Notification Impact on User Autonomy

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Abstract:

In this thesis, we investigated the impact of smartphone notifications on user autonomy, guided by (Aylsworth and Castro 2024)'s framework. Our two-week study involved 6 participants experiencing periods with notifications both enabled and disabled. Using the Day Reconstruction Method (DRM) and StayFree app for data collection, participants reflected daily on their notification experiences through diary entries. Interviews at the study's end provided deeper insights. Our findings suggest design strategies such as a notification-free baseline and implementing broader guidelines to reduce user responsibility. We challenge the view of "external constraints" by integrating "internal constraints" into autonomy theory, acknowledging how users interact with their environment.

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Resumé

I denne afhandling har vi undersøgt smartphone notifikationer og deres påvirkning på brugerens personlige autonomi. Dette er opbygget omkring (Aylsworth and Castro 2024) og deres definition af autonomi i forhold til smartphones. Vi har foretaget et to-ugers langt studie, hvor vi har undersøgt seks forskellige brugers oplevelse med at have henholdsvis notifikationer slået til og fra. For at indsamle data til dette studie har vi benyttet os af Day Reconstructive Method (DRM), hvor vi bad deltagerne skrive om deres oplevelser med notifikationer på smartphonen i en dagbog efter hver dag. For at hjælpe deltagerne med at erindre deres dag har deltagerne downloadet applikationen, StayFree, som giver dem et overblik over deres forbrug for hver dag. For at koble dette til autonomi, har vi opstillet tolv spørgsmål i dagbogen, som de skal tage stilling til. Vi har taget en abduktiv tilgang til dette, hvorfor vi har bedt deltagerne om kun at notere de mest bemærkelsesværdige oplevelser. Efter endt uge har vi foretaget et interview med hver deltager, hvor vi beder dem om at fundere over og uddybe disse oplevelser.

Ud fra dette studie, har vi udledt en række designimplikationer for autonomisk design, som kan bidrage til at skabe mere etisk og brugercentrerede oplevelser i forhold til notifikationer på smartphone. Nogle af de mest betydningsfulde fund inkluderer et udgangspunkt uden notifikationer samt en reduktion af brugerens ansvar gennem implementering af retningslinjer for notifikationer på et overordnet niveau. Vi udfordrer opfattelsen af udelukkende "eksterne begrænsninger", som beskrevet i (Aylsworth and Castro 2024), og har i stedet observeret et mere nuanceret billede. Derfor integrerer vi "interne begrænsninger" i teorien om autonomi og hvordan brugeren påvirkes af deres omgivelser.

Contents

Introduction

In contemporary society, the smartphone has become an indispensable part of most people's everyday lives, with a multitude of individuals relying on its various functionalities, many of which are convenient. In Denmark, a significant portion, 95% of the population between the ages of 16-44, as of 2020, owns and uses smartphones in their day-to-day life, which reflects their widespread adoption and integration into daily routines (Tassy and Bille Nielsen 2020).

However, alongside these conveniences, the negative aspects of smartphone use have also been recognized. Recently, the European Parliament acknowledged these concerns by previewing new EU regulations in December 2023 aimed at combating digital addiction (Yakimova 2023). They call for a move away from the current attention economy and towards ethical design by targeting, among others, the current utilisation of notifications. Therefore, they proposed the *Introduction of a digital "right to not be disturbed"* (Yakimova 2023). This refers to the invasive influence of notifications and a proposition to turn off notifications by default as well as make notifications less misleading and addictive (Yakimova 2023).

As smartphones undergo continual development, new features and applications are added daily. The growing number of applications on our phones results in an influx of notifications, each demanding our attention. This constant barrage conditions us to instinctively respond to notifications, leading us to develop habitual responses whenever we receive messages or alerts (Lukoff et al. 2018). Problematic smartphone features and design choices such as these can lead users to a feeling of lost autonomy, a consequence stemming from the behavioural changes in our habitual use of the smartphone (Lukoff et al. 2018).

Loss of autonomy can be described as acting without the experience of choice (Lukoff et al. 2018). This feeling has been studied in conjunction with overall smartphone usage and has found that there is a correlation between the two (Horwood and Anglim 2019). More specifically, these studies also indicate possible causation between push notifications and the feeling of loss of autonomy (Lukoff et al. 2018).

This may be a problem as people with a low sense of agency can be more easily influenced by the rewards or triggers that smartphones send out, such as notifications. These notifications can also contribute to a lack of agency, as many applications do not allow users to selectively enable or disable specific notifications (Horwood and Anglim 2019). This

results in the user having to make the judgement if they are willing to possibly miss important notifications. If the user knows they sometimes receive important notifications from one app but also receive a lot of unimportant notifications, the user often settles and leaves the notifications enabled (Horwood and Anglim 2019). Notifications, in general, foster a culture of constant connectivity, limiting time for reflection and regeneration. Individuals become habituated to preemptively check their smartphones or automatically respond to notifications (Peper and Harvey 2018). This is also apparent to some individuals who are actively choosing to disable certain features of their smartphone, such as notifications, which is a form of "non-use".

Overall, "non-use" is the opposite of use and covers an active action where a person decides to abstain from adopting or utilizing a particular technology, product, or service available to them (Baumer et al. 2014). Thus, non-use is a comprehensive term encompassing diverse modalities of abstention from different technological devices. However, in this paper, we want to focus on non-use in relation to smartphones and particularly notifications.

Non-use comes in many variations depending on how it is enacted by the user. In this particular case, the act of disabling notifications is what can be referred to as "Active Resistance" (Satchell and Dourish 2009). *Active Resistance* refers to a deliberate and considerate refusal to adopt technologies due to various reasons such as privacy concerns, management of personal data, political positions, environmental etc (Satchell and Dourish 2009). It challenges the notion that non-use is a transitional phase in which we are eventually going to adopt the technology, as proposed by the concept of *Lagging Adoption*, which refers to the idea that the non-user has simply not yet adopted the technology, but will eventually become a user (Satchell and Dourish 2009). Instead, it suggests that we are not necessarily meant to become users and it is up to us to make the conscious choice of being a user or non-user.

As suggested by this definition of non-use as *Active Resistance*, we are actively resisting the hold that technology can have on us. This refers to the idea of having agency and control over our actions and ultimately the feeling of autonomy. Therefore, it would make sense that employing this approach might lead to a greater sense of agency and a reduced loss of autonomy. Thus, we want to study this by employing non-use in the form of *Active Resistance* by encouraging smartphone users to turn off their notifications and see how it affects their use.

According to prior research, turning off notifications initially has some impact, but this effect is not enduring, as users tend to re-enable notifications after a while (Lukoff et al. 2018).

Thus, while it does have an effect, it's not a satisfactory long-term method for managing notifications. We aim to delve into how notifications influence smartphone users' autonomy by having participants disable notifications and share their experiences. This approach will enable us to thoroughly examine their impact and identify design implications that

can promote active resistance against notifications. This leads us to the following research question;

1.1   Research Question

How do notifications affect perceived user autonomy, and what implication does this have for designing notifications that increase experienced autonomy?

Related Work

In this chapter, we will examine existing work within the problem area. Furthermore, we would like to elaborate on how smartphone notifications affect smartphone users, and what existing tools and strategies are used to improve the users' digital wellbeing.

