Research Article

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Digital Probes Kit

A Concept for Digital Probes

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Abstract: (Cultural) probes have been used in various software design projects and HCI contexts over the last years. With the ubiquity of smartphones today, there are new ways to design probes material as digital probes. Smartphones allow to document everyday life in situ in mobile contexts and provide a permanent channel for communication between researchers and participants. Based on an analysis of strengths and weaknesses of traditional probes, we propose a concept for a Digital Probes Kit in the form of a digital diary and describe its potential.

Keywords: HCI, cultural probes, requirements elicitation, ethnography, digital probes, probes kit

1 Introduction

Since the seminal paper by Gaver, Dunne and Pacenti in 1999 traditional "cultural probes" have been taken up by a wide variety of HCI design projects [4]. Researchers consistently report on positive experiences with the technique, in particular in the context of requirements elicitation, even if that was not the original intent of Gaver and colleagues. Cultural probes are stimulating for the participants, pleasing, easy to use and productive. This conforms to our own experiences in several projects that used cultural probes (e. g. [12], in this issue).

While initially only paper-based media and disposable cameras were used for probes, various projects have been developing technology-based probes: digital systems that recorded their own usage. They collected data in particular contexts, e. g. in the household ("value probes", [17]), in urban life ("urban probes", [15]), or in health care ("cognitive probes", [13]). Berger and colleagues ([2], in this issue) use "sensor probes" to investigate how networked products for the Smart Home can be designed with the potential users. As an example, they install sensors in their homes and study what uses people find for the sensor data and how they make sense of this data. In some of these projects, probes explicitly served as prototypes for the technologies to be developed [13, 10, 8].

In this paper, we are interested in translating traditional probes into a digital format and run them on mobile devices. There are at least two projects bear some resemblance to the idea: Already in 2004, Hulkko and colleagues were looking for a digital tool for mobile user studies. In order to investigate people's actions in mobile contexts, they developed a self-documentation tool called "mobile probes" [7]. The technology was based on dual-band mobile phones with GPRS connections and an external digital camera. A system for the collaborative use and sorting of the collected data was also developed. And very recently, Gaver and colleagues [3] experimented with digital cultural probes. They developed a digital alternative to a disposable camera on digital devices, preserving the affordances and characteristics of an analog camera.

In the following we will propose a concept for digital probes that might substitute analog media such as postcards, paper diaries, disposable cameras and foldable city maps. Given the ubiquitous use of mobile digital technologies in both private and professional contexts, it seems worth investigating whether – for appropriate target groups and contexts – digital (mobile) probes might be useful and what forms they should take. Digital probes would have to preserve the strengths of traditional probes and to overcome some of their weaknesses. Installed on smartphones they are meant to provide a simple and handy solution for self-documentation and requirements elicitation in mobile everyday life. They will also provide new options for the cooperation between software designers and the target group.

In Section 2 we will summarize the strengths and weaknesses of traditional probes documented by a number of projects. Based on this analysis, we developed a concept for digital probes in form of a digital diary. This will be presented in the main part of this article (Section 3). The concept will be illustrated by wireframes. In the concluding

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ing Section 4 we will highlight the benefits of our digital probes concept and point to some related issues. Our contribution is meant to propose ideas and to stimulate further research and development. We do not discuss any implementation issues.

2 Strengths and Weaknesses of Traditional Probes

Cultural probes have been widely used and praised [5, 8, 14]. Unfortunately, projects rarely report on what did *not* work so well. This is why we critically analyzed our own experiences with probes in four projects we have been involved with. Our key insights were gained from the project **ParTec**.[1] In the process of developing an online neighborhood platform, the project investigated and evaluated techniques for participatory software development with regard to their suitability for communication and equal cooperation with older adults (see [12], in this issue). Three other projects were evaluated that largely built on ParTec's experiences with probes: **MobileAge** (see [9], in this issue) which aims at strengthening the public participation of senior citizens through digital public services, such as an online neighborhood guide. A **student project** under the direction of one of the authors used probes in order to understand the challenges of everyday life of working couples with small children. These parents want to be available permanently for matters of work and family [18]. A connected **master thesis** studied how young IT professionals use mobile technologies to manage their work-life balance [16].

In our analysis of these projects we focused on the question, what effects probes had in requirements elicitation. To what extent did they enable and enrich the communication between researchers and participants and what disturbing effects could be observed? We found probes to be one of the centerpieces of the communication between researchers and participants. The probes were used to elicit a wide range of information: biographical events and circumstances, social relations, opinions, feelings, attitudes and preferences, the use and significance of artifacts, activities and time-related data (points in time, durations, frequencies), locations and itineraries. (For a detailed description of the various probes used in these projects and their purposes see [11, pp. 28–32]; also [9, 12], in this issue.) The strong points for probes pointed out in reports about these projects strikingly correspond to the attributes of probes that have been pointed out by Graham and Rouncefield [6].

