Summary

Over the course of merely over a decade, smartphones evolved from being a technological gimmick to a fully fledged essential item ubiquitous in almost every modern society. For many a phone is defined as an irreplaceable tool providing services such as mobile banking, IOT control and multi-factor authentication, which without a doubt make smart phones one of the most common mobile devices on the planet. Aside from the pure utility, and only further catalyzed by the recent global COVID-19 pandemic lock downs, a major social role has been developing around smartphone use. As SMS functionality transitioned into instant messaging platforms and social networks, smartphones enabled higher connectedness with the metaverse of the internet than ever before. With such tight and invasive integration into human societies over a relatively short period of time, smartphones with no shade of doubt re-shaped the landscape of social interactions. Thus, the field of HCI is ripe with research on this phenomenon and with each technological revelation around mobile devices, a new areas of research are being discovered.

During our 9. semester, we delved into the field of HCI from the angle of phone use and its effects on mental well-being. Having performed an autoethnographic study measuring the influence of the frequency of received notifications and social media presence, we concluded that there exists a correlation between the aforementioned two. In that study we approached the problem from multiple angles. Given a different pre-existing levels of online present among the participants, we adjusted the starting conditions accordingly, such that a person with high online presence would block their notifications and be made more mindful of their phone use, whilst a person who used their device sparsely and not pursue frequent interactions on social media would open an account on a popular image board social network and enable their notifications. Even though the starting conditions were almost on the opposite sited of a spectrum, the conclusions aligned among all three research participants.

Driven by the results of the autoethnographic study, as the next step we started designing a prototype for a larger in scale study around provocative design and reducing the unnecessary phone use. As a final draft, a design was created, in which the system detects an certain usage pattern and follows up with disrupting the smartphone use by either altering the visual capabilities of the device's display. To measure the effects of the prototype, we enrolled a group of participants among which we had distributed copies of the software. Each trial has begun and ended with an in-depth interview, since we decided that for such a study, a qualitative analysis of the problem shall yield the most meaningful results.

JoMo - the Joy of Missing out: a User Study of Smartphone Usage Habits

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ABSTRACT

The portability and extended functionalities that phones have achieved over the years made them ubiquitous. In consequence, smartphones are have become intrinsic in people's lives. However, such availability and accessibility can lead to overuse. In this paper, we conceptualize a type of misuse, namely the Open-Close pattern, and propose a provotype to combat it by creating disruptions. The provotype is in the form of an android app called JoMo. We conduct a qualitative study for a week where we examine how participants react to disruptions of the Open-Close use pattern. The findings show that phone misuse is highly contextual, and that digital wellbeing cannot be necessarily reduced to screen time and notifications. Moreover, provoking people through disruptions to stop using their phones can be successful, but only in specific situations.

Author Keywords

hci, non-use, provotype, qualitative study, breaching experiment

CCS Concepts

•**Human-centered computing** → **Human computer interaction (HCI);** User studies;

INTRODUCTION

Frauenberger talks about the entanglement between people and technology, and the fact that the two are inseparable[16]. Smartphones represent one of the most prevalent examples of this entanglement, offering us ever present link to content, interpersonal connection and other services regardless of location or time[2]. With the rise and normalisation of this ubiquitous connection studies have been carried out investigating the effects of this new entanglement.

Research has linked phone misuse to interfering in social settings[7], causing procrastination in work and study environments[14, 32], and has been associated with negative outcomes such as problems with sleep, anxiety and mental stress [8, 34, 27].

Conversely, other studies have shown phone use can result in positive outcomes. When engaging in hedonic experiences where users derive pleasure from use in a controlled fashion. When used to align with meaningful personal goals positive outcomes have also been observed [5, 26], e.g. coordinating large group events or keep in touch with loved ones. [25].

Abelee et al. posits that digital wellbeing is a more ambivalent experience of both positive and negative aspects, where finding a balance between connectivity and disconnectivity is dependent on person, device and context specific factors[37]. Abelee et al. defines digital wellbeing as an optimising of this ambivalence through maximising of controlled pleasures and a minimising of disruption of daily responsibilities and tasks[37].

This may help to explain why digital detox apps that focus on restricting screen time are often ineffective. Forced phone abstinence may help to reduce negative experiences described earlier but also at the cost of positive experiences[38].

In the modern day of ubiquitous smart phones, there is a palpable social pressure to be available online and at times deviating from such expectation may cause social tensions and misunderstandings. Therefore, research carried out designated to break / disrupt a social norm as such, could be considered provocative or uncomfortable for a participant[33]. In our previous study we concluded that a more mindful approach towards the use of a phone could maximise the benefits of a technology.

As our first contribution, we conceptualize a phone usage pattern, namely Open-Close, that can be an indicator of problematic use. As a result between our previous semester and the aforementioned concept, we design JoMo, an android app, that has the purpose of recognizing the pattern and introduce a disruption as a signal for the user to reflect on their usage. Our second contribution our study provides empirical insights to our participants usage habits and the unspoken societal rules behind acceptable use.

The structure of the paper is as it follows. Firstly, we present related work from HCI regarding phone use and non-use, what is digital wellbeing and the concept of breaching experiments and provotypes. Secondly, we introduce our design and the process it took to get there. Moreover, we deployed our app and conducted a study. Lastly, we analyze the results through a thematic analysis, supported by quantitative data, and discuss implications.

RELATED WORK

In this section we will explore other areas of research related to phone use and its connection to digital well-being, current research non-use strategies to mitigate negative effects of smartphone misuse and finally breaching experiments and provotypes in HCI.

Phone use, well-being and non-use

In the past two decades smartphones have become ubiquitous in modern society, with the majority of adults and teenagers

owning their own personal device. Studies into phone usage show, that we spend a lot of our day using our phones, with up to three hours for an average user[12]. This can be in part explain by the way many apps have been designed to lure attention and maximise users engagement[39, 15]. With this rise in smartphone ownership and their use researchers have begun to investigate the side effects of this new paradigm shift.

Couples reported more conflict and lower relationship quality when experiencing interruptions to couple interactions due to technology[28]. Productivity in the workplace and at home have been found to be negatively impacted with increased phone use [14]. Late night screen time before bed has also been linked with poorer sleep quality which in turns leads to feelings of depletion the next day [23]. One study that explored maximising phone disruptions found that excessive notifications could lead to inattention and hyperactivity symptoms normally found in patients with ADHD (Attention Deficit Hyperactivity Disorder)[22]. In one survey researchers found that automatic habitual smartphone use to pass time or passively consuming social media were associated with a sense of meaninglessness and lower motivation to achieve a specific goal[26]. In the same paper, they also found users reported a feel of loss of autonomy when using their phones this way[26].

Diefenbach et al. define certain use patterns of smartphones as "adult pacifiers", which relates to our focus on Open-Close pattern of phone use and so called mindless scrolling[13]. At the same time a paper by Lee et al. establishes a link between compulsive use of a smartphone with heightened stress levels and anxious behavior[24, 36]. As a way to either combat the aforementioned or simply being made redundant by the ever-growing pace of technological advancements, people in certain situation might decide limit or stop the use of their smart devices[35]. Another interesting notion of non-use is being mentioned in Bruun et al. where the authors focus on social situations in a family setting[7]. Aranda et al. explore this idea of non-use further in their paper where they categorised two negative behavioural cycles, excessive use triggered by internal habit and an external trigger from social obligations[4]. Aranda et al. also suggest methods for disconnection through reducing triggers that allow for easy re-engaging through the use of obstacles or allowing for temporary partial disconnection by locking out all but the most critical phone functions[4].

While much research into the negative effects of phone overuse has been explored there are positive aspects well. Digital media when used for procrastination purposes was found to be linked to negative moods and a lower sense of well-being; however, when used for recreational purposes to recover from mental or physical exhaustion it was found to be linked to enhanced subjective well-being[31]. Also when used to achieve eudaimonic experiences which are experiences that are meaningful to us can often be associated with more positive outcomes, for example messaging family members who live abroad or far away[26].

Breaching experiments and provotypes

Breaching experiments[17] were introduced to social psychology by Harold Garfinkel, as a methodology to study people's reactions when the unwritten rules of society are broken. In recent years, the HCI field adopted this concept in order to study a plethora of problems, such as overcoming social expectations for better collaboration [18], studying technology in a home setting [30] or investigating ways to support innovation [11].

Provotypes [29], as described by Mogensen, should challenge the already existing design practices and the *'taken-for-grantedness'* in order to analyze them and spark new ideas[6]. At their core, both provotypes and breaching experiments hold the same idea: meaningful data can be generated by approaching situations in an unconventional/unexpected way.

DESIGN

In the present section we analyse some detox apps that are available on the market for Android phones, as a precursor to our design. We tried to observe some shortcomings in order to avoid them. Furthermore, we describe our designed that developed as a result of our analysis and provotyping[29] for a more balanced digital life.