Studies show that notifications can be highly disruptive at inopportune moments, depending on the content of the notification as well as the situation in which the user finds themselves in (Mehrotra et al. 2016) (Fischer, Greenhalgh, and Benford 2011). (Fischer, Greenhalgh, and Benford 2011), investigates whether the timing of notifications has any significance on acceptance and response time. Based on their findings, they conclude that natural breakpoints between tasks not only enhance user acceptance of interruptions caused by notifications but also improve response times. Identifying these breakpoints, however, is challenging; the way users cognitively experience these pauses during smartphone interactions can differ significantly from their physical manifestations. In relation to this, the study presents three types of breakpoints: Firstly the user finished a task both physically and cognitively, which leaves them ready for interruptions, which is the ideal scenario. Secondly, the user has finished a sub-task for a larger activity. Lastly, the user already started planning a new task and is therefore interrupted (Fischer, Greenhalgh, and Benford 2011).

(Mehrotra et al. 2016) elaborates on when and why notifications are perceived as disruptive. Firstly the task and the user's progress of the task is important. If the user is close to finishing the task, notifications are seen as disruptive, if the user is idle or has just begun the task they are perceived as less disruptive. Perceived disruptiveness is also affected by the complexity of the task, the more complex a task is the more disruptive it is. Lastly, the sender and the content of the notification are important when discerning the disruptiveness of notifications, notifications from a subordinate or from an application are perceived as very disruptive, while messages from friends or family are not perceived as disruptive. If the content of the notification is perceived as important, disruptive notifications are accepted (Mehrotra et al. 2016).

Much of the literature examined for this study, uses "Digital Wellbeing" tools as a method to combat the adverse effects of notifications or push notifications. The aim of using these tools is to create better well-being when using digital devices such as smartphones. One of these studies, (Cho et al. 2020) focuses on changing the nature of how users interact with social notifications through customizable instant messaging, where the user selects

the urgency of the message. This allows the user to enact social cues which might exist in real social situations to notifications, to avoid distracting the recipient of the message at inopportune moments (Cho et al. 2020). Firstly they introduced a private status, which is customizable, and should reflect the user's current activity. These statuses were something which could be customized further, so specific persons would see specific statuses, so a manager would perhaps see "busy working", while a partner could see "available". Lastly, the study also enabled the user to hide their status till the sender of a message sent the message to reduce the feeling of being observed. These statuses enabled the sender of a message to check the recipient's status to then decide whether the message should be shown as a notification or not, based on the perceived importance of the content of the message and the recipient's status (Cho et al. 2020). Furthermore, with the increasing availability of artificial intelligence and machine learning, potential tools are being devised to filter notifications based on the user's interactions with the specific notifications and their perceived importance to tailor the users' notifications based on their preferences and needs. (Visuri et al. 2019) conducted a study in which they used ML (Machine Learning) to automatically filter notifications. The data on which they trained the ML consisted of quantitative data on the status of the smartphone, such as battery level, screen state etc. Furthermore, they also gathered data on the notifications that the user received such as the application which the notification originated from, and the content of the notification, which includes a title and description of the notification. "Notification Outcome", which entails how the user interacted with the notification such as dismissing or opening the notification was also recorded. Additionally, to label the data, they used user labels on the importance of the notification and the timing of the notification. They used user labels to determine the importance and timing of notifications. (Visuri et al. 2019) argue that the perceived importance of notifications is highly subjective. However, there are tendencies for apps within specific categories to be perceived differently. For example, news notifications are often seen as highly important, while notifications from weather applications are considered the least important.

While some of the studies focus on the momentary interruptions these notifications pose, and how to limit or filter notifications to decrease information overload and daily interruptions. Others focus on how notifications as a feature on smartphones affect users' behaviour negatively. In regards to this, notifications are described as the potential triggers for habitual checking behaviour. This habitual checking behaviour causes regrets for the individual after using their smartphone, because of the unintentional nature of the interaction (Aranda and Baig 2018). Furthermore, they argue that there exists two negative behaviour cycles for smartphone use, the first is an experience of habits and excessive use, while the others stem from an externally reinforced cycle of social obligations (Aranda and Baig 2018). To combat these negative behavior cycles the study suggests three possible solutions. The first is to facilitate disconnection through awareness and support, the second is to reduce temptations triggers to re-engage and lastly, they suggest allowing for partial disconnection (Aranda and Baig 2018).

Although the negative impacts of notifications have been extensively investigated, the potential positive aspects of this topic remain less explored. A large focus has been on the distracting nature of notifications, an article by (Chang et al. 2023) challenges this notion, by investigating the user's motivation for interacting with notifications throughout tasks. They argue that disabling notifications while eliminating the distracting nature of notifications might instil anxiety and worry about missing important information. They also argue that users are selective about which notifications they respond to and use built-in functions, such as dismissing unimportant notifications and storing them in the drawer to respond to later. They found that different motivations for notifications occur at different times throughout a task, such as replenishment while being stuck, struggling or bored throughout the task as well as notifications related to the task might lead to improved performance (Chang et al. 2023).

To conclude, many of the studies focus on the momentary act of receiving notification and how this affects users, either by

1. Examining how and when notifications are distracting and how to use opportune moments to send notifications.

2. The importance of specific notifications to the user and how to improve this.

3. The effect notifications have on individuals, such as increased screen time and notifications leading to habitual checking behaviour.

In this study we would like to contribute by examining the effects smartphone push notifications have on the user and their feeling of autonomy through factors which (Aylsworth and Castro 2024) define as potentially being implicated by digital devices such as smartphones. This knowledge can hopefully contribute to a better understanding of how individuals are affected by notifications and how to design ethical notifications that do not undermine users' autonomy.

Autonomy Framework

In this chapter, we will delve into the concept of autonomy and explore its implications in the context of smartphone usage and notifications.

To relate autonomy to the usage of smartphones and their effect on individuals, Aylsworth and Castro mention that smartphones and platforms on mobile devices utilize individuals' attention to survive, which can prove troublesome because of the users' constant exposure to their mobile device (Aylsworth and Castro 2024). By being so deeply reliant on individuals' attention to survive, it is paramount for developers to use tricks to obtain and keep people's attention on their service. To manipulate individuals to spend their time and attention on these services, and, in turn, create habits of use, Nir Eyal uses the Hooked Model to explain the process of acquiring attention and keeping it (Aylsworth and Castro 2024). The hooked model is a 4-step method on how individuals get invested in using a particular digital service or platform. The first step is using a trigger (e.g. sending a notification), to get people's attention. After getting the user's attention, the second step is to invite the user to take action (e.g. reacting to the notification). In the third step, the user is then presented with a variable reward, as a response to the user's reaction (e.g. showing the user an interesting photo for reacting to the notification). The fourth and final step is an investment where the user is prompted to contribute to the service to create a sense of investment (e.g. uploading a photo themselves, liking the photo or writing a comment) (Aylsworth and Castro 2024). While services using users' attention as a way of surviving is not inherently bad in itself, it becomes problematic with the possibility of ubiquitous computing which smartphones facilitate, since it enables services to send notifications to obtain users' attention on a different level (Aylsworth and Castro 2024). To understand how these smartphones and notifications might undermine users' autonomy (Aylsworth and Castro 2024) proposes several aspects of an individual's autonomy these might undermine. They divide them into *Capacity* and *Authenticity*. Capacity is further divided into:

- *Baseline capabilities*

- *Freedom from external constraints*

- *Absence of cognitive inhibitions*

- *Having a sufficient range of options*

Firstly, *Baseline capabilities* are divided into several sub-elements. The first sub-element is being able to maintain *attention* over an extended period, which could be affected by external and internal triggers. An external trigger, like a notification, may divert attention, while an internal trigger, such as thoughts about engaging in smartphone-related activities like replying to a message, could similarly impact attention (Aylsworth and Castro 2024). Furthermore, *memory* is also a baseline capability, which is used to describe how smartphones might affect our working memory (Aylsworth and Castro 2024). Another capability is *delay of gratification,* which focuses on how smartphones affect our expectations and reactions to gratification. For instance, individuals may prioritize checking social media notifications for immediate gratification over engaging in productive long-term activities, such as studying or exercising. Lastly, *cognitive functioning* is also an aspect which might be interesting, focusing on how smartphones affect our ability to learn and perform (Aylsworth and Castro 2024). This phenomenon is often associated with multitasking, where individuals may watch a movie while simultaneously responding to notifications on their phones, potentially resulting in reduced depth of engagement with either activity. Furthermore, smartphones could also have an indirect effect on baseline capabilities, this could be by affecting the amount of sleep users get, which might affect attention, memory and cognitive functioning (Aylsworth and Castro 2024).

