



LockDoll: Providing Ambient Feedback of Smartphone Usage within Social Interaction

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Abstract

In group activities, members often could hurt others' feelings by using smartphones more than expected due to the lack of awareness on smartphone usage. Other members can remind them of their usage by asking not to use their smartphones, but our survey results show that explicit asking could bring about negative experiences in a group. To overcome this, we designed LockDoll, a tangible artifact that provides ambient feedback of smartphone usage to help members manage their usage. By following an ambient design pattern of symbolic sculptural display, we expect LockDoll to softly and yet, effectively intervene with smartphone usage in the group context. In this paper, we present the preliminary working prototype and discuss further design issues through a pilot study.

Author Keywords

Group Awareness; Smartphone Use; Tangible Interaction; Ambient Display

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction

Smart devices, especially smartphones, have become a mainstay in our lives today, providing us with useful func-

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Figure 1: LockDoll: A tangible artifact to alert the group with lights and other feedback actions in a calm and non-invasive manner.



Figure 2: PhoneStack Game: Everyone places their phones in the middle of the table; whoever looks at their device before the check arrives picks up the tab. [14]

tions and contents. Earlier studies, however, have reported negative effects of smartphone use, such as distraction and disruption in daily activities like studying and socializing [1, 2]. The use of smartphones in group settings was especially noted for decreasing the quality of social interactions within the group as well as for the harmful effects to the overall group dynamics [13, 17]. Also, Humphreys [3] reported that when someone uses a smartphone, their companion is often left feeling awkward and excluded.

Prior studies [6] addressed the need to limit smartphone usage in order to avoid distractions and focus on concurrent group activities. However, our preliminary survey found that people focused on their smartphones more than they expected, simply because they easily lost track of their own usage. Not only did they shift their attention away from their physical conversations, the use of their devices felt rude or inconsiderate to their companions. The survey also revealed that directly asking someone not to use their smartphone left both individuals feeling uncomfortable.

To address these distractions and help people stay focused on the people whom they are with, we have designed LockDoll, shown in Figure 1. LockDoll is a tangible artifact that when placed within a room (such as on a table) will provide ambient feedback for better awareness of smartphone usage during social settings. When smartphone usage becomes problematic, LockDoll alerts the group with a light and gesture in a calm and non-invasive manner. LockDoll's design is based on *Symbolic Sculptural Display* [16], a pattern of gentle abstract cues displaying information in the form of decorative objects often seen in both home and office environments. Our pilot study results showed that LockDoll can improve group awareness of mobile device usage while enabling social engagement to continue uninterrupted.

Related Work

Smartphone Distractions in Group Activities

There have been HCI studies to design mobile apps for minimizing smartphone distractions. While earlier work [10, 12] focused on supports like screen locking and usage monitoring that addressed individual use, later studies [5, 7] emphasized group interaction to improve self-regulation of smartphone use. However, these tools primarily focused on presenting the information after the occurrence (e.g., presenting members' past usage amount) and did not offer the information real-time during the activity when it was most needed. Recent studies have also been conducted wherein smartphones have been physically separated from their users during group activities (PhoneStack in Figure 2 [14, 15]), but it is less effective when smartphone use is needed during group activities such as web search. Lock n' LoL [6] was designed to overcome this by allowing group members to limit their use collectively. Our work is along with the line of these studies, but we further utilize a tangible artifact to provide better awareness on smartphone usage in an ambient and persuasive way.

Ambient and Tangible Interactions for Persuasion

The use of ambient cues from a tangible device has shown to be an effective tool to motivate a group of individuals to share their requests and opinions, while also improving user efficiency. Bewell [9] was designed by tracking smartphone activities and using mobile ambient displays that are gentle and informative. The feedback from Bewell can help people better understand their day life such as social interaction, physical activity and sleep patterns. Kozima et al [8] suggested 'Keepon' which is helpful robot with suffering from developmental disorders such as autistic children. It showed the effectiveness in eliciting motivation to share mental states. Kennedy et al [4] claimed that indirect requests via robots are polite and positively correlated with

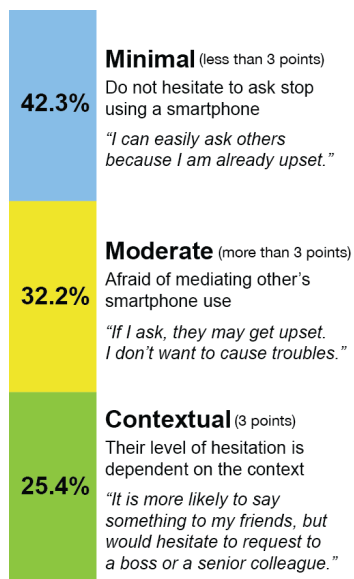


Figure 3: Hesitation in asking someone not to use smartphones.

learning gains. In this study, we used tangible and ambient interaction technique to provide awareness on smartphone usage more effectively without any negative or harmful interactions.

