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Introducing Mobile Device-Based Interactions to Users: An Investigation of Onboarding Tutorials

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Abstract. Various built-in sensors enable interacting with mobile devices beyond the screen. So-called mobile device-based interaction techniques are characterized by movements and positions in real space, e.g. twisting the device to switch between front and rear camera or pouring photos from one device into another for sharing. Although interactions should be as intuitive as possible, it is often necessary to introduce them, especially if they are complex or new to the user. Applications have to present interactions appropriately so that users can understand and use them easily. We conducted a user study to investigate the suitability of onboarding tutorials for mobile device-based interaction techniques. Results show that these types of tutorials are insufficient for communicating mobile device-based interactions, mainly because of their spatial and tangible characteristics but also their collaborative and representative interdependencies. Based on this, we propose suggestions for improving the design of tutorials for device-based interactions with mobile phones.

Keywords: Onboarding tutorials · device-based interaction · gestures · mobile phones.

1 Introduction

Current mobile devices, such as smartphones and tablets, innately provide numerous sensors, for example, accelerometer and gyroscope for sensing motions as well as orientation sensors or magnetometers for determining positions. Thus, mobile devices can cover a wide range of interaction techniques. Touch sensors of screens enable conventional input methods using multitouch. And also gestures that are invoked by deliberate device movements become increasingly available.

Interactions where devices act as physical interface without using the screen content directly are summarized to mobile device-based interaction techniques [14]. They can support users in a wide variety of single and multi-user situations: to interact with the mobile device as unobtrusively and discreetly as possible, e. g. facing the device's screen downwards to mute incoming calls, message alerts,

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alarms and media[1] during a meeting; to interact with distant interfaces, e. g. transferring data from a mobile device to a large display by performing a throw gesture [25]; to enable quick access to device functions without the need to push buttons or look at screens, e. g. twisting the device to switch between front and rear camera[2]; or to facilitate different multi-user tasks [18] for collocated collaboration with multiple mobile devices (e. g. [12,15,17,22]).

Although interactions should be designed as intuitive as possible, users need to learn them, because there is no commonly agreed-upon gesture set existing [23] and the development of interaction techniques is still going on, e. g. [4,6,13,26]. Thus, applications have to introduce interactions appropriately, so that users can understand and learn them easily. Tutorials support users in learning application functionality and interaction during the normal application flow or at the first start of an application, so-called onboarding tutorials. Design guidelines suggest that type of tutorial as effective especially for unfamiliar interaction [11,29]. Three main aspects influence interaction learning directly [10]: How to start the interaction? What movement do I have to perform? Which function is it mapped to? Most applications provide onboarding tutorials to introduce users to the app functionality, navigation and interaction. Such tutorials mainly use visual metaphors to impart interaction knowledge. But what if interactions base on movements, orientations and/or distances between two or more devices in real space such as described in the examples above? Are users still able to understand the interactions easily with provided visual explanations? To our best knowledge, no existing research investigates the suitability of tutorials for device-based interaction techniques. To address this issue and answering the questions above, we implemented a simple interactive prototype with preselected mobile device-based interactions in a collaborative scenario. As first step, we started with an investigation of onboarding tutorials as they are common for introducing mobile applications to understand potential problems and identify important aspects for users. Therefore we created onboarding tutorials which orientate on common design practices. With that prototype, we conducted a user study to investigate the suitability of such tutorial presentations for mobile-based interactions.

After giving an overview of related work, we present our study approach including the tested onboarding tutorials. Based on the results, we propose recommendations for improving the design of tutorials for device-based interaction techniques with mobile devices that base on spatiality and tangibility. We conclude with planned future work and a summary of our presented work.

2 Related Work

In recent years, there has been a lot of research on novel interaction techniques for mobile devices. These works show the specific characteristics of mobile-based interaction and also provide specific techniques for concrete interaction tasks.

[1] *Easy Mute* feature: https://www.samsung.com/ca/support/mobile-devices/what-are-the-advanced-features-available-on-my-galaxy-note8/

[2] *Flip camera* gesture: https://support.google.com/nexus/answer/7443425

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Moreover, there exists research and common practices on how to design tutorials for mobile applications. As mid-air gestures also deal with interactions beyond the visual screen content, we also present related work on tutorials for these type of interactions.

2.1 Mobile Device-Based Interaction Techniques

Mobile interactions beyond the visual screen content are characterized by motions in real space [2]. They therefore rely on using one or more built-in sensors, e. g. accelerometer [30]. Regardless of technology, research describes single-device interactions where smartphones act as physical interface that involves moving the device directly [19,27]. Chong et al. [3] classify mobile interactions in real space to connect different devices to *guidance-based* interaction techniques. Moreover, the design principles of Lucero et al. [21] extend personal mobile usage to a shared multi-user usage. A combined view on mobile device-based interaction techniques is given by Korzetz et al. [14]. They propose a model for guiding the design of mobile-based interactions with a physical focus for individual as well as collaborative use. They also point out information that is relevant for users to understand how to perform interactions, categorized by spatiality and tangibility. We use this for our investigation on the suitability of onboarding tutorials for mobile-based interactions.