Freedom from external constraints relates to individuals being forced into using specific technologies, examples could be workers having to use Slack, or students having to use digital platforms for their studies. This forced usage might have unintended and unforeseen implications, which might not have occurred if the person were not forced to use the technology (Aylsworth and Castro 2024).

The *absence of cognitive inhibitions* describes individuals' need for social validation and approval. Smartphone developers that exploit this need, can cause an absence of cognitive inhibitions for the users. An example used by Aylsworth and Castro is that while images on Instagram are heavily edited and present only the unrealistic perfect parts of people's lives, which most users of Instagram are aware of, it does not stop users of Instagram from comparing themselves to these unrealistic representations of people and their lives. This comparison can cause low self-esteem (Aylsworth and Castro 2024).

Lastly, a *sufficient range of options* could be seen as having options to choose from. This could be choosing to have a smartphone, choosing whether to have social media or not, etc. (Aylsworth and Castro 2024), turns this notion around and discusses how this might also be the option of being less connected by not using specific features on the smartphone, such as notifications. Furthermore, they suspect that this is an option many people do not feel is a viable option (Aylsworth and Castro 2024). This could be because of social expectations of being constantly connected and within reach.

For authenticity this can be divided into:

- *Freedom from manipulation and coercion*

- *Incoherent motivational states*

- *Alienated desires*

- *Adaptive preferences*

Firstly, *freedom from manipulation and coercion* relates to how smartphones and services on smartphones might use tricks to manipulate the user to interact with them, this could be the "Facebook Messenger" application that uses a "seen" status to notify the sender of a message when the recipient has received the message, which manipulates the recipient to respond faster, or the usage of variable rewards such as notifications when a uploaded picture receives likes, to coerce the user to check their smartphone obsessively (Aylsworth and Castro 2024).

Incoherent motivational states refer to discrepancies between a person's desires and their reflective considerations about how these desires impact them. For instance, how does a smartphone affect a user's ability to pursue their genuine desires? This could manifest as a user having the intention to reduce their smartphone usage, yet finding themselves unable to follow through on this intention (Aylsworth and Castro 2024).

Alienated desires, relates to how smartphones and services on smartphones transform users' beliefs and desires, through what Aylsworth and Castro describe as *"Technological seduction"*. This is caused by platforms using recommendation algorithms, which maximize profits by recommending what the algorithm believes the user wants to engage with, to keep the user engaged. This can result in the continuous recommendations of radicalizing content if, that is what accumulates ad revenue for the platform (Aylsworth and Castro 2024).

Adaptive preferences refer to when individuals' preferences are manipulated through prolonged exposure to digital devices. The preferences often change without the user realizing it. An example of this could be when an individual starts using their smartphone excessively eventually developing a preference for staying home and scrolling through their device instead of engaging in non-digital activities they previously enjoyed.

This list of the different elements by Aylsworth and Castro on how smartphones might affect users' autonomy, provides an idea of how these devices are developed to grab users' attention through any means necessary. In this study, we would like to further investigate how notifications might affect users' autonomy, through some of the aspects defined in this section as well as emergent aspects through our study.

Methodology

This study employs a qualitative approach, as we aim to uncover the participants' experiences and feelings of loss of autonomy. This qualitative approach is conducted using abductive logic, by letting the theoretic framework steer the discourse of the study and thereby delving deeper into emergent themes of significance to the framework, notifications, and the users through the interviews. Our primary methods for data collection include **the Day Reconstruction Method** (DRM) and semi-structured interviews. To complement these qualitative insights, we ask the participants to use the third-party application "StayFree" to gain information that the participants may have forgotten about their smartphone usage. This longitudinal study spans two weeks, and the participants document their smartphone usage and experiences in provided diaries using the provided DRM questions.

4.1   Day Reconstruction Method

The Day Reconstruction Method (DRM) is our main method for the study. It serves as a valuable tool for gauging daily effective experiences, offering a less labour-intensive and disruptive alternative to methods like the Experience Sampling Method (ESM) (Kahneman et al. 2004). In our study, the DRM method's primary purpose is to ensure that the participants are able to answer questions about each day individually. The participants are prompted to reflect on each day, either at the day's end or the following day, treating their experiences as a series of scenes to explore in detail (Kahneman et al. 2004). In our study, we aim to leverage DRM to prompt participants to reflect on their smartphone usage and notifications for a given day. By doing this, the answers that the participants provide us for each day can be used in the interviews to talk about individual days and experiences that the participants may not remember otherwise. This is important because we are more interested in the participants' individual experiences than in a general overview of their smartphone usage.

To aid recollection, as it is difficult to remember each preceding day, participants are encouraged to utilize the provided application, "StayFree". This app provides timelines of their activities for the given day, helping them recall the context and purpose behind their phone usage (StayFree 2023). By incorporating these reflections and utilizing the contextual cues provided by the application, we aim to minimize errors and biases in recall. At the end of each week, diary samples are collected and used to construct subsequent interviews.

The study is divided into two different parts of one week's length each. In the first week, participants use their smartphones as they normally would. At the end of each day, they review their notifications and smartphone activity using the app, "StayFree", and document their experiences in a provided diary using the Day Reconstruction Method. For the second week, the participants turn off all non-essential applications and document their experiences similar to week one. The methods that are employed and the duration of each part of the study are outlined in the timeline below 4.1.
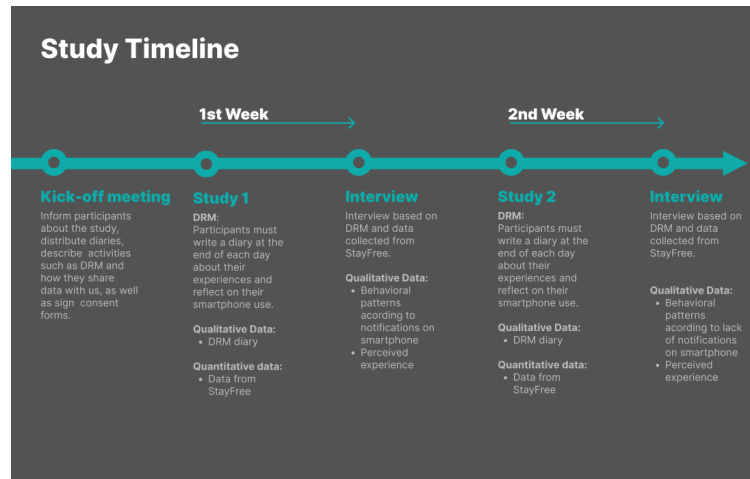

Study Timeline

1st Week → **2nd Week** →

Kick-off meeting
Inform participants about the study, distribute diaries, describe activities such as DRM and how they share data with us, as well as sign consent forms.