Strengths of Traditional Probes

- By their questions and instructions probes revealed the researchers' focus of interest to the participants.
- Probes stimulated and helped the participants to document their everyday lives and reflect on it.
- Probes sensitized participants for certain aspects of their (work) life and allowed to tell personal stories.
- Probes helped collect information in situ, thereby making the invisible visible to both, participant and researcher.
- Probes pleased, amused, entertained, surprised, provoked the participants.
- Probes defined the participants as experts of their everyday lives and their respective requirements; they valued their estimations.
- Aesthetically designed probes demonstrated appreciation for the participants' cooperation.
- The probes process constituted a dialogue and a relationship of mutual trust.

The probes provided an extremely rich material to be shared and subsequently discussed between researchers and participants. In most of the projects the communication process with probes took the following steps (Figure 1, intensified communication by means of probes shaded):

1. In a *kick-off* meeting researchers presented their research project, explained their questions and expectations, introduced the probes technique and presented the probes kit. Participants and researchers started to get to know each other. The participants studied the material, discussed it to among themselves and asked questions about it. Everybody left with a personal probes kit.
2. During the *probes phase* there was no communication between researchers and participants, apart from a phone call to arrange a date for the collection of the material.
3. When researchers came by to *pick up* the probes most of the participants took the opportunity to relate about questions and doubts they had had during the probes phase and their hope to have provided useful information.
4. During the *interpretation phase* researchers discussed among themselves and prepared individual interviews.

1 ParTec was funded by the German Ministry for Education and Research under grant number 16SV7186.

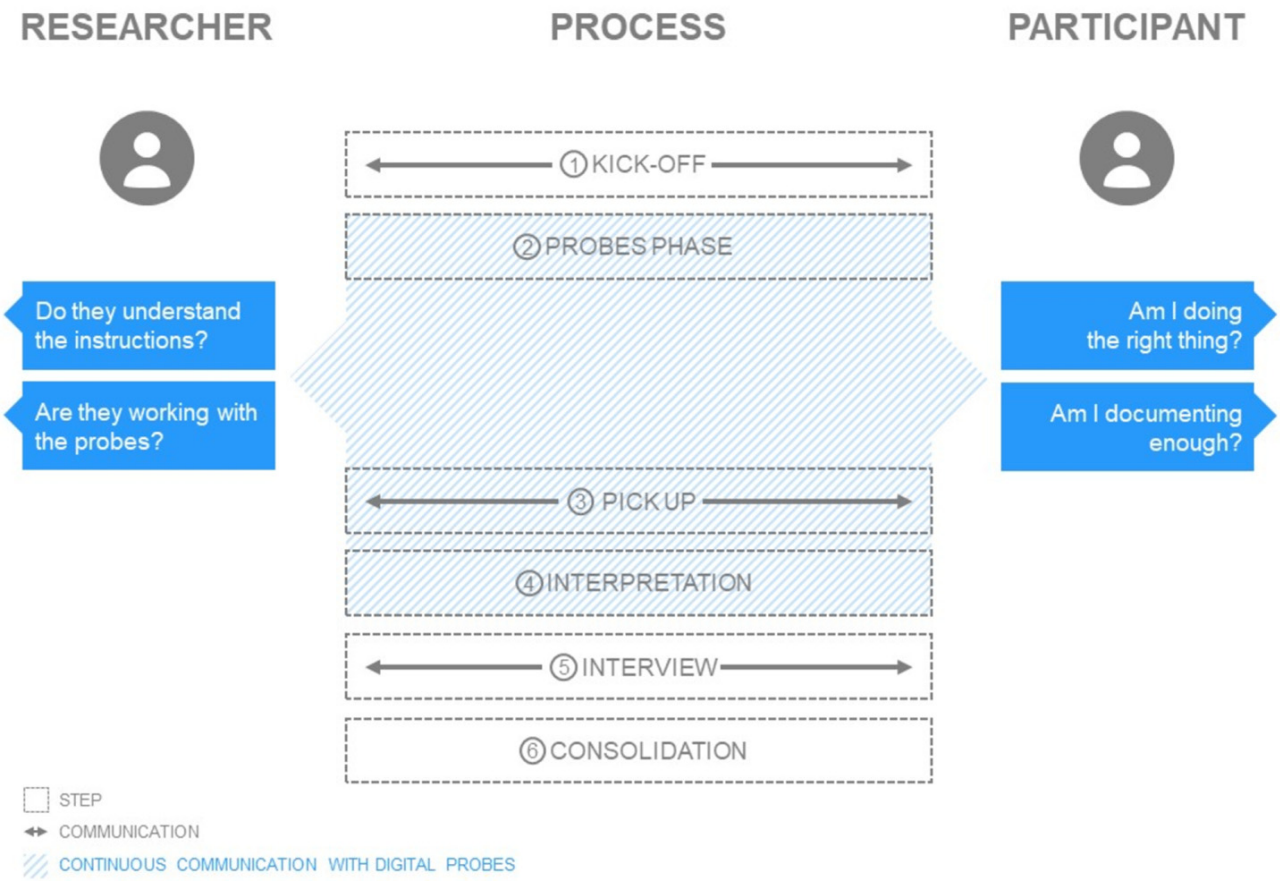

Figure 1: Communication process between researcher and participant.