2.2 Tutorials for Mobile Applications

Mobile applications should provide tutorials to introduce the application to users and to demonstrate how it can be used in terms of features and interaction [9,11,29]. As printed documentation and online help is assessed as largely ineffective (e. g. [24]), tutorial guidelines suggest to use visual instructions for graphical user interfaces rather than non-illustrated, e. g. [8] – regardless of still or animated. However, non-visual tutorials can be meaningful, too, e. g. for user groups with special needs like visually impaired people [28]. Tutorials can support users during the normal application flow, e. g. by providing instructional overlays and coach marks [7,9]. In contrast, onboarding tutorials are presented at the first start of a mobile application to introduce features and interaction. Especially for unfamiliar interactions, onboarding tutorials are rated as an effective tool [11,29].

2.3 Tutorials for Mid-Air Interactions

Our work aims at investigating tutorials for spatial and tangible interactions beyond visual screen content. *ShapelineGuide* [1] is a dynamic visual guide for teaching mid-air gestures to interact with large displays. The guide supports users during executing gestures. Timing of gesture guidance is also an important question [5]. As first step, we concentrate on evaluating common onboarding tutorials that are presented at the first application start. Ismair et al. [10] address

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the revelation of mid-air hand-poses and the teaching of their command mapping (focus on hand poses) by showing line figures which the user has to mimic with the hand. The MIME approach requires little on-screen space because the figures can be integrated in existing interface elements, but is limited to hand gestures and gestures which can be mapped to iconic poses. *ActionCube* [20] is a tangible mobile gesture interaction tutorial which associates user movements tracked by the device accelerometer to the movement and deformations of a 3D object displayed on the screen. This approach helps to understand the effects of acceleration, but not how to perform concrete gestures.

To our best knowledge, no existing research investigates the presentation of onboarding tutorials for device-based interaction techniques, i. e. interaction techniques for mobile devices with spatial and tangible characteristics in real space. We address this issue by evaluating a common onboarding tutorial for introducing device-based interactions to users.

3 Studying Onboarding Tutorials for Mobile Device-Based Interactions

The main goal of our user study was to investigate the suitability of an onboarding tutorial for mobile device-based interaction techniques. Using such a common type of tutorial allows for a fundamental valuation of specific characteristics that are important for tangible and spatial interactions. We collected data from questionnaires after performing tutorials describing various interaction techniques and a semi-structured interview at the end of the user study. Furthermore, the participants were observed during the study. In the following, we describe participants, the interactive prototype including the onboarding tutorials, our procedure as well as the study design to answer the following research questions (RQ):

- RQ1: Are common onboarding tutorials suitable for mobile device-based interaction techniques?
- RQ2: Which information do users need to understand that type of gestures with mobile devices?
- RQ3: What can we derive for future development of tutorials for mobile device-based interaction techniques?

3.1 Participants

We recruited 32 unpaid participants (12 females) from age 18 to 51 (M = 31.2, SD = 6.4) via email or personally. 23 participants stated that they use smartphones on a regular basis for standard applications. Only 2 participants do not use smartphones often in their daily life. Only a few participants had experience in interaction design or HCI. Most participants had an academic background. We divided the participants in 8 groups with 4 people each since we utilized the interactions for a collaborative scenario and wanted to investigate how participants support each other in learning new interaction techniques. To avoid

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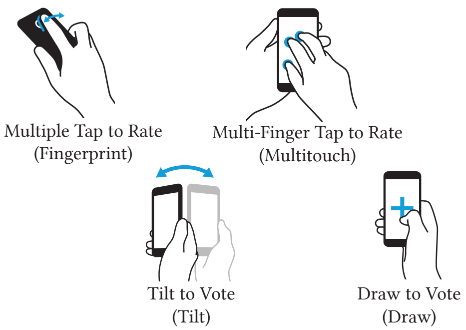

Mobile Device-Based Interactions	
Fingerprint	the number of taps on the fingerprint sensor corresponds to the user rating
Multitouch	the number of simultaneous touch points defines the rating score
Tilt	tilting forwards or sideways to accept or reject like „nodding or shaking the head“
Draw	drawing a plus or minus on the screen to accept or reject

Fig. 1. Examples of device-based interactions – anonymous voting and rating for collocated collaboration with mobile devices.

inhibitions while interacting with each other, we created the groups with people who already knew each other. We wanted to find out to what extent observing other participants while interacting influence their own interaction performance.

