

Title:

Smardio: Broadcasting to Spark Reflection on Smartphone Use in the Home

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Participants:

Christian Dannesboe Erik Kruuse Simon Dalgas Christensen

Supervisor:

Rikke Hagensby Jensen Enrique Encinas

Pagecount: 12 Date of Completion 18-06-2021 Seventh semester at Department of Computer Science Software Selma Lagerlöfs Vej 300 9220 Aalborg East, DK http://www.cs.aau.dk/

Abstract:

Smartphones have become common tools for everyday tasks and are utilized in the social context of family life. Even though smartphones are convenient, powerful, and helpful tools, they can prove problematic for social interaction as they promote individual user interaction. We designed, deployed, and evaluated a provotype named Smardio, engaging participants, promoting reflection on smartphone use and smartphone practices within the home. Smardio was subject to a month-long field study in three different homes to study how our proposed framework can be utilized to spark reflection on smartphone use in a family context. Our findings show that participants had different views on what constitutes smartphone use and that the acceptability of smartphone use depends on the context. Furthermore, participants engaged in discussions regarding smartphone use through competition. We demonstrate, through Smardio, how broadcasting can be utilized to spark reflection in participants and promote discussions in the home.

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Preface

Smartphone use has been a widely debated subject. Drawing upon our prior study's experiences, we study how provocative design through broadcasting can make people reflect on the practices on smartphone use in the home. The following paper draws experiences from a 9th-semester project in Software Engineering at AAU. The project studied how provocative design and gossip can reduce smartphone use in a family context by gossiping, i.e., broadcasting provocative statements about the participants' smartphone use. The provotype, named Gossiper, gossiped about the participants' smartphone use every time it detected someone using the internet.

Gossiper consisted of a Raspberry Pi, a router, and a speaker, all contained in a white wooden box to hide the hardware. When the Raspberry Pi detected internet use, it would broadcast in two different voices to imitate a conversation. This conversation was attributed to two dolls arranged on top of the white box. The participants were connected to the internet through Gossiper's router and signed up for Gossiper through a dedicated website. They had to enter their name on the website, which would be associated with their smartphone's IP address. The names were incorporated into the voice lines, naming the offending participant. Gossiper would broadcast provocative voice lines to encourage discussion and reflection on smartphone use in a social context. The participants were able to pause Gossiper for 30 minutes, thereby stopping Gossiper from gossiping about them, at the cost of a condescending remark about the action.

A week-long study with a single family of six was performed. The family consisted of two parents and four children, where two of the children were toddlers. Of the remaining children, only one was old enough to own a smartphone, resulting in three active participants. Through the study, we found that the effect of gossip was individual. Although the father was rarely gossiped about, he stated that he did not care". In contrast, the mother put her phone away when Gossiper gossiped about her. In the beginning, it was effective, but towards the end of the study, she expressed feeling frustrated with its constant gossiping, so much so that she started ignoring it. She stated that she *felt like the system was scolding her*", rather than provoking her. The oldest child, who had a phone, was usually in her room when she was gossiped about, making it hard for her to hear it, which resulted in those in the living room being informed about her use while she was absent. The second oldest child showed interest in the gossip, as some of the sentences caught his interest. In particular, he started asking his parents what they were doing, as one of the voice lines stated, that "X is doing something they are not supposed to". Although the effect was individual, the study found that Gossiper successfully promoted non-use of smartphones in a family context by using gossip, as Gossiper effectively got participants to stop using their smartphone when it gossiped about them. We based the effectiveness on the participants' statements that they became more attentive to their smartphone use, while others said that they got frustrated over the gossip. Future works of the project include expanding the study by incorporating

more participants, increasing the duration between triggering voice lines to decrease frustration, and using live voices instead of computer-generated ones. In addition, a future study should make it possible to explore more of smartphones' capabilities to enhance social interactions and make the act of putting down the smartphone a voluntary one, based on reflection, instead of being reminded of it every time you pick it up. Drawing upon the experiences of Gossiper, we propose a new provotype called Smardio. This provotype intends to spark reflection on smartphone use, rather than provoking for non-use, and taking into account that the presence of the provotype should advocate for adoption, rather than neglection of the system.

Summary

The purpose of this master thesis is to investigate smartphone use in the home by sparking reflection through provocative design and broadcasting. This paper consults related work regarding smartphone use to uncover the benefits and problems of smartphone practices. It describes provocative design and classifies current research into two categories: lock-based and push-based. Additionally, this paper describes related work regarding studies that apply broadcasting as a method of provocation on different practices. Based on the related work, we found that current research focuses on the negative aspects of smartphone use and implicitly advocated for non-use.

We designed a provotype called Smardio. This provotype consisted of a Raspberry Pi, a micro:bit, a set of speakers, all encased in an old tube radio. Smardio broadcast various voice lines constructed from research and our imagination on smartphone use. The broadcasts were designed to fit with the theme of an old radio, and presented as news broadcasts and advertisements. The broadcasts were designed to present different points of view, as Smardio intends to spark reflection and not solely promote non-use.

When Smardio detected the presence of a participant nearby it would, at most once an hour throughout the day, broadcast one of 50 radio-like segments designed as being either breaking news or advertisements. The content of these broadcasts was derived from either research or our imagination. Additionally, Smardio monitored the local network and, once a day, ranked the participants by their smartphone use, from highest to lowest, in a daily overview segment.

The design of the broadcasts of Smardio led to the framework presented in this paper. The framework describes the intended point of view presented by the broadcast. The points of view expressed in the breaking news and advertisements were not tilted towards either pro-use or non-use of smartphones. Additionally, the framework took the social context of smartphone use into account.

Each Smardio was deployed for about a month, with a total of three Smardios deployed. Before deployment, we conducted initial interviews to evaluate the habits and views on smartphone use for each family. A final interview concluded the study after deployment had ended. The initial and final interviews were used to compare the views on smartphone use and assess the effects of a Smardio in the family home.

Our findings show that our participants had different views on what constitutes smartphone use and that the acceptability of smartphone use depends on the context. Our participants expressed that Smardio made them reflect on what constitutes smartphone use, and that they became aware of what they use their smartphones for. They described the smartphone use as practical in nature, but that it usually dragged on into prolonged use. During the study, the participants became more aware of the context in which they use their smartphones. This included some participants listing unwritten rules on the legality of smartphone use. Smardio, as an intervention artifact, sparked reflection and discussion on smartphone use in the home through the broadcasts, and the daily overview segment created competition between the participants. Further studies could focus on exploring the impact of different points of view on smartphone use to design for engagement in social interactions.

Smardio: Broadcasting to Spark Reflection on Smartphone Use in the Home

Christian Dannesboe Aalborg University Aalborg, Denmark cdanne13@student.aau.dk Erik Kruuse Aalborg University Aalborg, Denmark ekruus16@student.aau.dk Simon Dalgas Christensen Aalborg University Aalborg, Denmark sdch16@student.aau.dk

ABSTRACT

Smartphones have become common tools for everyday tasks and are utilized in the social context of family life. Even though smartphones are convenient, powerful, and helpful tools, they can prove problematic for social interaction as they promote individual user interaction. We designed, deployed, and evaluated a provotype named Smardio, engaging participants, promoting reflection on smartphone use and smartphone practices within the home. Smardio was subject to a month-long field study in three different homes to study how our proposed framework can be utilized to spark reflection on smartphone use in a family context. Our findings show that participants had different views on what constitutes smartphone use and that the acceptability of smartphone use depends on the context. Furthermore, participants engaged in discussions regarding smartphone use through competition. We demonstrate, through Smardio, how broadcasting can be utilized to spark reflection in participants and promote discussions in the home.

KEYWORDS

Smartphone Use, Provocative Design, Human-Computer Interaction

INTRODUCTION

Smartphones permeate our everyday lives [9, 10]. They have become an easily accessible tool for us to interact with the world. We depend on them for daily tasks, such as making payments, interacting with smart devices, and online social interaction. Although connecting with the world can be a good thing, it sometimes comes at the cost of physical, social interaction.

Research suggests that the use of smartphones negatively affects the quality of conversations in face-to-face interactions and inhibits the development of interpersonal closeness and trust [40]. Family members feel frustrated when they perceive others' use of smartphones as non-urgent, as they do not know what the smartphone is used for [37]. Smartphones also lower empathetic concern between conversation partners with their mere presence [34, 40], as people are perceived as inattentive when interacting with their smartphones. Furthermore, the presence of smartphones reduces the joy of spending time with family and friends [20].

Researchers have explored solutions to the problem of smartphone use in a social context, using strategies revolving around locking the smartphone [8]. The bid to promote social interaction through locking has shown the greatest effect on those with a high willingness to reduce their smartphone use [29, 31]. Therefore, instead of forcing change in a person's behavior, we want it to be a cognitive choice brought on by reflection. Prior research has examined how provocative design can push ideas onto people to spark reflection [21, 26]. We have explored this in a prior study [12], and in this paper, we build upon the experiences gained. Gossiper, the provotype built in our prior study, gossiped about peoples' smartphone use. The gossip was successful at sparking reflection in the participants.

This paper considers the effect of broadcasting to spark reflection on smartphone use in a social context. Research into smartphone use has utilized provocative design as a means to spark reflection in smartphone users. We explore a push-based approach to spark reflection on smartphone use in the home. We aim to examine broadcasting as a means of provocation and the current practices regarding smartphone use in the home.

To examine smartphone use in the home, we developed a provotype [35], Smardio, as a tool for research through design [53]. We have created a framework designed to explore the spectrum of views on smartphone use to ensure impartiality in Smardio's broadcasts. This framework is based on related work and is used as a tool for our study. Smardio was studied through a month-long field study in three different homes.