5. In the subsequent *interviews* the researchers' preliminary understanding was discussed and additional information was exchanged. Participants also commented on the probes technique, their efforts of self-documentation and the sensitization effect they had experienced.
6. Results from various participants were then *consolidated* and written up, e. g. as personas and scenarios, for further use in the design process.

In our critical analysis of the probes processes in the projects mentioned above, we found the following problems (for details see [11, pp. 45–59]):

Weaknesses of Traditional Probes

- In the *kick-off* meeting, the probes kits were introduced as "presents" brought for the participants. When researchers came to pick them up after two weeks, participants had become fond of them and wanted to keep the probes material, because they wanted to carry on thinking or talking to others about it.
- During the *probes phase* the participants felt uncertain whether they were doing what was expected. Even though phone numbers and mail addresses were provided for contact, nobody got back to the researchers asking questions.
- Tasks that were not appropriate for the participants were not carried out.
- If probes appeared to be perfectly designed, people hesitated to write something in.
- Cumbersome probes with several components or probes that had to be handled in more than one context (e. g. at home and at work) were not taken along so that information got filled in retrospectively. This violated the ethnographic principle of in situ documentation.
- Only after having *picked up* the probes researchers could see whether participants had understood the instructions well and to what extent they had worked with the probes.

- Researchers could only start the *interpretation* of the probes and the preparation of the individual interview, after the probes had been returned.
- Every set of probes only existed once, so it was difficult to share the material for analysis among the researchers in the *consolidation phase*.

From these problems we concluded the following general requirements and ideas for digital probes:

General Requirements for Digital Probes

- In situ documentation should be simple, even in mobile contexts.
- Communication between researchers and participants should be facilitated at any time.
- Participants should be able to ask for clarifications and to deliver their data at any time to make sure they are doing the right thing.
- Researchers should be able to offer help, to explain and modify their questions and instructions, and to start early with data analysis.
- Clarification dialogues should be sharable among all participants.
- There should be ways to individually nudge participants.
- All individual material should be delivered to the researchers, but also kept by the participants.

The described strengths to keep, weaknesses to avoid and ideas to pursue provide a basis for the following concept for digital probes.

3 A Concept for Digital Probes

The idea for digital probes to help with requirements elicitation stems from the observation that today many people permanently carry a smartphone in their pocket. In addition, people already use smartphones for self-tracking purposes, hence the idea is familiar to those. This makes the smartphone an ideal "container" for probes and a tool for recording in situ. Of course, digital probes are only suitable for a target group of people with digital literacy, who own a smartphone and have a basic understanding of the device. Our concept of digital probes is based on the common functions of a smartphone such as mobile data connection, GPS, camera and microphone.

In the following we will demonstrate how characteristics of traditional probes can be mimicked by using familiar functions of digital media and we will propose ways of using the power of digital media to improve these well-known kinds of probes. According to the requirements above, we will suggest features that facilitate data collection and intensify the dialogue among researchers and participants.

In his analysis of what kinds of data are generally collected by what kinds of probes, Koch [11, p. 44] concludes that diaries including texts and pictures are the most versatile. So the basic structure for our proposed digital probes kit will be a digital diary. In personal diaries people document almost anything in free narration. Sometimes they add small items, like tickets, agendas, pictures or scraps of paper. Diary studies are quite common in social science. They give access to a person's life and thinking over a period of time. Digital diaries as we conceive them do exactly that. However, they are different from so-called media diaries used for mobile media ethnography (see [1]), because those mainly focus on media use and do not necessarily use digital media for the diaries.

Traditional diary probes help to document events and circumstances, social relations, opinions, feelings, attitudes and preferences, activities and time-related data. They require handwriting. Often they provide rudimentary structures in which activities are to be documented. For daily activities time periods (e. g. morning, noon, evening, night) are specified. In order to record daily patterns, timetables with time slots of one or two hours are provided, so activities, durations and frequencies can be recorded (for examples see [12], in this issue).

Digital diaries on smartphones can mimic these characteristics. Smartphone functionalities other than text input make it easy to collect data in situ. Writing longer texts on smartphones is not necessary. Pictures, GPS coordinates, video or voice recordings can be taken and existing material can be integrated or linked to. This makes digital diaries an ideal basic structure to collect and integrate various kinds of digital probes – a digital probes kit. Figures 2–5 show what kinds of documentation and communication such a *digital probes kit* might offer.

