Increasing Collocated People's Awareness of the Mobile User's Activities: a Field Trial of Social Displays

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ABSTRACT

Many activities that have traditionally been performed with different dedicated physical artifacts are now done with personal mobile devices. Consequently, the privacy of mobile interfaces has hampered social observability and chances for serendipitous interactions. For example, reading an electronic newspaper with a mobile device does not allow the surrounding people to be similarly aware of the reader's activity as traditional newspapers. Social displays are additional displays on mobile devices providing the surrounding people with light-weight cues about the activities of the device user. We implemented a prototype that reveals the user's current active application and presents its name on an e-ink display on the backside of a mobile device. We conducted a ten-day field trial with 13 participants using the prototype. The results show that the prototype was able to increase awareness of users' mobile activities and occasionally triggered interactions with others, without significantly violating the sense of privacy.

Author Keywords

Collocated interaction; activity awareness; social interaction; face-to-face interaction; backside display; social display; personal interface; user trial; field study.

ACM Classification Keywords

H.5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces.

INTRODUCTION

The designs of mobile devices have mainly focused on personal use and, consequently, they are also perceived as personal devices [10]. This is evident from, for example, the small displays, touch-based input, and vibration feedback that is intended as personal. In addition to the private interface, current mobile devices enable a broad range of activities that were previously carried out with dedicated physical artifacts. Therefore, many activities that traditionally allowed social elements have become private. For example, reading a newspaper allows others to see what one is doing, even to guess which section one is reading, and, especially in close relationships, to inquire about the content. Similarly, browsing photos or watching videos on mobile devices have lost many of the social elements that physical photos and televisions used to involve (e.g. a joint focus and a shared interface). In other words, the privacy and personal characteristics of mobile device interfaces have decreased the awareness that surrounding others have of the mobile user's activity. As a result, it could be argued that opportunities for shared experiences and serendipitous interactions around the activity have diminished.

Additionally, while mobile devices have enabled people to be increasingly connected to remote others, in many situations, a person engaged with their activities on mobile devices creates a private "bubble" or "cocoon" [32] and becomes absent-minded in the surrounding ongoing social situation [18]. As Turkle states, "when someone holds a phone, it can be hard to know if you have that person's attention. A parent, partner, or child glances down and is lost to another place" [32 p.161]. Especially within families or groups of friends, this can hamper the sense of community and create feelings of social isolation. To study this phenomenon, numerous projects and discussions have recently emerged in the HCI and CSCW research communities (e.g. [9,12]). Also public initiatives have been formed to solve this social issue, e.g. stop phubbing[1].

Awareness of others has been defined as "understanding of the activities of others, which provides a context for your own activity" [7]. Raento and Oulasvirta define social awareness applications as "the idea of a group sharing real-time context information via a personal and ubiquitous terminal" [27]. While the previous work on awareness systems has focused on remote awareness, our focus is on increasing awareness of the surrounding people. Therefore, in this paper we use the term "*activity awareness*" to refer to the awareness that collocated people have of the activities mobile users are doing with their devices.

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[1] http://stopphubbing.com/

Social displays are envisioned as additional displays on mobile devices that provide cues to nearby people about the mobile device user's activities in the digital realm (e.g. mobile services, applications, or content being used). Remote social awareness systems have been found to enhance communication and collaboration (e.g. [34]), encourage serendipitous interaction (e.g. [3]), and increase the sense of community (e.g. [4]). Considering these, this study aims to (1) explore the potential of social display in increasing activity awareness of others in the physical proximity; and (2) consequences of increased awareness from the social display to the mobile devices users and others in the surroundings.

This paper builds on our earlier paper [13] where the concept of social displays was first introduced, and focus groups were organized to evaluate a few early scenarios and to explore the design space with co-design activities. While that paper surfaced interesting and important user-centered aspects of how the concept could be utilized and what risks it involves, it was based on scenario work and focus groups. To advance the research, this paper presents a functional prototype consisting of both a software application and a simple hardware prototype. The hardware consists of an e-ink display that could be attached to the user's mobile device with the social display application installed. The application runs in the background and displays the icon and name of the currently active application on the device (further details in the Methodology section). This prototype was used to run a 10-day trial study with 13 participants, qualitatively investigating a broad variety of participants' viewpoints. With this empirical "in-the-wild" trial study, we could gain more detailed understanding of the benefits and risks involved in social displays, as well as their implications to the sense of privacy and social interactions.

To summarize, the contribution of this paper is two-fold. First, we present the design and implementation of a prototype for social displays. Second, we report the findings of field trial of using social display in real life situations for 10 days. These insights can be used to design appropriate applications for social displays as well as other technologies aiming to increase activity awareness and enhance social interactions between collocated people.

RELATED WORK

In remote communication, technology provides additional cues to mimic missing physical cues. For example, ContactContexts provides callers with current status of the person they wish to talk to in order to help them decide whether it is appropriate for them to make a call [24]. In close proximity, technology increasing awareness encourages collective interactions and increases sense of community. The Break-Time Barometer, for example, provides information about other colleagues in a workplace. [15]. A stationary alarm-shaped device provides social activity information occurring at different locations. The aim was to encourage people to convene together during their coffee breaks. Similarly, Walky applies microblogging to a mundane walking activity, telling other seniors in a community when someone is going out for a walk [22]. The information is believed to encourage further interaction between seniors within the community. Jabberwocky is a mobile application that enhances a sense of community by informing who in their surroundings have been previously encountered in public places [25]. This awareness information is also a resource for developing further social interaction. StudioBRIDGE provides additional information related to other people, groups, locations, and events in an open working space. It is found to help users to decide the appropriateness of initiating an online or face-to-face interaction with others [35].