Our paper is structured as follows. First, we discuss related work on smartphone use, provocation within HCI, and broadcasting. Then, we present details of how we designed Smardio. We continue by introducing our field study and describing our findings, where we explore smartphone use in the home and how Smardio provokes current practices. Finally, our findings are discussed, and we conclude with how Smardio sparked reflection on smartphone use in the home through broadcasting.

RELATED WORK

This paper reviews research on smartphone use in Human-Computer Interaction (HCI) and how prior studies have utilized broadcasting to facilitate discussion of different practices using provocative design.

Smartphone Use

Smartphones have evolved to follow and engage with people daily. Peoples' use of smartphones includes checking social media [46], watching cat videos [36], and playing games [11]. The use of smartphones can be perceived as both beneficial and problematic for social interaction, depending on the use. Smartphone use becomes problematic when people engage with smartphones unprompted during a conversation, as conversation partners perceive the smartphone user as impolite and less attentive [48]. According to Brown et al., the quality of these human-to-human interactions is reduced by the amount of time conversation partners spend on their phones [7]. The reduced quality of social interactions is not limited to the person not using the smartphone, however. Time spent together face-to-face is also worth less to the people who are using their smartphone simultaneously, as described by Rotondi et al. [43]. Misra et al. found that people conversing in the presence of a mobile device experienced a lesser degree of empathy [34]. These issues extend to the dinner table, as Dwyer et al. found that people felt distracted when their smartphones were present [20]. The use of smartphones has even spread to the bedroom. Salmela et al. found that smartphones frequently cause distraction and sleep interruption among couples and that this behavior is seen as normal [44]. In contrast to reducing the quality of interaction by spending time on the phone, Oduor et al. found that participants would start using their phones mid-conversation if they felt their conversation partner lost interest [37].

Checking a notification can lead to prolonged use, creating a disconnect between family members, as discussed by Derks et al. in [16]. Researchers have also studied compulsive use of smartphones and found that some people are spurred to do other tasks on their phones after checking them, increasing overall usage [37, 38]. Some people check their phones hundreds of times a day, showing signs of addiction [42, 49]. The prolonged use of smartphones adds up throughout the day. Sas et al. studied the smartphone use of millennials and found that over half of their participants used their smartphones between two and seven hours a day [45].

Smartphone use is not solely problematic for social interaction, as it can be utilized for both individual benefits [52] and to foster social interaction [23]. Jung states that there are certain benefits of using smartphones in a social context [28]. Smartphone users attempt to achieve "a sense of confidence, amusement, comfort, and restorative" [28] by using their smartphones. The value of smartphones goes beyond the single user, as Jung argues that smartphone users can enhance social interaction by utilizing the information available on the smartphone. Other benefits of smartphone use in a social context are the abilities to communicate, schedule appointments, and sharing entertainment.

By exploring related work regarding smartphone use, we examine both problems and benefits of using smartphones during social interaction. Research gives the impression that smartphone use can be both beneficial and problematic for social interaction, while it also offers a significant degree of freedom to the individual. We want to spark reflection on smartphone use in the home, and therefore we examine current design practices in the following section.

Provocative Design

Research has examined the problems and benefits of smartphone use, utilizing provocative design as a method to spark reflection on use practices [39]. Within provocative design, designers aim to spark critical thinking through provocation by challenging current norms, attitudes, and beliefs to promote discussion and social interaction [2, 18, 19, 35]. In particular, provocative design describes a product designed to spark reflection on use, benefits, or habits rather than simply focusing on solving a given problem. Ozkaramanli et al. described this as *"asking questions is as important as solving problems"* [39]. One way to categorize current provocative design research, aiming to spark reflections on technology usage in the home, is what we perceive as lock-based and push-based design. This division of design strategies is our effort to describe the mutually exclusive choice of whether a design utilizes a lock that prevents the use of the application or utilizes pushing ideas onto people to spark reflection. Lock-based design either mechanically or computationally locks applications from use, such as LocknType [29]. In contrast, push-based design tries to induce a specific social or emotional response from the users and their surroundings, such as Spkr [21].

The following subsections describe lock-based and push-based design examples to better understand our intentions and thoughts for this division.

Lock-based

Lock-based strategies refer to designs that restrict users' interaction with technology by implementing locks in various forms.

Bruun et al. designed a provotype, Pup-Lock [8], enabling family members to trigger lockdowns, locking all phones from a shared tablet. Any family member could trigger these lockdowns, and anyone who deliberately activated a lockdown would have to reflect on the actions and consequences thereof. Bruun et al. found that their strategy increased reflection on smartphone use, though some participants felt disrespected by their family members when a lockdown was initiated. They also found that participants would trigger lockdowns to catch the attention of those perceived as over-users in the moment.

Kim et al. conducted a study of their application LocknType [29], a proactive intervention application. They found that participants with a high willingness to reduce smartphone use required less complicated tasks to control their smartphone use. As Kim et al. stated: "Lockout tasks [...] gave the participants room to reconsider their app use intentions" [29].

Another example is in the study of Lock n' LoL by Ko et al., where participants create and join virtual rooms through a smartphone application [31]. A room can be activated to start socializing mode. These sessions are terminated when everyone taps a finish button. During a non-use session, individual participants can request permission to use their phone, which one other participant must accept through the application. Ko et al. found that their participants felt less guilty about disrupting co-located social interaction and that locking smartphones disrupts some of the benefits of using a smartphone during social interaction.

Push-based

The idea behind push-based strategies is to spark reflection by pushing ideas or topics onto people [21]. Instead of mainly sparking reflection via the information passed to users, pushy design sparks reflection by deliberately passing this information in a pushy, almost forceful way. This is supposed to take users out of their comfort zone by forcing them to reflect on the information. Pushiness is different from devices such as conventional smart-home assistants, which only respond when prompted, and thus do not actively push ideas or agendas onto people. Feltwell et al. described the effects of pushiness as *"even though the user experience can be negative, it is harnessing this pushy behavior as a powerful means to affect behavior change"* [21]. They described pushiness in their study of Spkr, a pushy smart-home device that pushed socio-political discussion topics onto participants to spark discussion and reflection.

Pushy behavior was also essential to our 9th-semester project, which intended to promote non-use of smartphones by gossiping [12]. Our provotype, Gossiper, would gossip by broadcasting through a speaker whenever the system detected that a participant used the internet on their smartphone. We found that the pushiness of Gossiper was effective at sparking reflection, as some participants stated that they became more attentive to their smartphone use. In contrast, others said that they got frustrated over the gossip. Additionally, the constant vocal presence of Gossiper hindered the adoption of the system.

Similarly, Kirman et al. introduced the Nag-baztag, which is "an illustrative application for teaching positive, environmentally friendly behaviors within a domestic kitchen environment." [30]. The design study, Nag-baztag, utilized both positive and negative reinforcement. The negatives could become pushy, such as sending constant reminders of a tap running via email, text messages, or Twitter and Facebook. Their contribution was to demonstrate how researchers can take advantage of research in behavioral science to make more effective and engaging applications.

A different view of the push-based strategy is expressed by My-Time, by Hiniker et al., in which participants proceed to self-limit their phone use by setting use-goals [26]. They found that when participants are supported in their goals, they reduce the use of applications the participants find are a poor use of time.

Broadcasting

In our prior study, Gossiper gossiped about the participants' smartphone use whenever they were using the internet on their smartphones by framing the broadcasts as gossip. Our expectations were that gossiping about whenever a participant was using their smartphone would lead to non-use. Even though Gossiper affected smartphone use, the effects of the system wore off over time, and the constant vocal presence of Gossiper frustrated the participants. These issues lead us to consider Smardio's presence and how it provokes through broadcasting. We denote broadcasting as the transmission of one or more messages through sound to one or more listeners.

Broadcasting has been utilized within other provocative design studies, such as the Energy Babble by Boucher et al. [4]. They deployed the Energy Babble to spark critical thinking about energy consumption. The Energy Babble is described as *"automated talk radios obsessed with energy"* [4]. The goal of Energy Babble was to promote sustainable energy practices and encourage communication within the energy-conservation communities

Feltwell et al. studied their provotype, Spkr, a pushy smart home device, intended to spark political debate within the home by reading a composition of different news, opinions, and online posts from various sources [21]. To expose the participants to a mixture of content, they decided to create 40% content aligned with, 40% opposing, and 20% neutral, compared to the participant's political alignment. The neutral percentages were essential to inform the participants about a topic rather than loading the broadcast with a political opinion. Therefore, we consider the points of view on smartphone use in our broadcasts to engage our participants and deliver content from different viewpoints on smartphone use. Through their study, Feltwell et al. found that Spkr sparked debate within the participants' households because of the conflicting viewpoints. They found that the ephemerality of the broadcasts made smart home devices powerful in attracting the attention of and initiate a discussion with the participants in the household. They also found that the ephemerality created an urgency for the participants, as they recognized that the information would not be repeated. On the point of urgency, Xu et al. found that the ephemerality of non-repeatable content, such as sound, gives the device the power to dictate when the participants listen to it [51].

Contents of Broadcasts

Broadcasts come in various formats, and broadcasting gossip has been explored in design workshops [13–15]. In 2004, Dunbar investigated the role of gossip in an evolutionary perspective [17]. His theory was that gossip started as a way of combating norm violators, which is essential for social functioning [17, 22]. As stated by Gluckman, the mere possibility of gossip is enough to keep would-be violators in check [24]. This means that the possibility that actions are subject to judgment by others can create reflection on various practices.