3.2 Apparatus

Interactive Protoype. To perform the user study we implemented an interactive prototype for Android devices. In order to gain insights into the usage of common onboarding tutorials for mobile device-based interaction techniques, we utilized interaction techniques for a collaborative scenario in which collocated users want to vote and rate anonymously (according to Kuehn et al. [16,17], see Figure 1). The interactions *Multiple Tap to Rate (Fingerprint)* and *Multi-Finger Tap to Rate (Multitouch)* are used for rating content, the number of taps on the fingerprint sensor or the number of simultaneous touch points on the display corresponds to the rating score. *Tilt to Vote (Tilt)* and *Draw to Vote (Draw)* is used for giving votes anonymously: Tilting the device forwards or sideways means accepting or rejecting displayed content, drawing a plus or a minus on the screen also stands for accepting or rejecting. The interactions use different device sensors (fingerprint, multitouch, accelerometer and gyroscope), are lightweight and base on metaphors (e. g. nodding/shaking the head, making a cross).

We utilize these interaction techniques for our user study for two main reasons. First, they address the characteristics of mobile device-based interaction techniques. Especially, tangibility and spatiality are very pronounced, whereas individual and collaborative use cases are implicitly included. The second reason is that the interactions can be embedded in one overall scenario which we assume is more comfortable for users to act in. We aim at keeping the workload low in terms of the implemented scenario that is why we implemented a realistic scenario to apply all interactions. The scenario comprises a digital painting exhibition with several pictures that can be assessed anonymously using the newly learned mobile device-based interaction techniques. The Android application contained questionnaires for the tutorial and the interaction techniques.

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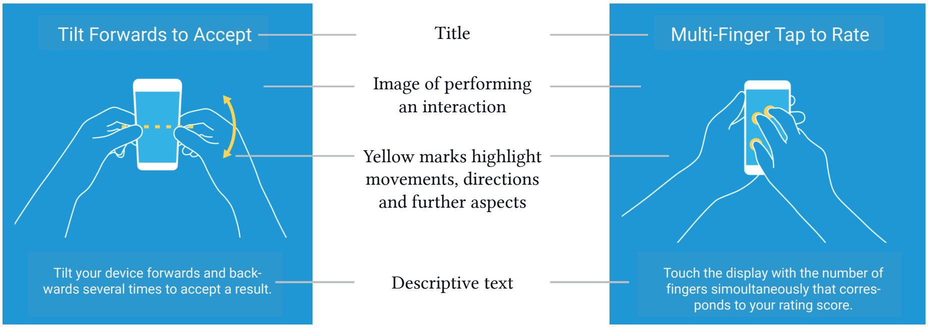

Fig. 2. Two examples of the tutorial that describes *Tilt to Vote* (left) and *Multi-Finger Tap to Rate* (right) and highlights main characteristics of this interaction techniques.

Furthermore, the application included a help function if users had problems performing an interaction as well as instruction text to work through the application autonomously. We provided device feedback in the form of vibration in case of a successful recognition and errors. The application logged all given answers to the questionnaires as well as all performed interactions when detected and the given rating and voting results. Furthermore, in case an error occurred, the application also logged this kind of data.

Onboarding Tutorials. We created a tutorial for each mobile-based interaction of the prototype to describe them properly. The tutorials orientate on common practices for tutorials [9,29] and were refined during several iterations. Figure 2 shows examples of our tutorials for the *Tilt* interaction technique and the *Multitouch* interaction technique and their main characteristics. To facilitate understanding of details to perform the gesture and the purpose of each interaction, each tutorial concentrates on the tangible and spatial characteristics as proposed by Korzetz et al. [14]. Each tutorial consists of one or two pages to show and explain different interaction phases, e. g. multimodal feedback. A clear and brief description communicates the key concepts and also includes a short title to name the interaction. The title is used to refer to the interaction during the user study. Furthermore, an image illustrates how to hold the mobile phone and how to perform the interaction. Yellow marks highlight specific characteristics such as movements and directions. Additionally, a short text describes the performance of the interaction in written form.

3.3 Procedure

After the participants arrived in our lab, we explained the global procedure of the user study. Then, the participants chose one of four provided mobile phones (two Google Pixel and two ZTE Axon 7). They started the provided Android application that described the participants' task and introduced the four mobile

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device-based interactions in a permuted order using the tutorial. Participants had to read the tutorial before trying the respective interaction. We asked the participants to either rate or vote pictures. In the first phase, participants were concretely asked to use an interaction (e. g. "use tilting to accept or reject the picture"). In a second phase, participants could choose on their own which interaction they use for the given tasks. After each described and tested interaction technique, participants completed a digital questionnaire within the mobile application concerning the tutorial and the usage of the interactions. The study leader observed the participants during the study concerning participants' statements, their prototype usage and performing interactions, e. g. execution speed or holding the smartphone.