In collocated situations, people are aware of others' physical presence. However the activities that are happening in the digital world (e.g. with a smartphone) can remain unknown. This creates a design space for the technology itself to increase activity awareness and create shared experiences in collocated situations. Some earlier research has explored this design space through different approaches. Pac-Man Must Die applies this limitation of awareness to enhance the collocated game experience by creating a shared display out of multiple mobile device displays and making it advantageous if the players perform shoulder surfing while playing [29]. O-SNAP supports collocated collaborative search on mobile devices by providing a mode that contains search-related information that users can share and comment across devices during the search [31]. Reetz and Gutwin study the effect of different gestural interaction sizes in maintaining awareness among collocated people in a group. The results show that gesture sizes do not have a significant effect on their visibility and awareness to surrounding others [28]. However, the study was limited to the observability and visibility of the gestures and did not address about what the user is working on.

Rendering the interaction through an attached pico projector is another approach for making mobile device interfaces more visible and sharable to collocated people. Cowan et al. suggested several use cases in which projectors attached to mobile devices could support face-to-face interaction, including facilitating spontaneous sharing, conversation triggers and playful interaction, collaborative coordination, and personal expression [6]. Tweeting Halo allows users to express themselves using personal projector to project the user's Twitter message on the ceiling above his/her head [23]. However, using a projector to extend the display to the environment has been found challenging in overcrowded shared spaces with respect to privacy [6,23]. The privacy issue concerns both private content being shared in public places and forcing eavesdropping, that is, others seeing content by mistake.

In addition to the pico projector, there are other physical objects studied for the purpose of encouraging interaction

between people. BubbleBadge is a small public display in a broach-like frame providing dynamic information [8]. BubbleBadge found to help enhancing face-to-face interaction in a non-intrusive way [8]. Urbanhermers is a small display aim to be used as a dynamic fashion accessory providing its users a channel to express and communicate something about themselves to others within face-to-face physical environment [20]. Mugshot [14] is a coffee mug with a small OLED display attached to it presenting an image with the aims to encourage and enhance social interaction during an encounter between strangers and acquaintances. Instead of utilizing another physical object, we are interesting in extending items that people are already using and carrying together with their mobile devices.

Backside of mobile devices has been widely explored as an alternative input channel for touch screen gestures (e.g. [6,21]). In this research, using a social display is an alternative approach for making interaction with mobile devices noticeable to others in one's surroundings. The backside displays have been explored in face-to-face interaction between customer and the service provider in a service encounter with stationary technology [11]. The authors argue that having a double display at a service counter has the potential to enhance trust, effectiveness, and collaboration in the service encounter. Similarly, Colley et al. propose using two-sided tablet computer to support doctor–patient interaction aiming to reduce barriers and provide useful information to the patients [5]. Kleinman et al. explore two-screen laptop, Billboard, [16]. Billboard is designed to be similar to social networks (i.e. users create own text on the outer display, allowing digital likes and etc.) and aims to invite and support social interaction between surrounding people. Zhu and Höök, similar to Tweeting Halo, share users' tweets on Twitter to collocated people via the phone case [36]. Yotaphone [37] and Inkcase [38] are existing commercial products that offer a second screen on the back of mobile phones as a supplementary information channel and that have gained great interest from people, especially the InkCase[2]. Although they are mainly marketed for personal use, we considered the backside display a promising form factor for increasing activity awareness. Such a display is less intrusive with respect to privacy than a pico projector, but may still allow for subtle presentation of one's current activity with a mobile device to other people around them.

In summary, this study extends the research on activity awareness with a purpose and approach that have not been well studied before. In particular, we explore the potential of the novel concept of social displays for increasing activity awareness in collocated situations, based on the visual cues people can see from the user's activity with the mobile device.

METHODOLOGY

As mentioned, this research continues our earlier empirical user research about the concept of social displays [13] . Compared to the previously conducted focus groups, with a functional prototype for a field trial, we believed to gain more profound and valid insights about the perceived benefits, risks and opportunities the concept has. The field trial allowed us to also look into aspects like how people utilize the social display in their everyday life, how it affects the behaviors and interactions between the user and the surrounding people. Furthermore, we wanted to understand if and how the experience evolves over the period of use, particularly considering the perceived benefits after the novelty factor has worn off.

Figure 1. Illustration of the prototype. A hinge enables the user to hold the phone without covering the display with their fingers.

Design of the Prototype

The prototype consists of a 3.5-inch display from InkCase [38] attached to the backside of an Android smartphone. It is a grayscale, electrophoretic ink (e-ink) display to which images can be transmitted from a smartphone via Bluetooth. With our application, called Social Display application, the display shows the icon and the name of the application that is currently active on the phone, making it possible for people around the user to see which application on the mobile device he is using at the moment (Figure 1).

