MindPhone: Mindful Reflection at Unlock Can Reduce Absentminded Smartphone Use

Nađa Terzimehić
nadja.terzimehic@ifi.lmu.de
LMU Munich
Munich, Germany

Luke Haliburton
luke.haliburton@ifi.lmu.de
LMU Munich
Munich, Germany

Philipp Greiner
p.greiner@campus.lmu.de
LMU Munich
Munich, Germany

Albrecht Schmidt
albrecht.schmidt@ifi.lmu.de
LMU Munich
Munich, Germany

Heinrich Hussmann
hussmann@ifi.lmu.de
LMU Munich
Munich, Germany

Ville Mäkelä
ville.makela@uwaterloo.ca
University of Waterloo
Waterloo, Canada

Figure 1: MindPhone is an intervention for absentminded smartphone use that asks users upfront about either their planned smartphone use intention or planned activity after the smartphone use. The latter method significantly reduces quantitative smartphone use and both empowered users to reflect and feel more in control of their usage.

ABSTRACT

We present MindPhone, a mindfulness-based intervention to tackle absentminded and excessive smartphone use. At unlock, MindPhone prompts one of two questions: what the user intends to do with the smartphone, or what the user intends to do in the real world after using their smartphone. Users may respond actively by writing, or passively by mentally reflecting. We evaluated the effectiveness of the two questions and two response modes in a mixed-method, 2x2 mixed field study with 28 participants over two weeks. Our results show that the real-world prompt significantly reduces absentminded use and encourages a quicker return to the real world, independent of the response mode. Asking about smartphone use intentions raises awareness of reasons for smartphone use. For everyday use of MindPhone, users wish to set the question and response mode based on context. We discuss including awareness of the physical world in future smartphone use interventions.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in ubiquitous and mobile computing**; *Smartphones*; *Field studies.*

KEYWORDS

Mindfulness, Digital Wellbeing, Mindful Smartphone Use, Mobile Application, Empirical Study, Intervention

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1 INTRODUCTION

Smartphones have become an essential part of life. They are always with us, widely available, and easily accessible. Smartphones have created many positive effects, such as constant access to information and feeling connected to others who are far away [19], are perceived by many as a blessing, others report the excessive amount of screen time [7], constant interruptions [31] or lack of meaning in smartphone interaction [30] to have become a curse. As a result, people increasingly desire to change their smartphone usage behavior [41], whether it be reducing screen time or using their smartphone for the right reasons [17, 30].

Previous research has used smartphone usage tracking to raise awareness and encourage reflection for past smartphone use behavior [28], to set daily or session app use goals [17, 33], and to temporarily discourage [37], restrict [23, 49], or block smartphone use in individual [5] and group [21, 24] settings. However, the efficacy of notifications and reminders about smartphone use is disputed, with some (e.g., [17]) claiming that they can change smartphone use behavior, whereas others conclude that they have no impact on screen time (e.g., [28]).

The above-mentioned works tackle the activities and behavior around the *smartphone device* solely, such as use quantity or patterns of use [15], but they are neglecting smartphones' dynamic relationship with users' real-life behaviors. More recently, though, Abeele [52] considered digital wellbeing the "optimal balance between the benefits and drawbacks obtained from mobile connectivity", and Harris et al. [15] added "negative consequences [in real life]" as a marker for problematic smartphone use. The notion of users' everyday behaviors being influenced by (problematic) smartphone use also appears in Google's manifest on digital wellbeing [13]: *"technology should improve life, not distract from it. [...] So that life, not the technology in it, stays front and center."* Dugas et al. [35] blamed absentminded smartphone use – aimless scrolling, use when bored – for everyday life inattention and distraction.

Although reports of real-world dysfunction are on the rise, interventions which try to tame absentminded smartphone use in HCI barely include users' physical world. MyTime [17] is an intervention implementing *aspirations* – the one thing users wished to achieve in a day – which theoretically could be real-world bound. A more recent study [6] proposes reminding users of the importance of the context in the real world over their phone use *during* smartphone use. However, there still is a lack of knowledge on whether raising users' awareness about their surrounding real world beforehand actually has a significant effect on smartphone use patterns.

We present an approach which differs from related work by placing an intervention at the actual moment of smartphone use. This is in line with the concept of in-the-moment awareness related to mindfulness. The term *mindfulness* has been discussed in both HCI [50] and the media [4], with no consensus definition to date. We take an approach close to Ellen Langer [25] and define mindfulness as *focused attention on the present activity, with full awareness of the context in which it is happening*. This includes awareness about intentions and purpose for a certain present activity.

With that in mind, we designed and developed *MindPhone*, a smartphone app that confronts the user with one of two questions at smartphone unlock (Figure 1). The first question draws upon previous research on meaningful smartphone interaction [30] as well as research on asking about the *intention* of using an application or website [33]. In contrast to prior work, the second question revolves around users' intended activity in *the real world, after the smartphone use*. We name the two questions, *Intention* (I) and *Activity* (A), and phrase them as follows:

I: *"Why do you want to use your phone right now?"*
A: *"What activity do you want to do after you finish using your smartphone?"*

We designed MindPhone to be neutral and explicitly not corrective, prescribing no value judgments. It does not use restrictions or blocking as punishment, nor does it raise awareness by confronting the user with usage statistics.

We also build upon previous works suggesting that writing down thoughts sparks a more profound reflection [47]. Hence, MindPhone offers two reaction mode: Passive and Active. In Passive mode, users mentally contemplate about the I or A question, whereas in the Active mode, users have to write their response in text.

To this end, we set out to investigate the influence of the differences in our approach by the means of following research questions:

RQ1: *Does reflection prior to smartphone use on a) the real-world activity or b) smartphone use goal promote mindful smartphone use patterns?*
RQ2: *Does smartphone use differ based on whether users mentally reflect or write down their reflections prior to smartphone use?*

We conducted a mixed-method study collecting data over four weeks, including a two-week field deployment of MindPhone with 28 participants assigned in two groups, based on receiving either the I question or A question. Each week, we tracked screen time and unlocks, and gathered absentminded smartphone use questionnaire scores (SUQ-A) [35] and qualitative feedback.

We found that the real-world activity question significantly reduces smartphone use, while encouraging users to return to the real world. The intention question raises awareness of reasons for smartphone use. Both the Active and Passive answer modes induce reflection and awareness, yet some participants enjoyed the active writing more, as it adds another barrier to smartphone use, which can further aid in taming compulsive phone-checking. Although quantitative measures of smartphone use increased after stopping the use of MindPhone, participants point to a shift in thinking towards smartphone use. We discuss the implications of setting the focus on the real-world in smartphone interventions and personalization and customization to incorporate a periodic use of MindPhone in everyday life.

