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*Published in:*

Proceedings of the 2023 ACM Designing Interactive Systems Conference (DIS '23)

*DOI (link to publication from Publisher):*

[10.1145/3563657.3596024](https://doi.org/10.1145/3563657.3596024)

*Publication date:*

2023

*Document Version*

Accepted author manuscript, peer reviewed version

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Jensen, R. H., Encinas, E., Strengers, Y., Dannesboe, C., Kruuse, E., Skovby, J., Bach, M., Tietze, P., & Christensen, S. (2023). Provotyping Accountability: Exploring Smartphone Use in the Home through Design. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference (DIS '23)* (pp. 1595–1609). Association for Computing Machinery. <https://doi.org/10.1145/3563657.3596024>

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# Provotyping Accountability: Exploring Smartphone Use in the Home through Design

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## ABSTRACT

In response to research concerns that smartphone usage negatively impacts intimate relationships, this paper presents a study exploring how design can encourage smartphone accountability in family home settings. We developed and deployed three provotypes with seven families via a Research through Design study intended to encourage reflections on ubiquitous and routinised smartphone usage. The provotypes progressively explore ways of making smartphone use visible by facilitating individualised accountability, competitive accountability, and collective accountability. We present insights into how these provotypes shaped family practices based on a qualitative study with 26 participants. We found that, by emphasising different forms of shared accountability, the provotypes reduced smartphone use, which in turn fostered family intimacy and togetherness, rooted in meanings of caring and sharing. Finally, we discuss our study's implications for how provotypes can help explore forms of accountability in practices involving sustainable technology use within the home.

## CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in interaction design**; *Field studies*; *Smartphones*.

## KEYWORDS

Provotyping; research through design; accountability; breaching experiments; smartphone use, intimacy and togetherness; practices

## ACM Reference Format:

Rikke Hagensby Jensen, Enrique Encinas, Yolande Strengers, Christian Dannesboe, Erik Kruuse, Jesper Skovby, Marcus Bach, Patrick Tietze, and Simon Christensen. 2023. Provotyping Accountability: Exploring Smartphone Use in the Home through Design. In *PRE-PRINT VERSION FOR Designing Interactive Systems Conference (DIS '23)*, July 10–14, 2023, Pittsburgh, PA, USA. ACM, New York, NY, USA, 15 pages. <https://doi.org/10.1145/3563657.3596024>

## 1 INTRODUCTION

The smartphone is an essential part of contemporary everyday life. These ubiquitous and user-friendly devices allow people to consume digital content everywhere and at any time. People use their smartphones for a plethora of practices, such as to communicate and socialise with others [30, 53], seek entertainment [89], find solitude [15] carry out work tasks [41], or relax and de-stress from busy family life [1]. At the same time, the use of cognitive interaction design techniques, like digital nudging [50, 76], has increased the time people spend on their smartphones [83, 84] making “checking your phone” a pervasive routine performed throughout everyday life [74], impacting how people engage in social gatherings [55, 71].

In this paper, smartphone use is conceptualised as the act of operating a mobile device with advanced computing capabilities for a multitude of reasons. Smartphone use may include making phone calls, sending and receiving text messages or emails, browsing the internet, using social media, taking pictures and videos, playing games, listening to music, and accessing various tools and apps. While there is a longstanding HCI research tradition that engages with improving design and evaluation efforts that facilitate the creation of desirable and personal user experiences for the smartphone [43, 50, 92], recent research finds that people are increasingly concerned about smartphone use and its impact on social relationships [9, 18]. The home has, in particular, become a contentious site for people's smartphone use in the presence of others [60]. As family members use their smartphones in many shared spaces in the home, like the kitchen, living room, and bedroom, different expectations arise regarding when and how the smartphone should be used

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DIS '23, July 10–14, 2023, Pittsburgh, PA, USA

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ACM ISBN 978-1-4503-9893-0/23/07...\$15.00  
<https://doi.org/10.1145/3563657.3596024>

[41, 73]. Consequently, how expectations of smartphone use are negotiated between family members shapes household dynamics and amplifies emergent tensions, particularly between parents and children [6, 18, 44, 60]. We also see HCI and Interaction Design research engaging with emergent tensions related to smartphone use. In this line of work, design research endeavours often frame smartphone use as an individual behavioural problem [44, 45, 51] to be solved by suggesting “good” and “bad” smartphone behaviours through design [26, 34, 42, 67]. Yet, little attention is given to design explorations that encourage alternative and critical viewpoints of how the use of digital technology (and smartphones) can play a role in future everyday life [12].

In this paper, we approach emergent tensions related to smartphone use differently. Instead of framing smartphone use as an individual behavioural problem, we aim to design alternatives that trigger families to reflect on smartphone use as an engaging social, shared responsibility that can be approached through reciprocal care [2]. To this end, we present a pedagogically-embedded Research through Design study [82, 93] aiming to explore alternative ways of designing that provoke discussions and reflections on routinised smartphone use in the home. In particular, our Research through Design process involves a *provotyping* study [56] where we designed and deployed provotypes, design artefacts — digital or physical — with the goal to provoke discussion among different types of users and stakeholders [88]. As *provotypes* [3, 37, 62, 69] expose and embody tensions [8], we engage with provotyping to cultivate emergent tensions surrounding current smartphone use in the home as a way to make these visible through engagement with different forms of accountability [24].

To frame accountability in this study, we draw on Garfinkel’s concept of *breaching experiments* [27], which are studies designed to trigger and disrupt socially shared expectations of everyday practices “so as to make them visible-and-accountable” [24]. To progressively explore different forms of accountability through design, we designed three provotypes (named Gossiper, Smardio and Tempus). Gossiper facilitates forms of individualised accountability by gossiping about smartphone use in the home. Smardio (smart radio) explores competitive accountability by broadcasting ambiguous radio segments on smartphone use throughout the day. Tempus (temporal usage) encourages collective accountability by presenting internet access in the home as a shared and limited resource.

To study the implications of the provotypes, we deployed the designs with seven families (26 participants). Gossiper was studied with one family for a week, while Smardio and Tempus were studied with three families each for a month. Building on reflections from the participants, we present findings on how each provotype accounts for smartphone use in the home. Those reflections reveal how cultivating emergent tensions [87] surrounding smartphone use form new understandings of shared family practices, e.g., eating, cooking, watching television, and playing games together. Further, our findings highlight that shared family practices may still involve digital devices in future practices. Nonetheless, by making ‘the use’ of such devices accountable through design, we show that alternative and more sustainable approaches [12] provide ways of exploring how design may shape digital technology use in a more

caring and collective way. Finally, we discuss the broader implications of how accountability and provotyping can be used in HCI for steering design towards more collective and sustainable practices.

## 2 RELATED WORK

### 2.1 Problematising Smartphone Use

The smartphone has become an indispensable ubiquitous computing device in everyday life [17]. To capture “smartphone use” in this paper, we view people’s use of such devices as the practice of engaging with digital elements that fulfil personal or social needs [53], such as communication [53], entertainment [89] and work [41], taking place within the family home [60].