The displays were attached to the participants' phones in the first meetings in a manner that the display would disturb the use of the mobile as little as possible. There was a hinge between the backside of the mobile device and the display to keep the user from covering the display with their hands and to allow the display to hang perpendicularly, thus maximizing its visibility to other people. In most cases, the display was attached slightly below the camera, as shown in Figure 1, so that it would increase only the thickness of the mobile device by approximately. 5.2 mm. The added weight was approximately 50g as the display itself weights only 45g. We considered this as a decent prototype that would not encumber the user excessively but still produce realistic user experiences in the everyday life. The same feature could be implemented with off-the-shelf solutions like the YotaPhone [37].

[2] https://www.kickstarter.com/projects/378232716/inkcase-plus-e-ink-screen-for-android-phone/description

The Social Display application creates a service running in the background of the smartphone and uses the getRunningTasks function of the ActivityManager class to identify the main running application. Every time the active app changes, the service creates an image file that contains the icon and the name of the app and sends it to the display on the backside, with a refresh rate of approximately 2 seconds. A pre-defined image is shown when the user is at the home screen or when the main display of the phone is locked. The lock-screen picture can be changed by the user chosen from any image in the phone's gallery.

Methods and Procedure

To address the research questions about user experience and social influences of the prototype, a field trial with 13 participants in a qualitative approach was conducted.

Study Procedure and Data Gathering

For each participant, the study consisted of 10-12 days of using the prototype, with his or her own smartphone. In the beginning of the study a one-to-one introduction and interviewing session was held with every participant, during which they were asked to answer questions related to their general attitudes and behaviors about privacy and their use of mobile phone in everyday life. The aim was to not only gather information about the participants and their expectations, but to stimulate their thinking so that they could comprehend the purpose why the prototype was developed. After the interview, the participants were introduced to the concept and the prototype, and the necessary applications and hardware were installed on their phones. Next, the participants answered an initial questionnaire regarding their first impressions and expectations of the prototype, as well as their viewpoints on certain privacy-related issues of phone usage. Some of the most significant questions and the accumulated data of the initial questionnaire are shown in Table 1. In all the questionnaires of the study, a 7-point Likert scale (from -3 to 3) was used to measure the participants' level of agreement, -3 corresponding to "completely disagree" and 3 to "completely agree".

In the evening of each day during the trial period, the participants provided answers to a short questionnaire regarding their experience with the social display during that day. With both open-ended questions and agreement statements, they were asked to describe their behavior and feelings while using their phone, as well as the behavior of people around them in relation to the use of the social display. They were also asked to report the conversations that occurred with others (if any) because of the content shown on the display.

A second interview meeting was arranged with every participant at the end of the trial period. They were asked about their experience and interactions during the whole study from various viewpoints: for example, the benefits and drawbacks of the social display to both the user and the surrounding people, memorable positive and negative experiences, if and how it had increased the activity awareness of people around them and the participants themselves, and how the display could be utilized in other ways or for other purposes. Again, the used methods included both interviewing and a questionnaire.

Finally, we had a short questionnaire and interview for the people who the participants often met during the trial (e.g. spouses, roommates, friends) to survey their impressions of the prototype and if they felt to be more aware of the participants' activities with mobile devices. Unfortunately, only 8 people (3 partners of participants, 2 close friends, 1 colleague, 1 classmate, and 1 roommate) responded.

Data Analysis

The analysis of qualitative data followed a procedure that reminds the affinity diagramming process [2] but with digital tools. First, it was transcribed (in verbatim) and digitized into excel files. Then it was collaboratively analyzed with a bottom-up data-driven approach, identifying a hierarchy of themes in the data and categorizing all the answers to the themes and subthemes. To utilize researcher triangulation, three researchers analyzed the data independent of each other. The gained insights were then discussed to form a common understanding of the findings as well as commonly agreed categories. For themes that were present in several participants' data, quantification was performed. As for numerical data from the questionnaires, the averages were calculated and some trend charts of how opinions change day after day were drawn. No advanced analysis of the statistical significance of any numerical results were calculated due to the limited N – however, that was neither the intention in this qualitatively driven study.

Questions	Mean	SD
Familiar people sometimes ask what I am currently doing with my phone	1.31	0.91
I often bring up the content I browse as discussion topics	1.69	0.61
My friends/family/colleagues sometimes peek at my phone	0.92	1.07
I often peek at the displays of other familiar people	0.15	1.56

Table 1. Selected statements from the initial questionnaire. The scale is from -3 (completely disagree) to +3 (completely agree).

Participants and Recruiting

The participants included 7 males and 6 females and represented 7 different nationalities (Finnish being the most common – 6/13), their ages ranging from 21 to 42 years old (average 26) consisting of full time university students (9/13), part-time workers (2/13), and full-time workers (2/13). The recruitment of the participants was done on a voluntary basis via email lists and bulletin boards at the local university. They were offered a gift worth 40EUR as a

compensation for their efforts in the trial study. The participants were selected based on a screening survey that inquired how active mobile users they are and how much they are engaged in various social activities, thus indicating how suitable they would be for using technology for such social purposes. The minimum requirements were that the participants are savvy smartphone users and socially active in their everyday lives. The chosen participants of this study in general are familiar with sharing their mobile device activities with others to some extent and also involve mobile devices in their interactions with others (Table 1).

