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Exploring the Non-Use of Mobile Devices in Families through Provocative Design

Anders Bruun[1], Rikke Hagensby Jensen[1], Jesper Kjeldskov[1], Jeni Paay[2], Camilla Mejlby Hansen[1], Katarína Leci Sakáčová[1] and Mette Hyllested Larsen[1]
[1]Dept. of Computer Science, Aalborg University, Aalborg, Denmark
[2]Swinburne University of Technology, Melbourne, Australia
{bruun, rjens, jesper}@cs.aau.dk, jpaay@swin.edu.au

ABSTRACT
Mobile devices are fast becoming an integral part of family life. While mobile technology provides constant connectivity to a world outside the home, it inevitably disrupts family dynamics and the social notion of being together. In this paper, we explore "non-use" of mobile technology in a family setting. To do this, we designed the Pup-Lock provotype, a design provocation intended to challenge established expectations and practices around mobile device use at home. We report on a five-week in-depth study of using Pup-Lock with three families reflecting on their mobile device usage and their experience of non-use. Our findings illustrate how mobile use shapes social expectations and how over-use creates tensions in families. We contribute by showing how provoking non-use through design results in desirable and meaningful ways to increase family interaction. We discuss implications of designing for non-use to challenge established domestic practices around technology use.

Author Keywords
Non-use, mobile devices, design provocation, family, practice, explorative field study.

CCS Concepts
• Human-centered computing~Empirical studies in interaction design

INTRODUCTION
Over the past two decades, mobile technology has become an increasingly integral part of our family practices. Mobiles play a dual role in family life. On the one hand, they are very useful for everyday communication and coordination of family activities. On the other, there is a problem with mobile over-use, for example, when a family member is constantly checking their emails, reading the news, using social media, etc., while the family is together. Several studies report on the tensions that occur between family members when it is noticeable that others are spending too much time with their mobile devices during family time [5,24,34,39,46,64].

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The ubiquitous nature of mobile technology and constant connectivity to a world outside the home can affect the quality time families spend together. The boundary between family life, public life and work life is eroding [24,39,46,53] and work related technology use is pervading our homes. People use mobile devices to stream video and music media or access social media for entertainment [9,10,38,40,60]. Videogames, played on mobile devices, provide feelings of relaxation and relieve stress [45], not only in people's spare time [13], but when they find themselves stressed at work [49]. In unfolding the discussion around technology over-use, Wadley [60] compares technology use practices to addiction, in the sense that people use digital devices to adjust from a stressed state to a state of relaxation.

While constant engagement with a mobile device can provide gratification to individuals, in a family setting, this over-use is problematic, and can lead to tensions between family members [5,23,24,39,46]. Facilitating non-use of mobile devices to relieve these tensions is challenging [39]. Non-use strategies include avoiding acknowledging the problem, seeking help through smartphone apps, or simply placing mobile devices out of physical reach [46,53]. The most commonly applied strategy is rulemaking, e.g. where parents limit children's access to technology at dinner time. However, these non-use strategies have limited effect, partly because they tend to lead to additional tensions [46,53].

In addressing this challenge, HCI researchers have studied how to influence non-use within the home using interaction design to challenge existing practices [16,26,27,30,48]. Alternatively, provocative design has been used as a means in supporting changes in practice, whereby the designed object challenges routines and beliefs and makes people reflect on their actions [3,19,47,69]. Our study investigates opportunities for provocative design as a means to intervene and challenge a family's mobile device practices towards time periods of non-use, while the family are at home together. In a five-week explorative field study with three families, we explore the potential of non-use to relieve family tensions caused by mobile over-use.

In this paper, we present related work on mobile device use and provocative design in HCI. We describe the Pup-Lock system, our study method, findings on how Pup-Lock influenced practices, and broader implications of the study.

RELATED WORK

Given the importance of studying technology use in the home, it is critical to understand the context of the family and households when exploring the non-use of mobile devices in families. In the following, we look at work covering mobile technology use and social expectations within a family setting, and the role over-use plays in causing tensions.

Family Time and Social Expectations of Mobile Over-Use

Family time is traditionally regarded as the daily social activity of relaxing together as a family [56]. Yet, the development and design of mobile technologies has radically changed how people go about their everyday lives, including family time activities. Continual advances in mobile device design means that smartphones, smartwatches and tablets, etc., are increasingly penetrating all aspects of our lives. Mobile technologies allow work life to encroach on domestic life and challenging existing cultural and social expectations [1,7], shaping how everyday practices are carried out [59] including those spent with the family.

Different understandings of what constitutes family time can create tensions, as seen in Blackwell et al.'s study [5]. The traditional view of family time is around a constant-engagement model, where family members pay attention to each other and continually interact. Technology interferes with this model, interrupting the constant attention and interaction between family members [5]. Such interruptions are explained by Southerton [63] through the notion of harriedness. Harriedness stems from the demand for people to be increasingly mobile – physically, socially, or even mentally. This creates pressure on people to coordinate time more efficiently [50,63], including during family time. With constant connectivity, issues from public life, for instance problems at work, easily spill over into private life [35].

Mobile technologies are often used by individuals to relax and destress while at home with the family [1]. Wadley [70] suggests we do this to regulate our mood and adjust ourselves from stressed to relaxed states. Examples include using videogames, media streaming and social media, to achieve relaxation and stress relief [9,10,13,38,40,45,49,60]. People respond to stress in different ways, and sometimes our behaviour can create tensions. Withdrawal from a stressful situation can be achieved with mobile devices, but it can appear as anti-social to others [43,68].