Our contribution is threefold:

System We present the design and implementation of MindPhone, a smartphone app that addresses absentminded smartphone use through mindful reflection at unlock.

Empirical We present the first empirical evidence that focusing on the real world instead of the device leads to a significant reduction in smartphone usage and encourages reflection and disengagement.

Conceptual We contribute the first explicit implementation, exploration, and comparison of using the real world as intervention input, as opposed to state of the art device-focused strategies, to tackle absentminded smartphone use.

2 BACKGROUND & RELATED WORK

2.1 Digital Wellbeing

Smartphone ownership is at an all-time high and continues to grow [36]. They have evolved into an ever-present entity, and increasing screen time has negative consequences such as poor posture [1] and neck pain [57]. Excessive phone use has also been linked to mental health problems, such as depression and anxiety disorders [11, 39]. We have even seen the creation of a new phobia, Nomophobia, which is the fear of being without a mobile phone [53]. Modern mobile technologies are commonly designed specifically to be engaging [14] as a consequence of the attention economy [10].

This phenomena is related to digital stress, which is stress that results from interactions with digital technologies [40]. Overload from technology has been shown to increase perceived stress and burnout, which lead to depression and anxiety [40]. This fits with our understanding of stress models, such as the transactional model [26], which defines stress as a state in which an individual perceives that their resources are insufficient to handle their situation.

In response, focus on mhealth (mobile health) has increased from both researchers [12] and institutions [55]. Google Digital Wellbeing[1] and Apple Screen Time[2] now come pre-installed on smartphones to track their usage. The industry also supports further developments in the area — Google introduced Digital Wellbeing Experiments[3] and Apple recently announced a Screen Time API [4].

Contemporary digital well-being apps are primarily designed to break existing unwanted technology habits [41]. Although there are many problems that arise from problematic phone use, phones are extremely useful and convenient when used appropriately. Smartphones are not inherently bad for us, but their potential for over use frequently leads to *digital burnout* [34]. Dugas et al. [35] address this dualism by differentiating between general and absentminded smartphone use. Whereas general smartphone use describes the organizational power of smartphones, absentminded smartphone use — behaviors such as compulsive checking, pointless scrolling, or other phone use without a specific purpose — is more closely linked to inattention in daily life.

Our aim is to support people in choosing to reduce their absentminded phone use, while empowering them to continue using it as a powerful tool. This is in contrast to *digital detox* approaches present in the literature, which have been found not to be effective for improving mood or anxiety [56]. Unlike other systems, we focus on both the smartphone and the world around the user.

2.2 Mindfulness and Smartphone Usage

There is no consensus definition of Mindfulness in HCI, but related literature focuses on reflection, mental well-being, and reduction of stress [50]. This field of research encourages positive relationships with technology and the fostering of meaning and purpose. Smartphone users have reported experiencing excessive and habitual technology use that they later regret or find meaningless [31, 51]. Promoting mindfulness is one method to tackle this excessive use.

Tran et al. [51] investigated triggers for obsessive phone behavior. Downtime, boring tasks, social awkwardness, and feelings of anticipation were all common triggers [51]. In nearly all these scenarios the user is filling their time with phone use without a specific goal or meaning. Tran et al. recommend creating meaningful experiences for users and promoting tasks with long term benefits beyond the immediate moment [51]. Other researches have proposed methods of reducing unnecessary phone use by gradually reducing support provided by applications so that users gain skills and eventually stop needing the tool [29]. In general, mindfulness researchers aim to organically reduce absentminded use by promoting mindful reflection and purposeful use.

2.3 Interventions to Regulate Smartphone Use

The race for digital well-being in HCI has led to the development of numerous interventions aimed at regulating smartphone use. In a recent overview, Roffarello and De Russis [41] distinguish between passive self-monitoring tools for reflection and awareness and more proactive interventions to regulate smartphone use as it happens. Lyngs et al. [32] further break down the latter category into temporary use limits and blocks, goal achievements, and rewards or punishment techniques.

Passive self-monitoring stems from research in Quantified Self [48] and includes (automated) tracking and visualization of quantifiable digital well-being markers, most commonly time spent on apps or the phone [44]. Leading smartphone manufacturers Apple and Google now offer Screen Time and Digital Wellbeing respectively that incorporate self-monitoring. Moreover, in Screen Time, people can set daily time limits on certain apps or websites. Google's Digital Wellbeing includes, e.g., a do-not-disturb mode during which notifications are blocked and a black-and-white mode.

Before Apple introduced Screen Time, the research works MyTime [17], AppDetox [27], and GoodVibrations [37] explored how setting use limits on certain apps influences peoples' screen time. GoalKeeper [22] is a study examining different levels of smartphone restriction that showed that light restrictions – blocking the device after a certain amount of time, but then unblocking it again when the time has passed – offer the best balance between intervention and positive user experience. An opposite approach to blocking is rewarding users for sustaining "good" smartphone use. Forest[5] is a mobile app that aims to regulate smartphone use by planting both virtual and physical trees. GoldenTime [38] is a study aimed at providing micro-financial incentives for adhering to time-boxed smartphone use. Moreover, interventions such as Let's FOCUS [21] and Lockn'Lol [24] aim to inhibit smartphone use for a group of people and turn this into a social event of its own.

We differ from the above-mentioned works by operating neither after (i.e., self-monitoring) nor during smartphone use (i.e., prompts on imposed restrictions) – our goal is to spark reflection and raise awareness for a behavior that is about to happen in the present moment beforehand. LocknType [23] is highly relevant as it introduces a friction through the use of various lockout tasks (e.g., type 30 random digits), which reduce app screen time between 13% and 47.5%. Motivated by these findings, we set out to design two modes in MindPhone: Passive, which mimics their pause screen by simply

[1] https://wellbeing.google/
[2] https://support.apple.com/en-us/HT208982
[3] https://experiments.withgoogle.com/collection/digitalwellbeing
[4] https://www.apple.com/ios/ios-15-preview/features/
[5] https://www.forestapp.cc/

displaying a question-screen, and Active, that requires a textual response to MindPhone's question, not imposing any rules as to what this response must contain.

Our approach includes raising awareness of the surrounding world. Similarly, Hiniker et al.'s [17] MyTime study showed that people wish to change a variety of things about their smartphone use, e.g., exchanging some activities for others, or limiting use in certain contexts. They propose eight intervention types, including mindfulness, to address these desires. MyTime [17] implements mindfulness by the means of *aspirations*. The aspirations asked users for the one thing they wished to achieve in a day, with users receiving reminders if their usage surpassed a certain time threshold. Half of the participants set aspirations, some of which were concerned with real-world behaviors, such as "Get a wedding ring for my husband". However, the connection to the real world does not appear to be a conscious design decision, as the researchers did not investigate differences between smartphone and non-smartphone aspirations. Furthermore, aspirations are framed as a daily goal to be achieved and as such, are concerned with the future. MindPhone's question, in contrast, revolves around the present moment.