In the following the various symbols and entries will be explained from top to bottom, starting with Figure 2. We look at it on Saturday, Feb 17 ("today").

Document the Day Using Various Media

(Tuesday, Feb 13)

Activities have been documented using various media: the participant took pictures of objects that she encountered during the day, a scribble shows the layout for a birthday invitation, an idea she had on her way back home, GPS coordinates indicate places she went to, voice

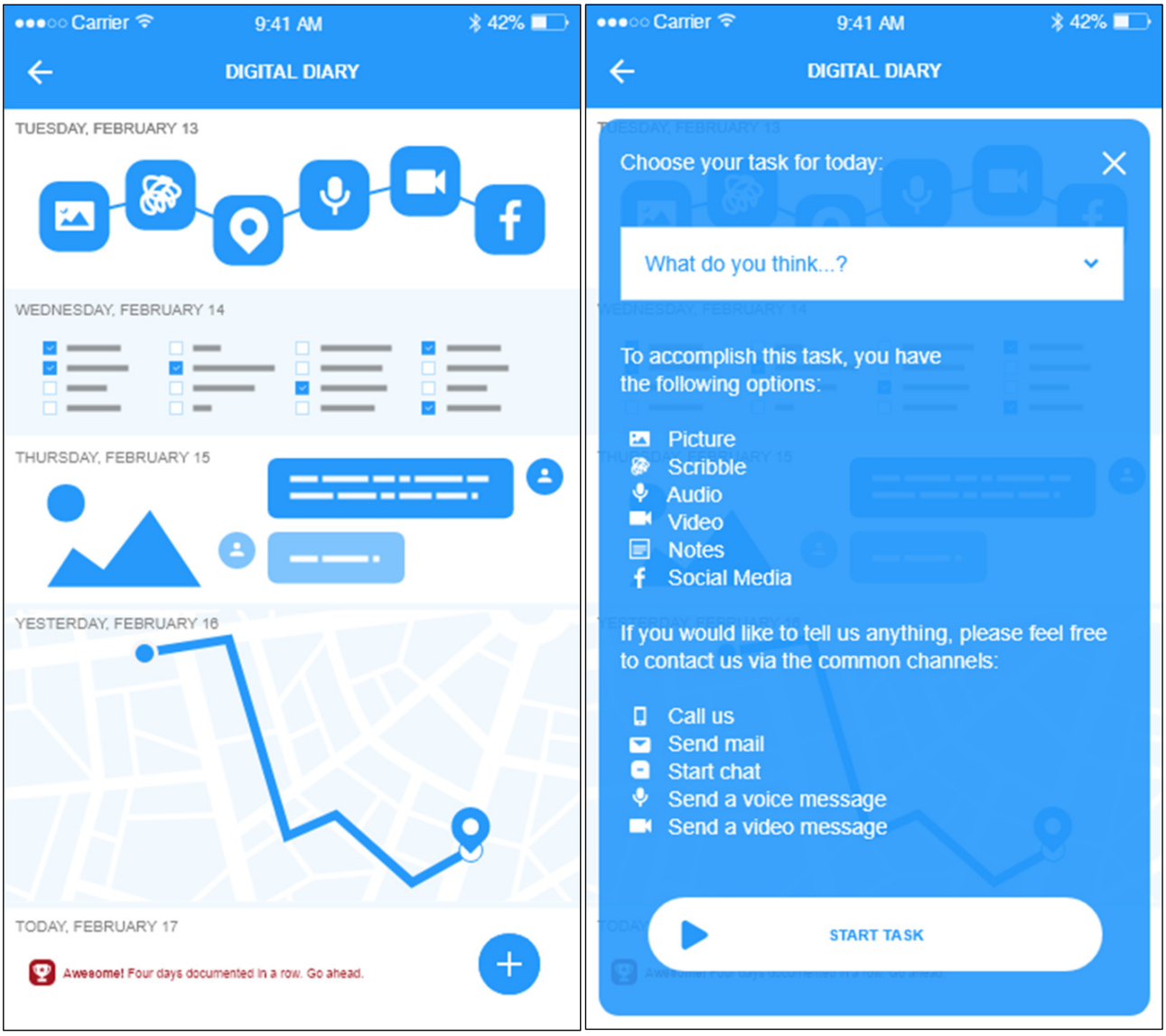

Figure 2: Digital diary as a digital probes kit.

and video recordings were used to report about the day. There is no text input. In addition, existing contents have been included: a link to Facebook. If a participant maintains a blog in which she describes everyday activities, parts of it or a link can be inserted into the diary. Similarly, contents from vlogs and postings from social networks can be used or referenced. Thus, content is used that the participants generate independently and that contribute to the documentation of everyday activities. This kind of documentation takes up the concept of the audiovisual platform Instagram.[2]

Answer Questionnaires
(Wednesday, Feb 14)

A questionnaire has been filled in. Such quantitative data can easily be collected and evaluated with a smartphone. Data of several participants may be consolidated by the researcher and shared with the group.