RESULTS

We start with an analysis of the user expectations and experiences from the social display prototype, covering aspects of perceived benefit, privacy, and effects on behavior. This is followed by the participants' impressions of the potential of the social display for increasing awareness and the social consequences of using the prototype with respect to interactions between the participants and others in the surroundings. The reported results include data from both the interviews (initial, final) and the questionnaires (initial, daily, final) and both from the answers of the participants and of their often-met friends or partners, which we refer to as viewers.

Expectations and User Experiences

When the concept of the social display was introduced to the participants in the first meeting, they found it interesting and often described it as "*unusual*" or "*different*". They expressed to be curious about the effects the prototype might create and about what others might comment on their activities with mobile devices: "*It would be interesting to see what kind of reactions I will get. It sort of tells how people pay attention to you while you don't even realize*" (M, 34). Most participants (11/13) were rather unconcerned with the idea of having the prototype for 10 days and presenting their phone activity to others and did not think that it would affect the way they use their mobile device. Only two participants were concerned with the fact that their activity will be exposed and cannot lie about their activity when having the social display, "*You cannot really lie with this thing. If someone asks what I am doing and he sees Facebook but I say something else, then…*" (F, 24).

Interestingly, after having used the social display for 10-12 days, the participants' opinions about the social display changed rather much (Figure 2). Participants tended to have more positive opinion regarding the privacy of social display. Even though their activities with mobile devices in fact became less private, it seems that the expectations of the privacy intrusiveness were more negative than the actual experiences. Considering the benefits, participants appeared somewhat disappointed by its impacts on social interaction. They mostly experienced interactions that they considered as minor social interactions: others around them, or the viewers, merely asked what they were doing but the interaction hardly developed into a conversation. Often, the viewers did not say a word but merely observed. When concluding their impression of the concept, many described the content of the display as too inadequate to trigger any significant interaction. After this overview, the following sections provide a more in-depth report of the expectations and experiences of using the social display.

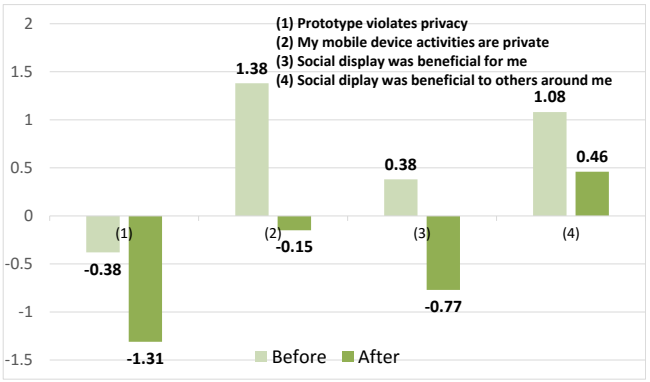

Figure 2. Averages of the participants' agreements with UX statement before and after the trial period. n =13; completely disagree = -3; completely agree = 3;

Impacts on Mobile Usage Behavior and Sense of Privacy

We identified two main factors in the social display that affected the participants' behavior while using their mobile devices: the looks of the prototype and its content. The prototype's appearance and the way it is attached were reported to draw attention, making the participants feel somewhat embarrassed during the first days, especially when in unfamiliar environments surrounded by strangers. However, they reported that this feeling reduced after a few days and that, over time, they started feeling more comfortable with having the prototype.

Interestingly, the social display showing only an icon of the currently used application was generally not considered to be too privacy intrusive at any phase of the trial. Before the trial there were some who had slightly more concerns than others regarding privacy but the prototype was acceptable even for them. Compared to what they expected before the trial, after the trial most of the participants (10/13) experienced less privacy issues. As one participant stated, "*it's not privacy intrusive because it doesn't show exactly what I am doing. If it showed for example all the messages I type, then it might be. I would be thinking what I'm writing all the time*" – (M, 22). Those participants whose privacy concerns increased (3/10) during the trial reported that they had come across situations that had raised their awareness of the visibility of their activity on mobile devices. Nevertheless, also according to their assessments the sense of privacy remained within acceptable limits: "*It was just interesting to realize I couldn't hold up my phone on my hands on lectures, because that would show the teacher what I was doing...*" – (M, 25).

Increased Self-Awareness of One's Own Mobile Device Use

Based on the initial questionnaire and interviews, all participants thought that excessive use of mobile devices in social gatherings is impolite. They admitted to often be guilty of doing the same when, for example, hanging out with friends, attending a lecture, or relaxing at home with other family members. The final questionnaire indicated that the social display in general did not affect participants' mobile device usage behavior (Figure 3: mobile usage when with strangers and when with acquaintances). Also in the interviews, it was often reported that the participants' behavior remained the same, however, with a clarification that they were more cautious with their activities in some situations. Most of the participants (8/13) noticed to become more aware and careful with their activities with mobile devices. Five of them reported that, at times, having the social display suspended the use of the mobile device in social situations because they felt that the use was not appropriate in the situation. The situations in which this happened included cases where they were expected to pay attention to ongoing activities in front of someone (e.g. in classroom, in a concert). Using a mobile device in such situations is already impolite, and having the social display seemed to add to the feeling of impoliteness.