Imada et al. describe the roles of positive and negative gossip in their 2020 paper [27]. They found that participants in their study were affected equally by positive and negative gossip, despite the possibility that the outcome of positive and negative gossip might be different. This means that broadcasts can engage participants through content with a variety of perspectives on smartphone use.

When engaging in social interaction, the social mechanism of reputation through altruism comes into play. People draw upon society's experiences and evaluate these to assess the reciprocity of others [25, 50]. If people prove to be cooperative, helpful, and involved in altruistic behavior, society grants them a reputation accordingly, exemplifying their status as an attractive member [50].

Exhibiting altruism and maintaining a good reputation through social displays is of great importance [5, 32]. Van Vugt et al. described that humans are willing to perform altruistic acts to be perceived as better partners for later collaboration [47], which means that a well-kept reputation creates opportunities unavailable to those who do not have a good reputation, i.e., those who do not cooperate.

The effects outlined by the Energy Babble can be utilized to engage participants in discussions on smartphone use, and smartphone use practices [4]. By incorporating ephemerality as a feature of broadcasts, one can create a sense of urgency in participants. Reflection can be sparked through competitive altruism by comparing participants to each other.

THE DESIGN OF SMARDIO

This paper aims to explore broadcasting to spark reflection on smartphone use practices in the home. To explore smartphone use practices in the home, we draw inspiration from Mogensen, who proposed the use of provotyping, which opposed to prototyping, does not guess at a solution but provokes the current practices [35]. We propose a provotype, Smardio, an abbreviation of the words smart and radio, to spark reflection on smartphone use by pushing information onto the participants



Figure 1: The smallest of the Smardios in assembled form.

Broadcasting as Means of Provocation

We want to spark reflection on smartphone use in the home without applying any type of lock. Therefore, we examine the use of pushy design as a method of pushing ideas onto participants. To do this, we use broadcasting to utilize the effects of ephemerality and thereby create a sense of urgency for participants to listen to the broadcasts.

We designed Smardio as an old tube radio, as it is a recognizable object from a time before smartphones. We chose an old tube radio, as we want to engage participants through a well-known object to not alienate them. In addition, the aesthetics of Smardio was designed to be easily adoptable in the participants' home yet not entirely blend in with the surroundings.

As Smardio looks like a retro radio, as seen in Figure 1, we designed the voice lines to be broadcast as if they were actual radio segments. We divided the different broadcasts into three radio-like segments: Breaking news, advertisements, and a daily overview. Each segment stems from usual broadcast types, as breaking news is used to deliver content in a news-like fashion, advertisements promote some practices through a product with certain attributes, and the daily overview can be compared to a daily weather forecast regarding smartphone use from the past 24 hours.

Designing Advertisements and Breaking news

The advertisements and breaking news segments had the purpose of presenting different views concerning smartphone use to the participants and thereby have them reflect. We designed 50 segments (30 advertisements and 20 breaking news), where the majority had a duration of under one minute. We kept the segments ephemeral to keep the participants intrigued and engage them to discuss the content of the segments, hence discussing smartphone use in the home. All 50 segments are available in Appendix A.

To ensure that no single view of smartphone use was featured too heavily, we created a framework to explore the spectrum of views presented in the voice lines, seen in Figure 2. The more towards either left or right a box is located, the more the content of the voice line tries to promote non-use or use of smartphones. If the box is located towards the middle, the content becomes more ambiguous. If the box is located towards the top, the content describes a personal



Figure 2: Spectrum of views. Purple boxes are breaking news, blue boxes are advertisements.

benefit, where towards the bottom, the benefit is social in nature. The exact position of each voice line is subjective but reflects a general position on the chart.

The breaking news voice lines, represented as purple boxes on the figure, mainly stem from research cited in the related work. The key points were extracted and packaged as a breaking news broadcast. The breaking news segments start with a 12-second long musical intro, reminiscent of an older news intro, to give the participants time to shift their focus to Smardio, whereafter the content of the segment is presented, followed by a short musical outro. These voice lines give the participants factual information to spark reflection and promote discussion.

As most of the research focuses on negative aspects of smartphone use, we created advertisements to explore the full spectrum of smartphone use. The advertisements were created from our imaginations and are a combination of infomercials and product advertisements meant to spark reflection. We made the advertisements interesting for the participants by taking inspiration from the work by Blythe and Andersen about unuseless design [3]. Here, Blythe and Anderson suggest that approaching a topic from a silly or humorous angle does not diminish the seriousness of the topic itself. Therefore, the advertisements were deliberately made to be silly.

Examples of Advertisements and Breaking news

Below are examples of voice lines from each quadrant in Figure 2 with the example numbers corresponding to the numbers in the figure. The voice lines are translated from Danish to English. Examples 1 and 2 are advertisements, and Examples 3, 4, and 5 are breaking news.

Example 1: "Do you ever wonder what others are using their smartphones for? Buy the new headset from EavesDropper today! You can adjust it to listen to other devices on your network so that you always know what others are doing. The product should only be used with the acceptance of others."

This product advertisement intends to provoke people to stop using their smartphones, as they do not want others to eavesdrop on their use. The EavesDropper is marketed directly to the individual for personal gain, and it promotes non-use by making people around feel as if they are being watched.

Example 2: "Now We-Sell-Radios are launching their brand new smartphone, with extra functionalities to catch your attention. All information about how much you use your phone is hidden away so that you don't have to worry at all! You use the time you need, so forget all your concerns! It's almost free; it only costs a part of your free time."

The product is marketed for personal use, and since all the use information is hidden away, the user will not notice how much time they use their smartphone, which is pro-use.

Example 3: "Research from Aalto University, Finland, shows that habits on smartphone use can be categorized as informative, interactive, and attention-demanding. Which are appropriate, and which are not? This is the next step research will consider."

The research in Example 3, based on the work done by Oulasvirta et al. [38], does not exhibit any opinion or expectation on whether smartphone use is good or bad. Instead, it raises questions without implying any bias.

Example 4: "Today, a research group from Milan presented the results of a survey investigating how smartphones affect time spent together with friends. By investigating the state of mind of a group of friends, they found that those using smartphones while together with their friends enjoy the time spent together less. Therefore, the research team recommends keeping the smartphone in the pocket while socializing with friends."

Example 4 describes some of the results by Rotondi et al. [43]. The results are communicated in a way that negatively portrays the effects of smartphones on social interactions with friends. Thus, this voice line promotes non-use of smartphones in a social context.

Example 5: "Research shows that smartphone use can be utilized to gather families for activities. This entails that the use of the smartphone is for the greater good of the family. An example could be gathering information from the internet to be used in the social situation. What do you use your smartphone for when you are together?"

The last example considers smartphone use to promote social interaction by utilizing the smartphone to gather the family. The voice line promotes pro-use in a social context, as long as the smartphone is used constructively. This example also questions the practices of smartphone use in social contexts.

Daily Overview

Contrary to the views expressed in the advertisements and breaking news segments, the daily overview focuses on the participants' smartphone use compared to each other. The segment ranks the participants once a day, at a designated time, according to their smartphone use from the past 24 hours. Additionally, this overview contains a description of each participant's change from the previous day by describing either an increase or decrease in individual use and whether the family's combined use has increased or decreased.

The daily overview ranks the participant with the highest smartphone use first, and the rest in descending order. This irony of first place being the one with the highest use is meant to spark reflection with the participants. Because the first place is associated with something that negatively affects the participants' reputation, they need to decide if they want to pursue first place, which is normally coveted.

Implementation

Smardio is a device designed to spark reflection through provocative design. This provocation is facilitated using a push-based strategy by broadcasting voice lines when it detects people's presence. Therefore, the device's main components consist of a pair of compact speakers connected to a Raspberry Pi, which acts as the minicomputer that controls the signals and timing for when to play, which broadcasts. All of this is contained inside the casing of an old tube radio with the original electronics removed and buttons glued back on, as depicted in Figure 1. Additionally, Smardio is connected via Bluetooth to a battery-powered BBC micro:bit V2¹, a pocket-sized computer with an LED light display, buttons, and an array of sensors. The micro:bit detects if people are present through a built-in microphone and sends a signal to the Raspberry Pi if a preset decibel threshold is exceeded.

When the Raspberry Pi receives the micro:bit's signal, it triggers one of the 50 breaking news and advertisements at random. These voice lines are configured, together with the families, to only play within a designated time interval. This interval delimits when Smardio should be active. Furthermore, to ensure that Smardio does not constantly broadcast, there is an hour-long cooldown between when a voice line can be triggered. Therefore, if the specific Smardio is configured to start at 9:00 and stop at 21:00 the same day, it would at most be able to play 12 out of 50 voice lines a day. This cooldown is implemented to, firstly, not bombard participants with broadcasts due to the participants' feedback in the study of Gossiper [12]. Secondly, to allow time for reflection on the previous broadcast. Lastly, to keep the broadcasts fresh for the participants, each broadcast should only be played a couple of times during field evaluation due to the cooldown.

Additionally, Smardio monitors the internet traffic of each participant, using a proxy server, and attributes them with an individual rank by comparing their internet use. These ranks are used in the daily overview.

METHODS

This study aims to investigate how to spark reflection concerning smartphone use in a family context. To explore this, we use a research through design [53] approach where we examine the impact the design of Smardio has on a set of families. The feedback gathered from the families is then the basis for further analysis.