Create Content, Explain on Enquiry
(Thursday, Feb 15)

The participant has taken pictures. Depending on the research question photos can be used, e. g., to document events and circumstances, social relations, activities, artifacts, places or itineraries. They help a researcher to see the world through the eyes of the participant.

2 Instagram LLC, https://www.instagram.com

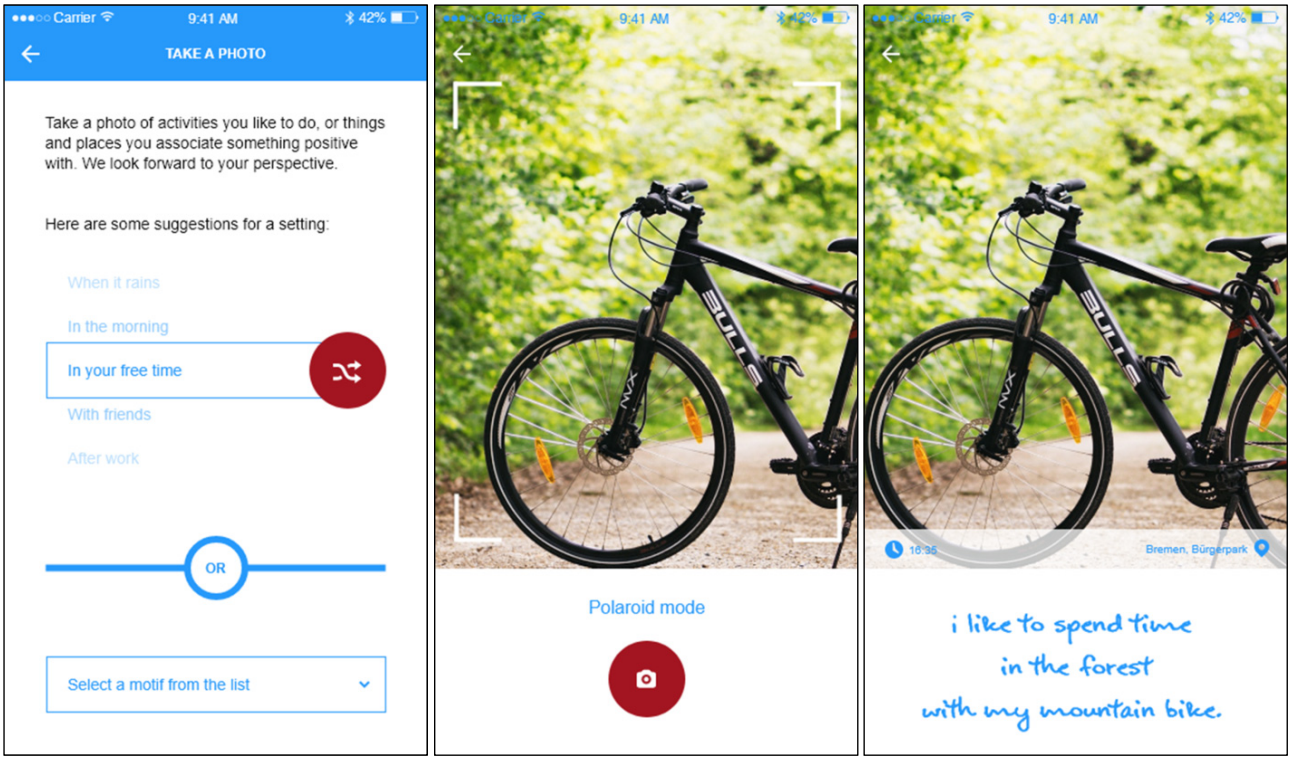

Figure 3: Picture with caption in Polaroid mode.

Smartphones can replace Polaroid and disposable cameras that are part of most traditional probes kits. Pictures are immediately available and can be viewed on a smartphone, but in addition they get stored and can be deliberately sorted in certain places. With an automatic recording of time and location, pictures can be more easily placed in context and interpreted by the researcher, but they are still not self-explanatory. Short comments may explain the pictures and provide a starting point for a further exchange. Common concepts of instant messengers such as Threema[3] or WhatsApp[4] can be used to embed a description directly in a picture. Captioning might also be done by voice recording.

Once the diary entries (in this case, the photos) have been released by the participant, they are visible to the researchers and a feedback function becomes available. Figure 2 shows that the researcher has asked for further explanations of an entry and engaged in a short exchange with the participant.