More recently, Cho et al. [6] studied the issue of regretful smartphone use with social media apps. Once the user goes down the rabbit hole, they propose reminding the user of the importance of the context and task they have in real-life, outside of their smartphone. Yet, they have not gone further than proposing such a solution.

With the listed points in mind, we designed MindPhone – an app-based tool to tame holistic absentminded smartphone use before it develops in the first place, by encouraging in-the-moment reflection and awareness of people's smartphone use intention and their surrounding physical world.

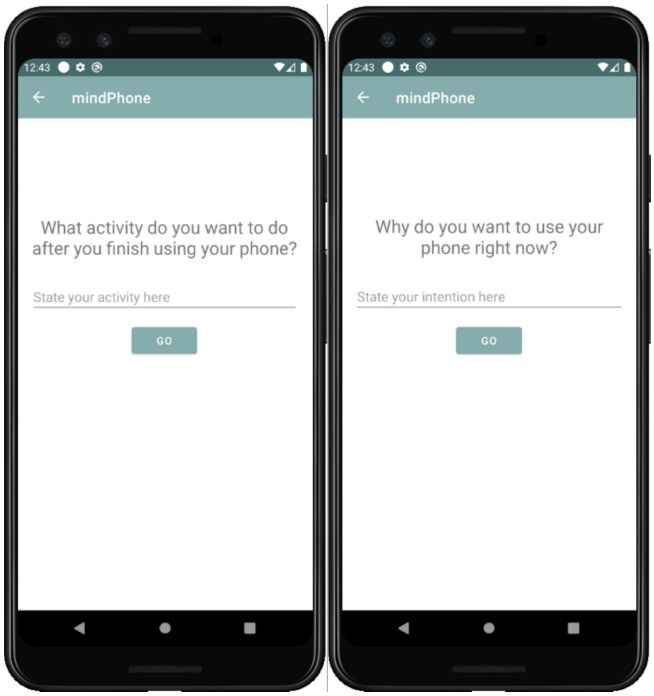
3 METHODOLOGY

We outline the design of MindPhone, followed by the study design and procedure, and our data collection and analysis protocols.

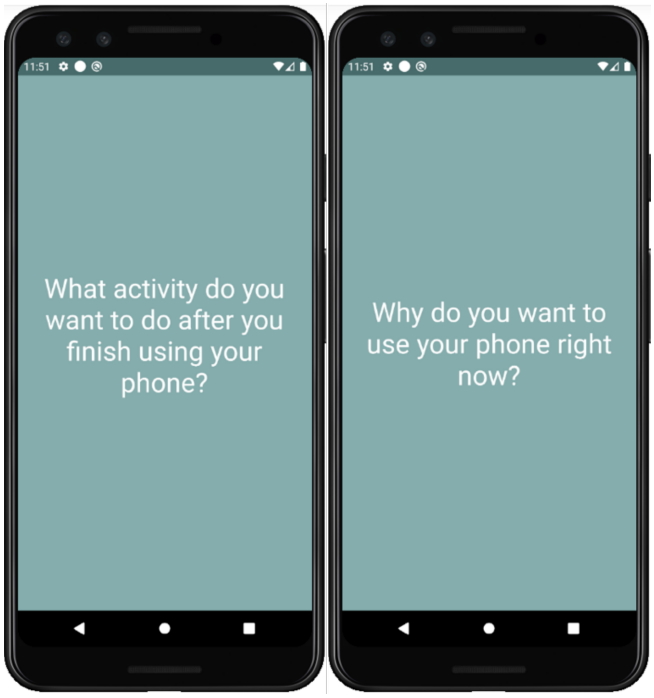
3.1 *MindPhone* Design & Implementation

We developed MindPhone in Android. To address RQ1, that is, to examine the difference between focusing on the smartphone use intention or the real world, MindPhone prompts the user with either the I or A question at unlock respectively (Figure 1).

To address RQ2, we implemented two modes: Passive and Active. They differ in the level of user input required after the I or A question has been presented at unlock. Passive mode automatically displays the question after unlock in an overlay[6] (Figure 2b). Users were told to react mentally to the presented question, meaning the app itself required no further user engagement – after seeing the question, users could simply swipe the overlay away by touching the overlay or pressing any of the home or back buttons. In Active mode (Figure 2a), users are asked to unlock their phone via the aforementioned sticky notification (Figure 3a). MindPhone then displays a screen containing an input text-field and users are asked to type their answer to the presented I or A question. To accelerate text input and lower user burden, the text-field suggests previously entered intentions or activities once the user types two letters. As we were cautious about the potential burden that typing text at



(a) The Active Mode contains an input text-field for the stated intention or activity.



(b) The Passive mode is implemented as an overlay and presented always after unlock.

Figure 2: The MindPhone App in Active and Passive Mode

[6]https://developer.android.com/training/wearables/design/overlays

(a) Participants unlocked their phones, and thus activated MindPhone in Active mode, via a sticky notification.

(b) Participants were reminded to use MindPhone if they did not unlock their phones using the sticky notification.

Figure 3: Additional design elements to ease MindPhone use.

each unlock might cause, we decided to give users the freedom to choose whether to use MindPhone (i.e., unlock with the sticky notification), or to bypass MindPhone by normally unlocking. If a user chooses to bypass the sticky notification, MindPhone shows a reminder toast (Figure 3b). The user is then able to enter the intention or activity with delay in the app itself. We used a sticky notification[7] to ensure that users received a question at every unlock. The sticky notification was a constant reminder of the study in the smartphone's unlock screen.

We decided against providing any additional information in the app, such as showing the number of unlocks or previously entered intentions, so that the users' behavior would only be impacted by the MindPhone questions, rather than by any presented statistics.

3.2 Study Design & Procedure

The study consisted of a pre-study survey, a two-week field deployment, two condition surveys (after each study week), and a post-study survey (Figure 4). We first assigned participants to the intention I or activity A question group in a counter-balanced order, meaning participants either received the intention or activity question at unlock for the entire two week field deployment of MindPhone (i.e., between-subject for the question). Within the groups, we counter balanced the order of the MindPhone mode, so that half of participants started with the Active mode, and the other half started with the Passive mode (i.e., within-subject for the modes). After one week, we switched the MindPhone mode (but not the group). In other words, all participants received both the Active and Passive mode, but only one of the two questions (i.e., either I or A).