Designing for desirable mobile use is also a key aspect in HCI research [43], as one success criterion of interaction design is the design’s ability to encourage continuous use [75]. This metric of success can also be found in interactive smartphone design. For example, the “successful” design of smartphone push notifications [50, 54, 91] and digital nudging [76] aims to keep users constantly engaged with digital content. Such design techniques greatly influence people’s smartphone use. For instance, Sas [74]’s study measured smartphone use among millennials and reports that over 60% of the survey participants use their smartphones between two to seven hours daily and check their smartphones every hour. In extreme cases, excessive technology use patterns resemble drug abuse [89]. In such cases, the smartphone is often used to regulate moods and transition from stressed to relaxed states [15].

Despite a continuous focus on creating desirable, personal mobile experiences [43], research has found that a sense of guilt often accompanies smartphone use in social settings when social expectations of refraining from use collide with the allure of extremely user-friendly interfaces and notifications. For instance, Hiniker et al. [35]’s study of caregivers at the playground highlights that adults’ smartphone use is a significant source of guilt in caregiving situations. These adults engage in systematic and specific use and non-use behaviours as a strategy to compensate for these feelings. Derks et al. [14] observe that adults feel that they are always expected to reply to work-related messages or emails; thus, boundaries of work-life and family-life intertwine. Similarly, Aranda and Baig [1] studied the dynamics of excessive smartphone use and feeling disconnected, finding that embedded in the design of mobile technologies lies an expectation that reinforces a social obligation to always be digitally present. This expectation of being both digitally and physically present contributes to what Southerton [81] refers to as an increased social sense of feeling harried and ‘time squeezed’.

The home has, in particular, become a place where emergent tensions arise regarding smartphone use. Both Aranda and Baig [1] and Bruun et al. [9] highlight that individuals often use smartphones to relax together with the family at home. However, Oduor et al. [60] observe that smartphones cause frustrations when family members are socially intimate and engage in non-urgent activities on their phones. Similarly, Salmela and colleague’s [73] study of smartphone use in the bedroom reveals that the intimacy in couples’ bed-sharing practices is shaped by smartphones taken into the bed. Others argue [6, 18] that smartphone use introduces tensions in modern family life, as adult and adolescent expectations of smartphone use are often misaligned and continuously negotiated.

## 2.2 Designing for Reduced Smartphone Use

As a result of the complexities involving smartphone use and the problems arising from negotiating the multiple and heterogeneous practices that make it possible, many people using smartphones in their everyday life are interested in reducing the time and attention they pay to their devices [34, 51].

One approach to design for reducing smartphone use is to view this as an individual behavioural problem. HCI and Interaction Design research includes studies showing that many families adopt strategies and rules to limit smartphone use [18, 60] and, in turn, research in HCI also provides design solutions that restrict the use of smartphones in a family setting [9, 34, 44, 51]. Here, the diametric framing of individualised “good” or “bad” behaviours is a seemingly aspirational design approach. For instance, Löchtfeld et al. [51]’s study of AppDetox highlights how users of this app primarily create rules to limit the time they spend on their smartphones for messaging and social media, as people designate the use of these apps as “wrong” and “bad”. Hiniker et al. [34]’s MyTime supports smartphone non-use, making participants willing to reduce their time with the apps they feel are a ‘poor’ use of time. Similarly, Ko et al. [44] developed “FamiLync” to explore limiting strategies in a family. The app provides a way to view one’s smartphone usage and encourages non-use by allowing the user to set limiting goals encouraging the entire family to cooperate in limiting smartphone use that motivates both parents and children.

Smartphone use not only influences intimate family practices – it also has complex and hidden implications for climate change and sustainability. For instance, Hazas et al. [32] illustrate how growth in data traffic across the Internet increases electricity consumption, while Røpke et al. [72] exemplify similar sustainability implications of family members using multiple devices at the same time. Preist et al. [68] complements this by demonstrating the CO<sub>2</sub> impacts of people streaming video content on their smartphones. However, viewing problematic resource consumption (e.g., sustainable effects of smartphone use) as a design case for individual behavioural change has been critiqued, particularly within sustainable HCI [36, 47, 65, 86]. In this line of research, scholars argue that reducing consumption and technology use through design should involve alternative design imaginations that go beyond the diametric framing of individual “good” and “bad” behaviours [10, 12, 37, 48].

Inspired by alternative design visions of minimalist technology use, sustainable resource use, and simple living [36, 39, 48, 90], we turn to alternative ways of framing design to minimise smartphone use through a practice lens [49]. A practice-oriented perspective is advocated in HCI as a complementary and critical lens to understand the relationship between humans, computers and patterns of use [7, 10, 48, 49, 65, 86]. By studying the practices of everyday people rather than focusing on individual behaviours, scholars propose that theories of (social) practice can offer insights into collective socio-material action and use patterns that result from socially shared activities [80]. Thus, practice can be framed as routinised performances of meaningful, desirable and socially-identifiable activities, like cooking, cleaning, and eating. Challenging smartphone practices through design can also serve research aimed at gaining a deeper understanding of how design may shape the practices that facilitate, inhibit and sustain smartphone use in everyday life.

## 2.3 Provotyping and Accountability

Bringing practice theory into HCI and design, Kuijer and colleagues [46–48] argue that by making practice an active ingredient in design, prototyped designs can be catalysed to trigger and provoke practices towards more desirable ways of doing. Likewise, Ozkaramanli and Desmet [62], Vines [88], Bardzell et al. [3], Boer and Donovan [8], and Jensen et al. [37] show that provocation through design may be used as triggers that challenge the status quo to expose assumptions and stimulate critical reflective discussions. These studies share the notion that design should be strange and de-familiar [4] to provoke, but not so extreme that it could potentially be rejected from use in everyday life.

Along this line, Mogensen proposes the notion of *provotyping* [56], drawing on both prototyping and practice perspectives. Mogensen argues that unlike the aim of prototyping activities (directed towards the future without considering current practice), a provotype’s goal is “to expose tension and problems in current practice; to provoke discrepancies” to provoke reflections on current practices to explore how possible future practices can be performed [56]. Thus, provocations can be understood to happen via concrete experiences of everyday people and their performances of everyday practices.

Provotyping shares many similarities with Garfinkel’s “breaching experiments” [27], where social norms are explicitly violated to learn from people’s responses to such disruptions. By “asking what can be done to make trouble” [27], these provocative “experiments” can also be viewed as triggers to the routinised, well-known, and socially shared expectations, by making the familiar “visibly-rational-and-reportable-for-all-practical-purposes, i.e. ‘account-able’, as configurations of everyday activities” [24]. As Crabtree [13] notes “construed of as a provocational rather than a disruptive procedure, breaching experiments have clear parallels with provotyping, where technological innovations ‘trigger’ cooperative analysis of practice and elaborate the design space” [57].