So, while technology use can regulate the mood of the individual toward a positive state, it can also cause tensions in a social family setting. For instance, studies have shown that the relationship between adults and children can change when an adult uses their mobile device while with their children [24,46]. When an adult appears absorbed in their interaction with a mobile device, not paying attention to their surroundings, children often can feel ignored. They react with frustration, trying to force the adult's attention back to them, resulting in the adult responding with robotic answers or gestures at the children [24,46]. Similarly, in studying the benefits and frustrations of technology use in families, Oduor et al. [34] found that family members felt pressured by social expectations, to continually monitor their phone, leading to tensions as others felt ignored or excluded. Salmela et al. [51] report that mobile use in the bedroom influences the intimacy of couples' verbal and physical interactions in bed.

In summary, tensions in the family around mobile device use originate from complying with contemporary social norms leading to the experience of harriedness. The ubiquitous nature of mobile devices further increases tensions between family members as they are ever present. Therefore, limiting mobile device use when families are spending time together is one way to reduce the extent of these problems.

Designing for Non-Use

Interaction designers design digital technologies for use. The good user is commonly portrayed as someone wanting to use a product or service, while the bad user opts out. However, Satchell and Dourish [52] argue that non-use can be framed as an *"active, meaningful, motivated, considered, structured, specific, nuanced, directed, and productive"* action. In particular, they argue that interaction designers have a responsibility to take people's concerns with technology seriously. Designing for "non-use" is a way to achieve this.

In exploring non-use of mobile devices in families, studies illustrate how families are putting strategies in place to limit mobile device use in the home. Blackwell et al.'s [5] and Oduor et al.'s [39] studies show that families want to reduce interruptions from technology to time spent together. The most common strategy in Blackwell et al.'s [5] study was making rules for children and teens, which included putting time limits on mobile device use. In Odour et al.'s study [39], family members regulated mobile device use with strategies, including consciously placing their devices out of reach or seeking help from apps, as a way to combat potential tensions associated with technology use in the presence of other family members. Ko et al. [28] explore limiting mobile use through a Lock n' LoL system in a social setting to help users focus on group activities. They report that such designs can have a positive influence on people's ability to mitigate smartphone distractions.

Studies investigating interaction design for sustainability likewise have examples of exploring non-use as a design strategy to challenge consumption behaviour. Ganglbauer et al.'s [16] study of food practices uses negotiation strategies for integrating new practices to influence food waste. Katzeff et al.'s [27] "peacetime" prototype [71] does not focus on energy-consumption directly but suggests non-electricity consuming activities, making non-consumption desirable without promoting the "less is best" sustainable ideal. Similarly, Jensen et al. [26] explore "hygge" as a desirable concept to promote togetherness and intimacy, to trigger practices towards lower electricity use in home lighting without promoting "consuming less" directly. These strategies of designing for desirable "less use" resemble Hallnäs and Redström's [18] notion of downtime or slow time, which contrasts the notion of harriedness [63].

Provocative Design in HCI

Over the past years, we have seen provocative design emerging as research approach in HCI for *"stimulating discussion around issues pertinent to design"* [69]. In related work, provocative design [3,19,69] is used to spark reflection towards people's use of technology [18,52], where *"asking questions is as important as solving a problem"* [41].

In HCI research, we typically use provocative design to construct critique through reflection, to provoke discussion, or to challenge norms and attitudes of both user participants and designers [69]. In this line of work, different approaches to provocative design have been used, including: a) construct design artefacts that call forth and provoke discrepancies in existing everyday practices [37], e.g., home electricity use [25]; b) challenge and disrupt existing social and cultural norms by articulating topics seen as taboo, e.g., the design of sex toys [2]; and c) promote critical engagement and reactions [14] about possible futures through techniques such as design fictions [6]. For instance, Helms and Fernaeus [22], use humorous design fiction to provoke reflection around sustainability and gender issues, while Søndergaard and Hansen [61] provoke collective design imaginings of digital home assistants through design fiction as a method. This HCI research shares the common idea of using design *"as a way to encourage discussion, rather than being a result of a discussion"* [19].

In designing for deliberate provocation, different approaches have been suggested. Bardzell et al. [3] suggest focussing on three different dimensions of provocation when designing provocative design artefacts - conceptual, functional, and aesthetic dimensions. Raptis et al. [47] use these three dimensions of provocation to design the provocative "Box" to challenge and spark reflection on households' washing practices. Bell et al. [4] argue for "defamiliarization" as a useful HCI research strategy to explore new design alternatives for the domestic space. In these examples, provocative design is used as a vehicle to make typical domestic things strange in effort to challenge existing politics and culture of home life through critical reflection.

Focusing on challenging and potentially changing existing everyday practices, Mogensen [37] proposes *provotyping* as a research strategy. Mogensen argues that the aim of a *provotype* is to expose tensions and provoke discrepancies in existing practices to trigger reflections in an effort to gain insights into how possible future practices may be carried out. Similarly, Kuijer and colleagues [30,31] suggest triggering everyday practices by making "practice" the unit of design, to explore the potential of "proto-practices" [29]. This approach to trigger or provoke change in domestic routines through design is inspired by Shove et al.'s framework on social practice change [59]. Kuijer et al. [31] exemplify this approach in a study exploring different prototyped designs to trigger bathing practices towards a more desirable way of bathing, which also happens to be a less energy-intensive way of using water resources. Kuijer et al. argue that the aim of studying practice change through provocative design is not to evaluate if the design works long term, but to study how potential "proto-practices" might come about to better understand how to make "desirable" changes [31].