¹https://microbit.org/

Participants

We recruited participants in family units through personal connections, which totaled nine participants distributed across three families. They were asked to participate in a study exploring smartphone use without giving a positive or negative connotation about the subject. We did this to avoid cultivating potential biases for future answers they might give. The criteria for the participating families were to be a couple living together and preferably have stay-at-home kids who have a smartphone. The names of all participants are pseudonymized, and an overview can be found in Table 1.

The first family (family A) comprised of three adults, a husband (James, age 68), a wife (Kristen, age 61), and a daughter (Mathilda, age 21). They lived in their own regularly sized house with two floors. James and Kristen were usually located by the kitchen-dining area on the first floor until 8 p.m., when they retired to the second floor. Mathilda was usually in her room except at mealtimes. James used his smartphone for practical purposes, such as checking his mail and bank information. He also used his smartphone for information acquisition, both historical, theological, and biological. The only social media account he used was Facebook. Kristen had a work phone but used her personal smartphone mainly for reading books. While working from home, she used her smartphone to play music and sometimes for procrastination if she wanted to get away from work for a bit. Interestingly, both James and Kristen said they have a reconciled relationship with their smartphone and did not want to reduce their smartphone use. Mathilda was active on multiple social media sites and spent a lot of her time tending to them. She, contrarily, expressed interest in lowering her smartphone use.

The second family (family B) consisted of two adults, a husband (John, age 45), a wife (Christine, age 44), and their two children, a daughter (Laura, age 17), and a son (Otto, age 14). They lived in an average-sized one-plan house. John used his smartphone a lot for watching sports and YouTube. Christine had a work phone but used her private smartphone for coordinating shopping and keeping herself updated through social media. Both John and Christine also used their smartphone for practical purposes and general searches, and each had a game they played semi-regularly on their smartphone. Laura and Otto were active on social media and frequented Snapchat, TikTok, and Instagram, and they both watched YouTube. The family expressed that they all wanted to decrease their smartphone use in certain situations.

The third family (family C) consisted of a couple, a man (Carlos, age 28), a woman (Simone, age 26), and their son (Terry, age 3). They lived in a two-story house with a kitchen-dining area and two living rooms. The couple used their smartphones for practical purposes such as day-to-day coordination. Besides that, Carlos used his smartphone for Facebook and games. Simone used her smartphone similarly. Interestingly, Simone had uninstalled Instagram, and at the same time, she had also blocked notifications from Facebook. She had switched to reading more posts on Quora as she found that more entertaining. The family expressed interest in reducing their smartphone use when interacting with their son.

Participant	Family	Gender	Age
James	А	Male	68
Kristen	А	Female	61
Mathilda	А	Female	21
John	В	Male	45
Christine	В	Female	44
Laura	В	Female	17
Otto	В	Male	14
Carlos	С	Male	28
Simone	С	Female	26
Terry	С	Male	3

Table 1: Participants.

Study Design

We conduct a month-long field study where we study smartphone use by deploying a Smardio in each of our three participating families' homes. The field study is performed to examine how Smardio affects our participants in an accustomed environment, their home [33].

A week before deployment, we performed a 30–45-minute semistructured group interview [1] with each family about their smartphone habits and views for comparison with a post-interview. All interviews were performed with one main interviewer and one support interviewer who ensured that all interview questions were covered. Terry from family C was not an active participant in our study because of his low age.

Smardio was set up in a central location in the home where the participants congregated. During the setup, all family members were present, and Smardios general functionality was explained. We tried to minimize any implications of provocation and reflection to avoid our bias affecting the participants. Furthermore, the specific Smardio's designated interval for when it could broadcast each day was configured with the specific family's input to ensure that it assimilated into the family's daily routines. We configured Smardio to start broadcasting three days after deployment to ease the integration of Smardio into the home and to collect preliminary data for the daily overview.

Approximately three days after Smardio started broadcasting, we were contacted by one of the families who made us aware of connection issues between the micro:bit and the Raspberry Pi. The problem was solved with new batteries and a quick reboot.

After a month had passed, we visited the families to retrieve their Smardio, take pictures of each Smardio, and conclude the study. We performed a 60–90-minute semi-structured group interview in their home next to their Smardio. During the interview, we explored their experiences and reflections from interacting with their Smardio. Because of scheduling concerns, we performed a separate interview with Mathilda from family A. For their participation, the families were each given a box of chocolate.

Data Analysis

We audio-recorded all interviews and later transcribed them. The transcriptions were subject to thematic analysis [6], and the codes were reviewed to find common codes between the interviews. After



Figure 3: Smardio in Family A's home.

coding all the data, we reviewed the codes and grouped them into initial themes. These themes were iteratively refined by repeatedly analyzing the data until the themes presented in the findings were found.

FINDINGS

All families were involved in the placement of Smardio, and each family placed their Smardio near their dining table. Family A placed their Smardio on a stool next to a bookshelf, within close proximity to the dining table, as seen in Figure 3. Family B placed their Smardio on a small wooden bench next to their dining table, in a highly visible place as seen in Figure 4. Finally, family C placed their Smardio on the kitchen counter facing towards their dining table, as seen in Figure 5.

During the month-long study of Smardio, all participants were exposed to all three categories of broadcasts, though family B's Smardio had issues regarding network monitoring, leading their daily overview to be faulty. This fault resulted in the rankings from the daily overview never changing. We found that there are many practices of smartphone use and that the social acceptability of use is associated with the purpose of use. The transcribed quotes are translated from Danish to English.

What Constitutes Smartphone Use

The participants reported that the main topic of their discussions and reflections was what they used their smartphones for. Their time with Smardio was described as an eye-opener to their purposes and practices of smartphone use.

"It was an eye-opener regarding what counts as smartphone use. I sometimes use my phone as a remote for the sound system, and I never thought of that as being smartphone use. Which, of course, it is. In that vein, there are probably things that you do not consider smartphone use because you are just listening to music. But it takes place via the smartphone." [Kristen].

Simone echoed Kristen's sentiment: "To me, it is mostly about the unknown [smartphone] use, that you cannot account for the amount of time you spend on your smartphone. How much I think I know about my smartphone use, but how little I actually know about it."



Figure 4: Smardio in Family B's home.



Figure 5: Smardio in Family C's home.

[Simone]. For Simone and Carlos, their reflections on what constitutes smartphone use appeared a lot in their daily conversations and were prompted by the ranking in the daily overview:

"It is mostly in conversations about what we use [our smartphones] for. For example, when the daily overview is on and says I used my smartphone the most, I can explain why. I might have spent that time on three hours of reading Quora." [Simone]

The "unknown" smartphone use was not limited to apps used passively or in the background. Many times the smartphones were used for practical purposes: "The time registered as used [using our smartphones] is spent on all kinds of things, it is to operate the sound system, the weather forecast, reading e-books, newspaper." [James].

The realization of what constitutes smartphone use came about as the participants started checking the built-in smartphone use overview on their smartphones:

"The reason why I noticed is that after I turned on [the sound system], I checked my phone myself to see what I used it for during the day. There I could see that there were things I never thought of as smartphone use." [Kristen]. In Family B, their daily smartphone use was especially present in their daily conversations due to their faulty Smardio:

"We have, multiple times, checked that I used Snapchat this many times, and I used Instagram for that amount of time to weigh it against each other. So I think it had made us more aware of how much time we spend on the different apps when we talked about how much time we each spend on [our smartphones]." [Laura].

Christine repeated the same notion but focused on her smartphone use in a social context:

"I have become more aware that I use it for something other than social interaction. As in, 'Wow, I am really using my phone for something irrelevant.' [...] [Smardio] has made us look at what we use our smartphones for. Not how much, although we did have some fun with the ranking, but what we use them for." [Christine].

The participants reported that they had gained an insight into what smartphone use is to them through their discussions and reflections sparked by Smardio. These reflections mostly revolved around what they used their smartphones for and what constitutes smartphone use. Simone noted that: "Seeing smartphone use as good or bad is an oversimplification [of a complex topic]" [Simone], due to the purposes and contexts of the use.

Two Faces of Smartphone Use

As eluded to by Simone, smartphone use is more complex than good or bad. The perception of smartphone use depends on the purpose. Smartphones can be used as practical tools; however, this can often lead to prolonged use at the cost of social interaction.

Smartphones as Tools

The participants described the notion of practical smartphone use. This emerged from a discussion of smartphones as an essential tool for modern life:

"You could say that the smartphone has become a tool, where you do all kinds of tasks that you previously had to do in person. Mathilda uses it for shopping and manages her bank account on her smartphone. If I have to get a hold of the bank, it is on my iPad or PC. Mathilda does all kinds of stuff, like banking, which you previously had to do in person. You do not do that anymore. In that way, it has become an essential tool if you want your life to run smoothly and do not want to resign from the electronic world. I have not been able to visit the library during COVID, so now I read books on my phone. It works as a remote. It has become an important tool to us." [Kristen].

Besides banking and shopping, smartphones were often used for other practical purposes, such as an encyclopedia: "Sometimes we have to Google something, or if we are talking about something and we need to find a reference to it. Then you find the article, and the smartphone becomes part of the discussion." [Mathilda]. These practical uses often had different feelings associated with them, compared to procrastination: "It is deeply satisfying. [...] When the smartphone is used to find concrete information, which no one present can give a more satisfying answer to than what I can find on my smartphone, then I do not see a problem with the use of my smartphone." [James].

In family C, the smartphones were sometimes used to entertain Terry for a couple of minutes when Carlos and Simone finished their dinner: "We talked a bit about the 'Nanny-phone.' When I place my phone on the table, it is sometimes because Terry has to be entertained so that we can finish eating in peace. If [this smartphone use] is on mine or Simone's bill is a different question entirely." [Carlos]. For Simone, her smartphone was often used as a tool for communication with distant relatives or friends: "I feel like my smartphone connects me with people outside our home. [...] I can spend two hours talking to my mother on FaceTime, and that is also part of my smartphone use." [Simone].