Take Pictures

Participants may be openly asked to take pictures of a certain kind (Figure 3). To inspire them for a picture to take, they may also be given a choice with a playful element such as a random generator. It enumerates everyday situations (e. g. "in the morning") as settings for pictures to take. Alternatively, predefined motifs (e. g. "your favorite leisure object") can be selected from the list. The indication of "Polaroid mode" is supposed to tell the user that the picture will be a one-time snapshot that cannot be altered or replaced afterwards. When the picture has been taken or chosen, the white space below it is active, so a caption can be added. The result is immediately visible on the phone.

Automatic Recording to Trigger Reflection

(Friday, Feb 16)

The participant has logged her itineraries and the locations she visited. In order to find patterns in everyday life an automatic recording can be switched on for a certain time. With consent of the participant, events on communication channels such as calls, SMS, e-mails, instant messengers or chats might also be recorded and statistically evaluated. In order to initiate a reflection on the side

3 Threema GmbH, https://threema.ch/en
4 WhatsApp Inc., https://www.whatsapp.com/?l=en

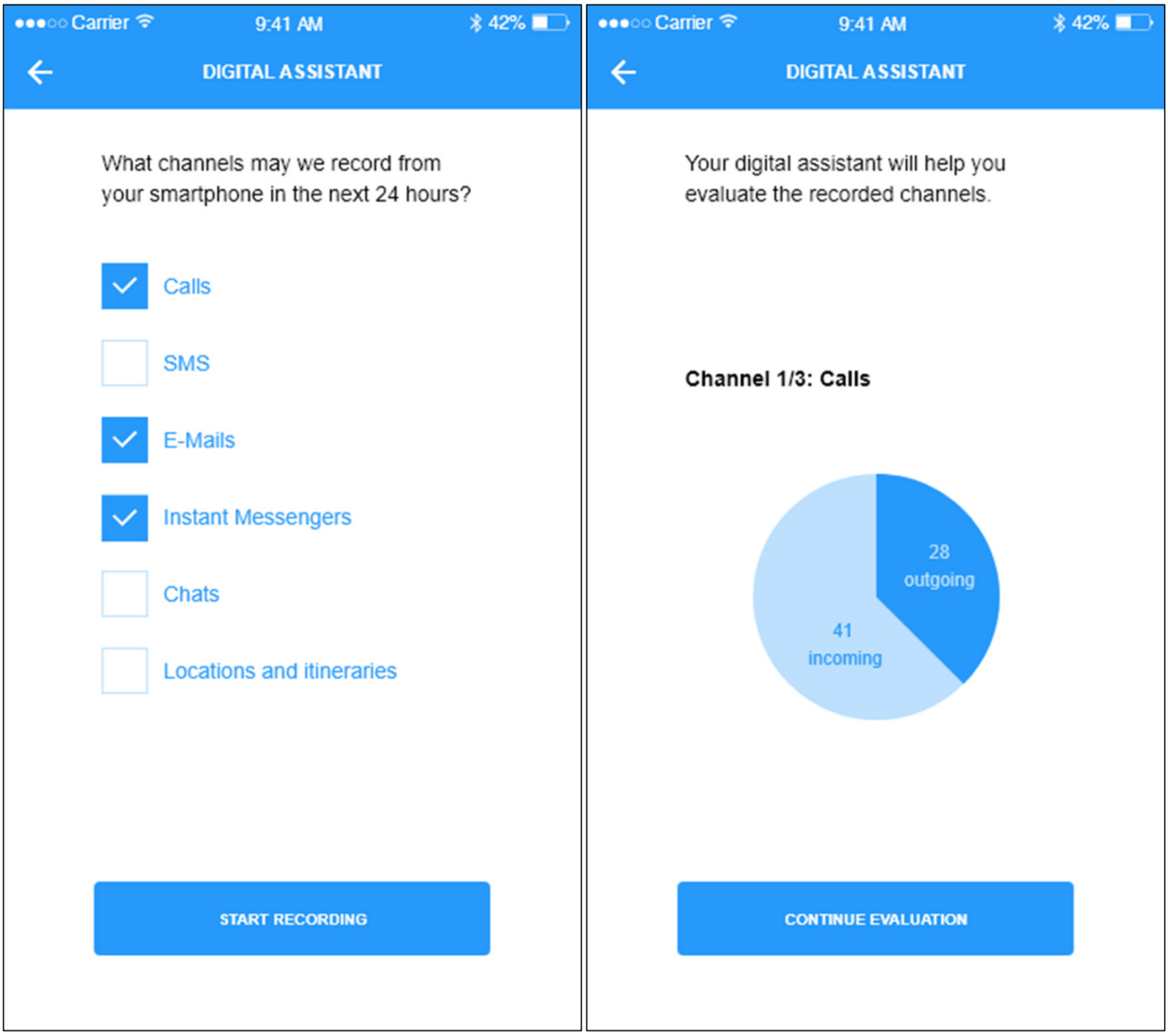

Figure 4: Self-reflection with a digital assistant.

of the participant, digital assistants within the probes may display the emerging patterns and offer additional kinds of evaluation (see Figure 4).