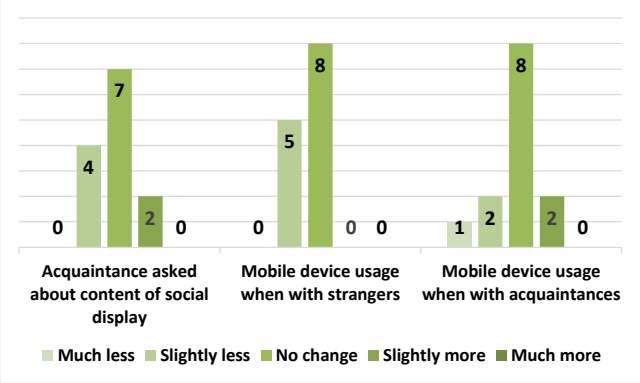

Figure 3. Effects of Social Display to device usage behavior and others around them

The feeling of impoliteness was observed to be related to the application one is using as well as to the situation. Participants reported to have felt less comfortable when the activities on mobile devices are not related to the ongoing activity in the social setting. "*Once we went to [a performance] and we were sitting quite close to the stage, at times I checked my phone. [At the spot,] the performers did notice what we were doing and they would think that we were not paying attention if they see that we are using Facebook, so I was trying to avoid showing that. I didn't want to disturb them*" – (M, 34). On the other hand, if the activity with the mobile clearly related to ongoing activities, the social display could, in fact, turn the use of a mobile device more comfortable in the situation: "*when you are in a social environment where it's impolite to use cellphones, and you want to read your e-mails and people are wondering 'is he really reading his emails or is he playing candy crush or something'. In that situation it can be reaffirming for the person that they can see that he's actually using Gmail. It can give more confidence to you that you're actually doing what you're supposed to do*" – (M, 22). Considering the formality of the social situation, self-awareness and being conscious of one's own mobile use was only observed in more formal social situations, such as a lecture or a performance. In casual situations (e.g. chatting or hanging out with friends), social display did not influence the participants as they reported using, e.g., Facebook or WhatsApp normally in those situations.

The Viewer Matters

When not in any specific social situations, the relationships with the others in the surroundings were reported to affect the participants' behavior in using their social displays. Here, the opinions were split in two main viewpoints. Half of the participants (6/13) were rather cautious with their activity and applications they are using when with strangers: "*I was hiding the display because I don't want other people to see what I'm doing. Other times, I didn't even use the application I wanted because I was surrounded by strangers and I didn't want them to know. The worst would be dating applications. Of course, I wouldn't mind to show that to my friends. For example when I was eating at a restaurant I didn't like it that everybody could peek and say 'Hey, look at that guy trying to get a date!'*" – (M, 24). Additionally, participants reported to be cautious if the applications they are using are related to others, i.e. strangers: "*we were in a party, and people came dressed up funny and weird, and also some people were dancing weird. I want to share this moment with my friends, taking a picture of a guy … when I take a picture of him I don't want him to see. I was more cautious there*" – (M, 34).

The other half of the participants (7/13), interestingly, did not notice any differences in their behavior with mobile devices while being with friends versus with strangers. They considered the content of the social display as rather generic and safe to share with anyone. Additionally, they did not consider the applications they use to be bizarre or unusual, and thought that strangers mostly only mind their own business anyway: "*There wasn't a difference between when with friends or with strangers. It was surprising. I thought I would be more careful among strangers but no. For example, Instagram and Facebook are quite okay. I don't feel ashamed of using those as long as it doesn't go into detail. If I were using some unusual applications, then maybe.*" – (F, 25)

Increasing Viewers' Awareness and Triggering Interactions

Visibility of the Social Display

Placing the social display on the backside of a mobile device can be questioned with respect to its visibility to others. As we required the participants to slightly change the way they usually hold the device (as can be seen in

Figure 1), some reported that when in a hurry they sometimes covered the social display. Moreover, this positioning makes the display visible to only those directly opposite to the device user. Nevertheless, the responses from the viewers indicated that all of them noticed the display and its content at least a few times in their encounters with the participants. Having said that, the social display was appreciated for allowing its content to be visible in the physical environment – allows quick glances without having to turn on any applications to get a cue of what the user is doing, "*it would be fine to have just an application that works with Bluetooth and shows what nearby people are doing, but you'd have to turn on the application every time you want to see what others are doing. It's not like you can just look around*" – (discussion between a participant M, 24 and his roommate). Moreover, the viewers reported that they did not feel uncomfortable or impolite looking at the participants' social display and most of them (5/8) found themselves peeking at the display at least a few times during their encounters.

Triggering Interactions with Others in the Surroundings

The participants reported having had various social interactions with their friends and relatives as results of having the social display. Most of them happened due to the novelty effect of the form factor: just having an additional display hanging on the mobile device triggered questions from particularly familiar people and acquaintances. Examples include friendly teasing and joking around because of the funny display, or even asking the participants to use the mobile device to see it again in action: "*I have a friend who had a funny reaction by saying 'Now I want to look at what you are doing'*" – (F, 24). Occasionally, others asked the participants about the content presented on the social display, including short questions like "*hey, what are you doing on Facebook*" or "*how is your calendar?*" Social display was then seen as a resource for a few jokes and small conversations, encouraging an open and fun atmosphere between family members or friends. Also, when the social display hinted about an atypical activity or application people got easily interested: "*when I was using something else, for example, I was looking for score results, one friend asked what it is about. I then explained that I was looking at sport results. It resulted in us having a sport-related conversation*" – (M, 22).