The smartphones were also used for practical purposes by the children in the study. Laura described a part of one of family B's discussions about her smartphone use: "It was mostly about the practical stuff: Is the internet used for something like Lectio², managing my schedule or homework, Googling something, sending someone a message regarding homework, or is it used purely for leisure?" [Laura].

The participants' smartphone use often started with practical tasks, such as checking notifications, the weather, or the schedule. However, smartphones make it easy for users to transition from a practical task to something different; all it takes is a click or two. Therefore, the practical tasks often ended up in prolonged use.

From Practical Tool to Prolonged Use

Christine brought up the idea that the practical tasks would turn into prolonged use:

"I do not think I use my smartphone that much other than for practical things. But those practical things apparently take up a lot of time or turn into something else. Maybe it takes longer than necessary. It is no secret that Facebook is a time-waster. I can go on Facebook to read something about an event for Otto's class and see 47 other events, or that it is someone's birthday. At that point, you are engrossed, and it might take even longer before I am finished." [Christine].

The participants, in general, described that they had become more aware of when their smartphone use would drag on into prolonged sessions:

"I think it is a case of self-awareness. We know what is good [smartphone] use and bad [smartphone] use, but the smartphone has taken over the world. Not just for our family, but in general. And I think you have to be aware of that because it has an effect." [John].

James noted the same idea, that smartphones permeate everyday life, but was quick to point out that, while he noticed he sometimes spent too much time on his smartphone, he was often able to "*put it away*" because "*what I was doing probably was not that important.*" [James].

The reflections on their smartphone use extended beyond the confines of the home. For Laura, this was the case when she was around other people:

"I think that my smartphone habits have changed when I am around others. When I am in the classroom talking to the person next to me sitting and staring into their phones, I get irritated and ask them to look up from their phones since we are finally back at school. I think [Smardio] has helped change my opinions on that. When I finally get to be around others, I dial back my smartphone use, and I want them to be present too." [Laura].

The use of smartphones while being an active parent also came up in discussions. This was prevalent in family C, where, as mentioned earlier, Simone and Carlos on occasion used their smartphones to entertain Terry for brief periods. Simone mentioned that,

²Online lesson and scheduling management system used in danish high schools.

while Terry being entertained by a phone was fine, she was not happy with her own smartphone use around him:

"When I am watching Terry, I do not want him to see that I am using my smartphone. So I hide it. And when I put it away and do not want to use it anymore, all it takes is two seconds, and I am back using it again." [Simone].

Carlos agreed with Simone, and he felt that: "It is a problem when our smartphones take time away from Terry." [Carlos]. They mentioned situations where Terry had to try a few times to get their attention because they were focused on their smartphones.

The use of smartphones is more than simply good and bad. Often, it stems from a practical need, but it quickly becomes lengthy. All participants mentioned this, and they described that Smardio helped them reflect on when and why a simple task might turn into prolonged use.

The Legality of Smartphone Use

Views on smartphone use are plentiful and complicated. One of our participating families described smartphones as an indispensable tool, while they also argued that smartphone use in a social context is rude. Our participants all agree that using smartphones in a social context has become a norm, to which some participants stated that they try to feel the room before using their smartphones. This phrasing relates to the act of interpreting whether it is socially acceptable, or as stated by Christine: "[Smardio] is stirring the evolution of how proper smartphone ethics are developed. What is legal, what is not legal." [Christine].

When Smartphone Use is Legal

Our participants found that smartphone use in a social context is legal if used for certain purposes.

Kristen stated that during breakfast, smartphones are legal tools of use in their home: "It is accepted, that during breakfast we sit and read [newspapers] on our smartphones" [Kristen]. Laura expressed that "[Smartphone use] has become a big part of our society today." [Laura]. James also commented that he uses his smartphone for "practical purposes, such as the weather, whether a shop has the items we need. Fast searches." [James]. Kristen stated that she found the legality of using her smartphone was affected by how others used theirs: "If we see others around us using their phones, then we are drawn to our own [smartphones]" [Kristen]. Simone described that using her smartphone while interacting depended on a social consensus:

"We have attended game nights where others have been scrolling down Facebook on their smartphone. It is disturbing. It has a lot to do with the context. [...] It is dictated by what the group does. It can be acceptable if others are talking a lot, and you start scrolling down Facebook. If both parties agree, it can even become part of the conversation." [Simone].

When Smartphone Use is Illegal

Some participants expressed that smartphone use becomes problematic when it inhibits social interaction. James found the act of using a smartphone during a social interaction as rude, and stated: "I think it is naughty and rude to opt-out of the social interaction, and concentrate on one's smartphone." [James]. Kristen stated that during any other meal than breakfast, smartphones are not allowed at their dining table: "During any other meal [besides breakfast] smartphones are not present. They might lie around by the table, but we are not using them unless one has to look something up." [Kristen].

Kristen also noticed that while she was out for a walk, she pondered why others would walk around, staring at their smartphones:

"We talked about it the other day when [a couple] was out for a walk with their dog, and they both walked around with their head down, walking together. They both stared at their phones. I thought to myself, 'if you are out for a walk in such a beautiful place, why do you not enjoy the surroundings and look at something else than the phone?'" [Kristen].

Christine stated that her friends' use of other smart devices disturbed her while they were on a trip together: "I was very aware of not using my smartphone. It took a lot of discipline, as I was on a trip with two others, who have it on their [smartwatch]. I found it incredibly disturbing. When they used their [smartwatches], I had to be stubborn and say to myself, 'do not use your phone here.'" [Christine].

Through our study of Smardio, we found that evaluating the legality of using smartphones during social interaction includes distinctions of the purpose of the use, who is involved in the use, and whether the use of the smartphone promotes social interaction.

Smardio as an Intervention Artifact

Smardio was developed to be deployed into people's homes, and in that particular context, spark reflection on smartphone use through provocation. All participants noted that Smardio quickly became an integrated part of the home, here exemplified by Christine: "I think [Smardio] quickly became a natural part [of the home], and I have not given the placement much thought." [Christine]. Smardio generally became the focal point of the family during the daily overview, where the participants gathered around their respective Smardio and listened to the daily ranking: "[When the daily overview started] we came running down the stairs." [Simone].

Participants felt that they were competing with each other to achieve the lowest rank and have the lowest smartphone use: "It created a spirit of competition, in the way that [Smardio] reads out [the rankings of the participants]." [Kristen]. Simone and Mathilda both described the notion of the fight to stay in the last place:

"It has been a fight to stay in the last place, but I have been lucky to do so the entire time. So it has been like okay, I did it yesterday, and I will try again tomorrow and the day after tomorrow." [Mathilda].

For Christine, the daily overview made her reflect on when she uses her smartphone in the evening, resulting in a behavior change:

"At the start when we got the rankings, I have to admit that I thought about it a lot when I sat on the couch in the evening. There, I tried to be more aware of watching TV [with the family], putting [my phone] away, and not reaching for it whenever there is a commercial break. It is okay to chill out to the advertisements once in a while and actually talk to the others in the living room, where I would normally look at my phone." [Christine].

The rankings only affected the participants to a certain point, however. James was number one most of the time and felt that "I have also noticed that I spend a little too time on my phone" [James].

Due to the faulty network monitoring of family B's Smardio, their rankings were always the same (from first to fourth: John, Christine, Laura, Otto). As a result, John felt that "I knew I was going to be number one, so it did not really matter. I might as well continue as I normally do." [John]. Conversely, the lack of change in ranking led to more discussions about smartphone use: "We have had multiple evenings where it did not change the rankings, where we then checked our use through our phones [to verify the ranking]." [Laura].

In family A, Kristen did not want to reduce her smartphone use, and as such, she had a smaller incentive to avoid being rank one. In families B and C, all members expressed interest in reducing their smartphone use, and the participants stated that their goals were to achieve as low a rank as possible. Based on the participants' comments, competition appears to be an effective tool to provoke people into reflecting on their smartphone use.

Families B and C both described how Smardio provoked them into healthy discussions and helped illuminate points of conflict regarding smartphone use: "[Smardio] opens up for discussions regarding how acceptable [smartphone] use is. You hear it all day long, and it kind of de-escalates the conflicts that might arise." [Simone]. Laura echoed this sentiment: "I feel we have been able to ask each other to put down your phone while we sit at the dining table" [Laura], and Christine added: "In some way, I think it is safe to say that [Smardio] has changed how we interact during the study." [Christine].

In general, the participants were enthusiastic about Smardio and its segments. The daily overview, in particular, sparked interest as the participants started competing with each other to achieve the lowest smartphone use. The rankings were also instrumental in sparking reflection on smartphone use in the homes, and some participants changed their behaviors.

Engagement Through Spectrum of Views

During the development of Smardio, we constructed a framework to express the dynamics involved in the legality of smartphone use. This framework was used to ensure diversity in the viewpoints on smartphone use in the broadcasts of Smardio. In addition, this framework enabled Smardio to engage the participants, whatever their opinions of smartphone use were.

The hourly broadcasts of the Smardios engaged the participants. Laura was intrigued by the broadcasts: "I walk up close [to the Smardio], and think 'what are you saying?'" [Laura]. Simone thought that the broadcasts were "Enlightening. [...]. Informative, and ironic." [Simone].