3.4 Design

In order to answer the above-mentioned research questions, we realized a within-subject design with the tutorials of the several device-based interactions as independent variable. The dependent variable was the execution error. We further collected quantitative data by means of a digital questionnaire after introducing and using the interactions. Additionally, we collected qualitative data from observations during working with the interactive prototype, the prototype protocols as well as during semi-structured interviews. To avoid learning effects, we varied the testing order of introducing the interactions.

4 Results

We received interesting insights from the user study concerning the usage of the tutorials to get to know new mobile device-based interaction techniques. For analyzing our data, we used observation notes and logging protocols from the implemented application. These protocols included performed interactions and resulting errors as well as the completed questionnaires. With 32 participants and 4 different interactions, we received 128 responses for the questionnaires concerning important information in the tutorials. In the following, we describe our main findings.

4.1 Execution errors

To gain an overview of how the participants could execute the interactions, we first evaluated the error rates for each interaction. From the logging files we received concrete numbers of errors while performing the rating interactions with 245 errors for *Fingerprint* (M = 7.7, SD = 10.3) and 140 errors for *Multitouch* (M = 4.4, SD = 6.8). The high standard deviations (SD) show that participants either had particularly little or many execution problems independent of the interaction as the effect of interaction technique on the execution error was not statistically significant ($F_{1,31} = 2.691$, $p > .05$). The most frequent error while using *Fingerprint* was that participants performed it too fast (126 of 245).

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Consequently, the fingerprint could not be recognized and the interaction failed. We will improve this issue in future interaction implementations. Other reasons were a wrong rating within the tutorial (44 of 245), fingerprint could only be recognized partially (19 of 245), too many failed attempts (6 of 245) and other technical reasons (50 of 245). *Multitouch* faced the same most frequent problem in terms of execution speed (125 of 140). Participants moved their fingers too fast from the display so that the number of fingers could not be recognized properly. The remaining errors were wrong ratings within the tutorial (15 of 140).

From the observations during the user study, we received insights on problems performing *Tilt* and *Draw*. Derived from the observations, the *Tilt* interaction most often failed because participants were insecure concerning the execution speed and the exact movement of the device combined with holding the mobile phone. Participants tried several ways of tilting and thereby made some comments regarding to interaction execution. Although, these characteristics were described in the tutorial, participants could not apply them easily. Overall, *Draw* failed least. Errors occurred because the strokes were not recognized properly either because participants used the wrong interaction, e. g. they drew plus instead of minus, or because the device did not detect the interaction correctly. From the partially high error rates, we derive that common tutorials do not address spatial and tangible interactions well (RQ1). As a result, the way of describing execution speed and movements for mobile device-based interactions like *Fingerprint*, *Multitouch*, *Tilt* and *Draw* should be reconsidered. Overall, the error rates were relatively high during onboarding, so that we assume imparting interaction knowledge should be improved within app tutorials for device-based interactions. To better understand the users' needs concerning learning mobile-based interactions, we evaluate the timing of tutorial access and asked for helpful information types.

4.2 Help function and repetition

Within the whole application participants were allowed to use a help functionality in the right upper corner that was marked with a question mark. Out of the 32 participants, one person used the help function for the *Draw* interaction whereas 2 participants needed help for *Multitouch* and 6 participants for *Fingerprint*. They all used the help function only one time each. For *Tilt*, 12 participants made use of the provided help, 6 persons even several times (up to 4 times). These results indicate that the more unknown or unusual interactions are the more information participants need. This impression is confirmed by the following observation: After performing the tutorial, participants could repeat each interaction technique. From the logging files we found that 3 participants each used the opportunity to repeat the interactions *Fingerprint* (9), *Multitouch* (14), and *Draw* (46) several times. In contrast, *Tilt* was repeated overall 92 times by 9 participants. This indicates that there was a higher need for repeating tangible, movement-based interaction techniques and that the common information from the tutorial were insufficient. Results indicate that implementing onboarding