Preliminary Survey

As a preliminary study, we conducted an online survey to understand the experiences and effects of individuals within social setting who were asked to stop their smartphone usage during the event or who requested such of others. The survey consists of three parts. First, we asked about hesitancy of requesting others to stop using their smartphone via a five-point Likert scale questions, followed by an open-ended questions to describe the reason for the Likert question. Second, the survey contained two open-ended questions about how they felt after they asked someone to cease using their smartphone and how they felt when others asked them not to use their mobile devices. Finally, our survey concludes with questions about the participants' demographics, asking about gender and age. The survey was posted in online forums and SNSs in Korea, and 59 participants freely responded to the survey (gender: 32 males and 27 females; ages: $M = 25.83$, $SD = 4.06$).

Results

Hesitancy. Using a five-point Likert scale question, respondents were first asked if they are uncomfortable requesting others to stop using a smartphone during group activities. The respondents' answers varied, but could be sorted into three categories according to the given points via the Likert scale. Then, we could label each group of responses by analyzing the participants' answers to our open-ended question

'Minimal': 42.3% of the respondents gave less than 3 points, indicating that they usually do not hesitate to ask other to stop smartphone use. We found that these respondents


tend to ask other to stop smartphone use by expressing their negative feelings (e.g., upset, disappointed). For example, a respondent said, "I can easily ask others because I am already upset." Another respondent mentioned, "It's my right to rebuke others for their rude behaviors."

'Moderate': 32.2% of the respondents expressed that they are usually afraid of mediating others' smartphone use (by giving more than 3 points). Most of these respondents worried about their request would cause conflict or hostility. One response said, "If I ask, they may get upset. I don't want to cause troubles.", while another commented, "I may hurt my friend's feeling by asking him to stop his smartphone use." Interestingly, some respondents expressed that individuals may actually need to use their smartphone. Once such response was "When my friend uses a smartphone, I assume that he needs to use it. So, I don't want to interfere with him."

'Contextual': 25.4% expressed that their level of hesitation is largely dependent on the context. One of the common responses was due to interpersonal relationships. For example, these respondents would be more likely to say something to their friends, but would be very reluctant to request someone of higher authority to stop their smartphone usage, such as a boss or a senior colleague. In addition, some of the responses mentioned the need of considering what applications they are using. If the smartphone was addressing an urgent or important issue, they answered that they usually can accept its use.


Negative experiences following requests to stop using smartphone use. Next, we investigated experiences following such requests to discontinue smartphone use within social settings. We asked the respondents how they felt after they asked someone to cease using their smartphone. This part was made up of open-ended questions,

Feelings after making non-use requests

 Negative feelings due to the member's poor manners

 Worries about the listeners maybe hurt

Feelings after getting non-use requests

 Sorry for others about their unintended overuse


 Upset from the request as the use was necessary or the requester often uses smartphone also.

Figure 4: Negative experiences following requests to cease smartphone use.

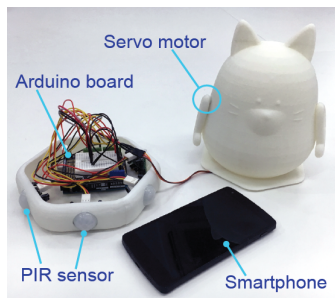


Figure 5: Prototype of LockDoll.

in which two researcher collaboratively extracted the main themes of the participants' responses. Most of the respondents expressed negative feelings (e.g., upset, disappointment, loneliness, and ignored) due to the etiquette of the other person. Some respondents conveyed regret in their requests, citing that they worried they had hurt the other person's feelings.

We then gave the respondents an open-ended question about how they felt when others asked them not to use their mobile devices. Similarly, two researchers analyzed the responses to our open-ended question to understand its corresponding themes. Many respondents answered that at first, they felt apologetic that the other person was upset. Interestingly, they confessed that they were not aware of their overuse until other pointed it out. Some respondents admitted they were angry when others asked them to stop. One mentioned, "My friend often uses a phone too." and another said, "I really needed to use it at that time, and I didn't use it very long."