Positioned in this way, provotyping can be viewed as the staging of familiar practices, through which the problematic is made visible by design and the experience is rendered “account-able”. In this sense, provotyping can be understood within the tradition of Research through Design in HCI, as provotypes are the chief elements in the process of generating and communicating accountable knowledge [82, 93].

## 3 RESEARCH DESIGN

We frame our study as Research through Design (RtD) [23, 28, 82], where we engage with provotyping [8, 56] to explore different forms of accountability progressively by making the problematic, routinised smartphone use embedded in everyday practices visible for family members [24, 27]. Thus, our provotypes should be seen as critical design alternatives [3, 20–22, 62] that problematise existing smartphone practices in the home, rather than solutions to these problems. Our starting point is the notion that smartphone use can result in individual patterns of use [9, 60, 61], both in terms of time spent on the phone [74, 83] and data consumed [68] that might hinder or disrupt meaningful familiar engagements in domestic settings. In the remainder of this section, we outline the details of our research design for conducting this study.

### 3.1 A Pedagogically-embedded RtD Study

In line with our approach to research, we here outline the pedagogical context that both constrained and enabled our research process. The research presented in this paper is the result of a fruitful and extensive collaboration between students and their supervisors. Authors 4 to 9 were Masters students in a software engineering program in a Danish university specialising in HCI. They were supervised by authors 1 and 2 during their one-year thesis project work. Author 3 provided mentorship and guidance in the process of bridging between pedagogy and research toward an original and relevant research contribution to the field of Interaction Design and HCI.

Our study comprises an open-ended field deployment study of the three provotypes (see fig. 1). The first provotype, *Gossiper*, was deployed for one week in one home. The other two provotypes, *Smardio* and *Tempus*, were deployed for a month in six different homes (three homes each). These disparities were a consequence of both the pedagogical demands that the students needed to satisfy and the empirical demands of exploring practices of smartphone use in the home. More specifically, *Gossiper* was designed as a pilot study and the students' first attempt to: test the technology underpinning the design artefacts (*design*), explore how family practices of smartphone use can be triggered and studied by means of provotypes (*research*), and familiarise themselves with the nuances of doing research through provotypes (*pedagogy*). After the experience gained with *Gossiper*, *Smardio* and *Tempus* were deployed under similar, more robust and comprehensive conditions, each building on the learnings from the previous provotype.

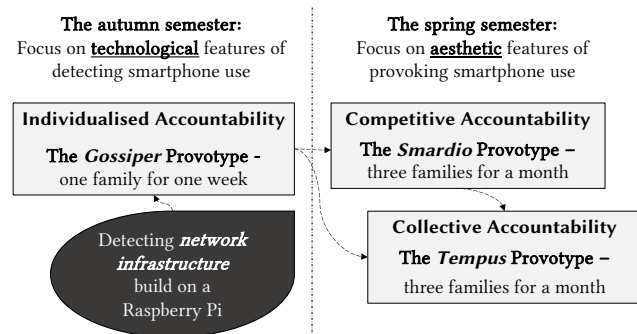


Figure 1: Timeline of the progressive development of forms of accountability and deployment of three the provotypes.

### 3.2 Accounting for Smartphone Use in Design

All provotypes share the same functional purpose of exposing family members' smartphone usage in the home. To capture and measure smartphone use in the home, we developed a specific network infrastructure to detect when a smartphone is in use. Most smartphone use is associated with apps that rely on a connection to the internet [51, 83]. Thus, we developed a software solution capable of analysing the provenance of internet packets sent over a household's network. We set up a Raspberry Pi as a routed wireless access point connecting all participants' smartphones to our network infrastructure. In this way, we monitored how much data and

how long specific smartphone devices were in use. We used this network infrastructure in the development of all three provotypes. Nevertheless, each provotype is different, both aesthetically and technologically, because the insights gained after the deployment (and subsequent field study and data analysis) of one provotype informed the design of the next (see fig. 1). The first provotype was designed in the European autumn semester, focusing on technological features, while the second and third provotypes were designed in the spring semester. The third provotype was being developed while the second provotype was deployed. We did so in order to explore how provotyping may render forms of accountability of smartphone usage in the home by making routinised smartphone use visible through three design iterations, one per provotype.

The first provotype, *Gossiper*, conceptualises and materialises problematic smartphone use through what we frame as *individualised accountability*. Here we consider smartphone use as an individual activity and responsibility. To frame this form of accountability, *Gossiper* was designed to report (gossip) whenever a smartphone is in use within the home.

In the second provotype, *Smardio* (a portmanteau of the words smart and radio), we consider problematic smartphone use as a form of *competitive accountability* where individual smartphone use is accounted for as competitive and yet joyful activities shared among family members. To create this form of competitive and joyful accountability, we designed *Smardio* to broadcast ambiguous daily radio segments that at times promote and also discredit smartphone use to different degrees.

Finally, the third provotype, *Tempus*, does not identify, publicly or otherwise, smartphone use by any single family member. Instead, this provotype distributes accountability among all family members by presenting internet access as a shared and limited resource. Here, we consider smartphone use as a family activity and responsibility – as a form of *collective accountability*. To this end, *Tempus* (a portmanteau of the words temporal and usage) is designed to decrease the network quality (lowers the download and upload data transfer speed) of the home's internet connection whenever a family member uses their smartphone in a shared setting.

### 3.3 Field Deployment Study

We conducted an explorative field deployment study to gain in-depth insights into how the three provotypes and their forms of accountability might provoke different practices within complex family constellations. To this end, each provotype was deployed in the home of different families in an effort to obtain insights into 1) how participating family members reflect, improvise and perform old and new routines when provoked about aspects of smartphone accountability, and 2) how the encouragement accounting for smartphone usage may shape new and different meanings of family practices.

**3.3.1 Participants.** We involved 26 participants from seven families living in Denmark (see Table 1) in this study. *Gossiper* was deployed with family One. *Smardio* was deployed with family Two, Three and Four, and *Tempus* with family Five, Six and Seven. We invited families with children still living at home (Elias from family five visited the parents' home 2-3 times a week), between the ages