Smardio's broadcasts seemed to resonate differently with each individual, as one participant stated that "*The fact-based, or alike, is what has caught my attention.*" [John], contrary to Mathilda, who said: "*Whatever it said during the day, I did not care.*" [Mathilda].

The effects of breaking news were the most potent for Christine: "When it says something about a University, then I get curious." [Christine]. In the same vein, Kristen found the research segments interesting: "When [Smardio] references to research, one has an opportunity to learn something new." [Kristen]. The advertisements intrigued participants, as the fictitious products from the broadcasts caught the participants' attention: "[advertised product], is something that I would consider buying. It sounds so convincing, as a *cool gadget*" [Laura]. Laura remembered an advertisement about privacy, which made her reflect on smartphone practices, to which she said "one does consider that people can see what you are doing on your smartphone." [Laura].

Kristen memorized a broadcast about putting the smartphone away and being social instead, to which James commented "that is what I feel targeted by." [James]. This statement by James shows that even though he did not perceive smartphone use as problematic before the study, he felt singled out due to his smartphone use. He mainly memorized the non-use points of view expressed by Smardio. Kristen elaborated: "[Smardio] is a little lecturing, as in 'Did you consider putting away your phone and asking those around you instead of looking it up on the phone?'" [Kristen].

The participants had different perceptions of Smardio's points of view on smartphone use. James and Kristen disagreed whether their Smardio was pro-use or non-use, as Kristen said: "I do not perceive it, as if it is a bad habit to use a smartphone" [Kristen], and James said: "There were no positive notes [about using a smartphone] [James]. Laura perceived it as pro-use: "I feel like it has been infavor-of smartphone use." [Laura]. At the same time, Simone was unable to find a pattern in the points of views presented in the broadcasts: "[breaking news broadcasts] were so different, that it was hard to get a general understanding of them." [Simone].

The framework engaged the participants, even though they have different opinions on their use. As the framework makes Smardio able to cater to multiple views on smartphone use, any viewpoint would be up for discussion. We would like to thank our supervisors, Rikke Hagensby Jensen and Enrique Encinas, for their supervision and the three families for participating in our study.

DISCUSSION

In the discussion, we outline the insights we have gained through developing, deploying, and evaluating Smardio to study how to spark reflection on smartphone use in a family context.

Social Perspective on Smartphone Use

Through the study of Smardio, we found that the participants evaluate the legality of smartphone use according to the social context and the purpose of use. This aligns with the findings of Oduor et al. in [37], as they state that family members become frustrated when they perceive the use of smartphones as non-urgent. We argue that certain conditions are determining whether the use of smartphones is legal in the social context. This evaluation indicates that there are both positive and negative effects of using a smartphone during social interactions. The legality of smartphone use seems to increase if the perceived use is beneficial for the interaction. The participants stated that smartphones become part of discussions and even improved the discussions at times.

The participants reported that they became more aware of what they perceived as smartphone use, as they did not consider practical and passive tasks as smartphone use before the study. This is also apparent in the study by Oulasvirta et al., who described that smartphones create pervasive checking habits [38]. The participants in our study caught themselves using their smartphones for what they perceived as irrelevant tasks and started to investigate what they use their smartphones for. The participants had reflected on their smartphone use and found that they spent a lot of time on social media apps, such as Facebook, Instagram, TikTok, which they described as irrelevant use.

The study of Smardio revealed that smartphone use could be an enhancement and obstacle to social interaction. Smartphone use has both negative and positive effects, dependent on the purpose of use. This partly contradicts the findings of Rotondi et al., who state that there is a coherence between lessened satisfaction of time spent with friends when a smartphone is in use [43]. Our findings show that the purpose of the use is essential to determine whether the use is inhibiting or improving the interaction. This is in line with the findings of Xi Yu et al., who found that smartphones can foster a sense of family unity while retaining a sense of personal space [52]. The families spent a lot of their social time at the dining table, where smartphones were utilized actively to find information which enhanced their discussions. Our findings echo the findings of Jung, who found that smartphone users can enhance social interaction by utilizing the information available on the smartphone [28].

We find that the value of smartphone use goes beyond the single user, as interacting with a phone can enhance social interaction.

Our participants' views of smartphone use were dependent on the context of use. They described that smartphone use as a distraction if the smartphone was not used to enhance social interactions. They described that the use of smartphones had to have a purpose in the interaction and that individual use sometimes clashes with the social interaction, as people tend to use smartphones as breaks.

Smartphone Practices and Spectrum of Views

The effect of our spectrum of views was that the presence of both positive and negative perceptions of smartphone use sparked reflection. By exposing individual use in the daily overview, we were able to promote discussions on the practices of smartphone use through competitive altruism, as described by Van Vugt et al. [47]. In addition, the participants stated that the broadcasts of their Smardio promoted discussions on smartphone use. By broadcasting segments catering to both pro-use and non-use in personal and social contexts, Smardio sparked discussions on the problems and benefits of using smartphones during social interaction. Smardio's ability to spark discussions with both pro-use and non-use broadcasts is similar to the findings of Imada et al. in [27], who found that positive and negative gossip affected people equally. Thus, Smardio sparked reflection through both highlighting benefits and problems of smartphone use practices.

By making smartphone use a topic of discussion, Smardio engaged the participants in discussions and reflections on smartphone use practices in the home. Laura stated this as she found that listening to the broadcasts opened up for discussions on use practices. Other participants said that their Smardio acted as a conversational prompt by inviting them to discuss the broadcasts. Interestingly, when asked to identify the main viewpoint on smartphone use in Smardio's broadcasts, the participants highlighted different views. This suggests that the different voice lines resonated differently with each participant, depending on their views on smartphone use. During the study of Smardio, some participants mainly remembered the breaking news, other participants the advertisements, while at the same time they did not agree whether Smardio promoted either use or non-use of smartphones.

Smardio intended to provoke the participants by utilizing the spectrum of views to expose the participants to various views on smartphone use, which let Smardio stay unobtrusive regarding what correct smartphone use practices are. This unobtrusiveness lets each participant create their own perceptions of what Smardio advocates for regarding the spectrum of views. The participants did not agree whether Smardio advocates for non-use or pro-use of smartphones.

Smardio as a Provotype

Designing a provotype to spark reflection on a practice that as ubiquitous as smartphone use was difficult. As was apparent in our prior study of Gossiper, we had to cater to the study participants, even when designing a provocative entity, as Smardio should be adopted rather than neglected [12].

Mogensen described provotyping in an article, in which he relates provotyping to the practices of developing systems that combine provocation and concrete experience [35]. He argues that researchers can understand current practices by developing systems that let participants experience current practices in alternative ways. Smardio was developed as a provotype designed to question current smartphone practices, as we wanted our participants to reflect on smartphone use in the home. Smardio sparked reflection in two ways: Through the daily overview and the breaking news and advertisement segments. The daily overview segments were catalysts for much discussion in all the families. The fact that the families themselves designated when the overview should broadcast each day made it something the families could plan to listen to together or record for an absent participant as seen with family C. Some participants reflected on the contents of advertisements and breaking news broadcasts, which exemplifies that the engagement with each type of broadcast segment of Smardio served a common purpose: Reflection through broadcasting.

Smardio was designed to be provocative in an engaging way. The retro aesthetics of Smardio were designed to be recognizable and non-threatening to cater to adoption into the participants' home and stand out to catch the participants' attention. This is in contrast to the approach presented by Hagensby et al., who developed The Box, a provotype designed to spark reflection on energy consumption in the home [41]. The Box was deliberately designed to be aesthetically provocative through its bulky metal exterior. We designed Smardio to be aesthetically pleasing to a degree where the participants want to have it in a prominent place in their living room. This was due to the need for Smardio to be present when the family is together in a place where they interact socially. Smardio's aesthetics did not promote discussions between the participants on their own as Smardio quickly blended into the home. However, Smardio's aesthetics did promote discussions between the participants and guests, as family C had guests who were intrigued and provoked by the aesthetics of Smardio, sparking discussions between the participants and guests. Additionally, family B was so pleased with the aesthetics of their Smardio that they requested to keep the old radio casing after the study had ended.

A key component of reflection on smartphone use was stated as self-awareness by some participants. Their opinion was that people already know what good smartphone practices are, but smartphones have made it hard to stay in control. Smardio served the purpose of a provotype by calling forth experiences in smartphone use practices and challenged these in the home of our participants through discussions and reflection.

Studying Smardio has shown that the effects of using a smartphone in a social context depend on the purpose of use. In this context, the use perceived as bad can be described as individual use, whereas good enhances social interaction. This description depicts that smartphone use can affect the social dynamics in multiple ways, either as enhancement of interaction or disruption.

Limitations

The amount of participants in our study is a limitation of our study. We recruited three families of at least two participants each, which is not representative of the vast differences in family dynamics. The sample size is too limited to give an exhaustive view on smartphone use in the home.

Another limitation during our study was the effects of COVID-19. This kept the participants from having guests, which limited the number of third-party inputs, and limited the discussions that the participants could have had with possible guests. The COVID-19 lockdown may have altered the participants' smartphone use during the pandemic, which may have impacted our data.

CONCLUSION

In this paper, we present findings from a month-long field study examining smartphone use in the home. The study is centered around a provotype named Smardio designed to spark reflection on smartphone use in the home through aural provocation featuring a spectrum of different opinions on smartphone use and a daily ranking of participants' smartphone use.

We successfully sparked reflection on smartphone use in the home using our broadcasts based on our spectrum of views, which was used to ensure a balance between segments of a particular opinion about smartphone use. We found that the participants reflected on what they used their smartphones for and what constitutes smartphone use. Often, smartphone use started for a practical purpose, but sometimes this turned into prolonged use. The social context in which the smartphone is used also affects its legality. Families may have certain parts of the day or specific tasks where smartphone use is permitted, even during social interactions, whereas smartphone use is frowned upon in other situations.