Study 1
DRM:
Participants must write a diary at the end of each day about their experiences and reflect on their smartphone use.

Qualitative Data:
• DRM diary

Quantitative data:
• Data from StayFree

Interview
Interview based on DRM and data collected from StayFree.

Qualitative Data:
• Behavioral patterns acording to notifications on smartphone
• Perceived experience

Study 2
DRM:
Participants must write a diary at the end of each day about their experiences and reflect on their smartphone use.

Qualitative Data:
• DRM diary

Quantitative data:
• Data from StayFree

Interview
Interview based on DRM and data collected from StayFree.

Qualitative Data:
• Behavioral patterns acording to lack of notifications on smartphone
• Perceived experience

Figure 4.1: Experiment Timeline

For the participants to collect data, we hand out diaries to each participant in which they write down their experiences each day. These diaries are utilized throughout both phases of the study, providing valuable insights into participants' experiences over time that we can take with us to the interviews to gain a deeper understanding. The participants document their experiences by answering 12 different questions, which in the end help us analyze how notifications affect the participants' perceived autonomy throughout the different days.

We have chosen to use these as a framework for DRM because our study participants are ordinary users of smartphones and may have difficulty assessing whether they are experiencing a loss of autonomy. By using these capacities and authenticities, we have specific parameters on which we can ask the user, and each of these parameters indicates whether the user is experiencing a feeling of loss of autonomy. We have formulated a question related to each parameter and provided the user with an example of how the question can be answered. In the appendix (Appendix DRM diary in relation to autonomy), all the questions provided in the diary are presented accompanied by a title. We also provide an explanation as to which aspects of autonomy each question relates to. To ensure the themes are clear to the participants, we take some liberties with our translation. As a result, some of the "themes" do not perfectly align with the aspects of autonomy.

Since the study participants are required to have notifications enabled in week 1 and disabled in week 2, the questions look slightly different in week 2, as they are not able to answer some questions related to notifications in week 2. In particular, questions 4, 6, and 8 are altered slightly, as these questions are asked directly with regard to the participants' experience with having notifications on. See the altered questions in the appendix (Appendix DRM diary template).

Since there are several questions and not all of them are necessarily relevant each day, we instruct the study participants to only answer the questions where they have something relevant to add. This way, we do not receive a lot of answers that may not align with the study participants' actual perceptions, as they are not forced to come up with something for each question. Furthermore, considering the large number of questions, it might be more feasible for participants if they are not required to provide exhaustive answers to each question. Once the study participants have completed the experiment and we receive their responses, we are able to compare their answers from week 1 with their answers from week 2. These are all qualitative answers and can therefore be used to identify emergent patterns that can then be explored and elaborated on in interviews with the study participants afterwards. The interviews are tailored to each individual participant and are based on their responses in their diaries. This way, these DRM questions, along with the elaborating interviews, can provide insight into the participants' feelings of loss of autonomy and whether notifications influence this.

4.1.1 Interviews

We conduct two interviews and one kick-off meeting as part of our study methodology. The kick-off meeting takes place prior to the beginning of the study, and the interviews are strategically scheduled. One occurs after the initial first week of the study, and the final one after the completion of the second week of the study, as outlined in the timeline 4.1.

During the kick-off meeting, we gain insights into participants' smartphone usage patterns and their perspectives on this usage. It allows us to establish a baseline understanding of their use for future reference.

The second semi-structured interview occurs after analyzing the DRM data from the first phase of the study. By doing this, the interview questions are tailored to each participant. Employing an abductive approach, we delve into significant experiences that each participant may have had, seeking to comprehend them through targeted inquiries.

For the third and final interview, we employ a similar methodology as the second interview. Additionally, we inquire about participants' observations regarding any changes in their feelings about their smartphone usage between the study's phases, particularly in relation to the impact of disabling notifications.

4.1.2 Third-party App as a Tool

The app participants use to fill out their DRM diary is "StayFree". It is a third-party app designed to track various aspects of smartphone usage. The specific metrics tracked by "StayFree" that we are interested in are outlined below (StayFree 2023):

- Number of sessions per day

- Daily use of different apps

- Amount of time spent per app

- Number of times different apps have been used

- Number of smartphone unlocks

When answering the questions in the DRM diary, the participants can refer to their "StayFree" application in order to aid them in their recollection of the day. The only time this is not allowed is for the very first question about Memory, as this would undermine the purpose of this particular question, which is to find out how well they remember their time on the phone. For the rest of the questions, the apps are used to refresh the participants' memory so that we can get more detailed and specific answers on the other aspects of autonomy.

We ask the participants to share their data with us insofar as they feel comfortable with this. This helps us to compare their actual behaviour with what they are claiming in the diary. For the sole purpose of being able to confront them with our findings during our subsequent interviews or to back up their claims. For example, if a participant claims that they feel as though they used their phone a lot more during week one than during week 2, we can see if this is true. Unfortunately, not all of the participants are willing to provide their quantitative data, as they feel this is too sensitive. Therefore, we are only able to do this for a select few of the participants who do provide their data.

4.1.3 Introduction to Participants

Based on our kick-off meeting and the information collected through our contact form, we compile common demographic details for each participant. Additionally, we provide a brief overview of the participants' smartphone usage habits to illustrate their perspectives on their current usage and any desires they may have to change it. This can be seen in the table below:

Participant Number	Gender	Age	Presentation of smartphone use
P1	F	24	She does not think that she uses her smartphone a lot, but is still intent on altering her use.
P2	M	28	Is of the opinion that he uses his phone a lot and is intent on altering his use.
P3	F	26	Is of the opinion that she uses her phone a lot and is intent on altering her use.
P4	M	27	Is unsure whether he is using his phone a lot, but is intent on altering his use.
P5	M	26	Is of the opinion that he uses his phone a lot and is intent on altering his use.
P6	M	29	He does not think he uses his smartphone much, and does not have any intent to alter his current use.

Table 4.1: Table depicting demographics of participants

Results

In this section, we have compiled the data to showcase emergent patterns related to how notifications affect participants' autonomy. This includes diary data from both weeks as well as from the two different interviews following each week.

5.1 Motivation for Participation and Previous Experiences

Generally, the participants wish to decrease their smartphone usage, and in our initial interviews, we found that several of them have, before this study, tried to limit their use through various examples of active resistance. In order to establish a base understanding of our participants and identify strategies that work or do not work for our participants, we will present their experiences with actively resisting smartphone use.

P6, the only participant who initially expressed contentment with his current smartphone usage, described how he decided to delete TikTok from his phone because he felt that it was consuming too much of his time. He reported that he thinks this decision has helped him decrease his overall smartphone use. P5 and P4 describe how they have also tried various forms of active resistance to decrease their smartphone use. P3 and P5 set a timer on certain applications that would exit the application once the time was up, but this was easy to bypass and did not work as intended. P5 reported that he ended up removing this feature as it did not affect his use, but was just an annoying feature in the end. P4 has removed the apps "Instagram" and "Facebook" from his phone and only accesses these services through his browser instead. Furthermore, P4 has also employed security measures on his phone so that he can only see the content of the notifications on his phone by unlocking it, while this might not be exclusively to limit smartphone usage, this also creates some friction. Occasionally, P4 will also, intentionally put his phone out of reach while working or doing other activities to avoid distraction. Similar to this, P2 leaves his phone in his jacket during work or social activities. P2 also sets his smartphone to automatically turn on a black and white filter on the phone at certain times or when he opens certain applications, closing all applications and turning off mobile data before bed. Furthermore, P1 has her phone on vibration most of the time. At the same time, P6 identifies different vibration patterns for different types of notifications to distinguish between the urgency of the notifications.