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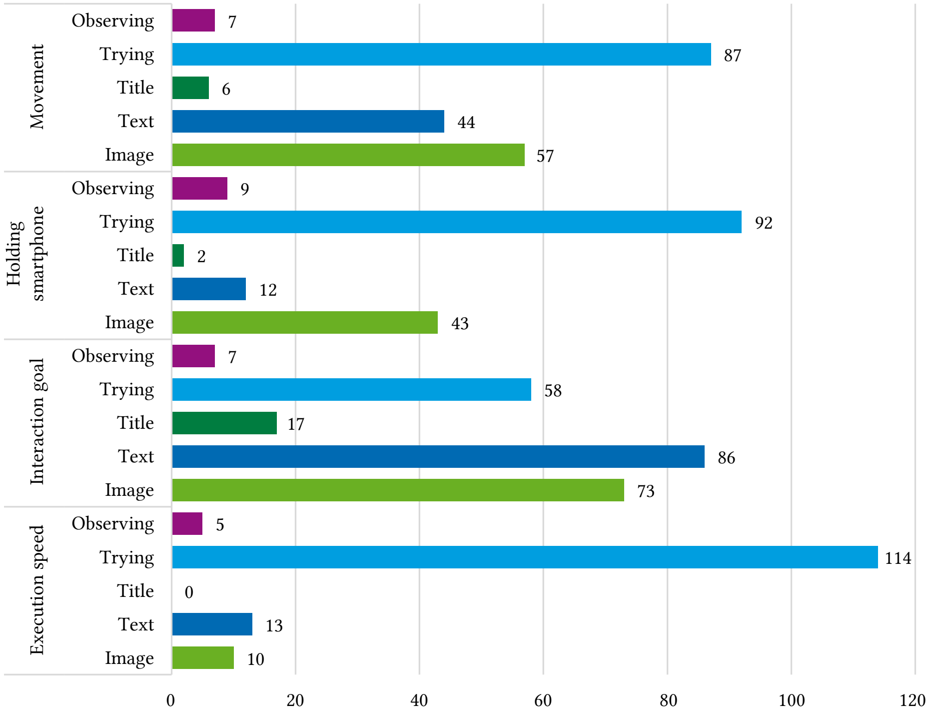

Fig. 3. Number of mentions how observing, trying, title, text, and image helped to understand movement, holding the smartphone, interaction goal, and execution speed.

tutorials is suitable to get a first idea of the specific mobile device-based interaction, but users also need support during application usage concerning when and how to execute interactions. Additionally, due to the high repetition rates we derive that useful feedback mechanisms should be investigated and applied.

4.3 Important information in tutorials

In the section above, we presented the results of the error rates that occurred despite using onboarding tutorials. To better understand what kind of information was helpful and what is missing, we prepared a questionnaire. After performing the tutorial, we asked the participants to assess the information we gave them to become familiar with the interaction techniques. Participants selected aspects that helped them to understand movement, how to hold the smartphone, the interaction goal, and execution speed to perform an interaction. Figure 3 presents the given answers. Overall, *trying* an interaction technique was mentioned most often concerning the usefulness to understand the interactions in terms of movement (87 of 128), holding the smartphone (92 of 128) and execution speed (114 of 128) in contrast to observing, title, text, or image. The *title* and *observing* were least helpful to become familiar with the interaction techniques. The *image*

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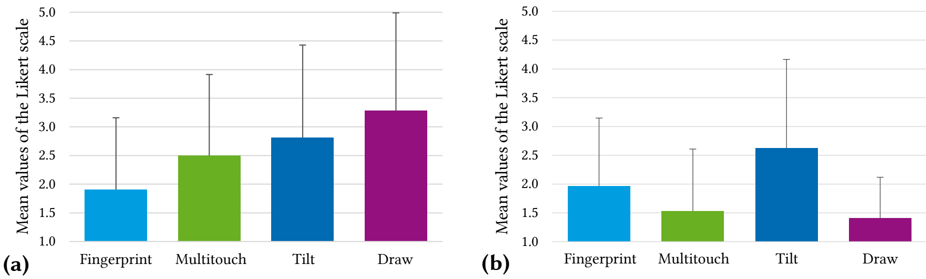

Fig. 4. Mean values (M) and standard deviations (SD) derived from the 5-point Likert scale (5 = completely agree) concerning the statements: (a) *Additional yellow marks helped to understand the interaction.* and (b) *I would have liked to have an additional video or animation that explains the interaction.*

was mentioned second to be helpful for understanding the movement (57 of 128) and holding the smartphone (43 of 128). *Text* was especially useful for getting to know the interaction goal (86 of 128).

Beside the questions concerning the ways they became familiar with the interaction techniques, participants rated on a 5-point Likert scale (5=completely agree) whether the yellow marks (see Figure 2) helped them to understand the interaction. Yellow marks were rated most helpful for both voting interactions *Tilt* (M = 2.8, SD = 1.6) and *Draw* (M = 3.3, SD = 1.7). Especially for *Draw*, yellow marks were rated as helpful whereas for the *Fingerprint* interaction it was surprisingly mentioned only four times as helpful (M = 1.9, SD = 1.2). However, applying ANOVA showed that there was a significant effect of the interaction on the helpfulness of the yellow marks ($F_{3,93} = 7.216$, $p < .0005$). We derived from these results that although we annotated visual content with further information, the tutorial remained static and did not show movements or execution speed. Figure 4a summarizes the mean values (M) as well as the standard deviations (SD) of the given answers concerning the helpfulness of the yellow marks within the tutorial. The answers varied, the standard deviations (SD) ranges between 1.3 (*Fingerprint*) and 1.7 (*Draw*). So it seems evident, that interaction tutorials should be adapted to the needs of individual users.