The dilemma of digital detox apps

Before diving into the design phase of JoMo we have decided to inspect and test for ourselves eight apps for digital detox that are already available on the market. Since all of us are android users, these apps were downloaded mainly from Google Play. However, Digital wellbeing is a native app for Samsung phones. We have reviewed the following apps:

1. Action Dash: Screen Time Helper
2. AppDetox - App Blocker for Digital Detox
3. Digital Detox: Focus & Live
4. Digital wellbeing
5. Freedom | Block Distractions
6. Off the grid - Digital detox
7. Social Fever: App time tracker
8. SPACE: Break phone addiction, stay focused.

These apps were design to fulfill a main purpose, namely to help the user reduce their screen time and help them combat smartphone addiction, thus offering a better balance between digital and real life. The way the majority of them implement this is by offering statistics about launches and screen time (nr. 1, 2, 3, 4, 7,8), by blocking the phone's screen for a period of time (nr. 3, 5, 6) or by blocking apps (nr. 1, 2, 4). Another thing they limit is the intake of notifications (nr. 2,8).

Although most of these ideas seem great, since they impose a hard lockout of the phone, it feels almost like a punishment for using the phone. So, to ease these feelings, some of these apps introduce a gamifying experience (nr. 1, 3, 8). They have designed challenges in order to provoke the user to not use their phone, together with a panel of achievements. Despite the fact that gamifying lockouts could be a fun way to approach this problem, at the end of the day the user might be tempted to spend more time on these apps in order to figure out what to do next to unlock another goal. Therefore, some detox app just end up shifting screen time from other apps to themselves, which could be hypocritical given the app's intention.

Moreover, by constantly sending notifications about statistics, the user might be tempted to pick up the phone more often

in order to see what is that notification about. The detox app might turn off the notifications from certain distracting apps, but it defeats its purpose if they are replaced by the app that was supposed to get rid of them. Furthermore, the permanent silent banner notifications might distract the user from the initial task they had to do on their phone, since they might be tempted to see the latest news about their phone habits. However, after researching android development documentation this more likely a workaround on the Android system in order to let these apps monitor activity by remaining active in the background.

Part of the detox apps that we have reviewed had functionalities that were not necessarily targeted at helping with non-use. For instance, Space offers *Location Map* which is just another view of google maps. In addition, they have a social aspect of the app. The user can add friends and compare progress and achievements. Another example is Freedom that has a built-in blog with posts that are not necessarily about educating the user about a better balance of their phone usage. These seem more like features that should make the user engage more with the app itself, rather than helping them combat the so called *phone addiction*.

In order to have a better view of these apps, we have classified them by the type of payment/ subscription an by the number of apps within an app, as it can be seen in Figure 13. On one hand, money can play an important role when a user chooses to use or not to use a certain app. On the other hand, the more functionalities a self-defeating app has, the more likely it is for the user to spend time on it.

Uncontrollable app switching

During the previous semester[33], we conducted an autoethnography study looking for a better understanding of our relationship with the phone. After analyzing detox app, we have realized that even though they offer support for people who want to reduce their screen time, lower certain app usage, or cut down the number of notifications, they do not offer support for people who jump from app to app when they are bored. We observed this type of unconscious behaviour on ourselves: opening-closing-opening again and again a number of apps from the same category, such as social media or games. This circle usually happens when somebody is mindlessly scrolling through an app's feed, but gets bored and moves to the next similar app. A possible Open-Close pattern can be seen in Figure 1.

JoMo

Drawing conclusions from the preliminary investigation, we began the design phase for the JoMo project - "Joy of Missing out". The main motivation behind the design of our application was for the user to interact with the application itself as seldom as possible. As a continuation of the theme from the previous research [33], the design had been evolving from elaborate provocative design, such as phone reading out loud notification contents no matter the system settings, to a few more refined contenders.

To exploit the aforementioned Open-Close pattern of phone usage, we have decided to implement a detection algorithm

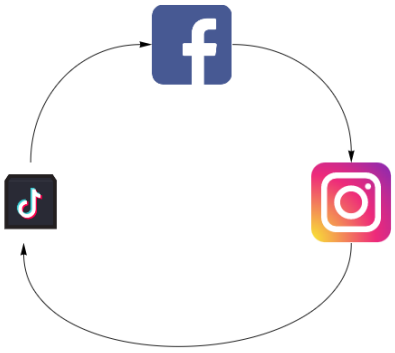


Figure 1: open/close pattern

based on counting occurrences of opened applications from a curated list within a sliding time window of 10 minutes. Should the threshold of 3 distinct applications be exceeded, the disruption mechanism shall trigger.

Our design considerations of the disruption mechanism gravitated towards visual cues [20, 9] for a user to nudge them away from using their mobile phone in certain situations. Among which the most promising were the hereafter mentioned designs.

Daltonizer

The Daltonizer, also referred to as the gray-scale mode, is a version of JoMo, that relies on changing the smartphone's accessibility settings, such that upon trigger, the screen would turn into a black and white monochromatic mode. Such disruption aims to deter people from interacting with their phone with emphasis on making the social media interactions (which heavily rely on visual content) less pleasant, while still allowing the user to be able to use their device to the full extent should they wish to do so.

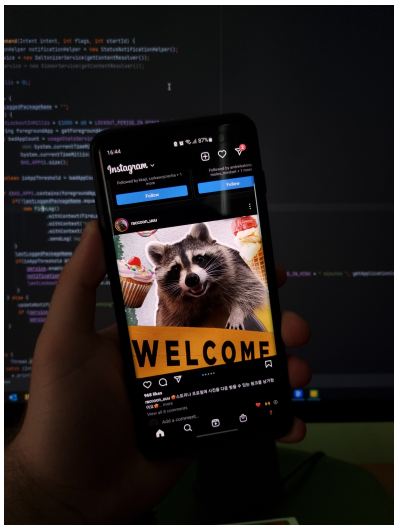
Dimmer

Dimmer functionality as derived from its name disrupts the user experience by altering the screen backlight brightness levels. Once the JoMo algorithm triggers, it should decrease the screen brightness to a minimum, thus rendering the phone barely usable - especially in brightly-lit areas.

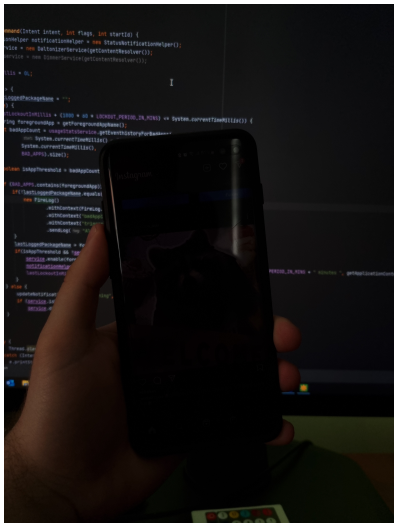
Having drafted these provotype ideas, we decided to deploy both of them to perform a comparative study, however due to unforeseen difficulties with a smartphone proprietor integration (as further outlined in Future work and limitations) that was not possible.

User Interface

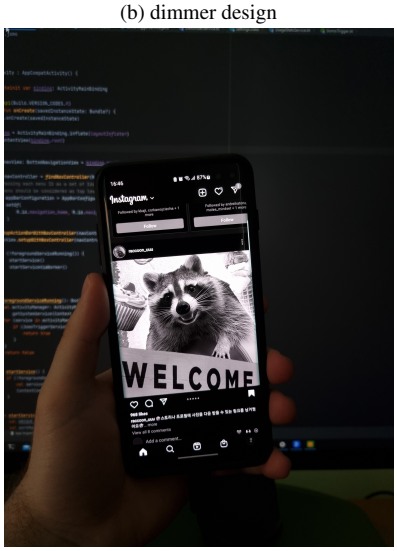
The user interface was designed with minimalism in mind. Since the mission of JoMo is to be simple and work towards helping its users reduce the unnecessary device interactions, we have decided to reflect that through the interface. The only interactive panel of the application shows the usage statistics, which are displayed only after pressing a button and such



(a) default view



(b) dimmer design



(c) daltonizer design

Figure 2: JoMo design visualised

interaction is logged in the database. To further reduce the incentives of interacting with JoMo as a mobile application, a list of potentially intrusive applications that we wish to target was predefined as well for the study, so that the user does not spend time re-configuring the settings nor periodically disabling certain applications to cheat the statistics.

STUDY

The aim of our field study is to determine how people interact with technology, more specifically smart phones. The first step we took was to determine their mobile habits through a semi-structured interview[1]. We then tested our provotype on the subjects for seven days in order to see how the disruptions affected their phone interactions. In the end, a final interview was held to asses the result of the study.