[7]Sticky notifications stay on the unlock screen regardless of whether they were previously addressed or not. More on: https://developer.android.com/guide/topics/ui/notifiers/notifications.

3.3 Data Collection & Evaluation Metrics

We collected data through the means of a pre-study survey and two condition surveys (for Active and Passive answer mode) after each week of MindPhone use. To investigate the persistence of potential effects, a post-study survey followed one week after MindPhone's field deployment, resulting in four surveys in total. We distributed the surveys as questionnaires via email at the appropriate times relative to each participants' start date. Participants received a unique ID at the beginning of the study for anonymization and data tracking purposes. We included questions on each of the following evaluation metrics in the surveys:

- **Screen time and number of unlocks.** All four surveys probed participants' amount of screen time in minutes for every day in the previous week, followed by the number of unlocks (as count variable) in the same manner. Participants self-reported these values, by following our instruction on how to obtain these from Android's pre-installed Digital Wellbeing app. As such, these are not users' estimates, but objective metrics recorded by the OS.
- **Absentminded smartphone use**. Each survey included the SUQ-A [35] questionnaire on absentminded smartphone use. We chose absentminded smartphone use, as that type of use is linked to inattention in everyday life, which furthermore contrasts with the in-the-moment awareness principle of mindfulness. The SUQ-A questionnaire contains 10 items on a 7-point Likert-scale on absentminded phone use, such as "How often do you find yourself checking your phone without realizing why you did it?". The questionnaire calculates a score as result, which we compared for the four data collection points.
- **Users' experience with MindPhone.** The two condition surveys and the post-study survey contained several open-ended text and Likert-scale questions about the user experience of the two conditions and MindPhone in general, including ease of use, preferred condition, emerged feelings during MindPhone use, and more.

3.4 Participants

We advertised and recruited participants through our university's mailing lists and social media. Participants needed to have an Android phone with at least Android 8.0 installed, as this should have ensured that they had access to Android Digital Wellbeing. We compensated each participant with a 30€ gift card voucher or three study points if they: 1) filled out all four surveys and 2) kept MindPhone installed on their smartphones for the study duration.

30 participants met the listed requirements. We furthermore excluded two participants, as they did not have Digital Wellbeing installed. This resulted in a final pool of $N = 28$ participants. Table 1 displays the participants' demographics.

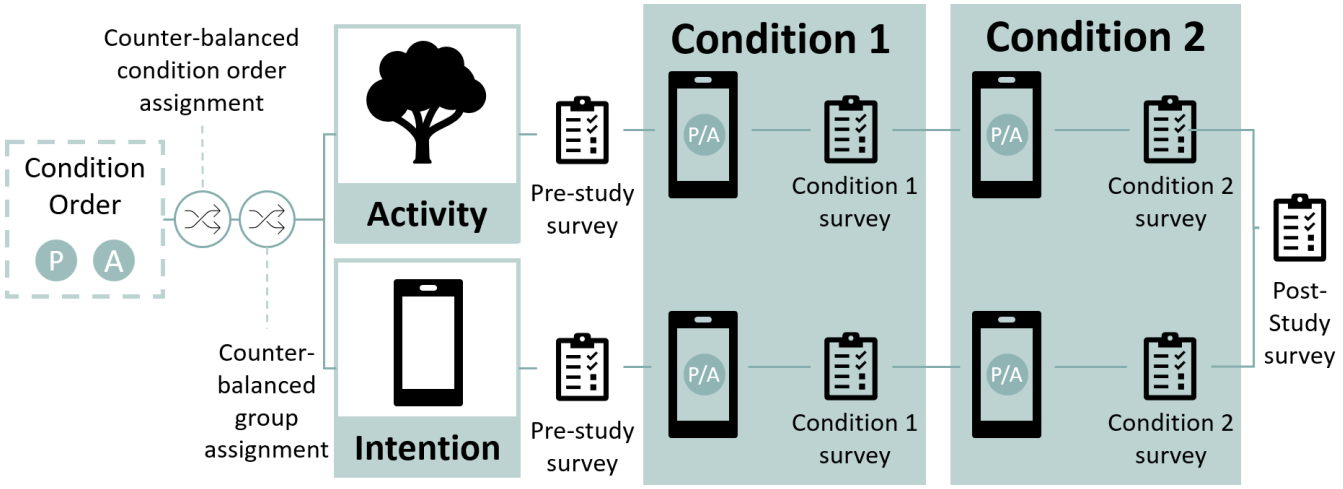


Figure 4: Procedure of the field study. Participants complete both the Passive (P) and Active (A) conditions in a counter-balanced order. Assignment to either the Activity or Intention group is also counter-balanced.

Table 1: Our field study differentiated between the smartphone intention (I) and real-world activity (A) groups, with participants being assigned to one of the groups in a counter-balanced order.

	Demographics
Smartphone Intention	N=15: 5M, 11F Age: avg 25,53 min=18, max=39
Real-World Activity	N=13: 6M, 8F Age: avg 25,62 min=15, max=38

4 RESULTS

In what follows, we first list quantitative findings for the question groups (RQ1) and the answer modes (RQ2). To understand our findings, we further qualitatively analyzed the open-ended text questions with an open coding process.

4.1 Quantitative Analysis & Results

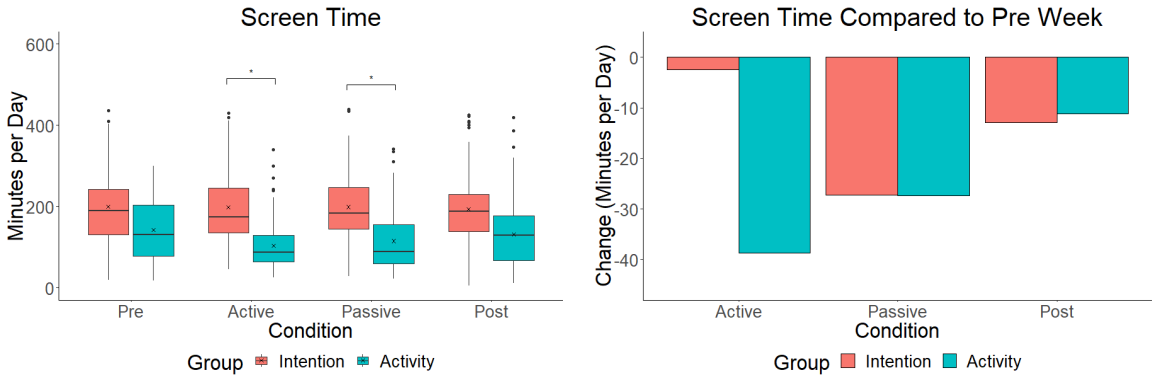
We tested the screen time logs and SUQ-A scores for normality with a Shapiro-Wilk normality test. The test revealed both logs to be normally distributed ($W = 0.99058$, $p = 0.6424$ and $W = 0.98004$, $p = 0.09517$ for screen time and SUQ-A, respectively). We used a Tukey outlier test with $k = 1.5$ to remove screen time outliers.

