication; Blind; Mobile Devices; Security; Tactile;

## 1. INTRODUCTION

Authentication mechanisms are often used to secure access to mobile devices, where personal and sensitive data may be viewed or stored. While PINs and graphical patterns (prescribed sequence of on-screen strokes) can be entered quickly into mobile authentication interfaces, the predominantly graphical nature of these interfaces can pose challenges for individuals who are blind. Difficulties can in part be attributed to the limited nature of assistive technologies. Furthermore, challenges can be faced identifying the threat of observation attacks when interacting with authentication mechanisms.

In this paper, we describe an exploratory study examining the perceptions of current authentication mechanisms, focusing solely on mobile authentication interfaces. A mobile tactile aid, originally proposed for eyes-free interactions [6], was also evaluated with individuals who are blind to determine its potential for supporting orientation when authenticating entry.

## 2. RELATED WORK

Researchers have begun to explore issues of privacy and security among individuals who are blind, which may impact their interactions with technologies [2,4]. While users are able to log-in using PINs in conjunction with assistive technologies such as

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Voiceover, and are able to mask content from the screen using built-in functionality, studies have suggested that users are unaware or not concerned about potential security threats, limiting their use of password-protected screen locks [2]. Limitations of assistive technologies have been found to impact non-visual authentication [4], as time can be spent attempting to input data and verify system status. Furthermore, interfaces which are largely graphical in nature (i.e. pattern unlock screen) are difficult to use with screen readers, as positional information can be challenging to convey through audio.

Technologies have been proposed to support individuals who are blind with the process of authentication. Examples include the use of on-screen taps which can be entered with one or more fingers [2]. The solution limits the risks of visual or aural eavesdropping. Accessible password managers have also been designed to limit help users deal with complex password policies and a large number of online accounts [3]. However, further work is needed to improve access to existing authentication mechanisms. In this paper, we describe a study focusing on the perceptions of mobile authentication interfaces by individuals who are blind, and introduce an assistive tool, designed to support users when entering PINs and graphical patterns.

## 3. SEMI-STRUCTURED INTERVIEWS

Semi-structured interviews were conducted with three legally-blind users, all of whom relied on the use of assistive technologies for interaction with their mobile devices (Table 1). The participants, all of whom described themselves as intermediate to advanced mobile device users, were asked about their experiences with authenticating entry to mobile devices, and questions related to privacy and security during this process.

Table 1: Participant demographics

	Sight status	Sex	Age range	Preferred assistive technology
P1	Legally-blind (No vision)	F	21-30	TalkBack (Android)
P2	Legally-blind (Light perception)	M	31-40	Voiceover (iOS)
P3	Legally-blind (Some vision)	M	21-30	Magnification with some use of TalkBack (Android)

P1, a fully blind user, preferred not to lock her Android device. She took this approach because unlocking methods were “too difficult to manage routinely”. While she had experience entering PINs, time would be spent listening for auditory feedback from the screen reader during this process. Errors could be made on occasion (if the finger slips), which could be both frustrating and time-consuming if re-entry was needed. In contrast, the other participants were very enthusiastic about using fingerprint authentication, as this was faster and more reliable than making PIN entry attempts. Fingerprint authentication, however, still required occasional PIN entry as a backup. Both P2 and P3

highlighted that they had spent time and effort learning the spatial position of digits on the PIN entry screen, to help them more accurately locate digits for entry.

P3 had also linked his device-based biometric reader to a password manager, allowing the fingerprint to quickly unlock both the device and authorized applications. Entering alphanumeric passwords was “otherwise always a hassle.” P2 who had greater levels of vision available in the past, had interacted with the pattern unlock screen, but had not felt secure when using simple patterns in public places or in unfamiliar surroundings. P3 was aware of the benefits of using stroke-based patterns, but felt that these would be challenging to perform consistently with assistive technologies.

All participants were aware of potential threats around them. For example, P1 was concerned about her passwords or other secure details being overheard by others, especially in a closed vehicle. While the volume of her screen reader could be reduced or headphones could be used to minimize the likelihood of a threat, these actions impeded her hearing for other purposes. However, because she felt that she “could not defeat these risks” she was content to leave her phone unlocked, and instead limit sensitive information stored or accessed via her phone.

#### 4. TACTILE AID STUDY

Tactile aids have shown promise helping visually impaired users explore mobile and touchscreen interfaces [5]. We examined whether an assistive tactile aid could support spatialization of two common mobile authentication types, PIN and 3x3 graphical grid patterns. Two web-based mockups of these interfaces, with a tactile aid feature, were presented to participants. When using the aid, tactile cues indicated when the pointing finger touched grid or PIN buttons, prior to starting to enter the passcode. To further help spatialization, the vibration pattern differed at the location of the first digit of the passcode to be entered. This aid intended to help a visually impaired user find interface landmarks, prior to entering a passcode. Standard tactile cues for button selection were also presented during authentication. Participants were asked to explore the interfaces and offer feedback, and to determine if it could realistically support blind users. They were also asked to enter in sample PINs and patterns of four and six-digit lengths.

#### 5. PRELIMINARY FINDINGS

Responses from participants indicated that the tactile cues clearly informed them of the starting point of a PIN entry attempt, and the vertical and horizontal edges of the interfaces. Cues were presented passively and offered the benefits of discretion, without the user drawing unwanted attention from others, or needing to cede their broader situational awareness by needing to wear an audio headset. Presenting information relating to the starting point was thought to offer promise to novice users, who were not used to identifying targets on the numberpad interface, or who may easily lose position and find it difficult to reorient on the interface. However, further cues may be needed to continuously support the user while entering the remainder of the PIN. P3 also demonstrated that using his current mobile device with assistive technology, unique audio cues are presented when the finger leaves the numberpad area while entering a PIN, which can assist a distracted mobile user. A tactile version of this feature was suggested for the app.

Participants felt that for users who had been utilizing smartphones for a while, the screen was so well mentally-mapped out that tactile feedback may only be beneficial under certain

circumstances. For example, in scenarios where headphones had been forgotten and discretion was needed, or in situations when the device was in a non-intuitive position (e.g. the phone at an angle in a pocket or bag, as the user may want to maintain privacy of the interaction, as described by [1]).

Mixed responses were received regarding the aid when interacting with the pattern unlock interface. While tactile feedback was found to be helpful, P3 was able to enter grid-based patterns with a 52.3% rate of accuracy (SD=0.31) in ten grid entry attempts using the aid. Further work will be conducted to investigate ways to support user awareness of where strokes have been made on the interface, to better support users when entering/ checking patterns.

#### 6. CONCLUSION AND FUTURE WORK

This paper has described a preliminary study examining perceptions of mobile authentication mechanisms, and the use of a tactile aid to support spatialization and orientation when using PIN and graphical patterns. A study is currently in progress examining use of the applications in situations where the screen cannot be observed, to better understand means of supporting accessible authentication under these conditions. The results of this should inform more secure and usable authentication designs for blind users. As the next step in the research, we aim to modify instances when tactile feedback is presented when performing authentication interactions to determine whether greater assistance can be provided to the user.

#### 7. ACKNOWLEDGMENTS

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