At the beginning of the study the participants were instructed to install JoMo and forget about it, mostly because it is an app that mainly runs in the background. However, they were informed of what the app does, mostly because we wanted to be transparent with them, and because some of the participants were concerned about the functionality of the app. The purpose of the app is to determine if the user enters into a vicious circle of repeatedly opening and closing a group of apps, and do something to disrupt it. Most detox apps just send a notification that you exceeded your time limit for the day, but that can be easily overlooked. On the other side of the spectrum, a detox app can hard-lock the phone for a short time period, thing that can become extremely intrusive in some instances, for example an emergency or work related tasks. JoMo is aimed at finding the middle ground between the two.

Our particular study focused on social media apps and mildly disrupting the open-close cycles by dimming the screen brightness or gray-scaling the screen. The user should be able to use the phone if they really have to, but the disruptions should make the experience a little bit less exciting, thus determining the participants to break the pattern of opening/closing time-wasting apps.

The apps that could potentially affect someone's well-being or productivity, based on our autoethnography [33], are the following: Facebook, Instagram, YouTube, Messenger, Twitter, LinkedIn, Snapchat, Tumblr, Pinterest, Reddit, TikTok, Tinder, Bumble, Happn, Discord, RIF, Twitch. This list was modified for some of the participants that used some of these apps for work. Another modification was done for P4: the number of switches between apps has been lowered to 2 for a time span of 10 minutes. From the pre-interview we deduced that maybe JoMo will not trigger with the default parameters due to P4's low usage habits.

Participants

The study was done on seven participants of different ages, genders and occupations (see Table 1). We gathered them by scouting volunteers from our social networks. The conditions they had to fulfill were to be android users and to actively use their phone.

We classified the participants by their phone usage levels, from low to high. For this instance, we take into consideration their

perception of the phone, their actual statistics for screen time, and reasoning for using their phone.

Data collection

We collected qualitative data[3] and enriched it with quantitative one by gathering user statistics and logs from JoMo. We conducted two semi-structured interviews, one before deploying JoMo, and one after. Both interviews were audio recorded and then transcribed for thematic analysis.

The purpose of the pre-study interview(Appendix A) is to ascertain a starting baseline for the study, to determine the participant's phone usage habits, their screen time and how they feel in general about their phones and their activity on it. Another interest was to determine if the participants think that their phone habits influence their mental wellbeing.

In the post-study interview(Appendix B), we talked about their experience using JoMo and how the app affected their daily phone routines. We wanted to know their perception of how effective was JoMo, and in what situations they did find the app useful.

During the interviews, we requested screenshots of their screen time statistics. Through logs, JoMo collected more granular data about what apps triggered the algorithm or how many times it was activated.

FINDINGS - QUANTITATIVE ANALYSIS

While the qualitative study was our primary objective, we did embed a logging solution in our smartphone application that tracked metrics such as the performance of the JoMo disruption algorithm. In the following section we will discuss some of those findings that play a supporting role to the section: Findings - Qualitative analysis.

As seen in the Figure 3, communication and social applications take the lead in terms of frequency of use. It appeared to us as an interesting revelation that the hierarchy slightly changed when it comes to the logged events where an application directly caused the JoMo algorithm to trigger - Figure 3b. This shift prompts us to theorize an emerging pattern, namely research participants interacting socially within instant messaging apps like *Messenger* would click links leading them to other applications such as forums and image boards such as *Instagram* or *Reddit*.

We do acknowledge that such a small sampling size is not representative for larger groups, however within the tested group of participants we did manage to observe certain hints of smartphone usage habits throughout the day. The Figure 4 describes a temporal distribution of JoMo disruptions per each logged application. We can observe that during the mid-day, social applications take a small lead over messaging applications compared to late afternoons and early mornings. Conversely, we believe that grouping the applications into categories and scheduling the time windows for the algorithm to interact with said groups could be a beneficial addition, as further discussed in Future work and limitations.

FINDINGS - QUALITATIVE ANALYSIS

In this section, we approach four themes that emerged from the two interviews we conducted with each participant. We discuss about the phone's role in one's life, how people have unwritten rules to comply with social expectation of using/ not using a mobile device in certain situations. In addition, we examine how the participants reacted to disruptions and what were their reflections on their mobile use.

Role of the smartphone

As part of the study participants were asked to categorise the role their smartphone plays in their life and categorise the types of apps they use and why. Many participants described picking up their phone for entertainment while they were bored *"Whenever I'm feeling bored, I just pick it up."* (P1), *"I think sometimes I get bored and try to see what's new on Instagram or Facebook "* (P2). These apps categorises as entertainment included social media sites such as Facebook, Instagram or Reddit, media content apps e.g. Netflix or YouTube.

Others described their smartphone as a tool for finding practical information to help plan their day, *"Checking what's the time? What's the weather before going outside or planning?"*, *"If I need to take the train. When is the train?"* (P6).

Participants also identified that communication as an important role of the smart phone, *"I use it to keep in touch with my family"* (P5), *"Plus I am an international in another country. The only way I can get in touch with my family is, you know, messenger, WhatsApp."* (P6).

Another common category was used for access via 2-factor authentication to access important work email or other secure web services such as online banking.

> *"Yeah it's very important. E-boks, access to my bank, my finances. Like even if I use my computer. The double step verification and that's always through phone. So I also need my phone at work when I log onto OneDrive. So it's like a key access, key to many things." (P6)*

When asked if participants could live without their phone, 2 factor authentication and communication often were cited as major reasons why they couldn't give up their phone even if they wanted to.

> *"So I considered it, but I don't think it's possible. I want to stay in touch with my family and friends. I mean, there's still some old people that don't have smart phones, but our world isn't really designed for it anymore." (P7)*

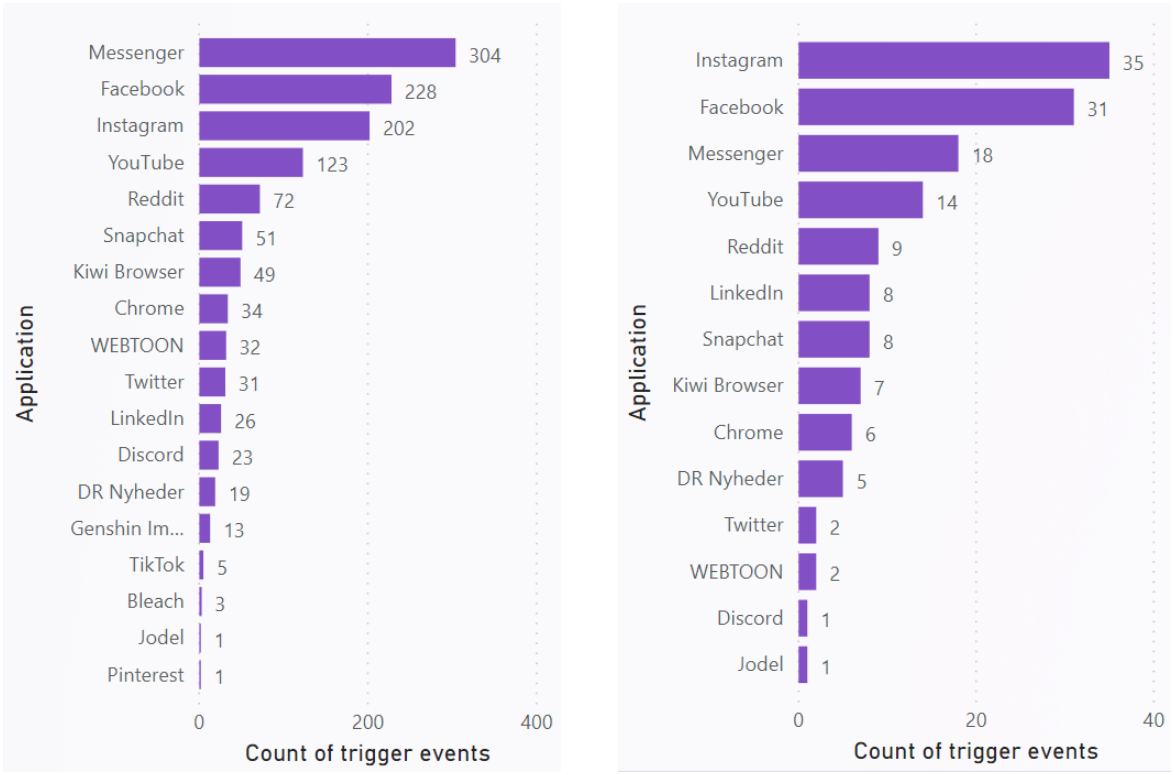
The participants identified many uses for their smartphones which would dynamically change throughout the day, depending what they were doing, who they were with or other contextual factors.