We performed a two-way ANOVA to test whether the groups (I vs A) and the response modes (Active vs Passive) significantly influenced screen time and SUQ-A. Although the order of the response modes was counter-balanced, we included order in the ANOVA model to test whether it had a significant impact on the results. The results indicate that order does not significantly impact neither screen time nor the SUQ-A scores so we safely grouped the participants regardless of mode order. The results are shown in Figure 5a (screen time) and Figure 7a (SUQ-A). The significance markers between groups and within the Active and Passive conditions were calculated with a post-hoc pairwise least squares comparison test. To more clearly illustrate the changes compared to the initial values reported in the pre-study survey, we show the differences relative to the pre-week measurements in Figure 5b (screen time) and Figure 7b (SUQ-A).

The number of unlocks is a count variable so we modeled the data with a Poisson regression. Our linear mixed model formula was: $unlocks \sim Condition * Group + (Condition|ID)$. In Figure 6a, the significance markers within the Activity group across the Pre-Active, Pre-Passive, and Pre-Post conditions, as well as between the groups within the Passive condition were calculated with a post-hoc pairwise least squares comparison test. We again display Figure 6b the differences between the pre-week measurements and all other conditions to more clearly illustrate the changes compared to the values reported in the pre-study week.

4.1.1 [RQ1] Group Comparison: Smartphone Use Intention vs. Real-World Activity Question. Both the ANOVA (see Table 2) and post-hoc analysis of the screen time logs (see Table 3) display that only the groups have a significant effect on screen time, which is also indicated in Figure 5a. The results indicate the Activity group to have significantly lower values of screen time regardless of whether they were in the Active or Passive condition ($df = 20$, $p = .0039$). Similarly, the results of the number of unlocks (see Figure 6a and Table 3) also indicate that the Activity group had significantly fewer unlocks than the Intention group ($df = 20$, $p = .0093$). Finally, results for the SUQ-A score, Figure 7a, also show that the Activity group had significantly lower SUQ-A scores than the Intention Group (df = 20, p<.0017).

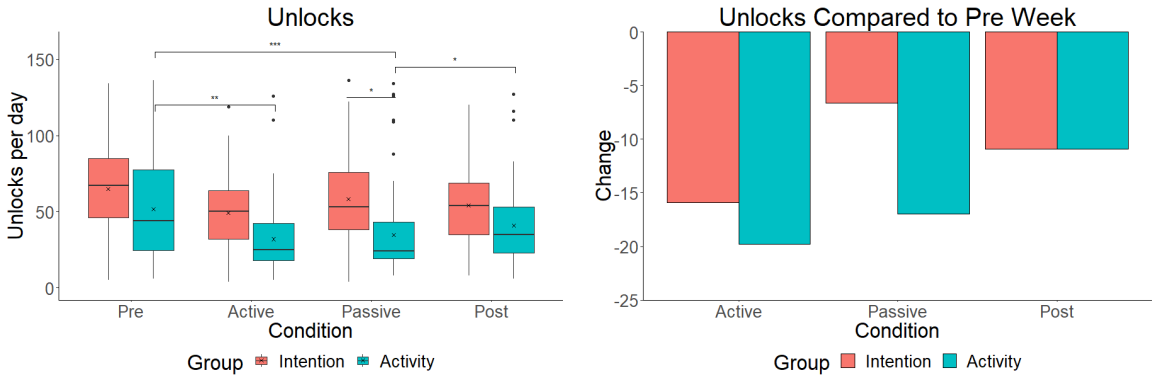
4.1.2 [RQ2] Condition Comparison: Active vs. Passive Answer Mode. The ANOVA test did not reveal a significant reduction in screen time between neither answer mode (see Table 2) nor compared to the Pre-week for the answer modes (see Table 3). Yet, both the Passive and Active mode significantly reduced the number of unlocks (see



(a) Log of daily screen time for all participants split by Condition and Group.

(b) Difference in screen time compared to Pre-week, split by Condition and Group.

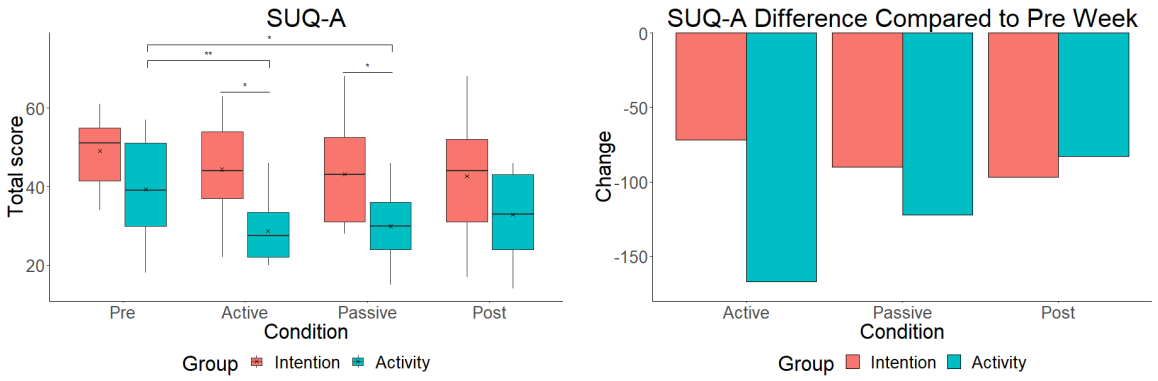
Figure 5: Screen time split by Condition and Group.



(a) The number of daily unlocks for all participants split by Response Mode and Question Group.

(b) Difference in unlocks compared to Pre-week, split by Condition and Group.

Figure 6: Unlocks split by Condition and Group.



(a) SUQ-A scores for all participants split by Condition and Group. Significant differences are indicated with asterisks.

(b) Difference in SUQ-A scores compared to Pre-week, split by Condition and Group.

Figure 7: SUQ-A scores split by Condition and Group.

Table 2: ANOVA results for the daily screen time and SUQ-A score.