In summary, when focussing on provoking established domestic practices through design, these studies have a common aim that the design should be strange and de-familiar [4] enough to provoke, but not so extreme that it could potentially be rejected from use in everyday life [3,47].

PROVOTYPING FOR NON-USE

Inspired by previous work in this area, the aim of our study is to challenge existing mobile device practices within the family setting. In particular, there is a need to explore the dynamic in families with young children, as the parents represent a user group caught between having a perceived need [50,63] and desire [70] to use their mobile devices while also experiencing non-use motivations [15]. To explore the concept of non-use through a provocative design approach, we developed the Pup-Lock system (a portmanteau of Puppy and Padlock). We frame Pup-Lock as a *provotype* [37], as the aim is to expose tensions and provoke discrepancies of use in existing mobile practices and explore potential "proto-practices" of non-use [29].

Pup-Lock is designed to deliberately provoke and trigger non-use of family's mobile device usage when together at home. We facilitated this provocation in the Pup-Lock design by allowing all family members - including young children – to lock all mobile devices in the household at any time, for a set period of time, to prevent these devices from being used. Thus, the unfamiliarity and strangeness of the provocation is reflected through individual family members not being in complete control of when to use their mobile devices, i.e. others can determine when to lock this.

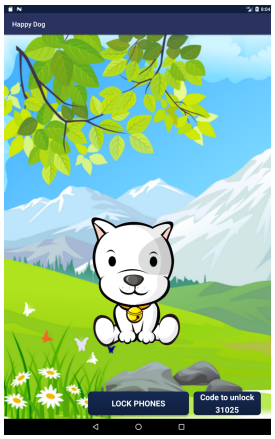
Triggering Lockdowns

The Pup-Lock system consists of two separate apps (see Figure 1). One central puppy app (Figure 1a), used to trigger lockdowns, is installed on a tablet accessible by all family members (this tablet was provided by us for the study duration). The second distributed lockdown app (Figure 1b), used to unlock an individual device, is installed on every registered mobile device in the household. We purposely designed the lockdown functionally to only be accessible on central tablet app for two reasons; 1) to give everyone in the family the possibility to lock all devices in the home as it was assumed not all members have a personal mobile device (e.g. young children) and, 2) to encourage reflection on the act of triggering lockdowns as we considered it to be a deliberate action to locate this functionality on a shared family device.

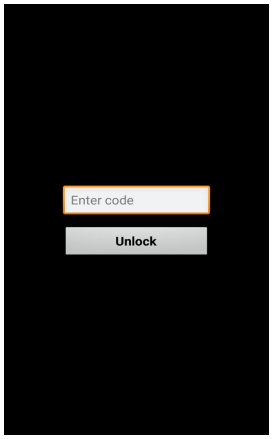
The main screen of Pup-Lock tablet app shows a puppy, a button to lock phones, and an unlock code (Figure 1a). When a family member activates a lockdown by selecting the "*Lock Phones"* button, the system prevents everyone on the same wi-fi network from interacting with their mobile device for 30 minutes. We chose this time limit to make the provotype strange and unfamiliar, but not too extreme to ensure it could

be infused in practice. Once a family member decides to lock all devices, family members can either keep their device locked or unlock their personal device for continued use (this requires the unlock code from the central app). Depending on the number of times mobile devices are unlocked, the cartoon puppy displayed on the tablet becomes sadder, and sadder. On the other hand, continued non-use of mobile devices means the puppy remains happy.

During lockdowns, mobile device usage is restricted by displaying the black lock screen (Figure 1b) on all registered devices. During a lockdown, the only functionality accessible on the mobile phones is an emergency call. Incoming calls, notifications, and messages are hidden until the mobile devices are unlocked.



a: The main screen on the central tablet



b: A mobile phone in lockdown

Figure 1: The Pup-Lock Provotype.

During the 30 minutes of lockdown, it is possible to unlock a personal mobile device by entering the unlock code (see Figure 1b). However, entering the unlocked code only unlocks that specific device. Other devices in the family continue to be locked. The lockdown screen will disappear after 30 minutes when all devices automatically unlock, and family members are again able to interact with their personal mobile device. The unlock code, displayed on the Pup-Lock tablet screen (see Figure 1a), is auto-generated each time a family member locks all family mobile devices, thereby preventing the code from being memorized. Thus, family members have to go to the shared tablet each lockdown to obtain the code to unlock their mobile device during the 30 minute period.

FIELD STUDY

The purpose of our study was to explore the concept of non-use and if it can influence mobile device over-use practices in families. As the study is framed as provotyping [37], we wanted to gain in-depth insights into how provocative design might trigger and shape different practices within a complex family constellation. To this end, we conducted a five-week qualitative, explorative field study with three families with young children (Table 1), using the Pup-Lock provotype.

Participants

The field study was carried out in the homes of three families all of which had young children (see Table 1). We used it to explore how families react to the provocative scenario of locking down all family members' mobile devices and collect participants' reflections on how they dealt with not being able to use their mobile devices for a period of 30 minutes. The study was designed to explore, sample and understand some of the engagement and appropriation strategies used over a prolonged study duration, and not to be representative of all families with children. Such explorative and open-ended study design is similar to other studies published in the proceedings of e.g. CHI [20,62], CSCW [8], Ubicomp [12], DIS [44,66] and MobileHCI [42].