Self governing of smartphone use

The ubiquity of smartphones in everyday life determined many of our participants to develop self-imposed rules when it comes to phone usage. However, most of these rules are regarding social situations in order to avoid phubbing(*the act of snubbing someone in a social setting by concentrating on one's mobile*

Participant Number	*Profile*	*Phone usage level*	*Version of JoMo*
P1	21, Female, student	High	Dimming
P2	28, Male, construction	Medium	Dimming
P3	28, Female, Data Administrator	Medium	Dimming
P4	34, Male, Senior Software Developer	Low	Dimming
P5	24, Male, student, software developer	Medium	Dimming
P6	25, Female, Marketing assistant	Medium	Dimming
P7	27, Female, front-end developer	Medium	Daltonizing

Table 1: List of participants



(a) All instances captured by algorithm

(b) Instances that triggered the disruption

Figure 3: Distribution of applications captured by JoMo

phone[10]). For instance, when talking about using the phone around other people, P1 reported that:

> *I don't have my phone nearby, it's either in my purse or on mute because I'm trying to give my full attention to people around me. (P1)*

Moreover, social expectations have a role to play in these kind of situations. It is considered to be disrespectful to pay attention to your phone when spending time with others.

> *I don't like being on my phone that much when I'm around people. Because it's kind of rude.(P7)*

Even if hard-imposed rules do not exist, there is still self-awareness to not over-use the phone in social settings, such as dinner with friends or family.

> *I also use the phone on social media when I'm with the friends, but not so much as I'm using it when I'm alone. (P2)*

As a result to social context and self-regulating phone usage, the majority of the participants end up extensively using their phone when they are alone. According to them, JoMo was consistent with this pattern, since it was triggered mostly when the subjects were by themselves:

> *I was mostly alone when the app triggered.(P1)*

> *While being alone, I haven't been using my phone too much around people or at all. (P6)*

These findings demonstrate that phone usage can be dictated by one's environment. Moreover, social expectations can greatly influence the behaviour associated with smartphones.

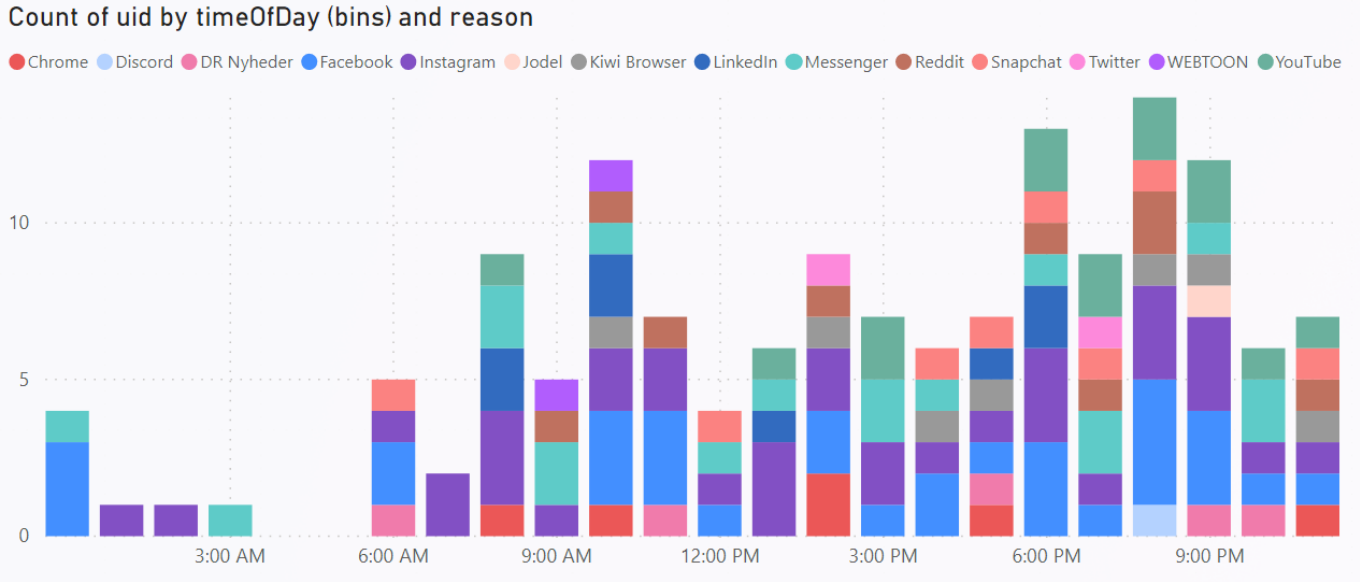


Figure 4: Disruption triggers by time of day and application name

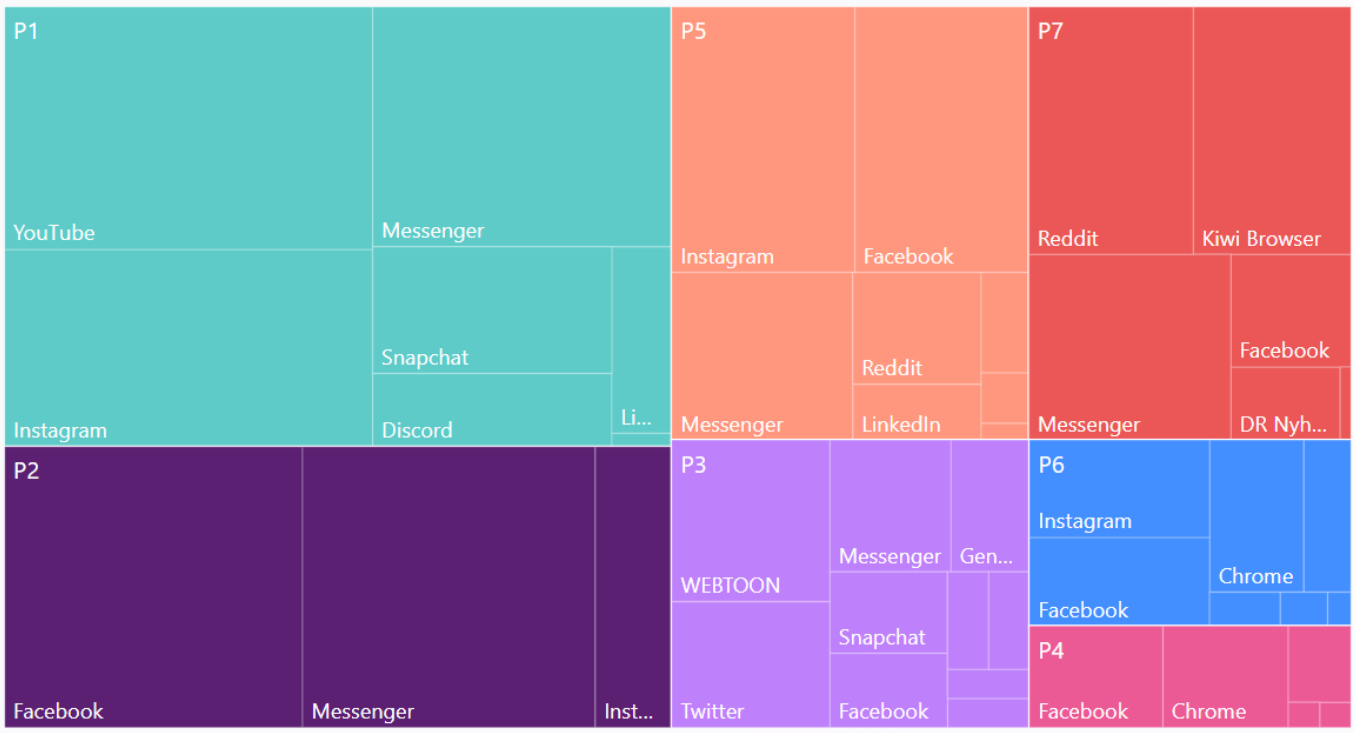


Figure 5: Disruption triggers by participant and application name

User's response to disruption

Interaction with a smartphone is a highly personalized experience, which was also reflected by the reports from our study participants. Nevertheless, we managed to categorize certain patterns when adapting to the disruptions introduced by JoMo. The majority of participants gravitated towards negative feelings associated with the disruption.