Furthermore, we asked participants whether they wanted additional videos or animations to describe the interaction techniques in detail. Figure 4b shows the mean values (M) and the standard deviations (SD) of the participants' answers. Contrary to what we expected, the majority of answers shows that participants do not want to get further explanations of the interactions through videos or animations, especially for *Multitouch* (M = 1.5, SD = 1.1) and *Draw* (M = 1.4, SD = 0.7). Both interactions show a low standard deviation, which underlines these opinions. However, in contrast to the other interactions, *Tilt* has a higher amount of positive feedback concerning the wish for a video or animation (M = 2.6, SD = 1.5). We argue that this interaction is the most complex one regarding movement and execution speed and could benefit from a dynamic ex-

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planation. Resuming the given answers, we can conclude some recommendations for improving tutorial design of introducing and learning mobile device-based interactions. The following section discusses the results of our user study and derives some recommendations for introducing device-based interactions with mobile phones.

5 Discussion and Recommendations

Reviving our research questions, we found that common tutorials are unsatisfying for becoming familiar with mobile device-based interactions (RQ1). Although study participants mainly had a technical background, following the tutorials and adapting the descriptions to the performance of the interactions still was difficult. We hypothesize that the unsuitability of onboarding tutorial presentations led to high error rates and a high number of repetitions while learning new interaction techniques. We therefore recommend to further investigate adapted tutorials for the specific characteristics of such interaction techniques.

For this purpose, we identified important information that users need to understand mobile device-based interactions (RQ2). Due to their tangibility and spatiality, most important is information about movement, direction, and execution speed. These are specifications that are difficult to present in static tutorials. Unexpectedly, the need of providing dynamic images such as videos or animations instead was overall low. However, interactions that involve motions benefit from dynamic tutorials. As device-based interactions vary in their strength of metaphor, we assume that more figurative interactions like 'pouring' [12] are better understandable by users within an onboarding tutorial. We summarize our recommendations for introducing mobile-based interactions as follows (RQ3):

- Interactions that users perform on-screen like *Multitouch* and *Draw* can be explained as static image with a clear focus on what the user has to do, e. g. drawing a plus or a minus on the screen.
- Interactions that are characterized by movement, direction and/or execution speed or, in general, are performed three-dimensionally like *Fingerprint* and *Tilt* also need support by dynamic three-dimensional media, e. g. meaningful animations or short video sequences, to understand execution details.
- Static images within a tutorial serve as starting point to understand how to hold the phone for execution.
- To become familiar with mobile device-based interactions, especially with more dynamic interactions, the own experience is important. Hence, onboarding tutorials should provide trying interactions in addition to text, images and animations or videos.
- Textual descriptions and an appropriate title are helpful to understand the app function, that is invoked by the device-based interaction.

We also recommend supporting interaction learning while performing the interaction by integrating multimodal real-time feedback (1) during the tutorial instead of first reading and then trying, (2) but also during mobile application

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usage. Mobile devices can sense if there is a characteristic movement and accordingly provide assistance for suitable implemented interactions. It is also possible to highlight which interaction is available at a certain time to make it easier to remember the interaction possibilities.

With increasing numbers of mobile and wearable devices, the need for appropriate tutorials increases, too. We contribute a profound starting point for further investigations regarding information for and types of tutorials for this special kind of interaction techniques with their distinct characteristics concerning tangibility and spatiality.

5.1 Limitations and Future Work

While our study provides evidence of the need for improving tutorials for mobile device-based interaction techniques, a comparison of such an enhanced form of tutorial would substantiate our findings. As preliminary hypothesis, we expect a lower number of errors and repetitions when adapting tutorials to the characteristics of mobile device-based interactions. When using the tutorials the first time, some of the participants also mentioned that they did not notice the yellow marks (see Figure 2). This fact was also affirmed by the answers form the questionnaire concerning visual marks, which varied strongly. We will therefore investigate how to make the visual marks more conspicuous. Additionally, we assume that the usage of tutorials depends on the individual background, which also influences interaction learning. Therefore, we will investigate how, for example, the technical background influences the need for certain information. Consequently, further remaining questions are: (1) what alternatives can be used to replace static onboarding tutorials, (2) how users can benefit from learning by doing tutorials, and (3) how to improve discoverability of interaction techniques. Although these questions are not part of this work, we will focus on them in future investigations.