All families were recruited through open calls in Facebook groups dedicated to discussing issues in different local communities. In these groups, we posted a promotional video introducing our study and inviting families to participate in our research. This included closed groups for residents living in particular municipalities in areas that attract families with children. All families participated on a voluntary basis and were explicitly told that they could opt out of the study at any time. None of the families received gifts or financial compensation for their participation.

There were three criteria for selecting participants. Firstly, families had to live in or close to our local area, as we deemed face-to-face contact crucial in introducing the system and study, and for conducting pre- and post-study interviews. Secondly, they had to have at least one child aged between two and 12 years. Families with young children are relevant to consider for our study as they represent a distinct user group with common non-use motivations [15]. Additionally, investigations indicate that adults' mobile devices practices potentially disrupt the early learning environments of children [24]. Mobile devise usage can displace play-based face-to-face interactions [64], an element essential to young children's learning [11,36]. The third criterion was that the families used Android based mobile devices, as the Pup-Lock system was developed for that platform only. This resulted in three families selected to participate in our study. Table 1 shows the structure of the three families, their ages, and parent occupations.

Family	Anonymised names, gender, (interviewed)	Age	Occupation
A	Adam, M, (I) Alice, F, (I) One son	33 32 3	Chef Teaching assistant
B	Brent, M, (I) Becky, F, (I) Three daughters	30 31 12,7,1	Postman Social & health assistant
C	Charlie, M, (I) Carmen, F, (I) One son 4	43 43 4	Train driver Social worker

Table 1: Description of the participating families.

Family A consisted of three members. The mother worked as a teaching assistant at the university and the father was a chef. Both parents had smartphones, which they used daily

to communicate with their friends and family. Furthermore, the father was often using his phone to relax after work by playing games and reading news online. Their son, aged 3, did not have a phone, but sometimes used a parent's phone or tablet to watch videos and play games.

Family B consisted of two parents and three daughters, aged 12, 7 and 1. The mother was a social and health assistant, while the father worked as a postman. Both adults and the oldest daughter had a smartphone, which they used on a daily basis for multiple purposes, e.g. playing music, games, social media, communication with friends etc. The middle daughter occasionally used her parent's or sister's phone. They also had a tablet, which was used by all family members except the youngest daughter.

Family C was composed of two parents and their son, aged 4. The mother was a social worker and the father worked as a train driver. Both parents had smartphones and tablets, which they used daily for relaxation purposes. Their son did not have a phone nor a tablet but was from time to time allowed to use the mother's phone and tablet to watch videos and play games, under supervision.

All families had extensive experience with using smartphones and tablets. This was important, as we did not want to introduce new technologies into their everyday lives.

Study Design

The study consisted of two phases: 1) a diary phase for three weeks, to collect qualitative data on families' mobile device practices before introducing the Pup-Lock system; and 2) an intervention phase for two weeks, where each family used Pup-Lock in their daily interactions with each other.

Diary Phase

In the diary phase, we obtained rich qualitative insights into the families' current practices around mobile device use and how that use shaped family relations. In this part of the study, we designed a self-reporting diary probe framed as a cultural probe [17]. The probe consisted of diaries for each family member, blank papers, pencils, colour pencils, and printed instructions and inspirational sentences (see Figure 2).

Figure 2: Cultural probe package for the dairy study.

For the three-week period, families were instructed to write in the diaries about the types of tensions that occurred in their family in relation to their mobile device use. They were also encouraged to document tensions in other ways, e.g. video, photos, and audio. We conducted semi-structured interviews with each family as a group, before and after the diary study.

Intervention Phase

In the intervention phase, each family was introduced to the Pup-Lock system in an initial meeting outlining the study process and explaining the functionality of the system to the family as a group. We helped them install the system on their individual mobile devices and showed them how to initiate the lockdown through the tablet device with the Pup-Lock system installed that we provided for each household.

Each of the three families were then asked to live with the Pup-Lock system during their everyday family activities for up to two weeks. We encouraged families to contact us in the case of any questions, doubts or problems with the system or the study. We also advised them that they could opt out of the study at any time during the two weeks.

We collected data from two different sources during the intervention phase. The first source was the usage logs collected through the Pup-Lock system. Actions of each family member with the system on their individual mobile devices was captured during the two weeks of the study. The logs contained information about when individuals locked/unlocked their phones with Pup-lock and how often they did this. The second source was the pre- and post- study semi-structured interviews. The usage logs were used to support the post-study interviews, providing information about how the participants used the system during the study, prompting follow up interview questions on clarification of behaviours and motivations.

Data Collection and Analysis

The interviews conducted in both the diary and intervention phases were systematised via interview guides [32]. In the diary phase, questions included topics related to current mobile device usage practices and the participants' reflections upon these. In the intervention phase, we discussed each family's experiences of living with the Pup-Lock system and if, how, and why it influenced their mobile device use in the family. Parents were interviewed as a couple as we wanted to encourage open and rich discussions.

All the interviews were audio recorded. A total of 5 hours of audio were transcribed, and 38 diary entries were analyzed. We conducted a content analysis using an emergent coding approach [33]. All data was coded at the sentence level, focusing on mobile device practices, tensions between family members originating from mobile use, and the influence of the Pup-Lock design intervention. All data was coded individually by two of the authors, who then discussed and agreed upon final codes. Coding was done in NVivo.