> *Sometimes. Yes. If I wanted to use the social media. I couldn't, if I was doing something like entering and exit, and enter again, it was a pain in the, you know, but yes, sometimes it wasn't.(P1)*

It was anticipated for the application to conjure an amount of negative emotions associated with the disruptions, as outlined by *P1*. The frustrations often stemmed from switching the

applications when the algorithm indeed properly recognized the open-close style of interacting with a phone. However, when shedding light onto the broader context of an interaction, it would promptly turn out, that such interaction was justified and within acceptable boundaries of using a device mindfully. In words of *P5*:

> *For example, if I have a message on a social media platform that contains some information about some other thing, which it's maybe on another social media platform, I kind of have to juggle between those two apps in order to get the full context of the message. And that's case when it triggers, since I will be switching between multiple applications.(P5)*

In a role of a balancing point on the spectrum of responses, a participant *P2* did acknowledge the intrusive design, however it was not too annoying to them:

> *It was okay. I think it didn't bother me too much, like to get crazy, but sometimes I was trying to listen to some music and do this, get on Facebook or Insta and my lights on the phone goes like too low and it did bother me a little bit, but not too much.(P2)*

As a result of the study we have also noticed, that several participants would notoriously override the screen brightness settings to cancel out the, so called punishment and go about their day:

> *Q: So there wasn't any situation when the dimming just went down and you said maybe that's enough phone for now?*
>
> *A: I think like maybe once or twice, but not that often. I mean, mostly I would just override it because I'm stubborn.(P1)*

At this point a distinct division can be made where we can group impressions of the participants based on whether they were willing to change their mobile phone habits before the study had taken place. In this category we were able to single out participants *P4* and *P5*, who during the interviews indicated willingness to do so.

An interesting case was made by participant *P5*:

> *Uh, I would guess at least in the beginning or kind of overall during the week, it kind of felt like a parent was watching me and you know, knowing that I had it (the feeling), whenever I was triggering that screen dimming, most of the times I was just putting my phone back in my pocket, unless there was something that I really needed to do.(P5)*

During the interview, the participant did not refer to the experience of the JoMo disruption as annoying, but rather supervisory and comparable to a parent or a personal trainer. Paired with aforementioned prior willingness to change one's own phone use habits, JoMo has proven especially efficient as majority of the time, the participant had decided not to override the brightness settings:

> *Probably 7 out of 10 times when I noticed the screen was dimmed, I just kind of gave up and I'd just put my phone back in my pocket.(P5)*

Additionally, it was also indicated on few occasions that the method of disruption - dimming, was considerably restrictive at times, especially in certain light conditions, which further deterred participants from using their mobile device or pushed them over the edge and encouraging them to override the settings manually:

> *Well, considering I have the dimming version a bit annoyance is the wrong word, but as it dims more it's not readable. It's a case of you now have to set the illumination back again. So of course it makes you realize that you're now at where you are now. Well, we're switching quite fast between two apps. But besides that, it wasn't that big.(P4)*

The one participant with a grey-scale version of the application exhibited more ease when dealing with the effects of the JoMo disruption. The experience requires a different mental effort. While still disruptive, it wouldn't be an experience-breaking obstacle:

> *It's more like an obstacle. Maybe it's like that, because often I would just like be mindlessly scrolling and then as soon as it turns black and white, I cannot do that anymore. (...) It's less relaxing to look at stuff that I'm used to looking at in color, you know, and the black and white it's the stimulating in a way as well.(P7)*

Having the participant *P7* describe their experience as an obstacle none the less, but requiring a different mental effort was a vastly different sensation compared to the previously discussed screen dimming disruption. The participant reported still being able to use the phone, however they would subconsciously be deterred by the extended cognitive load caused by the lack of colors. Similarly, a point was made that if in addition to the grey-scale, the app screen icons were scrambled they would further struggle with using their smartphone as they point out heavily relying on muscle memory associating applications strictly with their color.

> *it would also be a problem if we moved the apps around, I think it's also like muscle memory. Like where is it placed? But it tells a lot about the color.(P7)*

User reflections

Comprehensive awareness

Through interactions with Jomo we gathered insights into our participants reflections on their usage habits and their awareness of those habits. P1, P2, P4 and P5 reported more mindful reflections about their phone, a common theme being if their time spent was as useful or productive as it could be.

> *It kind of is helpful because I entered that cycle of entering and exiting and entering and exiting apps. So it kind of makes you more aware that you're just spending useless time on your phone, not doing really anything productive. (P1)*

It had suddenly made me aware that, oh, you just switched between the two apps quite fast of each other. Are you actually spending your time wisely? Now, could you be doing something not on your phone? (P4)

But as soon as I saw this screen going down, I was thinking, okay, guess I wasted enough time. I should probably do something more productive. (P5)

P3 and P6 both reported more neutral reflections on their mobile use habits as they felt they were in a good place with their phone usage and didn't see a need to change.

I have a healthy relationship with my phone and I don't want to change it. (P3)

Q: Has this study made you think more about how you use your phone?

A: I think I've become a bit more aware how much I jump between them (apps) but otherwise not really. (P6)

P7's reflections were a bit more complicated in that she had conflicting feelings regarding her usage habits, first she compared her usage to being like an alcoholic.

Q: You don't like thinking about your usage?

A: no because then it makes the usage less enjoyable.

Q: In what way?

A: I have to admit the problem. No.. again, I sound like an alcoholic(...) Because it's a lot of hours of my life. I use looking into a small screen instead of doing something fun out in the world. (P7)

However, later on she shared that she felt her usage wasn't negative when done to unwind or relax.

Maybe I could use my time more useful things. But it's also just a way to unwind and relax. So I don't see it as a negative thing in general, but when it gets too much like when I go up to four hours a day it sounds like I have a problem. It doesn't feel like it necessarily, if no one except me knows that I'm using it's four hours though. (P7)

In this quote she admits four hours of use is a lot, however, it seems to only be a problem if other people are aware of it. She also goes on to justify and defend her use in that it doesn't interfere with her daily tasks at home or at work.

I'm still a functioning human. Like I still do chores at home. I still go to work. I get my work done as well. So it's just, it's not like I'm on Reddit while I'm at work. So no, I don't think I have an actual problem. (P7)

These last two quotes suggest that P7's self perception on whether her usage is problematic or not is dependent on external context factors.

Interestingly a few participants also described JoMo almost as if a nagging parent watching over their phone usage.

Okay, fine. I overused my phone. Don't nag me. (P3)

I kind of felt scolded for being too much on my phone. Kind of like when your mother says. (P5)

Relative perception of functionality

As initially outlined earlier in User's response to disruption, we observed a mixed response to both the general JoMo experience as well as the disruption algorithm itself. Participants, who admitted that they would like to change their mobile use habits, perceived JoMo significantly more positively.

It's good to be punished sometimes to realize you're using it(the phone) too much. (P2)

On the other hand however, a significant portion of participants fundamentally disagreed with such sentiment. A number of people claimed the application to be annoying and they felt as though JoMo was punishing them for using their time on their smartphones.

I was upset because it distracted me from what I was doing I believe and I got the punishment that the screen went dark and I had to do something about it. (...) I think that when the screen turns darker and you are forced to change it so you can go on with your activity is kind of a punishment, you are being stopped, you can't continue what you started unless you change that. That's why I see it as a punishment.(P6)

While such opinion overlaps with participants who wanted to change their phone habits, the other group displayed more negative emotions during the interviews, which prompts us to conclude that while it was certainly expected to instigate emotions within people with this experiment, perhaps systems like JoMo when released in a real world scenario, should be carefully targeted and adjusted to assist people with changing their phone use instead of needlessly and negatively affecting stress levels.

Looking from the perspective of the preservation of one's self in modern-day tech-mediated reality [19, 21], an argument could be made that the behavior of our study participants can be attributed to their most primal self-preservation mechanisms. It seems like the participants who spoke out negatively about JoMo, relied heavily on smartphones as a medium of communication and manifesting their self in online societies. At the same time the participants happy with the effects of JoMo disruptions perceived their mobile devices as a tool above all and were able to draw the line more clearly between their online self and physical self. As *P5*, who was content with the effects of JoMo, defines his relationship with his mobile phone:

I would say it's a tool that is useful in a lot of scenarios and given also the nature of my studies and my work, and also some of the hobbies in some ways, everything is digital. I'm not sure how I could go for instance, a day without using it or probably I could go, but it would be a bit more difficult.(P5)

Interacting with systems, which continuously quantify the smallest aspects of people's existence and especially being aware of such procedures taking places has a significant impact on human psychology. Therefore, we believe that we can attribute this polarized perception of the experiment by people's prior intentions and their relationship with their phone.

User expectations and justifications

Although most of the participants were aware of their interaction with smartphones, some of them still feel like JoMo triggered at inappropriate times. For instance, looking up information on google shouldn't be counted for:

> *I think the case was someone updating something on Facebook. And I just checked out on it in the same essence, a question I wrote. So could you look up data and I switched to Chrome. So in that case, I actually was trying to do something on phone, meaning that I changed back the illumination to normal and then answered the question and put away the phone. I was using to phone with a purpose, not just to pause. (P4)*

In some cases, switching between apps is necessary in order to access the needed information:

> *I actually needed to multitask in order to get some information from one place to the other, which was kind of like back and forth between two social media applications. (P5)*

Additionally, P1 was scared in one instance of JoMo's trigger. The app dimmed the screen while she was using the phone at a red light, while driving. The panic was originated from the fact that she wasn't aware of her phone usage in that moment.