6 Conclusion

We presented an investigation of common onboarding tutorials for introducing mobile device-based interaction techniques to users. We motivated our work through elaborating characteristics of such interaction techniques and describing the research gap in related work. In addition, we conducted a user study to investigate a common tutorial approach for learning mobile device-based interaction techniques. The results show that, especially, with high tangibility and spatiality of such interactions, the suitability of common tutorials decreases. In future work, we want to compare onboarding tutorials with alternative types, such as tutorials that are provided during application flow. Derived from our user study, we give first recommendations on how to improve tutorials. With this work, we provide a starting point for creating useful and suitable tutorials for mobile device-based interactions, which we believe are beneficial for enhancing ubiquitous environments.

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References

1. Alt, F., Geiger, S., Höhl, W.: ShapelineGuide: Teaching Mid-Air Gestures for Large Interactive Displays. In: Proceedings of the 7th ACM International Symposium on Pervasive Displays. pp. 3:1–3:8. PerDis '18, ACM (2018). https://doi.org/10.1145/3205873.3205887
2. Ashbrook, D., Starner, T.: Magic: a motion gesture design tool. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 2159–2168. CHI '10 (2010). https://doi.org/10.1145/1753326.1753653
3. Chong, M.K., Mayrhofer, R., Gellersen, H.: A survey of user interaction for spontaneous device association. Journal on ACM Computing Surveys (CSUR) **47**(1), 8–40 (2014). https://doi.org/10.1145/2597768
4. Daiber, F., Kosmalla, F., Murlowski, C., Krüger, A.: Slackliner: Using whole-body gestures for interactive slackline training. In: Proceedings of the Symposium on Spatial User Interaction. pp. 174–174. SUI '18, ACM (2018). https://doi.org/10.1145/3267782.3274691
5. Delamare, W., Coutrix, C., Nigay, L.: Designing guiding systems for gesture-based interaction. In: Proceedings of the 7th ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS '15). pp. 44–53. ACM (2015). https://doi.org/10.1145/2774225.2774847
6. Dingler, T., Rzayev, R., Shirazi, A.S., Henze, N.: Designing consistent gestures across device types: Eliciting rsvp controls for phone, watch, and glasses. In: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems. pp. 419:1–419:12. CHI '18, ACM (2018). https://doi.org/10.1145/3173574.3173993
7. Harley, A.: Instructional Overlays and Coach Marks for Mobile Apps (2014), https://www.nngroup.com/articles/mobile-instructional-overlay/, visited on 2020-01-18
8. Harrison, S.M.: A comparison of still, animated, or nonillustrated on-line help with written or spoken instructions in a graphical user interface. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 82–89. CHI '95 (1995). https://doi.org/10.1145/223904.223915
9. Higgins, K.: First Time User Experiences in Mobile Apps (2012), http://www.kryshiggins.com/first-time-user-experiences-in-mobile-apps/, visited on 2020-01-18
10. Ismair, S., Wagner, J., Selker, T., Butz, A.: MIME: Teaching Mid-Air Pose-Command Mappings. In: Proceedings of 17th International Conference on HCI with Mobile Devices and Services. pp. 199–206. MobileHCI '15, ACM (2015). https://doi.org/10.1145/2785830.2785854
11. Joyce, G., Lilley, M., Barker, T., Jefferies, A.: Mobile application tutorials: Perception of usefulness from an hci expert perspective. In: Kurosu, M. (ed.)