**Table 1: Description of the seven participating families.**

Family	Anonymous name	Gender	Inter-viewed	Age	Occupation	Provotype
Family One	Gunnar	male	yes	31	Software consultant	Gossiper
	Maria	female	yes	30	Adult student	
	Caroline	female	yes	11	School	
	Dennis	male	no	8	School	
	Eric	male	no	1	Home childcare	
Family Two	Frederikke	female	no	0	Home childcare	Smdario
	Kristen	female	yes	61	Librarian	
	Peter	male	yes	68	Retiree	
Family Three	Mathilda	female	yes	21	Postal worker	Smdario
	Christine	female	yes	44	Bio-chemist	
	John	male	yes	45	Bank consultant	
	Laura	female	yes	17	School	
Family Four	Otto	male	yes	14	School	Smdario
	Carlos	male	yes	28	Software consultant	
	Simone	female	yes	26	Lawyer	
	Terry	male	no	3	Kindergarden	
Family Five	Anna	female	yes	52	Stay-at-home spouse	Tempus
	Thor	male	yes	51	Program manager	
	Elias	male	yes	24	Adult student	
Family Six	Betty	female	yes	51	Shop assistant	Tempus
	Egon	male	yes	50	Self employed	
	Ella	female	yes	15	School	
	Alberte	female	yes	12	School	
Family Seven	Sinne	female	yes	49	Social assistant	Tempus
	Hugo	male	yes	51	Military serviceman	
	Klara	female	yes	19	School	

of 0 and 24. The participants were recruited through our social networks. We chose to study smartphone use in families with children as they represent complex family constellations, with rich social-shared values regarding technology use within the home [14, 60]. Additionally, prior research indicates that such families represent situations: 1) where strategies and rules for restricting smartphone use are commonplace [6, 18]; and 2) where family members tend to implicitly agree that using the phone during a collocated social exchange is problematic [1, 9].

**3.3.2 Data Collection and Analysis.** Each provotype deployment consisted of a pre-deployment interview and a post-deployment interview. These activities were conducted by the Masters students (authors 4-9) under the guidance of the supervisors (authors 1 and 2). In the first pre-deployment interview, questions explored the family’s routines, understandings, and potential rules and tensions regarding smartphone use at home. After the first interview, we set up the provotype in a central, shared location decided by the family members. We explained general functionality during this setup, and participants were allowed to ask general questions about the provotype and the study. In the post-deployment interview, we asked the participants to reflect on their experiences living with the provotype, including reflections on their smartphone usage, activities performed together (with and without their smartphone), how they experienced the provotype (individually and collectively), and if and how the provotype influenced practices. During the deployments, we asked participants to share relevant photos with us. We also logged relevant smartphone use detected on the network infrastructure we set up as part of the design of the three provotypes. This data logged the amount of time, who, and when individual participants used their smartphone on the network.

In total, 22 of our 26 participants engaged in qualitative interviews, including all 14 parents and eight children aged 11 and above. We conducted 14 semi-structured interviews led by an open-ended interview guide [63]. The interviews were conducted in participants’ homes and included both parents and children to encourage

discussion among family members. All participants signed consent forms (parents signed for their children under the age of 18), and our study complied with the ethics requirements of the lead authors’ university. Both the pre- and post-interviews were audio-recorded and transcribed, totalling 12 hours of transcribed audio.

To present the participants’ accounts with the provotypes, we performed an inductive thematic analysis [77] of all the transcribed interview data, photos shared with us under the deployments, and data logs detecting smartphone use on our network infrastructure during each of the deployment. The insights from each deployment were used to inform future design decisions progressively, along with approaches outlined in related work. Our analytical approach is framed through Garfinkel’s “breaching experiments” [27] and practice theory [49, 65, 80]. Accordingly, we report on the participants’ rendered “account-able” experiences, and how those were made visible and accountable by the three provotypes. As a result, we see the three provotypes serving as Research through Design elements where participants were able to be held or hold someone else accountable for smartphone practices performed within the home. This framing diverges from analytical frames that implicitly assume desirable and preferable individual smartphone use and allows us to explore a range of participant responses and shared experiences through and with the provotypes. To this end, we also draw on Kuijer et al.’s [48] conceptualisation of making practices a unit of design to further explore the potential for the emergence of alternative (and likely preferable) smartphone practices.

We present the three provotypes and field deployments in the following three sections. First, we describe each provotype’s conceptualisation and design of accountability. We then report our findings on how each provotype was experienced and influenced family practices of smartphone use.

## 4 THE GOSSIPER PROVOTYPE

We purposefully designed Gossiper to cultivate tensions surrounding smartphone use in a family setting, not by artificially limiting functionality, as most examples in the literature demonstrate [9, 42, 45, 51], but through the use of gossip happening in a social setting. We considered that using the smartphone in a family setting may be considered a breach of normality as recorded in other research work [18, 35, 60]. Exposing this breach (through an explicit public disclosure in the form of gossip), our intent was to stage a form of accountability that rests entirely on the individual using the smartphone, although accountability is shared in a collective space. Using gossip as a reflective device was inspired by Dunbar [19]’s concept of gossip as a mechanism for bonding in social groups to create reflection on various practices.

### 4.1 Designing Individualised Accountability

Gossiper is a provotype that gossips about smartphone use to spark reflection among family members. It consists of two dolls facing each other, seemingly gossiping about the phone use of those around them (see fig. 2). We decided to embody the act of gossiping in two dolls to playfully attract the attention of both parents and children in the family, aimed neither to make it too strange [4] nor too scary for children. We hid all technology (see fig. 2) in a white wooden box to blend in with the family’s white walls.





**Figure 2: The Gossiper provotype. Left image: Hardware outside the box. Middle image: Hardware inside the box. Right image: Final provotype deployed in the kitchen of family one.**

Gossiper is designed to detect whenever a family member uses their smartphone. Whenever smartphone use is detected on the network, Gossiper announces which family member uses their smartphone through audio messages. These messages are designed as pre-recorded conversations between the dolls that include the name of the family member using their smartphone, e.g., *Doll 1: "Hey, have you heard?" Doll 2: "What?" Doll 1: "Gunnar [participant using their phone from family one] could not find the motivation to put his smartphone away. Doll 2: That's just bad!"*. The gossip is played through a speaker with two different voices to sound like two different entities, represented by an artificial female and male voice. This means that the two dolls gossip about a participant's smartphone use without family members directly influencing when and how the gossip conversation is performed. This design decision leaves the participants as observers or targets of the gossip. We aimed to invite the participants to curiously listen and "eavesdrop" on the conversation by not directly involving them and instead letting the artificial dolls gossip about them.

Gossiper was deployed in a family of six (family one) for one week. The family decided to place Gossiper in the kitchen on top of the microwave (see fig. 2). This placement ensured that it was out of the toddler's reach, that no wires were run through the room, and that when the family was gathered, it would be near Gossiper. Gossiper ran on a precise schedule each day (17:00 to 20:30 on weekdays and 14:30 to 21:30 during the weekend) agreed upon with the participating family. Participants could turn off Gossiper for 30-minutes whenever a participant decided to have a gossip break.

## 4.2 Experiencing Individualised Accountability

Our findings illustrate that Gossiper managed to stage different accounts of smartphone practices, provoking reflections on smartphone use and family time. The following insights address the most salient aspects of expectations of smartphone routines in the home, shaping the progression of our study and future design decisions.