> *I thought my phone was broken because I kept on opening it. And when I would open it, the light would go down and I didn't know what happened. I literally panicked. (P1)*

Asked about the habit of using her phone while driving, she argued that she wasn't *really in motion* while checking a message that she was expecting. Nonetheless, JoMo was effective in this situation, because it made P1 stop using her phone.

> *After I realized it was the app, it made me not look at my phone anymore, so that worked perfectly. (P1)*

A recurring subject during the post-study interview was the need to curate the black-listed apps. P1 noted that she would remove YouTube from the list because she mainly uses it in the background:

> *I'm mostly using it for music, for podcasts. So I don't really need to be watching the screen. (P1)*

Furthermore, communication apps, such as Messenger or WhatsApp, were not considered to be time-wasting. Participants use them to communicate with family and friends, though having a well defined purpose. On the contrary, P5 would add the default browser to the blacklisted apps, because it can be *a big time-waster*.

The joy of missing out

One area we were interested in was whether disengaging from the phone would lead to any benefits for our users, prompting the name of the app JoMo, "joy of missing out" in the hopes our participants would find joy away from their phones. For P1 and P2 they experienced some of these benefits.

> *"It kind of makes me feel at peace. I don't know if happy is the right word, because you know, you're not having this subconscious thought of comparing yourself to other people that you see online or having that fear of missing out because you see people having fun and you're at home doing work. So, yeah, I'm a lot more I'm calmer actually. (P1)*

> *It makes me realize, like we need to live more in the real life and less in the virtual one. (P2)*

However, many of the participants stated they felt they got very little from JoMo if anything at all.

> *I don't get that much out. I don't get anything positive out of it. (P7)*

> *It's just there. I don't have particular feelings about it. (P3)*

DISCUSSION

Our study was successful in disrupting smartphone use habits especially regarding the Open-Close pattern described where users would hop between apps possibly signalling a desire for diversion. Through our thematic analysis we also highlight empirical insights into how to maximise benefits from phone use and reduce negative well-being outcomes. In this section we will discuss these findings and their implications for HCI researchers.

Designing for reflection through disruption

Designing JoMo to try and optimise digital well-being was not a straight forward task as determining what use is good or bad is highly subjective and contextual. Studies into non-use approaches have been successful in increased positive outcomes such as feeling more present with loved ones[7]. However, complete lockouts are problematic as some users report increased feelings anxiety in situations of forced lockouts which could be in part due to societal expectations to always be available and reachable or from the fear of missing out[4].

JoMo tackles these design constraints by targeting one particular negative usage pattern namely habitual use when bored[4, 31, 37]. Using our insights from our previous study in which we later identified the Open-Close pattern as indicator of this kind of habitual use helped inform our design choices. This led to our design for JoMo to be disruptive by adding an obstacle to the usage through dimming or daltonizing when detecting the the Open-Close pattern.

This approach was successful in making users reflect on their usage, especially when engaging during periods of mindless switching. However, as we learnt from our thematic analysis JoMo as deployed for the study was far from perfect. Insights such as JoMo triggering when trying to look up important information or when trying to unwind and relax after completing daily tasks were met with annoyance and frustration. Contextualising mindless app switching is difficult in some situations, for example how do you distinguish between someone who uses web browsers to look up important information related to work or travel versus some who searches for cute

pictures of kittens? Also while digital media use when procrastinating tasks is linked to negative outcomes, use when recovering from mental or physical exhaustion has been linked to increased feelings of positive well-being[31]. This poses a very difficult contextual element for determining negative usage habits as both usage patterns are similar but the external factors of the users responsibilities determines if the use is positive or negative[31, 37].

There is no one solution that fits everyone's needs, therefore a need to tailor JoMo to the individual is necessary. Designers and HCI researchers would need to take into consideration users current app usage habits, temporal factors such as working hours or free time and other social contextual factors for JoMo to be effective in optimise user's digital well-being. One improvements we would suggest are the ability to categorise apps into groups such as work, entertainment or communication to allow for black or white listing of entire categories. Another improvement would be to have JoMo only trigger within certain time periods, for example during working hours or in free time.

Insights into phone usage habits

From our interviews and thematic analysis we gained many insights into how users view their devices and their phone usage habits in different social settings.

The participants shared some views regarding the phones role as a useful tool for services such as MFA(Multi-Factor Authentication), online banking or staying in touch with loved ones. However, while some saw their devices as purely a tool, for others it was also a way to pass the time when feeling bored or seeking distraction. We can see a split between the participants P1, P2 and P5 who engaged in habitual use to pass the time while bored while P3, P6 and P7 would more purposefully engage with their phones as a way to unwind and relax after doing their daily tasks / chores. P4 actively avoided using their phone beyond responding to social obligations or work related tasks. Interestingly these divisions correlate with the number of times they triggered JoMo as seen in 5 with P1, P2 and P5 triggering JoMo the most, P3, P6 and P7 triggering JoMo less and unsurprisingly P4 triggering JoMo the least even despite having a lower trigger threshold than anyone else in the study. In our findings where P3, P6 and P7 described JoMo as a punishment and experienced negative feelings toward the app. This could be explained by the fact they self-reported they felt their usage wasn't problematic and had no desire to change their phone usage habits which may. Conversely P1, P2 and P3 who expressed desire to improve their usage habits reported benefits from using JoMo. These findings would confirm findings in other papers that when using the phone for meaningful purpose or recovery from exhaustion users experience positive feelings in well-being whereas when used to procrastinate or from internal habitual triggers when bored resulted in less meaningful interactions and negative well-being outcomes[37, 31, 26].

An interesting observation from our analysis was that participants would trigger JoMo the majority of times when alone. Many of the participants expressed having self-governing rules about using the phones when in social gatherings. Expressing that using the phone was rude and impolite suggesting in certain social contexts users become more aware of their phone habits. This is not the case when users are alone which is when JoMo triggered in the majority of cases. This suggests that when isolated, participant's ability or desire to self-regulate their phone usage disappears. P7 in particular reflected that she felt that her usage time was high with over four hours in a day, but clarified that if no one knew how much time she spent on the phone it wasn't a problem. These findings support the idea that societal norms play a role how we use our smart devices[4], not only in expectations of being always reachable but also general acceptance that using your phone in social gatherings is seen as rude or impolite to others.

While we feel JoMo can be beneficial to helping minimise excessive meaningless use, we want to highlight these benefits are dependent on a number of contextual factors both internal and external. These factors include, does the user have a desire to change their habits, their motivations behind their hedonistic seeking activities, for example are they seeking to alleviate boredom or recovery from exhaustion? Are they in a social setting where phone use socially acceptable? One example highlighting the importance of these contextual factors is with P2 who experienced a disruption while driving, while initially causing panic in the participant it was successful in disconnecting them from their phone. However, this could easily change if the driver was following a navigation app, a disruption could cause more of a distraction and difficulty navigating in the best case and potentially dangerous accident at worst. These factors create a challenge for application designers and researchers to design for more mindful ways to disconnect and to balance user's digital well-being.

FUTURE WORK AND LIMITATIONS

Given our current findings, we believe that research can be further conducted to develop solutions towards a better balance in digital life. On one hand, exclusive non-use can lead to someone feeling like they are *socially deprived*(P1). On the other hand, overusing can have negative effects on someone's mental well-being, according to some of our participants. Future work might also include developing JoMo as an app to include functionalities such as user self-defined overuse patterns like scrolling too much on a single app or deciding what apps should be monitored for the open/close trigger. Another idea that was suggested by P4, was to make JoMo time dependent. During work hours it should monitor apps that can be considered as 'leisure', and on free time it should monitor work apps. In this way, the user could be nudged to remain focused at work, and to remember to relax in their free time.

During the deployment process we encountered problems when trying to install the daltonizer version on some of the participants' phones. Due to some special system settings that are available only on Samsung phones, but not as easily accessible on other android devices, the daltonizer could be deployed only to one participant. For future work, the gray scale mode should be implemented in another way such that it works on any android device. As a result, in the end we were not able to make a proper comparison between the two versions. Another limitation could be that JoMo is exclusively an

android app, thus excluding possible participants, who prefer other operating systems.

CONCLUSION

As smartphones shape the landscape of modern social interactions, it was paramount to acknowledge the existence of both positive and negative kinds of phone use. Furthermore, focusing on the hedonic side of interactions, our research had shown that even though our prototype worked successfully in terms of creating disruptions in usage habits, it is only viable to anchor such changes when one desires for the change to happen. In such cases, our study participants were more content with the effects of JoMo and in certain instances indeed enjoyed missing out. Otherwise, the system was mainly attributed as annoying and felt like a punishment to study subjects.