	Screen Time			SUQ-A Score		
Variable	***df***	**F**	**p**	***df***	**F**	**p**
Order	1, 22	0.37	.55	1, 22	3.79	.06
Condition	1.95, 42.92	2.09	.14	2.53, 55.36	7.53	.0005***
Group	1, 22	15.99	.0006**	1, 22	12.79	.002**
Condition X Group	1.95, 42.92	1.47	.24	2.53, 55.36	1.38	.26
Order X Condition	1.95, 42.92	2.61	.09	2.53, 55.36	0.97	.40
Order X Group	1, 22	0.11	.74	1, 22	1.87	.18
Order X Condition X Group	1.95, 42.92	1.49	.24	2.53, 55.36	0.17	.89

Table 3: Post-hoc pairwise least squares comparison results for the daily screen time, number of unlocks and SUQ-A.

		Screen Time		SUQ-A		Unlocks	
	Variable	***df***	**p**	***df***	**p**	***df***	**p**
Conditions	Pre - Active	66	.3581	66	.0011**	66	.0001***
	Pre - Passive	66	.1229	66	.0004***	66	<.0001***
	Pre - Post	66	.9520	66	.0137*	66	.0209*
	Active - Passive	66	.9345	66	.9903	66	.1716
	Active - Post	66	.6772	66	.8502	66	.0048*
	Passive - Post	66	.3252	66	.6837	66	.4292
Groups	Intention - Activity	22	.0006**	22	.0017**	22	.0254*

Unlocks in Table 3) and the absentminded phone usage (see SUQ-A in Table 3) compared to the Pre-week, independent of the mode itself. In other words, the quantitative results show no significant difference between the Active and Passive answer mode.

4.2 Qualitative Analysis & Results

For responses to the the open-ended text questions, we applied conventional content analysis [18] and performed a bottom-up, open-coding process. We coded responses related to each answer mode, experiences with MindPhone in general, the realizations participants made, feelings they had, and perceived effects on their smartphone use during and after using MindPhone. The authors jointly and iteratively discussed the identified themes and selected relevant participant quotes to represent our findings. We present the four identified themes in the following.

4.2.1 Setting an Intention Alone is Not Enough. Contrast to statements from the Actvity group, statements from the Intention group reflect that almost all group's participants perceived no change in their smartphone use. This perception overlaps with out quantitative findings in Section 4.1.1. More positively though, participants noticed a heightened awareness of their reasons for smartphone use:

> *"I don't think there was a big change, but I feel more aware of when/why I am using my phone."* (P_I3)

Most participants became aware of their negative behaviors, such as wasting time. Their statements express regret against the time that could have been used differently:

> *"I think [M]indPhone helped me to realize how much time I spend on my phone and made me think, why I don't use this wasted time for other purposes."* (P_I5)

One of the reasons for wasting time could be spiraling down the rabbit hole – the just "one more post". Our participants explained that it is difficult to stop this behavior by setting an intention and follow exclusively through the set intention – despite the intention itself being "useful":

> *"[...] actively setting an intention was new for me and made me realize that I often use my phone for "useful" things where it serves me as a tool and that I wouldn't want to miss this, but on the other hand it is so easy to lose the intention that was set in the first place and just do something else that got my attention."* (P_I3)

On a more brighter note, MindPhone positively surprised few participants about their smartphone usage:

> *"I always thought that I used my phone for the right things and in an good time sequence."* (P_R22)

4.2.2 The Real-World Helps. Our quantitative findings demonstrate lower screen times and number of unlocks for the group who acted on the A question. Whereas some participants expressed surprise by a question that does not evolve around the smartphone, they were mostly able to connect to it in the aftermath, praising the switch in thinking pattern from the device itself to its surrounding real world:

> *"It makes you think about it differently. The focus is on the AFTER and you think about whether I really need the cell phone now before I do the AFTER."* (P_R8)

The previous statement emphasizes the concentration on the real world in the Activity question – in turn, this made participants reflect on the interplay of their smartphone use and everyday life activities:

> *"[...] it's nicer that this app motivates you to think outside your phone. I was surprised that I started to reflect more on my daily actions. I can't say if I was more productive or so. But I definitely spent more time outside my phone."* (P_R10)

4.2.3 A Barrier to Tame Habitual Use. Quantitative results indicate that participants were able to reflect on their smartphone intention or real-world activity equally well with both response modes, particularly aiding in taming habitual smartphone use, i.e., quick smartphone checks born out of habit or boredom, which can have a spiraling effect towards absentminded phone use [51]. We could confirm these results in participants' qualitative statements. Although participants still reached for their smartphones, simply being confronted with a question was at times reason enough to quickly abandon their mobile device:

> *"I liked the fact that sometimes I unlocked my phone without a reason and [seeing Minphone's] screen I realized that I could do without unlocking my phone. In this way, I think that I used my phone less."* (P_I13)

The main benefit of the Active mode was the additional barrier – text input – that at times encouraged the user to give up on the smartphone use by either careful self-examination of the use's necessity or by simple laziness to type:

> *"You have a 'threshold' more to use your smartphone and think again about whether it is really necessary now. As a result, in some situations I did not use my smartphone."* (P_I15)

> *"I barely opened my phone 'for no reason', because I didn't 'want' to write my reason into [M]indPhone. That led to the fact, that I used my phone only for useful and reasonable things."* (P_I6_{active})

For some participants, the more profound self-examination was reason to believe the Active mode being more effective in taming absentminded use:

> *"... the active mode forces you to think about it and write the real reason of the smartphone usage down. That's why I feel like the active mode is more effective."* (P_I16)

The same barrier was also the main drawback of the Active condition for another set of participants, in particular when participants wanted to quickly check something, such as the time or a short message. In such cases, MindPhone was perceived as "annoying". If a smartphone activity was to be repeated, e.g., exchanging text messages back and forth, participants would often subsequently unlock their phone in a very short time span for the sake of the same intention. Consequently, they had to type the same planned intention or activity again – which they found inconvenient:

> *"The main thing was that you have to type what you want to go do every time you want to quickly respond to a message. Or your phone got locked in between answering messages and you have to, again, mention that the reason you want to unlock your phone is to respond to messages."* (P_I4_{active})

As solution, participant P_R24 proposed implementing a timer between the unlocks, which could also keep time spent on the smartphone task. The overall opinion is that the Passive mode is less intrusive, and as such, is better at accommodating quick smartphone checks:

> *"I didn't have to write anything and could just reflect for myself or if I had to do something quick[ly] I just could do it."* ($P_I12_{passive}$)

In a similar manner to Active mode, participants noted that the Passive prompt would sometimes cause them to not proceed with their phone use, but they found Passive to be less annoying:

> *"I found the passive mode to be quite useful, as I actually didn't use my phone a few times when I saw the question pop up and I realized that I didn't really have a purpose in mind. The active mode, on the other hand, I found to be annoying more than anything."* (P_I18)

Passive mode's greatest benefit seems to also be its greatest drawback – participants could much more easily ignore the question and eventually let it slide completely:

> *"Well, on the one hand I liked that I didn't have to type something before using my phone... on the other hand that is also the thing that I did not like, because it led to the fact, that I opened my phone very quickly. In these cases, there is very little time to reflect and to be frank, I did not always think of something useful to answer why I just unlocked my phone."* (P_I6)

To overcome this issue, P_I4 proposed shortly freezing the screen to enforce reflection:

> *"I think it would be better when the message always stays for 3-5 seconds for example, and only after that you can click it away. In this way you don't have to type, but you also cannot just get rid of it immediately. Which forces you more to reflect on your phone use than it currently does."* (P_I4)

Nonetheless, the ambivalence of quantitative findings and qualitative statements towards one or another response mode can also be found in participants' preference vote, as our analysis did not yield a strong preference towards either answer mode: 11 participants voted for Passive, 6 for Active, 2 for both equally, and the remaining 8 participants preferred none or did not express a preference.

4.2.4 Control by Me, or over Me? Although we designed the questions to be non-judgmental, some participants felt negative emotions such as guilt or pressure, whereas others compared MindPhone to a surveillance system:

> *"Sometimes when I really needed to use my Phone or when I was just waiting for something to happen, I felt guilty for using it, or could not think of anything I would do afterwards to fill in in the app."* (P_R9)

"I constantly felt like I was being watched." (P_I1)

More positively though, some participants felt they regained control and power – both during and after using MindPhone:

> *"I had only positive feelings [regarding MindPhone], even it was sometimes hard to describe. I had the feeling that I have more control over my smartphone usage."* (P_R20)

4.2.5 After Mindphone: Smartphone Use Rebounds, but Awareness Stays. The post-study week displays an increase for all three quantitative evaluation measures compared to the weeks where participants used MindPhone. In other words, participants experience a bounce back in their smartphone use once MindPhone is removed. Some participants were aware that their usage increased, but noted that they could incorporate the reflection process into their routine:

> *"I think middle long term, yes, [the effects] will remain. In the best case it's a mental method I learned which I can train so at some point I don't need the app anymore, but at the same time being able to go back to the app anytime would be nice."* (P_R10)

A few participants expressed worry over getting used to MindPhone or losing interest over time. Rather than a daily companion, as it is currently implemented, MindPhone may perform better as medicine for times when smartphone use goes up:

> *"I think it will be difficult to use MindPhone permanently, because at some point you will lose interest, but from time to time or at times when you use the mobile phone (too) often this is a good option."* (P_R8)

5 LIMITATIONS

With 28 participants in a between-subject design, our participant count is on the rather lower side. This might have led to a possible bias to study subjects. However, our quantitative findings could be confirmed with participants' qualitative statements. Furthermore, our sample is not representative of the general public. Nonetheless, it reflects the young adult population, which is more prone to problematic smartphone use [9].

Our analysis relied on self-reported data that participants obtained from the pre-installed Digital Wellbeing app on their Android devices. As such, it could be possible that participants were not honest about their use metrics or made a mistake when copying the values. However, at the time of implementing MindPhone, Android did not provide a screen time tracking API, meaning that automatically tracking these metrics would have meant implementing a custom screen time tracking feature. We determined that the risk of false data through mistakes or dishonesty was low enough to be acceptable.

Finally, any intervention unfolds its full potential if used long-term. Based on the two-week use of MindPhone in our study, we cannot tell how using MindPhone for an extended period could affect participants and for how long they would continue to use MindPhone without the incentive of participating in a study. Yet, we find this to be the exact opposite pattern of use that we envisioned for MindPhone. Namely, long-term use could make users dependent of MindPhone, risking users to spiral without it. On the contrary, we want to empower users to leave their smartphones and successfully follow their tasks and aspirations outside of their smartphones.

6 DISCUSSION AND FUTURE WORK

Our overall results show the potential for a non-corrective smartphone intervention at unlock that raises awareness of people's smartphone use as well as their surrounding physical world. In particular, the latter was effective in reducing screen time, number of unlocks, and absentminded use. People obtained additional benefits in their smartphone use, demonstrated in their statements on experiencing more mindful smartphone use and tucking their phones away to experience the world around them. Next, we discuss 1) the potential of including the real, physical world in similar interventions; 2) personalization of smartphone and broader technology use interventions; and 3) challenges and future opportunities around transferring MindPhone and similar interventions to everyday life.

6.1 The Real World Matters

MindPhone is, to our knowledge, the first smartphone use intervention that promotes the user to focus on the real world surrounding them. Prominent solutions on the market (e.g. [2, 13]) focus on *the apps people use*, while recent research emphasizes *what people want to achieve* in a smartphone session. Lukoff et al. [30] suggest that *"before picking up their phone, [users] could form a clear intention for use"* in order to promote meaningful smartphone use. Our work, however, differ from this prior work in one aspect – we also asked the user about the world outside of their smartphone.

Our two questions were intended to spark reflection on either the user's intended smartphone use or their planned activity in the real world. Our qualitative findings for the intention question point to more conscious and purposeful smartphone use compared to before the intervention. Yet, in more quantitative terms of effectiveness, we could not detect any significant changes in participants' use behavior. This finding suggests that an upfront, smartphone-level intervention on the *mere smartphone use* is not enough to induce actual behavior change – it needs an additional intervention mechanism such as reminders [33] or the question being swapped.

Contrarily, our findings suggest the real-world activity question to significantly reduce smartphone use. Participants' stated they experienced a shift in focus from the device to the surrounding physical world, making them leave their devices sooner to concentrate on the *present in the physical world*. This matches our expectations from a mindfulness perspective, yet participants needed some time to get used to it. Design studies show that users sometimes have a hard time thinking outside of current solutions [45, 54]. We thus suggest designers and researchers to find ways to include the real world in their approach *by default*, to brake spiraling during use or keep use to a minimum from start, so as the user can concentrate on alternative activities in the real world [17]. This awareness could be further amplified by, e.g., sensing people's context and subsequently adapting the question. For example, if a social or work setting is detected, MindPhone could ask *"Who are you with?"* or *"What are you working on?"* respectively. This way people might not only feel encouraged to leave their phones, but also might gain deeper insights into the everyday contexts in which they use their

smartphone [16, 20]. In the following subsection, we outline the importance of personalization to implement MindPhone, or a similar solution, for use in everyday life.