**4.2.1 Family time is fluid and influenced by smartphone use.** Our participants explicitly acknowledged how Gossiper influenced their actions and sparked reflections on their individual smartphone routines. Maria reflected: "At first, when it started [to gossip], I was pretty quick to turn off [the phone]", occasionally finding alternatives to using her phone: "I will not listen to this [Gossiper] anymore. The

TV will have to do for now". At the end of the deployment, Gossiper's constant gossip triggered the parents to reflect and account for their smartphone practices even before use had taken place: "It got to a point in time where I got so used to it [gossip], that I thought about it [the consequences], before using my phone" (Maria, F1). Gossiper also made the family reflect upon the time they spent together as a family. Maria mentioned that the family considered dinner a special time, as this was the first time they were all together during the day. Family time, however, was not restricted to a set of daily time frames. Instead, they gathered the children for certain activities, considered as family time, as Gossiper made them consider that "... it would be worthwhile not to use our phones after dinner time, but be together about other things" (Maria, F1).

**4.2.2 Feeling the room before using the smartphone.** Maria described the act of pulling out her smartphone while interacting with others as rude and stated that if she wanted to use her smartphone in a social setting, she tried to "feel the mood in the room". Hence, she would try to account for whether using the smartphone in a particular social setting was socially acceptable. Gossiper also engaged the children, as Maria mentioned how the two oldest children, Caroline and Dennis, had asked her: "are you doing something you are not allowed to? What is it?", and how Caroline had jokingly said: "Yeah, maybe you should not use your phone that much".

**4.2.3 Gossiping can be too provoking.** Gunnar understood Gossiper's two dolls as an exclusive social circle that intentionally excludes family members from participation: "I think it mimics, in a false way, a depiction of a social gathering that you are excluded from". Maria and Gunnar were explicit in voicing their discomfort with this situation: Gunnar wondered "Is it not a little hostile?" and "When they are two doing it [the gossip], then it feels a little more like a two-against-one feeling, than if it was a single entity saying: 'I see you using your phone'". Maria was more descriptive in her critique: "But it is also a bit annoying, irritating, and judgemental, sometimes. So you can get a little mad at it". At one point, Gunnar's annoyance with the continuous gossiping led him to pause Gossiper: "It might be because I was a little tired, as it was getting late. It made a lot of background noise, and I just had to stop it".

These findings highlight that staging accountability as individualised gossip may spark reflection but is experienced as annoying and uncomfortably provocative for the family.

## 5 THE SMARDIO PROVOTYPE

Gossiper’s deployment revealed how the concept of family time is fluid and influenced by the use of smartphones in a domestic context. It also alluded to the processes at play when considering whether smartphone use is socially acceptable at a given moment (what participants referred to as “feeling the room”). Further, it highlighted how designing to foreground individualised accountability can make participants feel annoyed and uncomfortable.

We carefully considered these insights in the design of our second provotype. With Smardio, we moved away from firmly promoting and fully restricting smartphone use and instead took a more ambiguous stance. Smardio was designed to spark shared family reflection by broadcasting ambiguous “radio segments” throughout the day in a shared family space. The radio segments were mainly designed to feature smartphone research, as described below. In addition, competitive accountability was staged by broadcasting a daily news segment accounting for individual members’ smartphone use and comparing it to other family members’ usage. We built three Smardios, and each one was deployed simultaneously in the homes of three different families for one month.

### 5.1 Designing Competitive Accountability

Smardio is an antique vacuum tube radio that broadcasts content related to smartphone use (see fig. 3), a design inspired by Gaver et al.’s Energy Babble [29] and Feltwell et al.’s [25] Spkr. The radio content was designed according to three common categories of radio broadcast (breaking news, advertisements and a daily overview). For each category, we intentionally designed segments advocating i)

the use of smartphones, ii) restricting use, and iii) more ambiguous perspectives between these two extremes. We designed Smardio this way to stage a confrontation between our participants and the views stated in the radio segments, hence revealing practices shaped by smartphone use [16]. In all, we designed 50 segments (30 advertisements and 20 breaking news) with a duration averaging one minute. The breaking news was designed as joyful voice lines reporting on current research findings involving smartphone use in a journalistic fashion. As an example, we used the results from Rondoni et al. [71] as inspiration to craft a radio segment that reports on the negative effects of smartphones on social interactions with friends (see fig. 3: (1)). The advertisements relied mainly on humour as a design strategy [33] to provoke reflection around smartphone use. An example of such an advertisement broadcast is the fictional product “We-Sell-Radios” (see fig. 3: (2)).

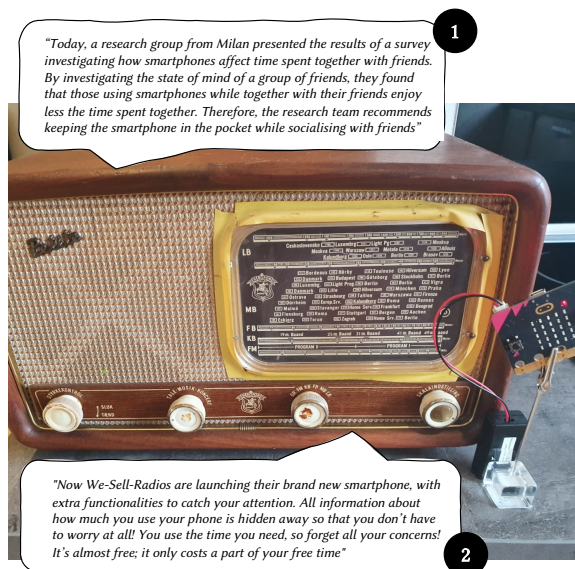
At the end of each day, Smardio also broadcasts a daily ranking positioning family members according to how much time they spent on smartphones in the past 24 hours. We were inspired by daily weather forecasts and how the ephemerality of their radio format might result in a sense of urgency that encourages the family to listen to this segment together. The segment ranks participants once a day, at a designated time. 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. Since Smardio’s “first place” (normally considered “the best”) depicts the family member using their phone the most, being ranked first place by Smardio, might actually be associated with something negative. Hence, Smardio accounts for a competitive predicament. Do participants pursue first place (the main reason why the combined usage is increasing), or do they lower their individual use and aim for last place?

### 5.2 Experiencing Competitive Accountability

The three Smardios were deployed in shared family spaces, determined by the participating families (see fig. 4). The following themes extend lines of enquiry first uncovered by Gossiper’s deployment (i.e. how smartphone use influences family time and how one “feels” the room to decide if using the smartphone is appropriate). Each theme below describes our participants’ experiences and reflections as a response to Smardio’s staging competitive accountability.

**5.2.1 Smartphone use is questionable if others are co-located.** Most participating families in this deployment described smartphones as an indispensable tool. However, all families that participated seemed to implicitly agree that using the phone during a co-located social exchange was problematic (as illustrated by others [9, 18, 30, 35, 54, 60]). Some also described feelings of guilt when using their smartphone, particularly in the presence of small children: “When I am watching Terry (Simone’s son), 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, F4).