Overall, these acts of resistance yield mixed results. P5 describes his strategy as ineffective, noting that the solution is more frustrating than beneficial.

5.2 Habitual and Active Smartphone Use Patterns

Throughout the two weeks, all of the participants stated that some of their use is habitual. This habitual use is linked to checking their smartphone for notifications at specific times throughout the day, for some, it is during the morning and evening, as described by P5. Furthermore, habitual use is also tied to specific activities and situations, these range from work and social interactions to natural breaks in between activities. Some of the use is perceived as acceptable. This includes social interactions like messaging or using it as a tool for everyday tasks. Almost every participant explained that they tend to use their phone in between activities, P1 elaborates on this as she uses her smartphone while she is watching a movie at home and she pauses the movie. P2 seconds this habit by explaining while he is waiting for food in the oven to finish cooking, he often defaults to using his smartphone. Furthermore, this in-between activity is often tied to use while being bored, which is often expressed positively. P5 explains it as such:

> "I think it's about lacking stimulation. I mean, you are not doing anything[...] [...]I think that's why you don't stop. I mean, I can stop. But then I get bored because we've developed this need to have something (to do) all the time."
> (Appendix Interviews Week 1 P5)

The participants often present a sense of urgency upon receiving notifications and reacting to the messages. This leads to a sense of automatic response which in some cases affects the participants negatively, by disrupting activities at inopportune moments, which leads to the participants being less focused on the activity. Both P1 and P3 express some concerns regarding their use of their smartphone during social interactions. P2, P3, P6 and P5 all express some regret about checking their smartphone while working. This is experienced by P5 as disrupting his workflow.

During week 2 the participants disabled all the notifications that they felt they could reasonably disable, which highly differed from participant to participant since they all have different applications. The act of switching from receiving to not receiving notifications also affected the participants in different ways. The frequency at which the participants checked their phones during work in particular. P3 described how she checked her smartphone more than she did in week 1, while P2 expressed that he checked his smartphone less. P2 also expressed that, for the first three days, he would check his smartphone in vain expecting a new notification. P2 explains this as:

> "So in that way, it was still disruptive at first, because I had to get used to not having notifications. But by the end of the week, if I felt the phone in my pocket, in my jacket, or saw it lying on the table, it wasn't like: 'Oh, now I need to go check it because nothing has happened on it.'[...]"
> (Appendix Interviews Week 2 P2)

Furthermore, P1, P2, P4 and P6 stated that checking and using their smartphone is more of an active choice compared to week 1. P2 explains this as using the smartphone when he

needs to research something or while a natural pause occurs rather than the smartphone nudging him for attention through notifications. This is also backed by P4 who states that he uses the applications "Ground News" and "Reddit" less in week 2 and only when he is interested in engaging with the content on those applications. After examining the data he provided this is partially true, he uses "Reddit" a bit more, approximately 16 minutes more in week 2, but does not use "Ground News" during week 2.

Certain applications are linked to active choice while others are linked to habitual behavior. P2 expresses that searching for something on "Chrome" is an active choice. For P5, watching videos on "YouTube" is described as an active choice. On the other hand, every participant has certain applications that they use habitually which varies from participant to participant. P6 describes that he habitually check the application; "X" while drinking his morning coffee, P1 defaults to using "Facebook" when a natural pause occurs and P3 checks "Instagram" habitually when she gets the urge to do so. While most of the participants remember which applications they habitually use every day, our findings indicate that the participants' working memory is affected negatively in regards to remembering the activities and interactions on these applications. On the contrary, the act of using the smartphone on one's own accord is linked to an enhanced working memory in regards to the interactions happening on the smartphone for some of the participants. P2 expresses this as:

> "I believe that the reason there is much one cannot remember might be because it is not an active choice to do it, or perhaps because one might be doing something else at the same time."
>
> (Appendix Interview Week 1 P2)

While P2 references working memory to using his smartphone as an active choice, he also mentions doing something else at the same time. This is also backed by (Aylsworth and Castro 2024), which states that multitasking using a smartphone whilst doing other activities severely affects individuals' working memory. P6 has a similar point when talking about his working memory:

> "If I sit and scroll through Twitter or "Reddit" for half an hour, most of it I can't remember what it was. [...] I'm just bombarding myself with a bit of dopamine for half an hour. But I think I can remember whether I've checked my E-boks today or if I've logged into my online banking today."
>
> (Appendix Interviews Week 1 P6)

Throughout the two-week study, the participants presented thoughts about what they classify as acceptable use and non-acceptable use. Acceptable use is mostly linked to using their smartphone at times when they are bored or in between activities. Furthermore, messaging is also classified as acceptable use and introduces a sense of urgency to stay updated. This causes some of the participants to shift their attention to their smartphones, which can result in a chain of autonomy factors being affected. Firstly, it reflects the

participants' attention away from the activity at hand, this becomes problematic for the participants when the activity is working or during social interactions. The lack of attention towards the activity might cause delays to the task and disruption of their workflow, or during social interactions might be interpreted as the participant being dismissive. Furthermore, it might result in the participant engaging in multitasking if the participant responds to the notification during the activity, which can affect their working memory. Using their smartphone when bored is not acceptable for all of the participants either, P5 uses his smartphone in the morning and evening which he is regretful about because he would prefer being productive. This is described as being because he lacks stimulation, which is tied to preferring immediate gratification instead of the delayed gratification being productive might provide. This is also linked to incoherent motivational states as he has a desire to be productive and decrease his smartphone usage but ends up choosing immediate gratification.

- **Habitual Patterns**: Participants develop habitual smartphone usage patterns tied to specific times and activities.

- **Active Engagement**: Disabling notifications leads to more deliberate and active smartphone usage.

- **Delayed vs. Immediate Gratification**: There's a conflict between delayed and immediate gratification when using smartphones, particularly in the morning and evening.

5.3 The Impact of Notifications on Attention and Smartphone Behaviour

Self-control is linked by several of the participants to the dichotomy between using and checking the smartphone as an active choice or checking and using the smartphone as a habit. P4 explains this as: *"Does my phone use me, or do I use the phone?"* (Appendix Interviews Week 1 P4). P6 also contemplates whether he is being manipulated by the smartphone or not. To this, he believes that he is aware of being manipulated, and therefore, he contends that he is not being controlled.

However, the sense of the smartphone affecting the participants' attention is also cemented in that they describe notifications as being *disturbing* and *interruptive* in week 1 of the experiment. However, it seems that the type and content of the notification often determine whether the participants find it to be disturbing or not. Trivial notifications, such as "sales notifications" as described by the participants, are often disturbing, while messages or "Emails" are often seen as important and therefore the participants allow themselves to be interrupted by them. The different types of notifications also manipulate the participants differently. P3 is intrigued by "Instagram" notifications about friends' stories, which leads to unintentional use that they later regret. It seems that the regret is based on her inability to delay gratification. P5 has a similar experience in that he sometimes lets themselves be

disrupted by "Vivino" notifications when the content of the notification is tempting and P1 experiences "Duolingo's" gamification notifications about losing a streak. The participants also show different degrees of interest and motivation to disable notifications. Before the study, P2 had already disabled most notifications, whereas P4 admitted to previously being too lazy to do so. However, after disabling them for the study, P4 found the experience enjoyable and decided to continue keeping them disabled. P3 explained that she did not know how to disable specific notifications and thought it was impossible to manage the different kinds of notifications, particularly on "Snapchat".