Perhaps to better target nudging users to break their Open-Close usage patterns, as the participants indicated themselves during the interviews, a disruption algorithm shall recognise application categories and take into account the temporal aspect of an interaction. That mainly stems from the fact, that whether phone use is good or bad is highly contextual and may depend on the time of day. Considering an example of rewarding one's self to social media in the evening in contrast to mindless scrolling out of boredom at work. Therefore, the joy in missing out is achievable with positive effects on well-being, however is must be applied with proper nudging mechanisms and context awareness.

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APPENDIX

Check-up list before the interviews

- Make sure that the consent form is signed
- Assure the participant that he/she can refuse to answer any question
- Tell the participant that he/she can withdraw from the study at any time
- Inform the participant about the length of the interview

PRE-STUDY QUESTIONS

Demographic questions

- What is your name?
- How old are you?
- What gender do you identify as?
- What is your ethnicity/nationality?
- Where do you live now? (Country/ maybe city)
- What is the highest degree or level of school you have completed?
- What is your current occupation?
- How many smart devices do you have?
- How long have you had your (current) smartphone?
- Family situation

Mobile habits

- How much time do you spend on your phone on a daily basis? Do you think this is a lot or too little? -> ask for actual data after and in the end ask if they are surprised
- In what situations do you think you spend too much time on your phone?
- What kind of apps do you usually use? (Category wise –let them categorize them) Ask for screen shots for the apps they used in the last week
- On what apps do you spend most of your time on? Why?
- Why do you usually pick up your phone? Give 5 situations.
- What do you usually do when you want to break your phone habits? Give examples.
- Have you ever used detox apps? Why? For how long?

Feelings towards mobile use/habits

- How do you feel about your phone?
- What do you think/feel about your mobile habits?
- How do you feel when you are not in the vicinity of your phone? Both when you think you lost it, and when you consciously leave it behind.
- Do you think that your phone/apps affect your mental well-being? If so, how?
- Name 3 apps that give you positive feelings and 3 that give you negative ones.
- What other people think of your phone usage habits? Have they commented on your phone use?

Opinions or beliefs about mobile use

- Do you wish to change your mobile habits? Why? What? In what situations?
- Do you think you could live without your phone?
- Do you think you could maximize the benefits of the phone, while reducing your screen time? How?

Final question

- Is there anything else you would like to add?

POST-STUDY QUESTIONS

Warm-up questions

- How was the last week?
- How would you describe your experience of using JoMo?
- Did the app trigger?
- Do you think that the number of triggers were enough/too many?

Mobile habits

- Do you feel like your mobile habits changed during the past week? If yes, how?
- Can I see your statistics for the last week? -> show them the comparison and ask how they feel about it.
- Do you think that JoMo was effective in breaking your usage patterns? If yes, please describe how, if not describe what you think should have happened.
- Did using JoMo made you more aware of your mobile habits? How?
- Did you stop using your phone when the dimming/daltonizing effect appeared? If yes, what did you do instead?
- Do you have any kind of mobile use patterns that you consider to be problematic?
- Is the app annoying? Why?
- Did you spend more time on whitelisted apps?
- Did JoMo trigger when it shouldn't?
- Did you overwrite the dimming? How often? In what context?

Did it triggered more when you were alone or in a social context?

-> Expand on answer

Feelings toward JoMo/ new mobile habits

- Do you feel like the relationship with your phone has improved?
- Do you think that a healthy mobile phone usage would have positive effects on your mental health? And do you think that you can achieve that with the help of JoMo?
- Do you think that JoMo was effective? Why?
- What do you think about the dimming/daltonizing effect?
- Do you think that the effect made you more aware of overusing your phone? How did that make you feel?
- Do you think that JoMo should trigger in other situations?
- Did JoMo made you more aware of other people's mobile habits? Did you share your thoughts about this with them? How did they respond?
- Would you like to keep JoMo? Why?

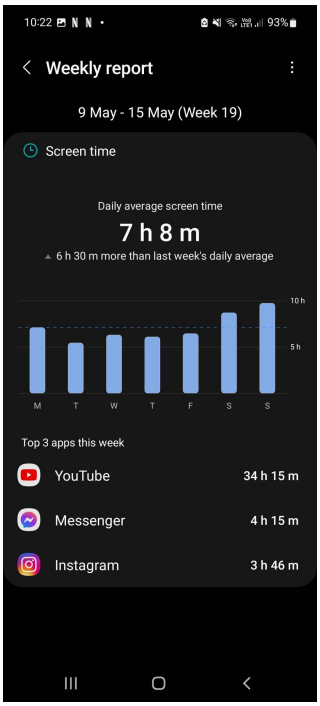
Opinions or beliefs about mobile use

- Did your opinions on mobile phone usage have changed?
- Do you think JoMo would be a good app to help other people with problematic phone usage?

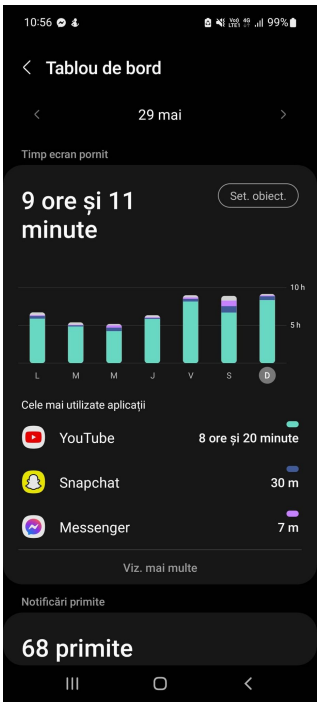
Final question

- Is there anything else you would like to add?