Further studies could explore the impact of different points of view on smartphone use to design for engagement in social interactions.

We contribute by furthering the understanding of smartphone use and how to provoke participants in the home to reflect on their smartphone use.

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A VOICE LINES OF SMARDIO

The voice lines of Smardio, divided into the categories of breaking news and advertisements. Each category showcases the voice lines advocating the most for non-use first. If any voice lines are advocating similarly for non-use, the one that is personal is showcased first.

A.1 Breaking news

1: "Dansk institut for mobil-brug har meldt ud i dag, at overforbrug af mobiler er blevet en normalitet. Professor i mobil-vaner, Peter Hansen, vil uddybe dette." - "Vi har i dag foretaget en måling som viser, at der det seneste døgn er sket en forøgelse af mobil-brug i de danske hjem. Denne stigende tendens kan betyde, at man mister empati og medfølelse, samt at man udvikler afhængighed af sin telefon. Denne måling viser også, at når telefonen er fremme finder man ofte på flere ting at lave når man først er i gang. Vi er som samfund nødt til, at gøre op med det stigende forbrug af telefoner." - "Dette var hvad Peter sagde i en pressemeddelelse i formiddags."

2: En undersøgelse fra Universitetet i Lapland, viser at mobilers indtrængen i vores alles dagligdag også har udvidet sig til soveværelset. Forskerne har fundet ud af, at mobilbrug i soveværelset har indflydelse både på den måde par snakker med hinanden, og hvordan de fysisk omgås hinanden. Dette kommer bl.a. til udtryk ved læsning eller mobilspil i sengen. Derfor opfordrer forskerne til, at man lægger mobilen fra sig, før man går i seng. **3:** En gruppe forskere fra Milano har i dag præsenteret resultaterne af en undersøgelse, hvor de har undersøgt hvordan mobiler påvirker den tid man bruger sammen med venner. Ved at undersøge sindstilstanden i vennegrupper fandt de ud af, at dem der brugte deres mobiler når de var sammen med deres venner havde mindre fornøjelse af denne tid. Derfor opfordrer forskerne til at man lader mobilen blive liggende i lommen, når man er ude med vennerne.

4: "Dit mobil-brug reflekterer dit sociale engagement" - Dette er overskriften til en ny artikel, som er skrevet af en forskningsgruppe vedrørende mobil-brug i dagligdagen. Deres undersøgelser viser, at folk ubevidst evaluerer hvorvidt man vil starte en samtale med andre, og at denne evaluering indebærer hvor meget andre bruger deres telefoner. Forskningsgruppen påstår, at øget mobil-brug fører til, at man er en mindre attraktiv samtalepartner. Derfor opfordrer forkningsgruppen alle til at lægge deres mobiler fra sig, hvis de gerne vil skabe nye relationer."

5: "Forskning viser, at der er sammenhæng mellem falmende social aktivitet, og brug af mobiler. Det viser en ny undersøgelse fra Universitetet i Essex, som har udført et studie vedrørende familier, kommunikation og mobil-brug. Det viser sig, at brug af mobiler forringer værdien af samtaler mellem familie-medlemmer, da man ikke opnår fuld opmærksomhed fra samtalepartnere, hvis mobiltelefoner er tilstede. Undersøgelsen viser samtidigt, at man får et stærkere socialt forhold til sine medmennekser, hvis man vælger at lægge telefonen fra sig i sociale sammenhænge."

6: En ny undersøgelse fra Aalto University (Finland) viser, at det at tage mobilen frem for at se hvad klokken er, hvilken sms der lige er kommet, eller hvilke notifikationer der venter, ofte leder til yderligere forbrug. Denne undersøgelse understreger, at vaner kan være drivkraften bag afhængighed. Institutet har derfor sat nye retningslinjer for, hvad gode mobil-vaner er.

7: "Vi har lige modtaget nyt om brug af telefoner hos familien Hansen. Vi stiller om til vores reporter Anders, som vil give os den seneste opdatering." - "Jeg står her med de seneste beskrivelser af mobil-brug i hjemmet, hvor det er tydeligt, at Patrick har benyttet sin telefon i meget længere tid end gennemsnittet. Det kan være, at der er gode årsager dertil, men dette vides ikke på nuværende tidspunkt. Alt vi ved lige nu er, at mobil-brug er stigende - Vi kan ikke sige noget om udsigterne for dette forbrug."

8: Forskning på et tysk universitet har påvist, at personer er mest villige til at sætte restriktioner på social medier og beskedapplikationer. Samtidigt viste forskningen, at det var de samme restriktioner, som oftest blev brudt. Hvordan kan det være, at vi så gerne vil mindske vores forbrug af disse applikationer, men har så svært ved at fastholde det?

9: Forskning har vist at notifikationer på mobilen er en af de stærkeste drivkrafter for vores adfærdsmønstre i andres nærvær. De påvirker vores adfærd uanset hvor presserende notifikationerne er. Selvfølgelig kan man slukke for notifikationerne, men vil det have den ønskede effekt? **10:** En forsker fra Lancaster University har i denne uge præsenteret resultaterne af en kortlægning af unges mobilbrug. Forskeren fandt at over halvdelen af de adspurgte unge brugte mellem to og syv timer på mobilen hver dag. De samme unge svarede, at de tjekker deres mobiler hver halve time. Vi vil derfor gerne spørge vores lyttere: Hvor meget bruger du din mobil?

11: Andres brug af mobiltelefonen er en refleksion af dig lyder det i en ny artikel fra Simon Fraser University. Hvis der er andre der går foran i brugen af mobilen vil man selv have det lettere med at bruge sin egen mobil. Det samme gør sig gældende når man ikke bruger mobilen. Forandring starter med dig.

12: Telefonselskaber såsom MereMobil er blevet lukrative, mest af alt fordi mobil-data er blevet yderst værdifuldt. Aktierne for disse firmaer er steget markant de seneste par år, da efterspørgslen på større data-pakker i mobil-abonnementer er stigende. Store SoMe firmaer udvikler deres produkter til, at forbrugerne bruger mere tid, data og opmærksomhed på de sociale medier, som giver gevinst for både mobil-selskaberne, og SoMe selskaberne. Hvad mon brugerne betaler?

13: Erick Oduors forskningsgruppe har i dag meldt ud, at de har kunnet klassificere aktivitetstyper af mobilbrug som værende 'lette' eller 'tunge'. Denne klassificering beskriver hvorvidt man vil acceptere at blive afbrydt, men problemer kan opstå, da man ikke kan se på folk, hvilken type aktivitet de er engageret i. Samtidigt kan folk have forskellige meninger om, hvilken kategori aktiviteten tilhører.

14: Nyere forskning fra Aalto University (Finland) viser, at vaner for mobil-brug kan opdeles i tre kategorier: Informative, interaktive og opmærksomhedskrævende. Hvilke typer mobil-vaner er hensigtsmæssige, og hvilke er ikke? Dette er hvad næste skridt i forskningen skal svare på.

15: Brugen af mobil-teknologi forskellige steder i hjemmet påvirker sociale forhold. Mobiler kan benyttes til at berige forholdet ved at skabe interaktion, men hvis de bliver brugt uden andres accept, kan de forringe forholdet. Dette blev påvist gennem undersøgelser fra Lapland Universitet i Finland.

16: IBM har i dag udgivet en ny undersøgelse vedrørende opfattelse af mobil-brug i de danske hjem. Den beskriver, at der er modstridende følelser forbundet med brug af telefon imens andre er tilstede, alt efter hvilket perspektiv man har og stiller spørgsmålene: Hvad syntes I om brug af telefoner, både når I er alene, og når I er sammen med andre? Er der forskel på, om du er sammen med familie, bekendte, venner, eller nogle fremmede?

17: "Mobil-brug kan anvendes til at skabe fri-rum," sådan lyder det i et studie fra IBM, som i dag har overleveret deres seneste undersøgelser. De har undersøgt hvordan mobiler kan hjælpe med at skabe bedre dynamik i hjemmet hos familier, som ikke nødvendigvis bruger deres telefoner særligt meget. Det viser sig, at nogle personer foretrækker at kunne trække sig fra sociale sammenhænge, ved at tage deres mobil frem. Så hvis nogen tager deres mobil frem under maden, eller imens i ser tv, så tænk en ekstra gang, før I påpeger det."

18: Undersøgelser viser, at mobil-brug kan benyttes til at samle familien til aktiviteter. Dette indebærer, at brugen af mobilen er til fordel for familien. Et eksempel kunne være, at søge information på nettet, som skal bruges i den sociale situation. Hvad bruger I mobilerne til når I er sammen?

19: Forskning fra University College London viser, at der er en positiv sammenhæng mellem at komme hjem fra arbejde eller skole, og sætte sig foran en skærm for at slappe af. Forskningen viser også, at online social støtte skaber mental bedring efter en arbejdsdag. Det tyder på, at mobilen er et godt redskab til at koble af, efter en lang dag. Så hiv mobilen frem, og slap af på din bag.

20: "Mobil-brug kan skabe samme effekt som euforiserende stoffer", sådan er konklusionen fra et studie udført af en forskningsgruppe fra Melbourne University. Konklusionen udvindes af, at mobil-brug kan skabe samme euforiserende effekt som afhængighedsdannende stoffer. Det beskrives dog, at det stadigt undersøges, om denne effekt er vane-dannende eller ej. Samtidigt kan effekten også give øget produktivitet, siger leder af forskningsgruppen, Greg Wadley. Erhvervssektoren er nu i gang med at etablere brug af mobiler som produktivitets-fremmende middel.