LockDoll Design

Design Approach

We considered the preliminary survey results and prior studies when we designed LockDoll. The results revealed that people often lack the awareness of their own smartphone usage in social settings, which disrupts group interactions and negatively affects the participants. In addition, a significant number of the survey respondents expressed hesitation in asking others not to use mobile devices because of the subsequent effect on the group and individual feelings.

We designed LockDoll with these challenges in mind, providing ambient feedback for better awareness of smartphone usage by all members of a group. Tangible artifacts have been widely used in providing useful information and

gentle persuasion [8, 19]. Similarly, we believe that a physical cue can improve awareness of a group's smartphone use in gentle, non-invasive way so that individuals are encouraged to change behaviors without the need for conflict.

LockDoll was specifically designed to increase awareness of smartphone usage by providing cues that do not interfere with a group activity. Because we adopted *Symbolic Sculptural Display* [16] in our design approach, information is clearly displayed in an abstract manner, mimicking objects often found at home or in an office. Furthermore, we shaped our Symbolic Sculptural Display in the form of a smart pet; LockDoll mimics the image of a cat. Smart pet is one of the design approaches used to gently persuade user behavior [11] in that behavioral improvements can be accrued as the attachment to the pet increases. We chose the cat for LockDoll because cats are generally recognized as calm, curious, and appealing [18]. Also, we provided feedback by having it wave its arms similarly to the way a cat moves to gain the attention of its owner. However, we considered the possibility that if the waving arm action appears too often, it might be disruptive. To address this issue, we configured the waving arm action to appear only when users use their smartphone heavily within a certain amount of time. Prior to reaching that limit, we designed a system of ambient light feedback to prevent overuse of the LED lamp.

Working Prototype of LockDoll

Figure 5 is the first working prototype of LockDoll, created by a 3D printer with ABS (Acrylonitrile Butadiene Styrene). It includes a smartphone with a camera LED lamp, an Arduino board, four PIR sensors, and a servo motor. The arm motion of LockDoll mimics that of a cat, waving its front paw. Also, LockDoll can turn its lamp on. LockDoll's motion and lamp are actuated when members of the group are focusing on their smartphones too much. The LockDoll client

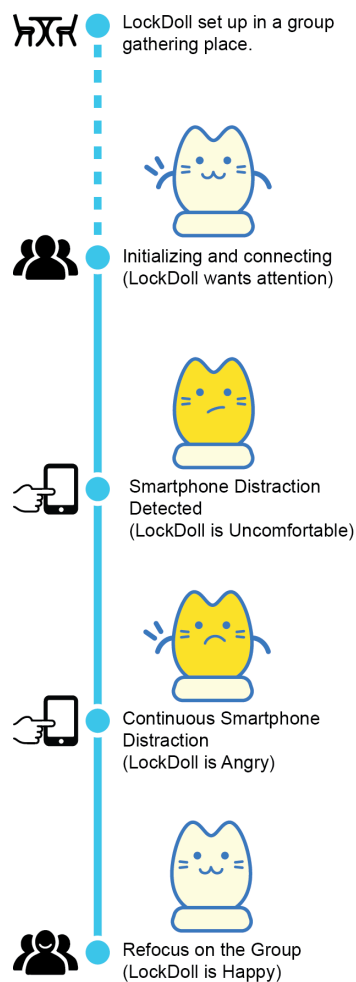


Figure 6: LockDoll Interaction.

application is used to link each participant's smartphone with LockDoll, and monitors their phone usage during the connected session with the doll. LockDoll has the following four states.

'Initializing and connecting (LockDoll wants attention)': Once LockDoll detects group members based on four PIR sensors, it waves its arms to remind them of connecting to the LockDoll and limiting their smartphone use for their group activities. At first, users should connect their smartphones to LockDoll by typing an unique PIN code assigned to each doll. After smartphones are connected to it, LockDoll monitors their usage within the group setting and provides applicable feedback.

'Smartphone Distraction Detected (LockDoll is Uncomfortable)': When one or more group members are using their smartphone more than a certain period time, LockDoll becomes uncomfortable with this distraction and express this concern by turning on its lamp, thereby gently notifying the group about its current feeling. For the first pilot study, we used five minutes as the time period for this event, considering that the participants in prior study [6] were satisfied with the five minutes of free-usage time in a group limiting session.