Half of the viewers (4/8) agreed that social display increased awareness of what the participants were doing with their mobile devices. This awareness sometimes increased the curiosity and resulted in a conversation: "*I've noticed she was using different Russian apps which I was not familiar with and I asked her about it. Now I understand more of her interests and what she likes*" – (close friend of a participant). The awareness was also found to help indicating interactivity status of the person: "*it helps to see if [the user is] paying attention to me; if [he is] listening at all*" – (close friend). This also allows others to interrupt and try to draw the user's attention back to the ongoing interaction: "*My girlfriend and I were having a discussion and at the same time someone messaged me on Facebook. […] She knew that I was doing that because of the [social display]. She didn't like it and made a joke about it*" – (M, 34).

Social Display versus Traditional Artifacts

The prototype aimed to increase activity awareness to a similar level as what more traditional artifacts as newspapers, books, or televisions allow. While most of the viewers (6/8) expressed positive opinions about the social display, only 4/8 of them actually reported that their awareness regarding the participants' activities with mobile devices increased. This implies that the prototype is lacking some aspects that traditional artifacts have. Participants indicated that traditional artifacts, e.g. a newspaper or magazine, provide much more information about what the person is doing: *"[Social display] gives clues about what you are doing; in that sense it is similar to [those traditional artifacts]. But when you are watching a movie, TV or reading a newspaper, [those artifacts] give others a lot more information. For a newspaper, if you don't see the article, you might still see which section or headlines [one is reading]. This brings an in-depth conversation topic. Social display doesn't provide to the same extend because it just shows [the name of the application, for example] WhatsApp or Gmail. They might think that, 'OK, he is doing that', but not anything else*" – (M, 22). Moreover, the prototype has a disadvantage in terms of size and the limited viewing angle, making it is less observable compared to a book or a newspaper: *"[social display] almost fulfill its purpose, but when you are reading a newspaper, almost everybody in the same area can see it*" – (M, 24).

More Detailed Content: More Interesting yet Intrusive

The application for social displays showed simply the name and icon of the application currently in use. Most of the viewers (6/8) agreed that the display should provide more information than this to make it more useful for others and increase the likelihood of triggering social interactions. "*As you can only see the application that is being used, it's hard to comment on the things that are really happening. You don't really know much more than before, only you get more curious of what is happening.*" – (close friend). In addition, the participants reported similar comments from their other friends and relatives: "*Feedback that I got from other people by showing only the application I'm using was that it doesn't give enough information to do anything with that*" – (M, 27). They pointed out that the activity on a mobile device could be interesting, but displaying the application a user is using does not usually tell enough about – or even have a direct relation to – what the user is doing. It was agreed that for specific applications like games, the name and the icon of the application can be enough. For internet browsing and social media the application name is inadequate: "*I don't think it gave out*

enough information. The thing is that I usually check news and other things from Facebook or Chrome. It only shows the application, not the news title. It doesn't show the actual stuff that I'm looking at. People are not going to say 'Hey, what's on Chrome?' For Facebook yes; maybe once or twice they asked me 'what's on Facebook?'" – (M, 25).

The viewers agreed and some of the participants (7/13) explicitly stated that adding more information would make the content on the social display more interesting, better increase activity awareness, and increase the possibility of having an interaction between users and others around them. The detailed information was envisioned to be, for example, news headlines or Twitter activities.

While the participants envisioned interesting uses and contents for the social display, some speculated that it would also affect their behavior more if it showed more than currently: "*if it showed more, then I would probably think about what I am doing a lot more. I wouldn't want everyone to see on which webpage I am. I don't see any point in that. I think it is too much*" – (F, 24). One participant proposed an alternative design with additional information related to the activity already hinted by the social display: "*If I am using [social media], I could show also the activity that I am doing, like if I'm posting something, chatting, or looking at a profile. […] if I am using the email, it could say that I am reading or writing; a bit more information but not too private*" – (F, 24).

Instead of sharing more details about the current application, allowing device users to customize content on the social display could make the content more interesting. Interestingly, the possibility to customize the content the display showing when their mobile devices are locked or at the home screen got little attention: only 3/13 actively changed the pictures. Others seemed to associate the customization with changing the background picture on their devices, which they not either were actively changing. "*[Being able to change the picture] is quite nice. It is the same as background picture of the phone. In the beginning I changed it a lot, but now it has been the same for maybe a year*" – (M, 24). Also, none of the viewers mentioned about the participants' custom pictures. Instead, some participants (5/13) envisioned an option of replacing the application icons with user-selected pictures, writing own messages to the display, expressing one's mood through the display, or manually selecting content to be shown. "*It could be really good if there were features that allow writing something into the display, changing the setting, and also writing own message to others. It makes the display more personal. It's more 'me'*" – (M, 22). A possibility to choose which content to be presented also satisfies participants' concerns for privacy.