For teenager Laura from family three, feelings of annoyance emerged when others were using their phone in her company. Furthermore, Smardio sparked reflections on her own smartphone



**Figure 3: The Smardio provotype. The smallest of the three Smardios in assembled form. 1) A radio news segment reporting on the negative effects of smartphone use, based on research results reported in [71]. 2) A humorous radio advertisement of a fictional product, “We-Sell-Radios” promoting smartphone use.**





**Figure 4: Smardio at home.** Left image: Family two placed their Smardio on a seat next to a bookshelf, within close proximity to their dining table. Middle image: Family three placed their Smardio on a small wooden bench next to their dining table, in a highly visible place. Right image: Family four placed their Smardio on the kitchen counter facing their dining table.

use when together with 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, F3).

Others argued that smartphone use in a social context is impolite “I think it is naughty and rude to opt-out of the social interaction, and concentrate on one’s smartphone”, (Peter, F2), or even seemingly absurd when combined with other activities (in this case, outdoor activities): “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, F2).

**5.2.2 Smartphone “feeling” before smartphone “using”.** In line with our findings from Gossiper, our participants agreed that using smartphones in a social context has become commonplace, but using the smartphone in a social setting seems to be preceded by an appraisal of the context in order to interpret whether smartphone use is socially acceptable. For Christine from family three, Smardio encouraged reflection in this regard: “[Smardio] is stirring the evolution of how proper smartphone ethics are developed. What is legal, what is not legal”, (Christine, F3).

Simone (from family four) described that using her smartphone while interacting depended on a form of group 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, F4). Searching for group consensus echoes similar reflections accounted for by Kristen: “If we see others around us using their phones, then we are drawn to our own [smartphones]”, (Kristen, F2).

**5.2.3 Resisting smartphone use.** Our participants accounted that in many situations, smartphone use stems from what seems like a practical need but it quickly takes up more time than intended: “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, F3).

For some participants, resisting use was not an easy task. Yet, Smardio’s broadcasts sparked reflections on smartphone use when socially together with others: “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 theirs, I had to be stubborn and say to myself, ‘do not use your phone here’” (Christine, F3).

Smardio’s ranking broadcast invited participants to account for the time they spend on their smartphones and, by extension, on whether a particular situation was conducive to it or not: “[When the daily overview started] we came running down the stairs”, (Simone, F4). Broadcasting this radio ranking daily, participants felt that they were competing with each other to achieve the lowest rank of smartphone use: “It created a spirit of competition, in the way that [Smardio] reads out [the rankings]” (Kristen, F2).

Being held accountable through family competition brought on personal reflections on how the smartphone was (not) used to stay competitive. Simone from family four, and Mathilda, the grown-up daughter from family two, described how they fought to maintain last place. Mathilda described this: “It has been a fight to stay in the last place, but I have been lucky to do so the entire time. Like okay, I did it yesterday, and I will try again tomorrow and the day after tomorrow” (Mathilda, F2). As the rankings were experienced as competitive endurance, it resulted in episodes where smartphone use was resisted for the sake of other practices involving family members. For instance, Christine from family three reflected that: “At the start, 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, 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 others in the living room, where I would normally look at my phone” (Christine, F3).

## 6 THE TEMPUS PROVOTYPE

In the final iteration, we frame collective accountability by conceptualising access to smartphone data as a shared family responsibility. When designing the Tempus provotype, we were inspired by visions

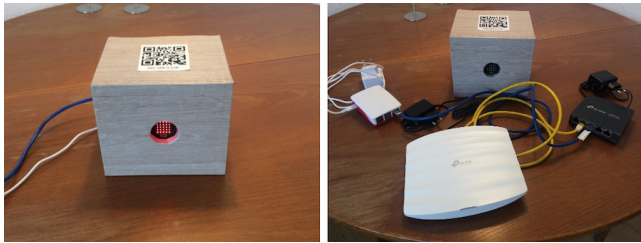
from sustainable HCI using design to trigger resource-intensive practices [39, 48] and how designing may foster caring practices [2, 70] that views the design and collective use of digital platforms and infrastructure as limiting resources to be cared for.

Towards this end, we designed Tempus to reconfigure access to the internet and smartphone data within the home as a shared but limited resource for all members of a family. When a family member uses their device in the presence of other family members, the network quality decreases (access to the internet is experienced as “slowing down”) for the entire family. Since family members can impact the quality of the family’s network, the internet becomes a shared resource as they now have to consider their own and others’ (smartphone) needs. We used the field study to explore participants’ practices, reflections and challenges when the internet becomes a limited resource. To this end, we built three versions of Tempus and deployed them simultaneously with three families for one month.

### 6.1 Designing Collective Accountability

Tempus consists of three parts: a physical object, a controlled WiFi (see fig. 5: right image), and a web interface. The physical design is a wooden box with a LED display (see fig. 5: left image). We designed the wooden box to look minimalistic and fit into the participants’ homes as part of the decoration. The LED display is a Micro:bit that consists of a 5x5 array of LEDs connected to a Raspberry Pi that runs the software of Tempus. The LED display represents the current network quality. Tempus lowers the network quality if any family members use their smartphone at the same time and next to Tempus. When all 25 LEDs are turned on, it represents the best network quality, and for every fifth LED turned off, the network quality worsens.

To restore network quality, the members of the family are asked to document their engagement in a family activity by uploading a picture of the activity to a purposefully designed website. Tempus hosts the website on the local network, which means that it is always available even when network connectivity is blocked. The website provides two functionalities: 1) families can upload a picture to increase network quality, and 2) see a gallery of uploaded pictures. The families also add a description of the uploaded photo. Tempus does not verify whether the uploaded practice depicts a shared family activity; it is left for the family to determine. We designed it



**Figure 5: The Tempus provotype. Left image: Tempus with hardware hidden away. 25 LED’s illustrate the quality of the network, while the QR code brings the families to a website where they can restore network quality by uploading a picture of them doing a family activity. Right image: shows Tempus with the Raspberry Pi, switch, and access point.**

this way, to further visualise the idea of internet access as a limited resource and caring for network quality is a shared responsibility.

In common with Gossiper and Smardio, Tempus encourages moderation in smartphone use. Still, in contrast with the other provotypes, it only does so when two or more family members are together and without publicly acknowledging anyone in particular. Thus, Tempus conceptualises and materialises problematic smartphone use as *collective accountability*.

### 6.2 Experiencing Collective Accountability

Each family choose a frequented site, such as the living room or the kitchen, as the space to deploy Tempus. Our findings show that Tempus was instrumental in revealing practices resting on forms of accountability that derived from collective responsibility. Access to the internet as a shared and limited resource had important implications for how each family member used their smartphone and this was negotiated with the rest of the family members. The deployment of Tempus complements and expands the findings from Gossiper and Smardio with the following themes.

**6.2.1 Performing family time.** The participating families mentioned that unspoken rules and expectations already existed to regulate smartphone usage. However, most participants stated that smartphone use during family time felt wrong or counter-intuitive. The few participants who used their smartphones in moments mentioned that it was because of work or similar ‘important’ matters. This echoes findings of others [1, 9, 14].