PARTICIPANTS SCREEN TIME

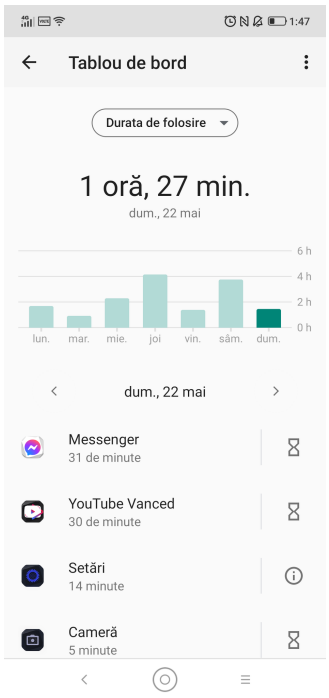


(a) Pre-study screen time

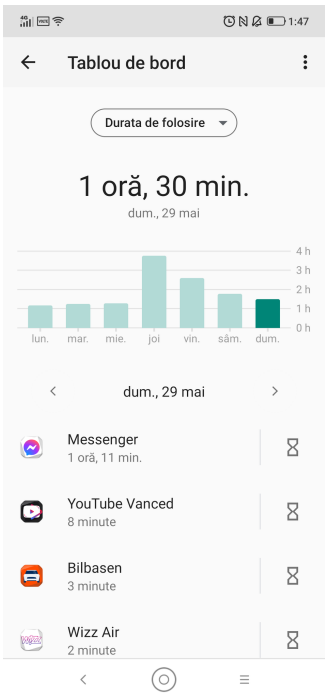


(b) Post-study screen time

Figure 6: Participant 1



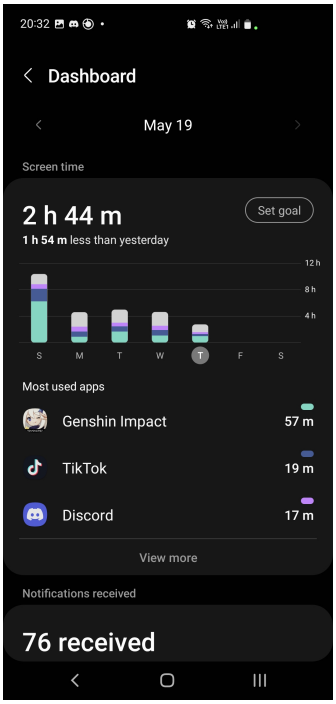
(a) Pre-study screen time



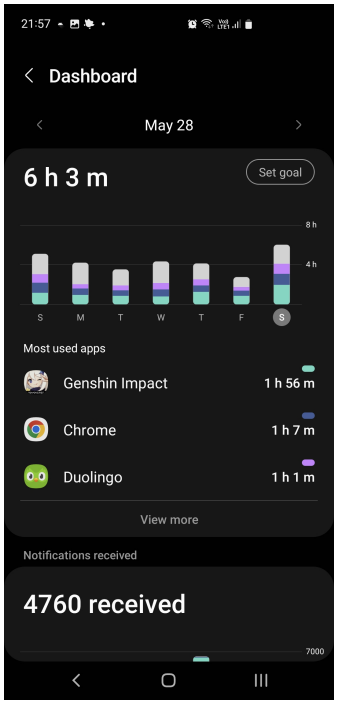
(b) Post-study screen time

Figure 7: Participant 2

OTHER PICTURES

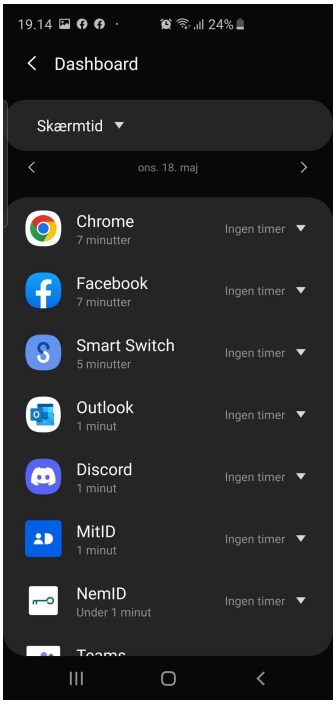


(a) Pre-study screen time

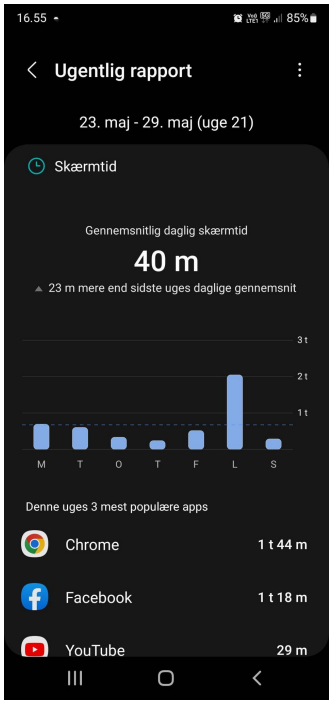


(b) Post-study screen time

Figure 8: Participant 3

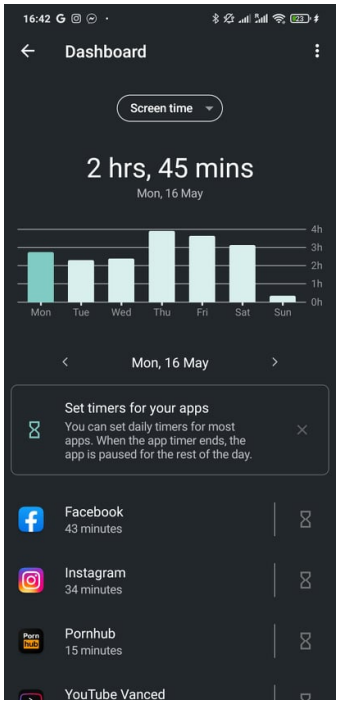


(a) Pre-study screen time(this photo includes only one day because the participant just had changed phones the day before the pre-study interview.)



(b) Post-study screen time

Figure 9: Participant 4



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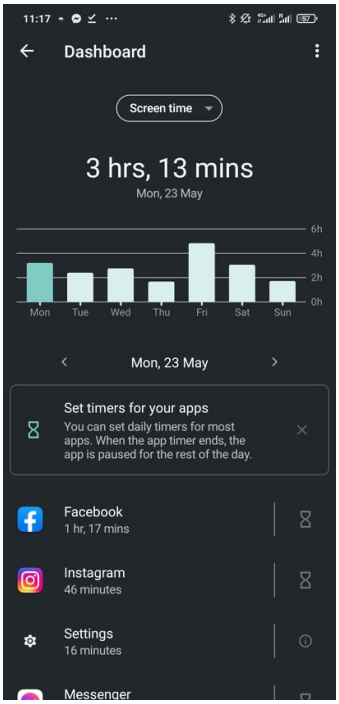
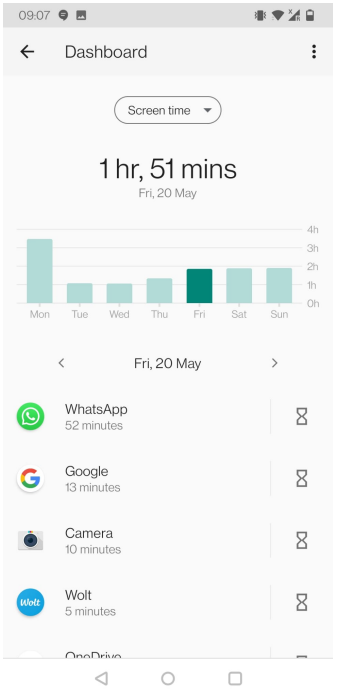
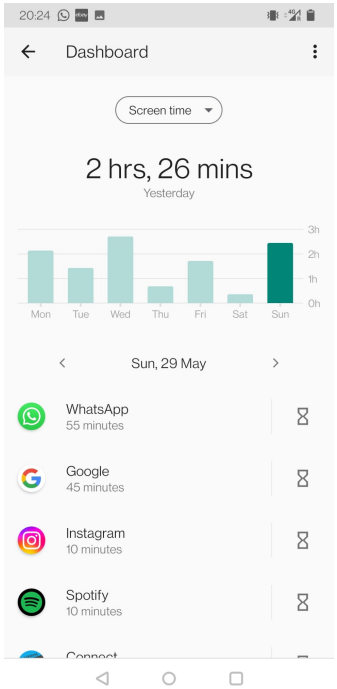


(b) Post-study screen time

Figure 10: Participant 5

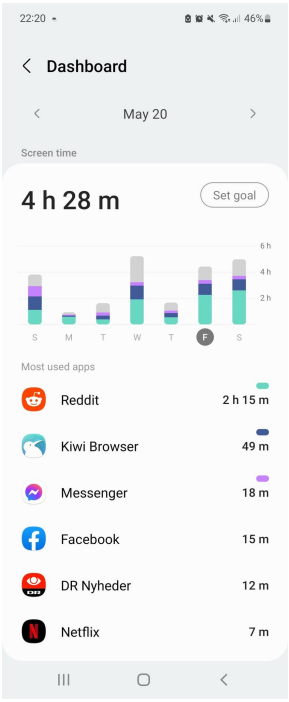


(a) Pre-study screen time

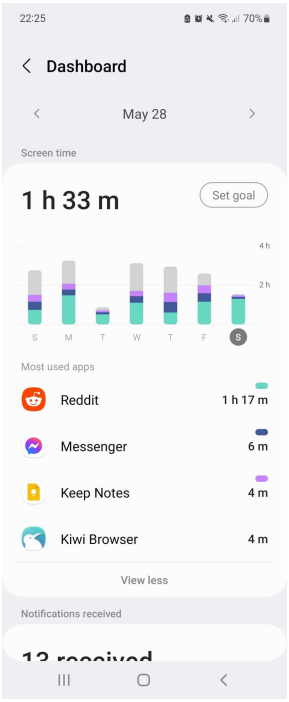


(b) Post-study screen time

Figure 11: Participant 6



(a) Pre-study screen time



(b) Post-study screen time

Figure 12: Participant 7

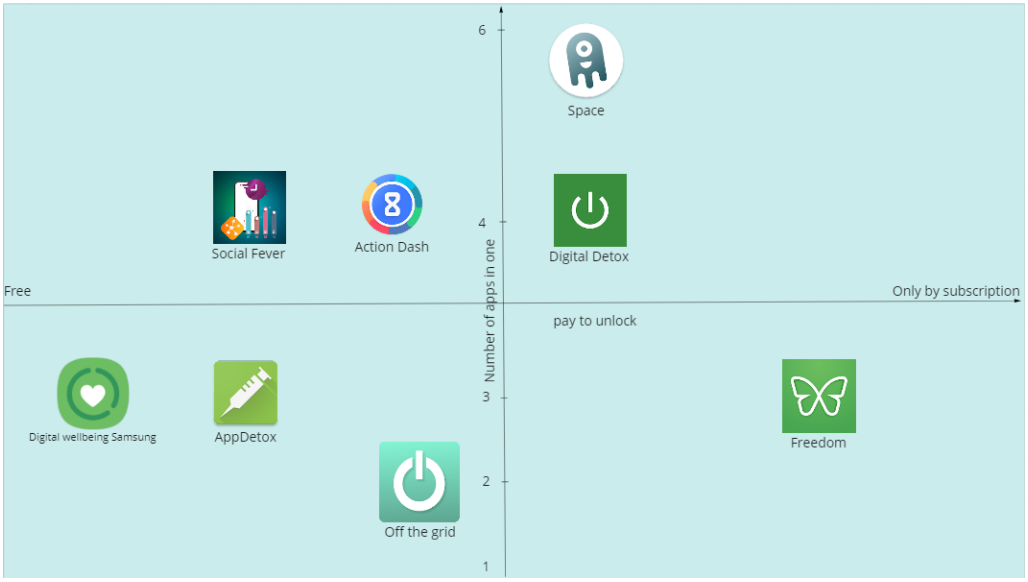


Figure 13: Apps classification x axis: paid price for the app, y axis: numbers of apps within an app