'Continuous Smartphone Distraction (LockDoll is Angry)': LockDoll becomes angry when someone continues using their phone, ignoring his lamp alert about the smartphone distraction. The doll further waves its arm to suggest the individual stop using their phone and focus their attention towards the group.

'Refocus on the Group (LockDoll is Happy)': When the user recognizes the alarm from LockDoll and stops using their phone, LockDoll turns off the lamp and stops waving its arm.

Pilot Study and Design Issues

We performed a pilot user study to explore further design issues of LockDoll and to evaluate its feasibility. We recruited two groups of friends (a total of seven participants). Their age ranged from 26 to 31 ($M = 28.85$, $SD = 1.55$). Most of them were graduate students, with one undergraduate participant. We introduced them to LockDoll, and asked them to use LockDoll in their group activities. One group decided to use LockDoll during a research meeting in a lab office and another group wanted to use it for sharing information about their daily lives. Their conversations lasted for about 20 minutes and we recorded their activities and LockDoll interactions with a video camera. After the group activities, we interviewed all the participants about their experiences with LockDoll, and analyzed their feedback to extract further design issues.

Design Issue #1: Group Awareness on Smartphone Use

All the participants reported positive experiences with group awareness in smartphone use through LockDoll. Most of the participants mentioned that they became more careful in using their smartphones during group activities because LockDoll continuously reminded them of their usage. One participant said, "I often used my smartphone in a group without guilt. However, after LockDoll, I needed to be more careful in my use because I didn't want to make LockDoll angry at me." (P3) Another participant expressed, "I was just checking my Instagram and LockDoll started to act out after some time. At that time, I quickly stopped using my phone because I felt that made others uncomfortable." (P6).

However, some of the participants wanted to have more fine-grained information about their usage since the current LockDoll only provides feedback on overall usage amounts of smartphone use within a group. One participant mentioned, "It will be helpful to provide app types because some apps need to be allowed." (P1) Another participant wanted

to see the person using the phone, resulting in making LockDoll angry, but others expressed concerns with this option due to potential embarrassment.

Design Issue #2: Attachment to LockDoll

We evaluated whether the LockDoll design is attractive enough to potentially increase the attachment of the users. As user attachments become strong, interactions with LockDoll can be active and smartphone usage behavior can be more effectively mediated. In the interview sessions, all the participants positively evaluated LockDoll's appearance by appreciating its cuteness and familiarity. Furthermore, the recorded video showed that the participants tended to quickly respond to LockDoll's actuation. One participant said, *"I felt that I had to soothe LockDoll as soon as possible once LockDoll felt uncomfortable."* (P1)

However, some participants wanted to see LockDoll's states more diversely, as if it were a real pet. For example, one commented, *"It would be more interesting and enjoyable if LockDoll had facial expressions or facial colors."* (P1) In addition, another participant talked about physical interaction with LockDoll by saying, *"Like some toys, LockDoll can react when I touch."* (P3)

Design Issue #3: Soft Intervention on Smartphone Usage

We found that LockDoll can softly intervene with users to avoid smartphone distractions. One participant said, *"When having LockDoll's gesture, I was able to naturally bring up a subject about not using smartphones without embarrassing someone. That was quite interesting."* (P4) Also, LockDoll lessens the burden of directly asking someone not to use their smartphones during conversations. One participant mentioned, *"I was often upset during group activities due to others' smartphone use. However, it is difficult to ask others not to use their smartphone. I thank LockDoll because it does the job for me."* (P2).

However, in our interview, we found the necessity of flexibility in LockDoll's mediation. For example, when group members really needed to use their smartphones for information purposes, the actuation of the current design may cause another distraction during their activity. Therefore, smartphone usage contexts should be more carefully considered when we design LockDoll states and reactions.

Future Work

We plan to refine the LockDoll design by following an iterative prototyping process including further pilot tests. Specifically, we will focus on design issues that we discovered in the first pilot. First, we will improve LockDoll to provide fine-grained awareness on a group's smartphone usage. For example, smartphone app usage can be classified by app categories (e.g., game, productivity, and communication), and different actuations (e.g., light color) are mapped into each categorical usage. Second, we will design additional physical interaction with LockDoll in order to increase the opportunity of attachments. We will use physical interaction in particular to deal with a group's overall smartphone needs. For example, when smartphone use in a group is really necessary, LockDoll will allow use after a user pets it (like touching a snooze button). After an iterative prototyping process, we will conduct further user studies. We will recruit participants and ask them to use LockDoll for several days in the wild. This field study will help us to understand how and why the users utilize this artifact in their daily lives.

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