Inspire Reflections by Images

(Today, Feb 17)

After pressing the plus-symbol the participant sees the tasks for today (see right side of Figure 2). The first one is labeled "What do you think…". This mimics traditional postcard probes presenting a question accompanied by an image that is meant to inspire the participants to think a while before answering (see Figure 5). Questions often address feelings, attitudes or opinions, the image creates a mood. The small format of a postcard indicates the expected length of the answer. It is enough to write just a single word or a sentence; but the participant may as well fill the whole format with small handwriting.

A digital probe of this kind may offer input by typing into the smartphone. The participant may also write something on paper and store a digital picture of it. Figure 5 shows an example, in which the participant selects the voice recording option (microphone icon) to answer the question. Taking up the idea of limiting the space for answers, the space for voice recording is limited in time (here 2:30 minutes). The timer and the frequency variation are displayed as feedback for an ongoing recording. As a playful element, the remaining time is displayed by a timer clock with a pause/continue function.

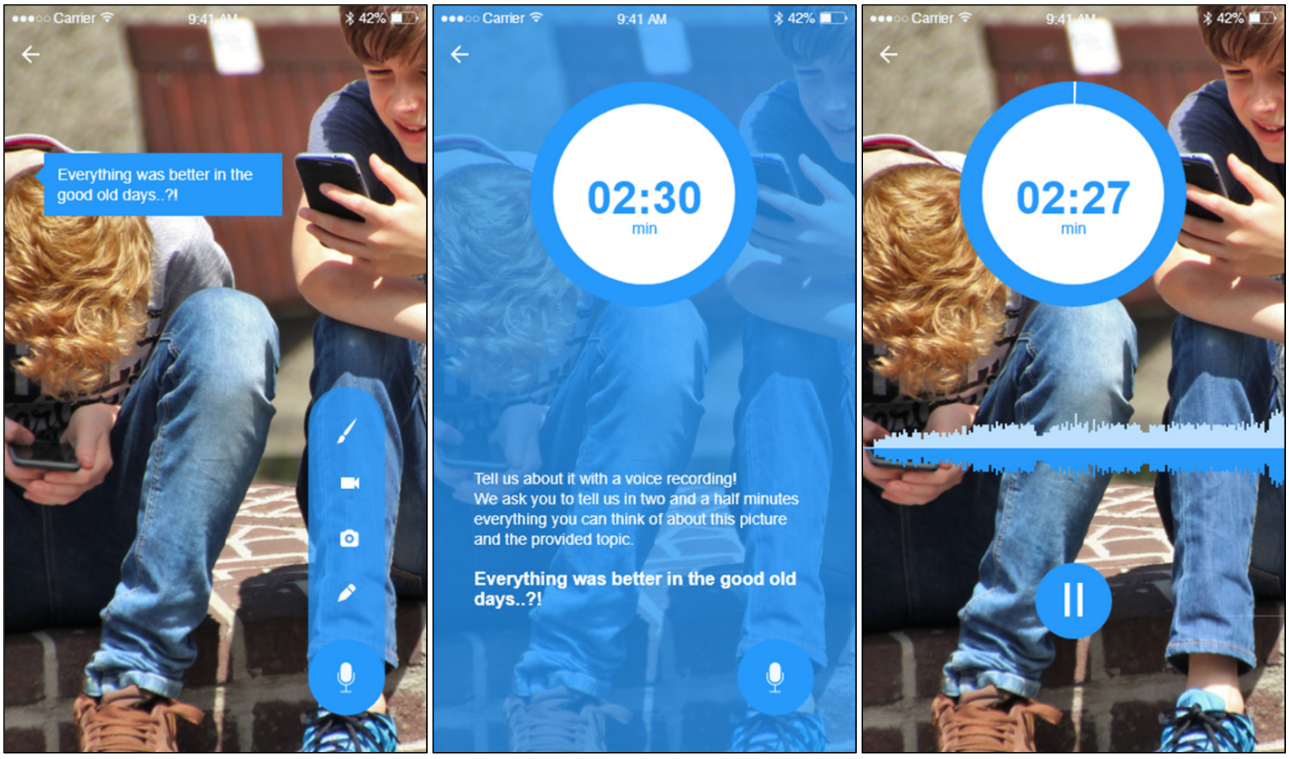

Figure 5: Audio recording an answer.