Another part of self-control which the participants stated as problematic is the situations in which the participants use their smartphones because of notifications. P6, P5 and P2 describe that they feel disturbed by notifications on the phone during their workday, and that, depending on the notification, they act on the notification, which affects their attention. P6 and P2 feel that it is okay to check their phone during work occasionally but that it depends on the amount of work they have to do. P5 explains that the notifications nudges him to check his phone mostly during the day when he is working, while in the morning or at night he feels compelled to use his phone out of habit instead.

Notably, P6 attributes the disturbing nature of his phone, not to notifications in particular, but to habits and internal triggers that urge him to check the phone. However, in week 2, almost all of the participants claimed to be slightly less disturbed by their phones after turning off most external triggers in the form of notifications.

In week 2 Participant P3 stated that she had developed what she described as a "4-step-checking routine" about checking her phone as a result of no longer receiving any notifications. She describes this routine as such:

> "I have developed a really annoying '4-step checking' to check whether I have received an "Email", a message on 'Messenger' or a message on 'Instagram'"
>
> <div align="right">(Appendix Diary Week 2 P3)</div>

This is because she was no longer receiving any notifications from these applications and so she was afraid she might miss out on important messages, which she also referred to as FOMO (Fear Of Missing Out). P4 also refuses to turn off "Messenger" notifications in week 2 for this very reason. This is backed up by statements from P2 and P5 who claim that, while they were using their phone less, they felt as if they were checking "Messenger" a lot more, as they no longer knew when they received a message. The consensus among the participants from week two was that they all missed receiving notifications from apps in which they communicate with other people. On the other hand, some people found it liberating to be without certain notifications. In the table below we have surmised which notifications each participant kept enabled for week 2 and subsequently, which notifications they turned back on after the study had ended. Unfortunately, we do not have data detailing which notifications were enabled during week 1 for each participant, as we had encouraged them to turn on all of their notifications and did not have the

foresight to ask which.

Participant	Notifications enabled for week 2	Notifications enabled post week 2
P2	SMS	SMS, Messenger, Email, Snapchat, Netbank, E-boks, Tv2News, DrNews
P3		Messenger, Email, Instagram, SMS
P4	Tinder, Messenger, Kaspersky, Wechat, Email, SMS	Tinder, Messenger, Kaspersky, Wechat, Email, SMS, "Reddit"
P5	SMS	SMS, Messenger
P6	Email, SMS, Messenger	Email, SMS, Messenger, Snapchat

Table 5.1: Table depicting notifications enabled during week 2 and post-week 2

This indicates that notifications facilitating communication, such as "SMS", "Messenger", and "Email", were most important to the participants, as these were consistently re-enabled after the study concluded. Many participants also reported feeling liberated by the fresh start the study provided, as they had 'cleaned up' their notifications and now only needed to enable the ones they genuinely missed. This is the opposite of the position that the participants were in before, as they then had almost all notifications enabled and needed to disable the notifications they did not want.

- **Notification Disturbance**: Notifications, particularly trivial ones, disrupt participants' activities and lead to increased smartphone usage, highlighting the impact of external triggers on attention and their ability to delay gratification.

- **Adaptation to Notification Changes**: Participants develop new checking routines and habits in response to changes in notification settings, indicating a nuanced relationship between notifications, habits, and perceived control over smartphone usage.

- **Importance of Communication Notifications**: Communication-related notifications, such as "SMS" and "Messenger", are consistently re-enabled by participants post-study, underscoring their significance in facilitating communication and maintaining connectedness.

5.4 The Effect of Disabling Notifications on Smartphone Use Patterns

Overall the participants' smartphone usage does not change much from week 1 to week 2. They all have varying ideas of what their desired usage is. P5 wishes to use his phone only 30 minutes a day, while P2 finds two and a half hours as "acceptable". However, they all acknowledge that what they spend their time on also determines whether their usage can be deemed "acceptable". P5 claims that direct messaging applications, such as "Messenger", are "acceptable use", and, at the same time, that he wants to cut down on using applications like "Facebook" and YouTube. This sentiment is echoed by others as well. P1 claims that if she actively chooses to use her phone on something of interest, rather than "mindless" scrolling, then it is more acceptable. Many participants noted that situational factors, such as specific events, physical environment, and personal expectations, played a significant role in their phone usage, often more so than notifications. During week 2, P6 was expecting an important message and was constantly checking his phone to see if he had gotten his message, which had a large effect on his usage for that day. Furthermore, P2 ascribed his, noticeably decreased usage in week 2 to being outdoors more than in the previous week.

However, multiple participants did not decrease their use nor stay within their desired use in week 2 of the study. P3 and P1 both describe that their smartphone use is higher than they would have wanted in week 2. P1 found her phone to be more "boring" during week 2 without the notifications, but she also described that she was particularly "bored" this week in general, which, according to them, might explain why she used her phone a lot this week. P5 felt that he used his phone a lot less during week 2, but the quantitative data only showed a slight increase by an hour. However, the number of times he checked his phone increased dramatically from 352 times in week 1 to 451 times in week 2. P5 also ended up not using "LinkedIn" at all in week 2 as he explained that he normally only opens "LinkedIn" through notifications (Appendix Qualitative Data P5 Week 1 & Appendix Qualitative Data P5 Week 2). Similarly, P4 also checks his phone a lot more. He went from checking his phone 255 times in week 1 to 368 times in week 2. This means that, while he checked his phone a lot more in week 2, he spent the same amount of time (Appendix Qualitative Data P4 Week 1 & Appendix Qualitative Data P4 Week 2). Therefore, the act of turning off notifications seems to have little effect on the participants' smartphone usage time-wise. However, it did have an impact on their phone habits and routines from week 1 to week 2. This is especially apparent with P4 and P5, who both would check their phone much more often in week 2. This is also backed up by P2 who claims that he checks "Messenger" much more often in case he has received a message, as well as P3 and her 4-step routine. By decreasing external triggers, the number of internal triggers among the participants was increased, which might stem from a general need to stay updated and FOMO.

- **Stable Usage**: Smartphone usage remained relatively stable from week 1 to week 2, despite varying desired usage times among participants.

- **Notification Impact**: Turning off notifications did not reduce usage time but increased the frequency of phone checks.

- **Situational Influence**: Specific events and environments significantly influenced phone usage patterns.

5.5 Frustrations Stemming from Presence and Absence of Notifications

In week 1, almost all participants become irritated by various notifications that they receive. Participants P4, P3, P5, and P2 classify the notifications that are perceived as unimportant or insignificant as "advertisement notifications," which are designed to pull the user into the app. What they have in common is that none of these notifications are targeted to the specific user, unlike a personal message from a friend; instead, they concern offers on "Vivino" and new filters on "Snapchat". For example, P4, P3, P5, and P2 all describe these notifications as "annoying" but often end up opening the app anyway. Additionally, they describe the notifications as *annoying, but not annoying enough to actively turn them off.* (Appendix Interviews Week 1 P5). For P6, the irritation is more about the number of notifications rather than the specific notifications. He describes it as stressful when notifications pile up, and it is not clear which ones are important and which ones are trivial. This indicates that he feels like he does not have a sufficient range of options regarding sorting notifications. All of his notifications pop up randomly on his phone and it is not clear to him which he needs to deal with and which he can ignore, resulting in him more or less considering all the notifications. P3 describes how she needs a better way to sort notifications, as she currently finds it difficult and almost impossible to access these settings. Similarly, participant P4 mentioned his desire to filter notifications on "Messenger" but is only able to mute or unmute different groups. Since both important and trivial notifications come from the same groups, this solution is ineffective. P4 feels forced to read each individual notification from the "Messenger" group chat to determine whether it is something he needs to engage with. By doing so, he allows the notification to interrupt him, regardless of its importance.