A.2 Advertisements

1: Er du også træt af af din samlevers uendelige mobilbrug? Så prøv Gossiper! Den sladrer om alle de tilmeldtes mobilbrug uafbrudt indtil de stopper. Med Gossiper kan du let sørge for, at din samlever bliver træt af dig, ligesom du er træt af dem.

2: Kender du dét, at man bare lige skal se hvad der er af nye spændende opslag på de sociale medier? Eller bare lige at skulle se de nyeste nyheder på telefonen? Der er andre omkring dig, som er mindst lige så interessante. Hvad med at droppe telefonen, og spørge andre i stedet?

3: Har du hørt om det nye klistermærke fra Mobil-Nej-Tak? Det er ligesom at slippe for reklamer i post-kassen. Køb det i dag, og gør andre opmærksomme på, at I ikke ønsker mobil-brug imens I er sammen. Mobil-Nej-Tak, Socialitet-Ja-Tak.

4: Har du overvejet at skifte mobil-abonnement? Hos os ved MindreMobil kan du få en rigtig god pris på et mobil-abonnement, der varertager dine nærmestes behov. Vi nedsætter hastigheden på din mobil og sørger for, at du ikke har lyst til at brugen den. MindreMobil, mere familie.

5: Er du lægger med G? Så husk at læg telefonen fra dig - Ikke kun imens du kører bil, men også når du er sammen med andre. Det er 'lægrest'.

6: Undrer du dig nogensinde om, hvad de andre laver på deres mobiler? Køb det nye headset fra EavesDropper i dag! Du kan indstille det til at lytte til andre devices på dit netværk, så du altid ved hvad folk laver omkring dig. Produktet må kun anvendes med andres accept.

7: Vidste du, at folk bruger flere timer om dagen på deres mobil, hvor de ser katte videoer og spiller spil, i stedet for at bruge tiden på fysisk aktivitet, kultur, sport eller at være sammen med familien? Studier har vist, at folk der bruger meget tid på mobilen bliver set som mindre attraktive. Så læg telefonen fra dig, hvis du gerne vil være lægger!

8: Nu er den her: Sladrehanken - Apparatet som fortæller om hvornår folk bruger deres mobiler. Vil du gerne vide hvornår dine børn, dine forældre, eller andre bruger deres telefon i hjemmet? Sladrerhanken har svaret! Bestil den i dag, og få den til halv pris, hvis du bor med en samlever.

9: Hver dag ser jeg folk gå og kigge ned i deres telefon på gaden. Selv dem der går rundt med deres familie og venner. Det er lige trist hver gang. Det er trist at familier er blevet så generte at de ikke kan snakke med hinanden ansigt til ansigt.

10: Børge er far i en familie, med kone og børn. Både Børge, mor og børn har egne mobiler. Børge lægger sin mobil i en kasse når han kommer hjem fra arbejde, da han ved, at det tager opmærksomheden fra resten af familien. Vær som Børge, og læg mobilen væk. Bare en kort stund.

11: Vidste du, at folk bliver generet af mobilbrug ved spisebordet? Sammen kan vi gøre noget ved dette. Rådet for Mobilbrug har sat nye retningslinjer for, hvad god mobilbrug er. Læs mere på vores hjemmeside og vær med til, at sætte pris på andres nærvær.

12: Kan du høre det? Det er lyden af stilhed. Det er fredeligt, men også lidt kedeligt. Hvis du ikke ønsker stilhed, kan du prøve at snakke med nogle andre. Spørg dem om ting, start en samtale. Hvis du starter, følger de andre nok med.

13: Vidste du, at der hver dag ryger et par fingre til uopmærksomhed? Rådet for Sikker Mobilbrug lancerer nye retningslinjer, som skal sikre at mobilbrug ikke forårsager at folk kommer til skade. Sikre dine fingre på sikkermobilbrug.dk.

14: Nu er de her. De nyeste værktøj til at bringe familien sammen: Familietids-frembringeren og Hygge-Frembringeren. Få Familietidsfrembringeren ganske gratis, allerede i dag. Du beder blot dine familie-medlemmer om at lægge deres telefoner fra sig, så er I allerede i gang. I kan også prøve Hygge-Frembringere, det nye device fra Vi-Sælger-Radio. Brug den i sengen, brug den på sofa'en, brug den på toilettet flushing toilet. Hygge-Frembringeren kan bruges af hele familien samtidig til at skabe hygge hver for sig. Prøv den allerede i dag. Så har du altid hyggen lige i lommen.

15: Bliver du også forstyrret om aftenen, når du helst ville hygge dig alene? Så har vi den nemme løsning! Installer den nye Ghost app, som ignorerer alle, der prøver at forstyrre dig, når du helst ville være fri. Med Ghost app'en bliver hele aftenen fri, så du kan

gøre lige som du har lyst.

16: Vidste du, at man ofte finder på andre ting at lave på mobilen, når først man har taget den frem? Hvorfor fortsætter vi med at bruge telefonen? Er det en ny kattevideo? Er der en notifikation fra Facebook? Noget nyt fra arbejdet? Hvad er dine prioriteter?

17: Nogle gange har man brug for at koble af. Nogle vil mene, at mobiler er et godt redskab til at kunne skabe fri-rum, og alene-tid. Andre vil mene, at det at være social er deres fri-rum. Hvad er dit?

18: Hvad laver dine venner, kolleger, din familie? Hold dig opdateret gennem telefonen - Enten ved opkald, beskeder eller internettet. Du får alt med i én pakke, gennem vores abonnementer hos FamilieMobil. Flere GB, udvidet opkald, og fri sms. Hold dig opdateret, hold dig til FamilieMobil.

19: Føler du at dit mobil brug er privat, så køb det nye skærmfilter fra Vi-Sælger-Radio der gør at kun du kan se din skærm. Dette vil forhindre at dine venner kan kigge dig over skulderen og læse dine beskeder. Nu bliver de faktisk nødt til at vente til du har posted dine opslag. Køb privatliv i en uprivat tid.

20: Sidder du også nogle gange i din egen lille boble, når du er sammen med din familie? Kan du ikke følge med i samtalen? Prøv den ny samtale app som kan føre samtalen for dig. Hvis samtalen løber fra dig så lad teknologien gøre arbejdet, så du kan sidde og slappe af.

21: Er du typen der kan lide at tage billeder, lave hash-tags og gode overskrifter? Så skal du prøve den nye sociale platform: TheShowOfMe. Upload billeder, tag dine venner, familie, og bedst af alt: Hold alle andre up-to-date med, præcist hvad du laver. Følg dine venner, inspirationskilder, dine favorit-influencere, og hav alle andres meninger lige ved hånden. TheShowOfMe, det handler kun om dig.

22: Er du træt af at du ikke får nok motion? Prøv vores løbe simulator Smartrun på din smartphone i dag. Her kan du holde din avatar i god form og derved få det godt med dig selv. Smartrun stay fit, også på telefonen!

23: Nu lancerer Vi-Sælger-Radio deres nyeste telefon med ekstra funktioner til at fange din opmærksomhed. Alt information om hvor meget du bruger din mobil er gemt væk, så du slet ikke skal bekymre dig. Du bruger den tid du har brug for, så glem alle bekymringer! Du kan få den næsten gratis - det koster kun en del af din fritid.

24: Under corona mødes vi ikke fysisk med alt for mange. Derfor er det godt, at vi alle har en mobil, som gør os i stand til at holde kontakten. Så grib mobilen, så kan du snakke med venner og bekendte over video, og det er ligesom at være der i virkeligheden. Husk: Test negativ, forbliv positiv.

25: Har du snakket i telefon i dag? Det kunne være, at et opkald ville løfte humøret hos en ven. Bare en lille samtale. Små samtaler har små priser hos os, ved SocialMobil. Vær social, og få SocialMobil

i dag, med gratis oprettelse.

26: Synes du også at corona-nedlukningen har været træls? Så har vi godt nyt til dig! Vi-Sælger-Radio er tilbage med vores helt nye suite af apps, som har alt hvad hjertet begærer når det kommer til at holde kontakten med omverdenen. Vil du video-chatte med bedsteforældrene, game med vennerne eller klare dagens onlineundervisning? Så hent den nye SuperVideoApp, som gør dig i stand til alt!

27: E-bøger er det nye alternativ: Du kan tage alle dine bøger med dig, hvor som helst, når som helst. Du slipper for at slæbe tunge bøger, og den husker hvilken side du er kommet til. Bøger er yt, E-bøger er nyt. Så brug dit hoved, og brug din mobil.

28: Vil du gerne bruge din telefon mere? Så prøv MobilBrugs-Boosteren i dag! Jo flere telefoner er tilsluttet på én gang, jo hurtigere bliver nettet. Så kobl jeres telefoner på, og boost jeres fællesskab. MBB.dk - Vi skaber fællesskabet.

29: Vidste du, at man ofte finder på andre ting at lave på mobilen, når først man har taget den frem? Vi har alting lige ved hånden: Facebook, Mail og diverse katte videoer bare et klik væk. Mobilen er vores bedste ven, og alt er bedre med den.

30: Har du overvejet at skifte mobil-abonnement? MereMobil lancerer nu et mobil-abonnement, der varertager dine behov. Vi øger hastigheden på din mobil og sørger for, at du hellere vil bruge mobilen end at være sammen med familien. MereMobil, mindre familie.