Nevertheless, partaking in conserving Tempus’ network quality was experienced as a novel approach to account for smartphone use by all the participating families. Each addressed the conservation of the network resource as a joint family task, and taking pictures became part of their daily routines. Yet, how each family maintained the network quality involved different practices. When family six saw that too many LEDs were missing, they did an activity together, uploaded the pictures shortly after, and both adults and children had fun doing so: Egon: “We had fun with it”. Betty: “You had a lot of fun”. Egon: “That was also something we did together” (Betty, F6).

In comparison, family five and seven focused more on taking pictures whenever they did something together and uploaded them when they needed to improve their internet access. Another approach chosen by families five and seven was to plan ahead. If the families knew that someone would need internet access later, they uploaded a picture so the person could use their smartphones without disturbances. Finally, family seven reflected much on reducing their smartphone use to help conserve LEDs, as described by Hugo: “I certainly had a focus on it. I have not always. . . yeah, I have certainly thought about it many times - trying to conserve the dots [LEDs] a little” (Hugo, F7).

**6.2.2 Limiting smartphone use as intimate, social “hygge”.** All families reported how Tempus inspired them to participate in shared activities that did not involve smartphone use. Family five and six, for instance, reflected that Tempus helped them invent new practices or engage in practices they had not done for a long time, for example, playing board games, as seen in (fig. 6: left image). Furthermore, family three described how Tempus increased their awareness of shared and meaningful activities. The most common



**Figure 6: Uploaded pictures with participants' descriptions of the intimate, family situations: Left image: (F5) "Still playing, who wins?". Middle left image: (F6) "Washing cloth". Middle right image: (F6) "Family hygge". Right: (F7) "Morning hygge".**

word in the participants' titles of the uploaded picture was "hygge", a commonly used word in Danish to describe desirable situations of intimacy, informality, belonging, and togetherness [5, 39]. Photos examples are shown in (fig. 6: Middle right and right images).

This further suggests that the families enjoyed engaging in these practices without using their smartphones. For instance, family five reflected on how they found alternative family activities that they could share and all enjoy. Thor: "That's really what we gather the most energy by [enjoying the outside in walks and talks]". Anna: "But it is also 'hygge' with these outside activities", Elias: "That's something alternative. Mum rarely bothers to play a game". This way of understanding how design may limit smartphone use but still foster joyful and meaningful experiences is novel and expands current research in this area. By purposely designing Tempus to provoke collective accountability, our findings illustrate that such triggers can shape new understandings of what meaningful experiences are when together as a family.

In family six, Tempus also influenced the children's practices with friends. Betty described how her daughter Alberte and her friend had to do other things than being on the tablet because of the network quality: "When you are a guest, and the network does not work, then you are not on the internet either, and you do something else together" (Betty, F6).

**6.2.3 Shared care practices mean less smartphone use.** That participants accounted for Tempus' LEDs suggests that they cared to maintain the network quality even when they did not experience reduced network quality. Thor from family five compared looking at Tempus to watching the weather forecast or looking outside to see if it is raining, referencing how checking for active LEDs became an everyday routine. Betty from family six even went as far as to compare it to a pet: "Imagine if the internet went out? Imagine if they could not do anything on it [the internet]. Yeah, I do not know; it is probably like an animal that needs feeding", (Betty, F6)

The participants joked with each other about their smartphone usage and who was responsible for lowering the network quality. During the interview, Klara and Hugo discussed who used their phone more during the evening, thereby removing LEDs. Klara: "Yeah, you are also good at sitting and using your phones during the evening. I am not alone in that". Hugo: "Yeah, but there are some who are better than others", (Klara, Hugo, F7)

Furthermore, participants believed that other family members used their smartphones less than before the study. Betty from family

six told a story where the children, Ella and Alberte, looked out the car windows during a family trip, whereas they would previously sit with their smartphones when the family drove somewhere: "[...] You used to use it [smartphone] in the car. That time we drove to [danish town], it did not even come out of the pocket. You looked out the window for once" (Betty, F6). Similarly, Anna from family five noticed her husband Thor's phone remained in his pocket when engaged in shared practices. "[...] You [Thor] did not pull out your phone when we played games, or when we sat on a bench and such. You do not pull it out like you used to do. So I actually think [Thor has used it less]", (Anna, F5).

## 7 DISCUSSION

Our critical-reflective and pedagogically-embedded study brings a complementary perspective to designing interventions indicative of future potential (and sustainable) design pathways [12]. We now discuss the implications of our findings for design researchers and practitioners in HCI.

### 7.1 Accounting for Smartphone Use through Provotyping

Our study aimed to spark reflections on smartphone use in family homes using a research through design study [82, 93] framed as provotyping [56]. While others have studied the consequences of smartphone use in the home [1, 18, 59, 60, 73], we approached smartphone use through a practice-oriented design lens [39, 46, 48, 49]. By staging particular forms of accountability [24, 27], we endeavoured to cultivate emergent tensions [87] in current smartphone practices, made visible through the design of three provotypes. Thus, our approach contrast most HCI design efforts, which tend to adopt design strategies that restrict smartphone use by focusing on individual smartphone behaviour [9, 34, 42, 44, 45, 51, 66].

Our study shows that our provotyping approach disrupted familiar smartphone practices in the home, through which the problematic was made visible by design and the experience rendered "account-able". The design and deployment of our three provotypes contribute to understandings on how staging accountability [24, 27] can provoke socially shared expectations in support of fostering intimate, fun and meaningful encounters. Our provotype study provides different clues and insights in this regard, exploring different forms of accountability, namely: individualised accountability designed through gossip, competitive accountability materialised as



ambiguous news segments, and collective accountability staged by positioning smartphone internet access as a limited resource which requires shared and caring responsibility to conserve.

The Gossiper and Smardio deployments illustrate that when individual smartphone use is exaggerated, gossiped about, or positioned as a competitive element, the reflectiveness of smartphone usage can foster collective family awareness that may be experienced as an annoyance but also as playful and joyful. Yet, more notably, our study further demonstrates that when accountability for smartphone use becomes a collective family responsibility, as staged by the Tempus provotype, smartphone use might be experienced as a caring practice. More specifically, as Tempus reconfigured internet access as a shared and finite resource, it reframed smartphone use and associated practice. Yet, how the participants engaged with these “restrictions” were often encountered with nurture and care. In particular, we see that thinking of care when designing for minimising resource use can bring about meaningful encounters – perspectives also reflected in other studies [2, 70].

Hence, our provotyping study shows that when people are provoked and removed from their comfort zone, we gain new understandings of current practices that facilitate, inhibit and sustain smartphone use. By progressively exploring forms of accountability [24, 27] as a provocative design device [56], we also gained insights into how minimised smartphone use is carefully negotiated through shared reflexivity, which in turn, may be performed as meaningful practices without the active use of the smartphone. Therefore, we find that by accounting for the problematic in current practices through provotyping is a compelling way to explore alternatives to technology use in the home and to further understand the role of design in shaping family practices.