Analysis of emergent codes led to a thematic understanding of how the participating families currently used their mobile devices in everyday life, and how they experienced the provocative design and lockdowns during the intervention. Analysis resulted in nine over-arching themes, divided into those related to before using the provotype, and those related to using the provotype, as described below.

FINDINGS – BEFORE THE PROVOTYPE

In this section, we explore four themes identified during the diary phase, before the provotype intervention. We describe how mobile devices are infused in different family activities, and how the usage of these devices is part of a new norm which is creating tensions between family members. Lastly, we describe young family members' use of mobile devices and the kinds of strategies put in place to control this.

Immersive Experiences for Relaxation

All families reported that their mobile devices were used in a variety of activities taking place in their homes. These were mostly activities involving individual family members using their own personal mobile devices. This included browsing or looking at social media like Facebook, engaging in online conversations, playing games or streaming media. Most of the participants described this as a way of using their mobile devices for relaxation - it helped them to de-stress and "switch off" from their busy and hectic work or school life. Participants used their mobile devices to block out the world around them. Brent from family B, for example, described this as, "*I go into my own little bubble…".*

Interestingly, this use of mobile devices was reported by at least one family member in all families. However, while individuals experienced this kind of mobile device use as relaxing, it created tension amongst other family members. It made them feel excluded, ignored, or lacking in attention, because the parent or child absorbed in the use of their mobile device was not mentally present. In family A, for example, Alice described a situation where Adam responded angrily after she tried to get his attention several times because he was utterly immersed in using his mobile device:

> *"[…] and then he's like: 'what!?' And I say, I asked you six times, but you didn't respond, so I had to ask six times. But he says he heard me the first time".*

Mobile Use as a New Norm

All the participants described the use of mobile devices as part of their daily lives – they had become a household norm. Becky from family B expressed her relationship with her mobile phone as:

> *"I always need that phone by my side, not because I truly want it, but it's just a part of it now".*

Using mobile devices had become an integral part of family life and automatically checking the mobile device had become a new norm. As Charlie from family C explained:

> *"I realise from time to time how often per day I am using my phone without consciously making a decision to use it. It happens automatically like a habit".*

Adam from family A also described his use as, *"This mania… you have to look and see what is new out there. It's like a virus".*

One reason why the participants felt this constant need to check their mobile devices was an expectation to participate in social activities facilitated through the use of mobile devices. This was expressed, for example, by Brent from family B:

> *"It's become too important without being important [...] Now people always need a phone and they can get upset if you don't pick up your phone and it's just wrong".*

Mobile Device as Young Children's Pacifier

While the very young family members in the families were not old enough to own their own mobile devices, our study showed that they were still users of them. Using mobile devices became infused in daily family practices, such as dining and cleaning, because it was convenient form of "entertainment" for the young children. Often, mobile devices were given to young children to calm them down or pacify them, especially if the family had a busy morning or the parents were in the middle of doing chores. Carmen from family C described a typical family dinnertime scenario where: *"we allow him to watch, sometimes while I feed him, because sometimes he doesn't want to have dinner".*

Some participants expressed concern with this type of mobile usage for the very young children, but then argued it was a convenient way to occupy a child. This was described by Alice from family A who often would let their three-year son use her mobile tablet:

> *"I gave my son the iPad to calm him down. I don't like to do that. But it is an easy solution to have a calm child".*

Rules Around Mobile Device Usage

One concern of the parents was that their children became very inactive when using a mobile device. As Alice from family A shared:

> *"When I see our son sitting in front of TV or a smartphone, I often feel sad to see this little, very active boy suddenly looking like a zombie without spirit, just in paralysis".*

To overcome these concerns, families tended to put rules in place that support "family time" without the disturbance of mobile devices. An example was family B's strategy of dinner time, explained by Brent:

> *"We plan the children's tech time with around 15 mins buffer time to, for example, make them come to the dinner table on time".*

However, these rules could create tensions between parents and children, because the children sometimes reacted negatively when limits to their mobile use were set by the parents. This was seen, for example, in family B when the oldest daughter was asked to limit her mobile usage, as Becky explains:

> *"She becomes really upset if she has to hand over her phone, and she does that as well if we just ask her to take some time off without it".*

Furthermore, parents did not always agree on the rules that should apply to the children, which could cause tensions between the parents. For example, Adam from family A described the following rules his wife put in place for their son's use of mobile devices:

"Sometimes I felt a bit angry when my wife put some strict rules for technology use on our baby. Sometimes he would come to me and I would give him the iPad or phone even though I shouldn't give him that".

Overall, participants reported that mobile device usage had infused new practices and rules in their homes, which had a direct influence on social expectations and family life.

FINDINGS – WITH THE PROVOTYPE

In this section, we describe how some of the practices noticed during the diary phase actually changed during the intervention phase when the Pup-Lock provotype was introduced into the family homes. When inspecting the usage logs, we see that family A triggered a lockdown nine times, family B ten times, and family C six times. We can also observe that families had a similar pattern of using the system. The families activated the lockdown almost every day during the study period. Typically, activation occurred once a day. Two of the families (A and B) had a few days where they activated the lockdown multiple times during the day. Unsurprisingly, activation occurred predominately between seven and nine o'clock in the evenings when family members were usually spending time together. More surprisingly through, the usage logs showed that none of the families unlocked their phones. In the following sections, we describe explore five themes identified during the provotype intervention.