P5 and P6 mention at the end of week 2 that while they acknowledge that turning off notifications can be beneficial, they still think that they would not consider this when installing new applications in the future and ascribe it to them as being lazy. P1 does not describe the notifications in week 1 as "annoying", but after the second week, she describes the lack of notifications as pleasant and liberating and recognizes that the notifications in week 1 might have irritated her without her realizing it. P4 states that he was misled by a notification from the dating application "Tinder" in week 1 because the sound and vibration are the same regardless of whether it is a message from a "match" or a "service

message" about there being many users on the app at the moment. P4 also sees this as confusing and misleading since he would not have acted on it if he knew what the notification was about.

In week 2, when the participants have turned off notifications, most participants become frustrated by the lack of notifications they find important. Everyone finds direct messaging notifications important and finds it time-consuming to have to manually check apps like "Messenger", "SMS", and "Email". Both P6, P1, P3, and P5 become more critical of which apps they allow to send them notifications and will exclusively turn communication notifications back on. However, P5 and P6 mention at the end of week 2 that while they acknowledge the effect of turning off notifications, they still think that they won't consider this when installing new applications in the future and ascribe it to them as being lazy. P2 will turn communication notifications back on but also wants to receive notifications about news such as "TV2 News". P4 does not immediately intend to turn any notifications back on but is considering turning "Reddit" notifications back on as the only exception. Thus, most participants also experience frustration over the lack of notifications, but primarily communication notifications. Several participants explain this with a feeling of urgency around these types of notifications and talk about a limited time window in which they can respond to these notifications. This results in the participants lacking in both the ability to delay their gratification and cognitive function because they respond automatically and often lose focus on what they were doing before the notification arrived. Therefore, their attention is also affected by these automatic responses to irrelevant notifications. Additionally, several participants mention experiencing a feeling of FOMO and the thought that there could potentially always be an important message waiting stresses them out. For P3, the urge to stay updated on her messages becomes so great that she develops a 4-step routine as previously mentioned. This routine also gives her a feeling of frustration, as it is more cumbersome for her to stay updated than before. P6 describes the need to respond to messages promptly as a social norm. He describes a time frame within which it is acceptable to respond, though he does not define this time frame precisely because it can vary depending on the situation. This need to fulfil P6's idea of social etiquette to gain social validation and also FOMO, as explained by P3, is an indication of an absence of cognitive inhibitions. According to P6, this is not helped along by features on certain messaging applications, specifically "Messenger's" "seen" feature, a feature that makes the sender of a message aware that their message has been seen and influences participants' feelings of being compelled to respond. A feature like this makes it difficult to take one's time to reply, as there is an external constraint imposed by this social norm.

This highlights the complex relationship between participants and their smartphone notifications. Initially, notifications, especially "advertisement notifications", were a source of frustration, while often still pulling users into the apps. Despite recognizing these notifications as bothersome, participants often engaged with them. The experiment underscores the duality of notifications as both bothersome and essential, revealing a dependency that

affects attention, lack of cognitive functioning, and lack of a sufficient range of options.

Ultimately, the findings show frustration regarding receiving notifications that are deemed unnecessary but also a similar response to not receiving notifications that are deemed necessary. This indicates a desire for options and customisation for the user, but without overwhelming them, as they do not want to spend much time determining the relevance of their notifications.

- **Frustration with "advertisement notifications"**; Participants were frustrated by "advertisement notifications" but often engaged with them despite the frustration.

- **Frustration from Missing Important Alerts:** Turning off notifications led to frustration due to missing important communication messages, causing FOMO and an absence of cognitive inhibition.

- **Need for Customization:** Participants express a strong desire for improved customization of notifications, yet they are seldom motivated to take action to achieve it.

Discussion

Overall, we have found that the participants have reacted very differently to this two-week study. The participants had different points of departure with regard to how and how much they used their phone prior to the study, which, evidently, has had an effect on the outcome of the study as to how they react to turning off notifications. Furthermore, the degree to which each participant was willing to alter their notifications was also varied. Throughout this section, we seek to determine if the participants experience a feeling of loss of autonomy by discussing the capacities and authenticity of the autonomy framework and comparing these to our results.

6.1 Participant Profiles

Based on table 4.1, we have categorised the participants within 3 profiles. We did this because, initially, we saw some similarities between certain participants' motivation to change their smartphone use. The different profiles can be described as such:

1. **The Satisfied Minimalist** (P6): Content with his current smartphone use and sees no need to change.

2. **The Intentional Reducers** (P2, P3, P5): These participants believe they use their smartphones a lot and are motivated to change their habits.

3. **The Indifferent Reducers** (P1, P4): These participants do not perceive their smartphone use as excessive or unsure, and they have a desire to alter their usage patterns.

It is important to note that the participants' idea of what "satisfactory use" is differs from participant to participant. For P2, satisfactory use, with regard to time spent, is described as two and a half hours and for P5 this is described as 30 minutes. Yet, they are still both classified as "Intentional Reducers" as their attitude towards their respective smartphone usage is similar. With this basic understanding of the participants, we have an idea of the underlying motivations of the participants as well as their perception of their use. The Satisfied Minimalist, P6, expresses an overall contentment with his use. The Intentional Reducers, which is a larger group of participants, P2, P3 and P5, all are somewhat dissatisfied with their smartphone usage and express motivation to change it. Finally, the Indifferent Reducers, P1 and P4, are seemingly indifferent to their smartphone use, yet show an intent to change their current smartphone behaviour. While the profiles reflect the participants' attitudes towards smartphone use, they all reacted very differently to the different aspects of autonomy regardless of how they were profiled.

During the two-week study, the goal was to determine how the participants reacted to the intervention which we imposed on them, that is disabling all of their notifications. The number of notifications that they turned off was of course voluntary, as we gave them the choice of selecting which applications they did not want to disable notifications from. A pattern becomes apparent when examining the participants' willingness to disable notifications. As presented in table 5.1, The Satisfied Minimalist and The Indifferent Reducer disabled the fewest notifications, keeping communication notifications enabled whereas The Intentional Reducers disabled almost all notifications.

The participants' motivation and the varying number of notifications enabled for week 2, do affect how the participants experience the second week of the study, in differing capacities. It also varies how many notifications the participants had enabled before the study. We asked them to keep their notification settings as they were before the study in week 1. In this way, the participants start with slightly different baselines.

6.2   Notification Types

Based on our data from the participants, we have chosen to classify notifications into targeted and non-targeted based on emerging patterns in our results. The classification of the notifications applies to all the participant profiles and is described the same way across all participants.

6.2.1   Targeted Notifications

Targeted notifications are those that specifically address a user and concern something relevant to the individual user. This can include anything from messages on "Messenger", service updates about the need to update one's password, to notifications about someone starting to follow the user's "Instagram" account. However, some notifications is not as clearly targeted as others. One of these is direct messages in a "Messenger" group chat. Participant P4 describes being a member of a "Messenger" group chat, but many of the messages sent in the chat are not specifically addressed to him but to other members of the group chat. This might suggest that these notifications are non-targeted, but because the sender chose to send it in a group that the user is part of, we choose to classify them as targeted.

Furthermore, the type of notifications also affected how *interruptive* or *disturbing* their smartphone was. Targeted notifications, such as text messages, presented a sense of urgency, which the participants usually acted upon. This, we refer to as interruptive, as they still interrupt their actions but are seen as important or meaningful. The participants did not refer to notifications such as these as disturbing, as they were relevant or important enough to warrant action.