The Displayed Information is Just "Good to Know"

As mentioned, the participants reported occasional interactions with others around them as a result of the social display and its potential in increasing activity awareness. However, most of the time, social display provided merely good-to-know information, which does not necessarily intend to encourage interaction regardless the detail of the content, "*One doesn't need to ask what does s/he doing in the phone, just look at the screen and be aware*" – (classmate). Even if more detailed or interesting information was provided, it would not necessarily increase interaction between people, as one participant speculated: "*Even if you are reading a newspaper, nobody actually comes to you and says something about it. I guess it has the same effect. People might know what you are doing but they don't say you anything*" – (M, 34) Nevertheless, this awareness can stop others from asking or interrupting the user as they already know what he is doing: "*I guess without the display, it would be easier to get interrupted because you don't know what the other person is doing*" – (M, 27). Although the majority did not notice any difference to previous times, a few participants agreed that there are slight changes in others' asking and interrupting also observed (Figure 3: acquaintance asked about content of social display).

Some of the viewers interpreted activities on the users' mobile devices as private actions and was none of their business, thus, they did not pay much attention to the social display in general: "*I think what people are doing with their own mobile is covered by privacy. I'm just curious in what they are doing but I did not pay much attention in that screen because it is not my business*" – (roommate). Participants also reported similar perceptions with others during the trial: "*everybody could see what I'm doing with my phone, but nobody cared*" – (F, 25). One participant commented that others did not care because there is no good reason for them to do so: "*People do stuff and others don't care. Why should they?*" – (F, 24). Another mentioned that regardless of the activity on mobile device, he will wait until the user finishes using the device: "*I don't care too much about what applications other people are using…if I want to talk to somebody I will probably wait until they're done using their phones. The fact that they just use their phone is the most important for me*" – (M, 24).

However, the situations vary depending on the situation and relationships between the device user and others around. For example, as mentioned by two participants, their family members were quite interested in the content on the social display and were asking about it all the time: "*My family, they were interested in what I'm doing with my phone. When I was at my parents' house, my mom was always asking, 'what is that app', 'what is that for?'*" – (F, 21). At the same time, no serendipitous interactions with strangers were reported by any of the participants.

DISCUSSION AND FUTURE WORK

This study explored the potential of social display in increasing activity awareness with a trial study in real-life contexts. The results indicate that the display helped increasing awareness of user's activities on mobile device

to others in the surroundings, up to a certain extent. In general, the social display emphasizes users' mobile activities, making them more observable and unambiguous to people around them. This was found to often result in making the use of the mobile device more acceptable in certain social situations. In some other social situations, however, also depending on the applications used, it can make the mobile device usage quite bothersome to both the user and others around them.

Activity Awareness and Privacy of Social Display

Mobile devices provide their users with freedom of interaction, communication, and activities anywhere and anytime regardless of the contexts. Interestingly, the social display not only increased the awareness of the surrounding others but seemed to encourage the participants (i.e. the mobile device users themselves) to pay more attention to the ongoing social situation and consider when the use of mobiles is appropriate. The results imply that there are three main factors that affected the participants' decision whether to use their mobile device or not while having the social display attached: (1) the application they were about to use, (2) the ongoing social situation, and (3) their level of familiarity (relationship) with the viewers. All these factors, along with the personal privacy tolerance, which varied from one participant to another, also affected the way users believed to be perceived by others. For example, some participants did not prefer the use of dating applications when among strangers but considered it fine when among friends. As a result, occasionally hiding the display or avoiding use of mobile devices in some social situations was reported.

The current design of social display is in the borderline if it invades the privacy of the mobile device users or not. On one hand, it does not provide in-application privacy configuration and sometimes it seemed to exceed the desired level awareness be presented to others around. On the other hand, when we consider privacy as the right to select what information is known to what people [33], social display actually allows the users to control their privacy relatively much. Activity awareness applications usually provide the awareness information on the audience's own devices (e.g. [24,35]). The information is constantly presented and viewers can access the information anytime and anywhere with or without the information owner knowing. This is not the case with the social display: the activity information can be seen only by the people in the physical proximity and when the user is using the mobile device. This allows users to evaluate the ongoing situation and timely react to it by, for example, hiding the social display or putting the device away.

Social Display Bursting the Mobile Bubble

Some events of serendipitous interactions as results of the social display were reported. Additionally, the social display and its content were perceived as sources of jokes and small conversations, leading to an open and relaxing atmosphere among friends and family members. However, generally the potential for social consequences like engaging people in social interaction was hampered by the lack of detail of the user's activity on the social display.

Ongoing social interactions create social norms; for example, the expectations from others to pay attention to an ongoing joint activity, and thus, reduce the social appropriateness of using mobile device in the situation. The social display seemed to make people more self-aware in this regard. Often this related to politeness and consideration of others, e.g. not disturbing others by using personal mobile devices while being involved in a social situation that demands attention. In other words, the reasons behind hiding and suspending the use of mobile device were not only about the users not wanting others to know about applications they are using (i.e. privacy-related reasons), but also about presenting themselves appropriately in the current situation (cf. [27]).

Moreover, the aforementioned factors, application and social situation, can also generate understanding and empathy from surrounding others towards the users. For example, when the use of a mobile device is generally considered improper but necessary due to for example work reasons, the social display increased the acceptability of mobile device use. Consequently, the social display provides activity awareness not only to others around them, but to the users themselves, increasing one's self-awareness related to the appropriateness of using mobile devices.