Increased Reflections on Mobile Device Usage

With the introduction of the Pup-Lock system into their families, they all described how the system managed to provoke reflections on their mobile device practices when they were together as a family. Living with Pup-Lock drew attention to the mobile device usage taking place in the family and all three families said they talked more than usual about their mobile device use during the study. In particular, they discussed how they did not realise the amount of time their mobile use took them away from spending time with their family. In all the families this kind of reflection led to a changed understanding of how and when to use - and not use - their mobile devices. This was described by Adam from family A, who used his mobile phone extensively before the study, but now started to reflect on this:

"After the study I understood, that I should give my family more attention instead of looking at my phone all the time. I've talked to my wife about the fact, that we could have much more time together, if we didn't use our phones".

While both Charlie and Carmen from family C did not see themselves using their mobile devices a huge amount before the study, living with Pup-Lock made them reflect on their mobile device practices. Using Pup-Lock showed them that they could *"easily live without"* their mobile devices for 30 mins, but Carmen reflected that more extreme constraints on usage would be challenging:

"I remember we talked about it, that it is not difficult to get away from the phone for 30 minutes, but it would be more difficult, if we had only 30 minutes to use the phone".

Members of families A and B, in particular, reflected on, and changed, how much time they spent using their mobile devices during the study. They described that they were *"quite surprised"* about how they were using their mobile devices. Some family members were positively surprised by their own behaviour, admitting that they *"didn't need the phone for so long"*. As Adam from family A said, *"I honestly didn't think that I would be able keep the phone locked for 30 minutes"*. Some were also surprised by seeing a change in the mobile practices of their spouses. For example, Brent from family B said, *"I was surprised how fast my wife got used to not picking the phone up"*. Becky added that she believed her participation in our study would also reduce the extent of her mobile device usage in the future:

"I think I find it easier now, to let go of the phone. I am not that addicted to it anymore. I can now drive to the school without the phone and do something without having the phone on me.

This finding resonates with existing studies showing that provocative design can be used to trigger reflections that infuse different understandings of current practice and can lead to changed future practices. [25,26,31]

Triggering Non-Use Lockdowns

The families described both positive and negative experiences associated with having their mobile devices locked by other family members. On the positive side, some participants reported that they *"felt fine about it"*, *"took it ok"* or *"smiled"* when their phones were locked. It is worth noting that in this study, no one used the unlock code when a lockdown was triggered. All members of the family waited the full 30 minutes before resuming their usual mobile device interactions. Interestingly, family members that used mobile devices extensively before the study, had the most positive experiences of living with Pup-Lock. Before the study, Becky in family B used to spend many hours playing games or on social media platforms, and usually when the family was together and watching television in the evenings. However, during the study, this family typically triggered the lockdown at these times because it *"is a good way to learn how to just be together, for instance just lying and watching television together, and watching an episode of a series, where both of us are focused".* Other families also observed that the provoked non-use influenced practice in the family. For example, in family A, where Adam used his mobile phone extensively before the study, his wife Alice noticed:

"…a difference in my husband's behaviour, which was a big plus. I really liked his behaviour, when phones were locked. Surprisingly, he reacted very well. He didn't complain, he just put his phone down and actually came to us, so we could spend time together".

Alternatively, some participants reported that it was not easy to let go of their habits around mobile device use. This was especially the case when lockdowns were suddenly triggered

without warning. For instance, in family A, Adam's three-year-old son would sometimes trigger the lockdown at an unpredictable time:

> *"Sometimes it was quite annoying, when my son locked the phone and I was in the middle of something, which I wanted to finish. But I accepted that I couldn't do anything with my phone for 30 minutes".*

Adam also mentioned a situation where the mobile devices were locked, and he kept checking his phone to see when it became unlocked because *"I wanted to call my father. So, I was waiting for it to unlock and I was checking. It was quite annoying".*

Some family members even reported a feeling of being disrespected when lockdowns were triggered, which led to tension between the parents. In one instance, Brent from family B described a tense situation, in which he and his wife disagreed on triggering a lockdown period:

> *"When you come home, and you did not even look at us, you just said 'we will lock the phones now', and you did not even ask what the rest of us were doing".*

The possibilities of triggering non-use through design may change some practices around mobile device over-use, but at the same time, it can cause new tensions in families.

Managing Lockdowns as a Family

Families reported episodes of using Pup-Lock as a way to get the attention of family members who were absorbed in using their mobile devices. To avoid tensions between family members, all families decided collectively, at least once during the study, when to trigger a lockdown. Alternatively, whoever wanted to lock the mobile devices, first checked with other family members. Although the adults in family C described they had no problems with setting aside their mobile devices for a 30 min period, Carmen still always asked her husband if it was ok to trigger a lockdown:

> *"Because I took the phone from my husband, I felt a bit – not guilty – but maybe he wants to use it. I was thinking on his behalf".*

Carmen also planned lockdowns around her own needs to use her mobile device. The only time she really needed her mobile was when talking to her parents, which she did every day. As she stated, she planned lockdowns *"only after our conversation, so I was sure, that they would not want to reach me while the phones were locked".*

Brent, from family B, described the situation of locking the mobile devices as, *"We did that together. It was like, 'Now we all agree that we would lock the phones', and then one of us locked them"*. He was particularly concerned about not randomly triggering lockdowns because, as he said, *"I also did not want to lock it if she [wife] was actually doing something important with her phone"*.

It was quite important for families to reach an agreement on when they would lock the mobile devices. Alice, from family A, explained, "*I was locking the phone when I was sure, that my husband is not doing anything he can't interrupt. I didn't want to make him nervous*".