6.2 Personalization and Contextualization

Not all screen time is created equally, and users have context-dependent goals, *"to maintain many aspects of their smartphone use while simultaneously limiting others"* [17]. We therefore discuss to whom MindPhone might appeal to and which configuration is appropriate for which situations, acknowledging the greater message that there is no one size fits all, or always, approach.

MindPhone's Intention question might appeal to those who believe their smartphone use to be rather meaningless [30], and who as a result want to limit, reduce, or displace a certain smartphone activity for the sake of a more tool-driven or purposeful smartphone use. For people who perceive their own smartphone use as positive, the intention question could raise a rewarding feeling of pride. Future work could explore what smartphone intentions users perceive as worth continuing or stopping in order to highlight or interfere respectively. Our results suggest that the real-world Activity question contributes to the goal of reducing overall smartphone use (i.e., screen time, pick-ups) and dependency on it. As such, MindPhone may help to ease fear of missing out [8] and encourage users to pursue aspired activities in the surrounding physical world, e.g., do a short physical exercise instead.

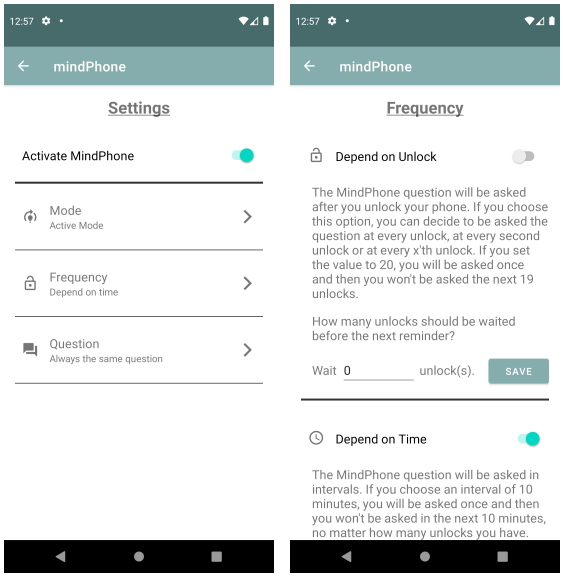
Our quantitative results showed that mentally confronting users with a question (as done in the Passive mode) is enough per se, confirming the results found in LocknType [23]. However, qualitative findings suggest a highly bi-modal distribution of preference. Whereas some participants enjoyed the extra barrier of Active mode, others found it highly burdensome – in particular in the case of repeating answers. These participants appreciated Passive mode's low intrusiveness, whereas others quickly skipped it without acknowledging it. MindPhone could, e.g., let the user decide which mode to use (see Fig 8a) or offer the Passive mode per default (as the mode that requests lower user engagement) and switch to Active mode once a certain threshold in, e.g., time or unlocks, has been passed (see Fig 8b). Additionally, when in Active mode, MindPhone could show the previously entered answer and ask whether it is still valid, surpassing the need for an unnecessary additional text-entry.

Apple recently introduced Focus for iOS[8]. Focus automatically adapts the smartphone (i.e., used apps, notification blocks, etc.) to a user's context of use. However, it is difficult to accurately determine smartphone use contexts in order to automatically deliver personalized solutions, as they are highly individual [16, 20]. Future work could thus try to match different setups of MindPhone to predicted, intervention-needing use [42, 43].

6.3 Towards Life-Technology Balance

In our real-world Activity question, the cognitive effort necessary to think upfront – i.e., outside the device from the device – might initially require careful planning and reasoning, compared to a straightforward question asking what people want to do on the device they are about to use. This cognitive effort might be initially reduced by offering a selection of, e.g., most named activities. As the first intervention to do so, we ought to let users come up with their planned activity instead of abstracting the activity's importance [6] or recommending it from, e.g., user's to-do list.

More research is needed in examining which real-world activities users would rather swap their smartphone use for, e.g., reading a book, studying for an exam or cooking dinner. Similar to work-life balance, future work could aim to understand and formalize life-technology balance, that is, life-smartphone balance in our case. We believe that this balance is highly individual, with some users actually enjoying their presence in the digital world more than in the real world. We rather speak for those who consider their digital presence a small part of their real-world presence. As such, we see MindPhone to have set grounds towards this understanding, in which even meaningless or habitual use have a place in a user's life, as long as other everyday life activities do not suffer from it [3].



(a) Settings screen. **(b) Frequency setting.**

Figure 8: MindPhone v2 could offer a settings screen to reflect the need for personalization and contextualization.

6.4 MindPhone for Everyday Use: Challenges and Opportunities

We designed MindPhone to empower instead of control, to up-skill instead of tie up. Consequently, we do not intend MindPhone to be a daily companion that people need to rely on for the rest of their lives, but rather a tool from which people can learn about themselves and choose to act upon if they wish. Our results demonstrate that MindPhone, and similar interventions, have the potential to significantly impact the relationship between smartphones and users by giving users more control over their use, reducing mindless use, and encouraging healthy reflection.

One potential challenge for implementing MindPhone in everyday life, is the fact that MindPhone asks users to explicitly write down the activities that they are doing in outside of their phones, which is normally inaccessible information for phone and

[8]https://support.apple.com/en-us/HT212608

app providers. In an academic context, participants have explicit control over their data and the use is restricted to scientific purposes. However, in a commercial context the use and sale of data is less constrained, presenting a potential risk for the user [46]. However, mitigating this problem is the responsibility of not only technology designers, but also commercial and regulatory bodies.

Future work is needed to fully understand the long-term impact of MindPhone, and the most appropriate frequency of intervention. For example, should MindPhone be activated on, e.g., a monthly basis or only when smartphone use has crossed a certain threshold? We think that some of this challenge will be solved by including points discussed in the previous section, such as rotating questions, automatically customizing frequency or switching modes to fit a person's inner and outer context. Ideally, we envision "positive disengagement" [29] as a result of periodic MindPhone use, where people engage with MindPhone when they feel that they need it and eventually become self-sufficient in sustaining a level and style of use that they are satisfied with.

7 CONCLUSION

This paper presents MindPhone, an intervention for absentminded smartphone use that is based on mindfulness. We found that asking participants about their intended activity in the real world after using their smartphone significantly reduces absentminded use, screen time, and unlocks. Asking users about their intended smartphone use does not quantitatively impact behavior, but participants felt a heightened awareness of their usage. We found no significant difference between mentally reflecting or actively writing responses to the questions, but the preference for response style was highly individual. We contribute the first smartphone intervention system that prompts users to think outside of their phone, and provide design recommendations for implementing such a system in the field. Adapting a focus on the physical world outside of our devices has the potential to empower users to be more mindful and satisfied with their smartphone use.

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