## 7.2 Decoupling the Smartphone from Intimate Family Practice

In this paper, we presented an alternative and unconventional approach to study problems derived from smartphone usage in the home. In an HCI research community that predominantly champions designs that foster personalised, desired use [78], the diametric framing of “good” or “bad” behaviours is a seemingly aspirational approach to study problems derived from excessive technology use [9, 15, 18, 42, 44]. Instead of explicitly designing and evaluating smartphone use as a matter of desired behavioural change supported by new technology [44, 51, 67], we purposely set out to embrace and unfold alternative ideas, which may shape smartphone practices towards minimised use when together as a family. For this, we were inspired by work undertaken in the domain of sustainable HCI, which has focused on the sustainability implications of people consuming limited or problematic resources (e.g., water, electricity, food) embedded in everyday practices [36, 47, 65, 86]. Sengers and others [36, 39, 48, 90], for instance, have argued that reducing resource consumption through design should involve alternative design imaginations that go beyond supporting “good” and “bad” behaviours [10]. Our study shows such an alternative approach. All three provotype deployments presented in this paper illustrate that by disrupting and reorienting ideas about how desirable domestic practices can be performed, restricting smartphone use can be experienced as fun and joyful.

Additionally, we can understand the implications of our provotypes through broader sustainability and consumption research, which shows that resource constraints during crisis [11], migration [85] or deliberate design [38, 39, 48, 90] may result in a shift towards less resource-intensive practices. We observed such a shift in our study, where families were provoked to reflect on constraining their smartphone usage. The findings illustrate that staging accountability as a provocative device was often experienced as an unconscious, albeit pleasurable act of decoupling the smartphone from intimate family practice. We saw this, particularly in the Tempus deployment. In this prototype deployment, we framed problematic smartphone use as collective accountability by constraining access to the Internet, thus making this access a limited and yet a shared resource. Interestingly, we saw that smartphone use, in particular in these families, was minimised. Instead of family members relaxing individually on their phones in shared family spaces, these families engaged in practices embedded with meanings of care and family intimacy. For instance, we saw family members engage in more nostalgic practices that resemble intimate family “hygge” time [39] e.g., playing games together, going for a walk, and eating without smartphone interruptions. By returning to practice memories [52] of how such practices were performed prior to the widespread ubiquity of the smartphone, family members were able to meaningfully decouple smartphone use from these practices.

Furthermore, our findings illustrate that when family members were using their smartphones, the act of using them was more deliberate and conscious. Curiously, we observed how this resulted in the decoupling of practices from one another. For instance, some families reflected that playing games were no longer coupled with practices of reading or socialising on their phones simultaneously. This implies that our provotypes facilitated “triggers” for proto-practices to emerge [48, 79, 80], which in turn, can further provide insights into how future, meaningful family practices may be performed in less resource-intensive ways.

## 7.3 Taking Care of Time

We and others show [6, 18, 60, 73] that the problems derived from smartphone use are complex, multifaceted, and have widespread implications for intimate social relationships. Yet, most studies do not account for the broader societal implications that increased technology usage may foster. Scholars have, for instance, highlighted that digital technology and smartphone use have complex and hidden sustainable implications, such as growth in data traffic across the Internet puts vast demands on how much electricity is consumed [32] when people stream content on their smartphones [68] and use multiple devices at the same time [72].

As illustrated in our study, design objects can be useful provocations to “trigger” novel reconfigurations [39, 47] of household practices, as “making” and “squeezing” time [81] to be available for the family, becomes a shared and cared responsibility. Taking care of time in this intimate way, reflects related scholarship on slow technology [31, 58], temporality [59] and slow energy [40, 64, 90]. Following this work, our provotype study invites further research and design efforts that prioritise “slowing down” [58] our use of smartphones (and other technologies) in ways that encourage, facilitate and support practices that emphasise collective, shared

and focused practices with others. In addition, we suggest further work that resorts to provotyping to trigger resource-intensive practices and gain insights into collective socio-material action and the consumption patterns that arise from “account-able” socially shared practices.

## 7.4 Research-led Pedagogy with Provotypes

The work presented in this paper is the result of an extensive collaboration between students and supervisors within a research-led pedagogical context. Similarly to Garfinkel’s breaching experiments, where students explored people’s responses to purposefully designed violations of social norms [27], our paper is the result of, mainly, students disrupting everyday practices involving technological use through provotyping. In this regard, the students represent a fundamental strength of our research design. Through the pedagogical process and by virtue of a strong commitment to disrupting, learning from and understanding people’s everyday practices, the students brought their original and reflective perspectives to the project, embedding the provotypes with forms of thoughtful provocation that their supervisors could not have anticipated or realised.

At the same time, the findings discussed in this paper are “limited” in the sense that they may not uphold the methodological or empirical rigour one may expect of a design research study of this kind. Because of this, we refrain from framing our findings as reliable, transferable or generalisable insights. Instead, in line with other Research through Design endeavours, we see our findings as “provisional, contingent, and aspirational” [28]; indicative of future potential design pathways that require further research.

## 8 CONCLUSION

In this paper, we set out to explore alternative ways of understanding aspects of smartphone use through three provotypes deployed in the homes of seven families. Our starting point was the notion that smartphone use can likely result in individual patterns of excessive use [9, 60, 61], both in terms of time spent on the phone [74] and data consumed [68, 83] that might hinder or disrupt meaningful and intimate familiar engagements in domestic practices. Additionally, following studies that illustrate how smartphone designs can enrich social interactions [30, 53], our aim is not to idealise non-use practices, but rather to help facilitate meaningful social encounters with others. We, therefore, acknowledge that intimate family practices may still involve devices, including smartphones, albeit in a more deliberate, considered and collective way.

Our study shows the value of viewing smartphone use as collective practice [49, 65]. We were able to demonstrate that when people are provoked, they reflect, improvise, and perform old and new routines that can facilitate collective responsibility and foster intimate connections with others. In this way, our provotypes can be viewed as alternative, reflexive Research through Design tools [12], which enable HCI and Interaction Design researchers to obtain creative inputs and deeper understandings about how the design of technology (and framings around accountability) may change and shape socially shared and “account-able” domestic practices.

In conclusion, the central contribution of this paper is showing the value of a pedagogically-embedded Research through Design

project that highlights the importance of framing smartphone use as collective accountability through design-led disruptions of smartphone use. When positioned in this way, our study provides inspiration for future design objects and studies that frame smartphone use as a constrained and limited resource, attempt to decouple practices involving the smartphone from those focused on intimate connections and activities, and emphasise slowing down the speed of practices that have led to the multiplication of practices simultaneously involving the smartphone and other devices [72]. More broadly, we conclude by reaffirming the potential for provotypes and pedagogically innovative collaborations to inspire the design of technologies intended to foster other forms of collective accountability and sustainable responsibility.

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