Clarification and Nudging

Participants can contact the researchers by various channels (see right side of Figure 2). Questions concerning the probes and the process will be solved and the resulting clarification dialogs may be shared in the group of participants. If participants did not send data for a period of time, the researchers can individually nudge them. An automatic message or a personal message by the researchers reminds and tempts them to work with the probes.

In order to introduce users to what might be recorded in a digital diary, various inspiring examples should be presented when the diary is first opened. This might include, e. g., a cinema ticket, a spoken comment on a book, newspaper clippings, a picture from a restaurant, the logo and location of a recently opened fashion store, pictures from a trip or a written report on a chat with a neighbor or colleague.

4 Conclusion

Traditional cultural probes have turned out to be powerful tools for requirements elicitation in various application contexts. In this article, we have presented our analysis and reflection on several participatory projects as to what strengths and weaknesses of the probes technique have been documented. Following the idea of making the probes material digitally accessible on smartphones and having participants record data online, we have presented a concept for digital probes in form of a digital diary. This diary has been designed to integrate all features of traditional probes and thus provides a digital probes kit with many options for documenting everyday life activities and situations, thoughts and feelings in situ.

We have described concepts that might be implemented using common smartphone functions. The idea is to store all recorded data on the participant's smartphone and have the user release and send them to the researcher at any convenient time. An extra *pick-up phase* for the data becomes obsolete. We also presented options for commenting and explaining, sharing and nudging that allow a dialog between researchers and participants during the probes phase. The continuous release of data and the intensified dialog would help to intertwine the phases of *documentation* and *interpretation* (see Figure 1 in Section 2). Used to the extreme, this would enable a requirements elicitation process that approximates an ethnographic observation and inquiry in situ.

Like any other new digital tool, an interactive prototype of a digital probes kit as we have proposed here will

have to be evaluated in case studies with software developers/researchers and participants. As for traditional probes much will depend on an appropriate, usable and appealing design of the digital probes material. The illustrations in this paper were meant to show the concepts and functions of digital probes, they do not claim to include all necessary details and usability considerations.

Between researchers and participants, a suitable personal arrangement in the *probes phase* will have to be negotiated, tried out and evaluated. Certain arrangements might be technically enabled. Obviously, researchers cannot be permanently available and responsive to the participants for two weeks. They might, however, share this duty with another person. Using smartphones on the "receiving" side as well, researchers can easily respond to inquiries. Automated triggers could help them to think of nudging participants to use the digital probes. Automated reminders might also be sent to participants if they did not release any data for a certain amount of time. Another scenario might be to automatically ask for information on a specific situation if, e. g., no context information has been provided for a captured image.

A sharing of clarification dialogs, of inspirational data or ideas about what to document among the group of participants may additionally facilitate the *probes phase*. The effects of such features would also have to be tested.

As all diary data will be delivered digitally and in different formats (e. g. text, pictures, location information, graphics, video and audio recordings), ways will have to be found to normalize, organize and consolidate them. Current technologies that automatically convert voice input into text or summarize content from social media can facilitate subsequent coding and tagging. With digital probes, comparing and contrasting participants will become easier for certain kinds of data in the *consolidation phase*. It will be possible to search and sort probes data in various ways. For the *interview* following the probes phase, the digital material will have to be presented in a suitable way, probably on a tablet, so all participants can refer to it in conversation. These situations will also have to be tested.

Data security is another issue that will have to be dealt with for the enormous amounts of confidential and logged digital data that will be transmitted and stored. The intended use of the personal diaries and the logging of communication channels must be transparent to the participants. If not agreed otherwise, during the *probes phase* participants must be in control at all times and have the option of deactivating data release or access for researchers. For this reason, a visualization of the outgoing data would be suitable, which makes the data flow as transparent as possible for the participants.

Using traditional probes for requirements elicitation in our own projects, we found that a feeling of mutual trust and personal appreciation was at the heart of participatory design. This trust developed to a great extent by the cultural probes technique with subsequent interviews (see 2018, in this issue). We believe that documentation and communication by a digital probes kit as presented above may enrich and facilitate the requirements elicitation process. However, we do not in any way suggest to leave out personal bilateral or group meetings. Face-to-face interaction in a kick-off to prepare the probes phase, in the follow up interview as well as in the phases following data consolidation across all participants is indispensable.

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Image Sources

Wireframes created with Adobe XD, a user experience design software application by Adobe System and "Wires, free wireframe kit". https://www.behance.net/gallery/55462459/Wires-wireframe-kits-for-Adobe-XD

- 2 Boy Sitting on Brown Floor While Using Their Smartphone, from Pexels https://www.pexels.com/photo/2-boy-sitting-on-brown-floor-while-using-their-smartphone-near-woman-siiting-on-bench-using-smartphone-during-daytime-159395/
- Free stock photo of bicycle, bike, forest, by Pexels https://www.pexels.com/photo/forest-bike-bulls-100582/

Bionotes

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