Encouraging heads-up interaction and bursting the mobile bubble have recently been hot topics in HCI research. Public initiatives have raised awareness of the issue and aimed at encouraging people putting away mobile devices in social situations (e.g. projects Look Up[3] or stop phubbing). However, such general-level normative regulations do not take into consideration different uses of mobile devices in different social situations. Many of the other research prototypes are designed for specific contexts and activities. For example, [30] focuses on game play between children and [19] focuses on learning. Some go further and propose applications that limit the use of mobile devices with in-app social support and competition [17]. We argue that social display is a simple approach that allows social and context-based flexibility and meaningfully utilizes the concepts of peer pressure and social norms to burst the mobile bubble. Moreover, the display also allows a device user to appropriately create a socially acceptable bubble without too complicated method as in [18].

Customizing Social Display

With social display, mobile device users might not be able to use their mobile devices normally and whenever they want. They have to consider their privacy and self-

[3] http://bit.ly/1s2h19J

presentation according to the ongoing situation. As a result, participants, at times, wanted to replace the activity cues with something else, allowing them to be able to use their mobile devices normally. Currently, the social display is designed as a fully automatic display showing cues of any applications currently active on the mobile device. Instead, social display could provide less information about the users' activities by replacing the visual cues of some applications – especially application that users are not comfortable revealing, such as dating applications – with user-created-contents. This approach could provide the feeling of control over privacy and self-presentation and at the same time persist the characteristic of automatic disclosure of an activity awareness application. However, allowing users to customize the social display behavior could affect both user's and viewer's awareness. Viewers could be less aware of the user's actual current activity, thus, user themselves could be less worried about their mobile device usage in respect to ongoing social situation.

Methodological Reflection and Limitations

Social display is a close-proximity social awareness application. In most of the awareness applications, reciprocal behavior is expected: a user has the role of an information provider as well as a viewer [1]. One of the differences between social display and other social awareness applications is that the user has only one role: an information provider, and viewers are others who the user encounters face-to-face. In this regard, the results of the study could have been more complete if we had had a better access to the viewers who our participants came across. However, due to recruitment challenges, it was not always possible to recruit participants together with the viewers (e.g. those who spend a lot of time with the participants). Furthermore, due to the length of the trial period, constant observation of the participants was not feasible. Our results are primarily based on participants' report of their experiences and discussion with some of the viewers they have encountered. The questionnaire sent to the participants on daily basis was helpful in collecting experiences that the participants might have otherwise forgotten to report at the end of the study. It also allowed us to access the results and bring up some clarifying questions in the final interview. However, in a future study with a shorter trial period, we would consider also a direct observation and shadowing as methods for more inclusive qualitative data gathering from different perspectives.

Finally, we had participants from 7 different nationalities to provide a rich set of data with as little cultural bias as possible. Although the sense of privacy and social interactions are also defined by the culture, we did not observe strong differences between participants' feedback that could be explained by their cultures. The differences were mostly based on their personalities, preferences, background knowledge of technology, and social situation and their relationship with people they interacted with during the trial period. Even though the participants represented various cultures and probably have encountered many people from various other cultures, the study was conducted in the context of Finnish culture, which probably makes an overarching effect. Anyway, with such a qualitative study, the methods and the participant number do not allow making conclusions about the effect of culture, so this remains as an aspect to be considered in future studies.

Opportunity: Social Display as a Semi-Public Display

Mobile devices are considered to be private, especially the main display and the content on the device, even for family and friends [10]. In our earlier study, as a display attached on the backside of a mobile device, the social display was questioned considering its visibility and appropriateness for others in the surroundings to look at [13]. The results of this study indicate that the social display is not as private and personal as previously thought. Rather, it is a semi-public display, especially when the user is among family and friends. Similar findings are reported when examining the function of smartwatches as public displays [26].

The main difference between the current social display and a typical public display is that the former has a dedicated owner, i.e. the user of the mobile device. The owner is in charge of whom the display is visible to, and his/her activities with the mobile devices directly affect the content of the display. As a result, any interactions caused by the display is controlled by its owner and revolves around him or her. However, the use of the social display is to provide information to others in the surroundings, but not to the device users themselves. It will be interesting to further explore how others in the surrounding could gain more benefits by being aware of the user's activity (e.g. utilizing social display in collocated mobile collaboration with multiple mobile devices, similarly as in [19]).

CONCLUSIONS

Mobile devices can serve for a broad range of activities. While this has benefited people in many ways, it comes with a social cost. Many activities that were more easily observed and allowed shared experiences have become private when moving to mobile devices. We implemented the social display prototype aiming to increase surrounding people's awareness of user's activity with a mobile device. A 10-day field study with the prototype was conducted with 13 participants. The results imply that the social display has the potential to increase activity awareness and occasionally encourage serendipitous interaction between mobile device users and their collocated family members and friends. Additionally, the social display underlines the user's activities with their mobile devices, thus raising self-awareness regarding the appropriateness of using mobile devices in different social contexts. The social display was found to encourage its users to be more careful with the usage of their mobile devices, and, before using them, consider ongoing activities around them more carefully.

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