However, some families also reflected on the option of only being able to access the Pup-Lock lockdown function from a single device, thus influencing how and when lockdowns could be triggered. In family B, Brent reported that because the Pup-Lock tablet was placed in their oldest daughter's room during the study this affected their locking behaviours:

> *"We would probably lock the phones more often, if we could lock them from our phones, because when we needed to go to the tablet, we just did not use it as much as we wanted to".*

Overall, families actively planned when to spend time together without using their mobile device. These non-use periods were easily managed as a family through Pup-Lock.

Desired Family Time through Non-Use

A recurring theme in the study was families use of Pup-Lock to get a spouse or parent out of an absorbed over-use state with their mobile device. As Alice, from family A, explained, *"I locked the phones, because I wanted to talk to my husband"*. Alice also shared that their three-year-old child would trigger lockdowns to get his father's attention:

> *"our son understood it as when he wanted dad's attention, he should go and push the button, because one time he was saying: 'Dad, dad, and then he just went to the tablet and started pushing the button to lock the phones and laughed".*

In the case of family A, triggering the lockdown of mobile devices mostly resulted in a desired outcome. For example, Adam would stop using his mobile device and give his attention to the other family members when it was locked. He described the result as, *"I was playing with my son or talking to my wife. They had my attention 100%."*. This was supported by the usage logs which show that family A locked the phones, but never used the unlock code. Changes in the relationship between parents started to occur as a result of the enforced non-use. Brent, from family B, described lockdown periods with his wife as desirable because, *"[Pup-Lock] is very good for couples as it is a good way to learn how to just be together.*

The meaning of family time during the 30 minutes lockdown period also started to change. Participants stated that they "*played more all three together"*, and *"had more uninterrupted time together"*. Time spent together as a family became synonymous with time to trigger the lockdowns. For example, Becky in family B, stated that most lockdowns occurred in the evenings at their home, so that they could spend time together as a family:

> *"The reason I had the feeling that we did it most in the evening, was because this was time the whole family was together. There wasn't anyone who needed to do something else, so in the evening we were all together".*

Charlie, from Family C, said that dinner time was a situation where lockdowns were desirable, as they improved the time spent together as a family. As Charlie said, "*We can eat*

without the phones… That was nice. So, we talked more during the dinner". Furthermore, the feeling of having lockdown time that could be spent away from the mobile devices became desirable for all families. Adam, from family A, reflecting on their daily lockdowns, said, *"even though it was only 30 minutes a day, I think it gave us time for family life, which wasn't interrupted by the technology".*

Interestingly, non-use was experienced as desirable, where time spent away from mobile devices actually became meaningful time spent together as a family.

Feeling Free

One of the main reasons why the 30-min lockdown periods were so popular with family members, was because during these times they experienced a sensation of feeling free. Although participants in family C did not initially have the impression that they used their mobile devices extensively, as Carmen shared, the lockdown periods were experienced as free time:

> *"I felt free. I felt like now I have time to do something else, maybe more valuable, maybe more meaningful for my family, like spending time in the garden or eating together and talk about how the day was and what we are going to do next".*

It is interesting that this feeling of freedom was made possible through Pup-Lock's enforced periods of non-use of mobile devices. This allowed family members to spend time doing activities that felt more meaningful and joyful to them. Getting enjoyment from the lockdown periods was reported by Alice, from family A. She explained that she no longer felt harried by the social obligations of notifications on her phone. Instead, she could actually engage in activities that were more meaningful to her:

> *"I am doing something with my son and the sound interrupts, what we are doing. And I want to continue the activity, but I also have this feeling, that I should check, because maybe it is something important. But it usually isn't […]. It was nice to have 30 minutes with no interruptions".*

In this way, lockdown mobile device non-use periods gave families the freedom to do meaningful activities.

DISCUSSION

The overall aim of the explorative field study was to investigate the potential of provocative design to challenge current practices around mobile device use. We wanted to understand how family members responded when faced with the choice between using or not using their mobile devices. In the following, we discuss our findings in relation to the theoretical background and related work within HCI.

Expectations of Technology Use Leading to Tensions

As shown in research, excessive use of mobile technology is not the primary source of tensions on its own. Rather, the use of mobile technology seems to enhance tensions caused by contemporary societal norms related to daily stressors [56], spill-overs from other conflict situations [54,57,67], and general harriedness [63]. This was evident in our findings.

As Shove argues [58], social shared expectations also shape how people embed technology into their everyday practices. We found that when new mobile technology enters the home it infuses new practices, which also carry expectations of how such devices are used. Our families used mobile devices as a way to relax and "switch off" when they came home from a busy and hectic work or school life. This confirms Wadley's [70] point that people use technology as a means to regulate their mood and adjust themselves from stressed to relaxed states in ways that resemble addiction.

However, we confirm that excessive use of technology creates tensions between family members, as other family members feel excluded, ignored, or lacking attention, as found by Blackwell et al.'s [5], Odour et al.'s [39] and Salmela et al.'s [51] studies. Our study shows that family members' constantly needing to check social media or to be engaged in online conversations also creates tensions. This constant need to stay in touch with online social networks resembles Southerton et al.'s notion of harriedness [63]. Southerton argues that harriedness is associated with experiencing lack of time and the acceleration of daily life. This leads to anxiety and tensions, whereby people feel obliged to coordinate practices within their social networks. However, our study shows that the ubiquitous character of mobile devices seems to enhance this pressure of always feeling obliged to be connected to the "world" via mobile devices. Even when sitting at home, people's social networks pervade this private space, and are only a click away.