Human-Computer Interaction. Interaction Platforms and Techniques. pp. 302–308. Springer International Publishing (2016). https://doi.org/10.1007/978-3-319-39516-6_29
12. Korzetz, M., Kühn, R., Heisig, P., Schlegel, T.: Natural Collocated Interactions for Merging Results with Mobile Devices. In: Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct. pp. 746–752. MobileHCI '16, ACM (2016). https://doi.org/10.1145/2957265.2961839
13. Korzetz, M., Kühn, R., Kegel, K., Georgi, L., Schumann, F.W., Schlegel, T.: Milkyway: A toolbox for prototyping collaborative mobile-based interaction techniques. In: Antona, M., Stephanidis, C. (eds.) Universal Access in Human-Computer Interaction. Multimodality and Assistive Environments. pp. 477–490. Springer International Publishing, Cham (2019). https://doi.org/10.1007/978-3-030-23563-5_38
14. Korzetz, M., Kühn, R., Schlegel, T.: Turn it, Pour it, Twist it: A Model for Designing Mobile Device-Based Interactions. In: Proceedings of the 5th International Conference on Human-Computer Interaction and User Experience in Indonesia. pp. 20–23. CHIuXiD '19, ACM (2019). https://doi.org/10.1145/3328243.3328246
15. Kühn, R., Korzetz, M., Büschel, L., Korger, C., Manja, P., Schlegel, T.: Natural Voting Interactions for Collaborative Work with Mobile Devices. In: Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems. pp. 2570–2575. CHI EA '16, ACM (2016). https://doi.org/10.1145/2851581.2892300
16. Kühn, R., Korzetz, M., Büschel, L., Schumann, F.W., Schlegel, T.: Device-Based Interactions for Anonymous Voting and Rating with Mobile Devices in Collaborative Scenarios. In: Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia. pp. 315–317. MUM '16, ACM (2016). https://doi.org/10.1145/3012709.3016067
17. Kühn, R., Korzetz, M., Schumann, F.W., Büschel, L., Schlegel, T.: Vote-for-it: Investigating mobile device-based interaction techniques for collocated anonymous voting and rating. In: Lamas, D., Loizides, F., Nacke, L., Petrie, H., Winckler, M., Zaphiris, P. (eds.) Human-Computer Interaction – INTERACT 2019. pp. 585–605. Springer International Publishing, Cham (2019). https://doi.org/10.1007/978-3-030-29381-9_36
18. Kühn, R., Schlegel, T.: Mixed-focus collaboration activities for designing mobile interactions. In: Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct. pp. 71–78. MobileHCI '18, ACM (2018). https://doi.org/10.1145/3236112.3236122
19. Leigh, S.w., Schoessler, P., Heibeck, F., Maes, P., Ishii, H.: Thaw: Tangible interaction with see-through augmentation for smartphones on computer screens. In: Proceedings of the 9th International Conference on Tangible, Embedded, and Embodied Interaction. pp. 89–96. TEI '15 (2015). https://doi.org/10.1145/2677199.2680584
20. Linjama, J., Korpipää, P., Kela, J., Rantakokko, T.: ActionCube: A Tangible Mobile Gesture Interaction. In: Proceedings of the 2Nd International Conference on Tangible and Embedded Interaction. pp. 169–172. TEI '08, Bonn, Germany (2008). https://doi.org/10.1145/1347390.1347428
21. Lucero, A., Keränen, J., Jokela, T.: Social and spatial interactions: Shared co-located mobile phone use. In: CHI '10 Extended Abstracts on Human Factors in Computing Systems. pp. 3223–3228. CHI EA '10 (2010). https://doi.org/10.1145/1753846.1753962

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https://doi.org/10.1007/978-3-030-49062-1_29

22. Lucero, A., Porcheron, M., Fischer, J.E.: Collaborative use of mobile devices to curate sources of inspiration. In: Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct. pp. 611–616. MobileHCI '16, ACM (2016). https://doi.org/10.1145/2957265.2961830
23. Nielsen, M., Störring, M., Moeslund, T.B., Granum, E.: A procedure for developing intuitive and ergonomic gesture interfaces for hci. In: Camurri, A., Volpe, G. (eds.) Gesture-Based Communication in Human-Computer Interaction. pp. 409–420. Springer (2004). https://doi.org/10.1007/978-3-540-24598-8_38
24. Novick, D.G., Ward, K.: Why don't people read the manual? In: Proceedings of the 24th Annual ACM International Conference on Design of Communication. pp. 11–18. SIGDOC '06, ACM (2006). https://doi.org/10.1145/1166324.1166329
25. Paay, J., Raptis, D., Kjeldskov, J., Lauridsen, B.M., Penchev, I.S., Ringhauge, E., Ruder, E.V.: A comparison of techniques for cross-device interaction from mobile devices to large displays. In: Proceedings of the 14th International Conference on Advances in Mobile Computing and Multi Media. p. 137–146. MoMM '16, ACM (2016). https://doi.org/10.1145/3007120.3007140
26. Perelman, G., Serrano, M., Bortolaso, C., Picard, C., Derras, M., Dubois, E.: Combining tablets with smartphones for data analytics. In: Lamas, D., Loizides, F., Nacke, L., Petrie, H., Winckler, M., Zaphiris, P. (eds.) Human-Computer Interaction – INTERACT 2019. pp. 439–460. Springer International Publishing, Cham (2019). https://doi.org/10.1007/978-3-030-29390-1_24
27. Rico, J., Brewster, S.: Usable gestures for mobile interfaces: evaluating social acceptability. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 887–896. CHI '10 (2010). https://doi.org/10.1145/1753326.1753458
28. Rodrigues, A., Camacho, L., Nicolau, H., Montague, K., Guerreiro, T.: AidMe: Interactive Non-Visual Smartphone Tutorials. In: Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct. pp. 205–212. MobileHCI '18, ACM Press (2018). https://doi.org/10.1145/3236112.3236141
29. Satia, G.: Mobile Onboarding: A Beginner's Guide – Smashing Magazine (2014), https://www.smashingmagazine.com/2014/08/mobile-onboarding-beginners-guide/, visited on 2020-01-18
30. Scoditti, A., Blanch, R., Coutaz, J.: A novel taxonomy for gestural interaction techniques based on accelerometers. In: Proceedings of the 16th International Conference on Intelligent User Interfaces. pp. 63–72. IUI '11 (2011). https://doi.org/10.1145/1943403.1943414