One strategy families with children use in an attempt to control mobile device usage during family time is to set up rules [5]. However, our study showed that these rules also created tensions between family members. This is because family members have different expectations around mobile use in the home. Firstly, children sometimes react negatively when parents put limits on their mobile device usage, as adults and children have different expectations of what is regarded as appropriate use of mobile devices by children. These different expectations mainly come about because this generation of adults did not experience a childhood where using mobile devices was part of the norm. Secondly, tensions arise because parents have different expectations of how mobile devices should be used during family time. Because the use of mobile devices in a family setting has been established as a norm in many families, disrupting such accepted behaviours can lead to tensions within the family. Thirdly, while parents set up rules for mobile use, they often "disobey" these rules themselves, because during hectic periods in the family, the mobile device becomes a convenient way of "babysitting" or pacifying children. Finally, all the families in our study found the same solution for avoiding tensions around mobile device use, by establishing common ground around which the family would actively plan and manage mobile free periods during their time together. Our provocative design caused reflections around device use, which led to the use of Pup-Lock as part of their daily activities.

Designing for Togetherness Through Non-Use

Discussions of tensions caused by excessive technology use is ongoing, even to the point where, ironically, smartphone vendors are attempting to support users in interacting less with their products. For example, Apple now explains that their iOS 12 operating system supports visualization of time spent interacting with their smartphones [65]. While commendable, it can be argued that people who are going to check their smartphone usage are those that are already aware of their over-use and are taking their own initiative to reduce it [21]. Instead, as Sengers' reflections [55] on pace of life illustrate, expectations of efficiency and productivity are often embedded in the design of IT and mobile technology. With constant mobile connectivity, the lines between public and private life become more and more blurred [35]. This demand to constantly attend to and interact with our mobile devices creates notions of harriedness [63], demonstrating that the design of mobile technology also shapes social expectations for people to be increasingly efficiently and mobile.

Based on our findings in this study, we argue that if the aim is to enrich family interactions by reducing mobile device use, it is not enough to simply provide a visualisation of smartphone usage and leave it to the users to alter their behaviour, without any support to do so. Instead, we want to highlight that changing expectations around mobile device usage requires more than visualizations of time spent interacting with devices. As our study shows, design can play an important role in addressing this problem, by exposing tensions in current practices through provotypes [37]. When an intervention is designed to affect all family members, then as a family they can reflect on and outline how meaningful future practices might be supported. This aligns with recent studies showing how, by challenging routines and making participants reflect on their actions through a designed object, we can facilitate change through provocative design, cf. [3,47].

One of the more interesting findings from our study is learning that the participating families really enjoyed spending more time together as a family during the enforced non-use periods. Participants felt relief during lockdown periods, as they were no longer slaves to their smartphone and the steady flow of messages that they felt obliged to reply to. Explicitly enforcing a 30-minute non-use break from their devices was experienced as a desirable outcome. This is interesting because it shows Pup-Lock managed to challenge the meaning of family time in these families. Where before the Pup-Lock provotype they would often spend time at home relaxing and using their individual mobile devices, spending non-use "mobile free" time was something that all our participating families really enjoyed. This was because they could then do things as a family, creating a feeling of intimacy and togetherness. Non-use lockdown periods were experienced as desirable because they represented in an increase in the quality of time spent together as a family.

The desirability of non-use qualities of a design can be found in other studies. Jensen et al. [26] found outcomes of togetherness and intimacy in their "hygge" study, while the Katzeff et al. [27] study suggested that non-electricity consuming activities encouraged time spent together. Thus, we believe non-use as a provocation opens up for different and new ways of designing human-centred ubiquitous technologies, such as mobile devices. Non-use can be experienced as a desirable quality of a design.

Based on our findings we recommend further exploration of provocation as a strategy for limiting mobile device use within families. Such provocative design could support short, planned breaks away from technology, which was received positively by all families in our study. It would also be interesting to provoke the alternative situation, whereby a system lets users decide when technologies can be used.

CONCLUSIONS

Through qualitative field studies of three families with young children, we explored the potential of using provocative design to challenge excessive mobile use during family time. The Pup-Lock provotype was designed to challenge current practices in a family around mobile device use, and provoke reflections and behaviour change around this. This system is unique, in that it facilitates all family members, including young children, to initiate "non-use" of all family devices for a set period of time. This allows families to reduce technology use, with the option to personally opt out of the lockdown (which interestingly, no participant in our study did). Through provocative design, we were able to explore how family members reacted when faced with a choice between using their phones or not.

Our findings revealed that participants were more attentive towards their family during the period of using the Pup-Lock system. Participants felt relief during lockdown periods as they were not interrupted by their smartphones and the steady flow of messages they usually felt obliged to attend to. Furthermore, parents reported reflecting on their use of smartphones more than usual. They said they became more aware of how much time mobile device use took away from spending time with their family. The enforced non-use made family time more about togetherness and intimacy. It helped them put aside technology and be attentive to the family. However, it also introduced tensions in some situations, particularly when lockdowns were initiated without warning or consulting others. Interestingly, all families appropriated Pup-Lock to actively plan for coordinated technology free periods during the day, to spend more time together.

Finally, our study demonstrates that provocative design and designing for non-use in families with young children, is a promising alternative to common limitation strategies, which reportedly have limited effect in challenging practices related to mobile technology use. To further unfold this area, we suggest that HCI practitioners and researchers engage with more diverse demographics such as families with teenagers or single-parent families.

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