6.2.2 Non-targeted Notifications

Non-targeted notifications are typically advertisement notifications intended to draw the user into the app. For example, this could be an offer on a bottle of wine in the app, "Vivino", or a notification about 'boosting hour' from Tinder. These types of notifications are not particularly relevant to the individual user but are often sent out to all or many users of the same app at the same time. One of the non-targeted notifications that are not as clearly non-targeted as others is "Duolingo's" gamification notifications about losing a streak, as mentioned by P1. The streak in the app is personal, but the purpose of the notification is to draw the user into the app, and the notification is sent to all users of the app, just at different times depending on when they last used the app. Therefore, we choose to classify these types of notifications as non-targeted. The same applies to the notifications about "Instagram" stories that friends have posted, as described by Participant P3. These are also sent out to multiple followers of the specific person who posted a story and, in most cases, do not have special relevance for the individual recipient.

Non-targeted notifications were seen as disturbing in the sense that the participants did not necessarily act upon these and described most of these notifications as disturbing or annoying. Paradoxically, the notifications that participants ignored but still registered were the most disturbing and distracting. This was likely because participants could not distinguish between targeted and non-targeted notifications by sound cues or vibrations. Exemplified by P2, among others, who enabled all notifications during week 1, which led to an increased response rate for non-targeted notifications as he was expecting targeted notifications. All notifications seemed the same, at first glance, to most of the participants, prompting the participants to act on the notification regardless. Participants also frequently complain about receiving various types of notifications from the same application. For example, participant P3 has enabled notifications for "Snapchat" because she wants to receive targeted notifications when her friend messages her. However, she also receives unwanted and non-targeted notifications about filter updates from the same app.

- Targeted notifications are seen as interruptive.

- Non-targeted notifications are seen as disturbing.

- The same app can send out different types of notifications.

6.3 Impact of Disabling Notifications on Work Behavior

During work, the participants had different experiences related to disabling notifications. The profile Intentional Reducers had opposite reactions regarding their usage. P3, spent more time checking, while P2 and P5 spent less time checking, even though the participants turned off all notifications. P3's attention was significantly more impacted than the rest of the Intentional Reducers due to her focusing more on her phone and less on work. The profiles; The Satisfied Minimalist and Indifferent Reducers, felt no significant change in usage and attention, by disabling notifications. This is likely because these pro-

files did not disable all notifications and had prior precautionary measures limiting their smartphone usage during work.

Multitasking during work will affect the cognitive functioning of the participants. (Aylsworth and Castro 2024), elaborates on why multitasking can be detrimental during work, as it often results in resumption errors when switching tasks as well as cause the task to be slowed down because it takes time to reacclimate to the task.

P2, P5 and P6 reasoned that the frequency of checking their smartphone during work depends on the amount of work, the repetitiveness of the task, and the content of the notifications. The notion that the user's susceptibility to interact with these notifications is based on the timing and content of the notification is also supported by (Mehrotra et al. 2016) and (Fischer, Greenhalgh, and Benford 2011). To contribute to this work we found that the repetitiveness of the task was also significant. This suggests that the level of engagement in a task can influence an individual's susceptibility to interact with notifications during work.

Based on the findings, in regards to notifications affecting the participants' attention, a possible solution should be to discern which notifications are relevant to the user and which are not, thereby only sending relevant notifications, as the ones that are not relevant are regarded as disturbing. The study (Visuri et al. 2019) explored this topic and one of the criteria they used to determine if a notification should be sent was the timing. They asked the user to rate the timing of the notification and thereafter used ML to find patterns. By doing this the ML would at some point figure the users working hours out and not send irrelevant notifications during that time, which could benefit the user's attention.

- The Intentional Reducers exhibited varied behaviours when disabling notifications during work: P3 increased phone checks, while P2 and P5 decreased theirs. Notably, P3 was more distracted, focusing more on her phone rather than her work (Mehrotra et al. 2016).

- Different participant profiles, such as The Satisfied Minimalist and Indifferent Reducers, showed no significant change in usage or attention when disabling notifications, likely due to not fully disabling notifications.

6.4 Challenges of Delaying Gratification in Smartphone Use

Delay of gratification, which we choose to refer to as "self-control" when interviewing the participants, delves into how users tend to prefer immediate, short-term rewards over long-term benefits.

Most of the participants (The Intentional Reducers and The Indifferent Reducers) frequently expressed a desire to reduce their screen time. Yet, the immediate enjoyment

of interacting with their devices frequently outweighs the commitment to reduce usage and experience greater satisfaction later.

The number of notifications each participant disabled affected how much internal triggers and external triggers affected the participants' usage and their ability to delay gratification. All the participants besides, two of the Intentional Reducers, P2 and P3 expressed improvements regarding their ability to use the smartphone of their own volition thereby delaying gratification. Both The Satisfied Minimalist and The Indifferent Reducers generally felt less affected by the disturbing and interruptive nature of their smartphone by limiting the external triggers to their most important notifications.

Whereas The Intentional Reducers felt varying success with disabling most of their notifications. P3 was severely affected by turning notifications off, with a large increase in internal triggers causing her to develop the aforementioned "4-step" routine. This caused her to check applications more often thereby delaying gratification less and affecting her attention and cognitive functioning negatively. Participant P2 experienced an adaptation period in week 2 but managed to delay his gratification and eventually adapted. He explains his success with the fact that he felt compelled to adhere to the guidelines, knowing he was part of this study and also the fact that he knew it was only for a week and he could turn the notifications back on after that week if he wanted to. This implies that a set time period and some guidance may be beneficial when trying to get people to delay their gratification regarding their smartphones.

When considering the participants' incoherent motivational states, which for the study, we translated to the actual usage compared to their desired usage, the actual usage was quite similar during the two weeks. Disabling notifications did not affect any of the profiles' total smartphone usage in any significant matter. While notifications may not have affected the participants' usage with regard to time spent, they might have affected other elements of their smartphone use that contributed to inconsistency between their ambitions for usage and actual usage. However, the frequency with which they check their smartphone was affected as well as their overall smartphone habits.

The Intentional Reducers and Indifferent Reducers noted that they felt an increase in internal triggers and for one of these participants, P3, this was even the cause of distress. On the other hand, the Satisfied Minimalist generally felt liberated and did not experience the increased amount of distress caused by internal triggers. Participants also experienced less usage of specific applications. This was also linked to the participants using their smartphones more on their own accord. A balanced management of notifications, such as only enabling the most important notifications was linked to the participants using their smartphones more of their own volition and therefore spending less time on their phones during these inopportune moments.

This notion that disabling notifications is not always an ideal solution is supported by (Chang et al. 2023). They argue that notifications provide benefits such as contributing to

relaxation during breaks. Furthermore, they argue that disabling all notifications results in distress and anxiety, which we also discovered was true for one of the participants.

While both external and internal triggers can be detrimental to the user's ability to delay gratification the timing of such delays is also important to consider. From this, we can infer that participants across all various profiles agree on the following points:

- Both external and internal triggers negatively impact the user's ability to delay gratification.

- Disabling external triggers somewhat reduced usage during work and social activities for some participants.

- Disabling all notifications could lead to an increased number of internal triggers, potentially causing distress and heightened checking behaviour for some users.

6.5 Pressure to Respond: Navigating Expectations and Digital Constraints

Common for participants across all profiles is that once they have read a message, they feel compelled, to some extent, to engage with it, making it too late to remove it or address it otherwise. Almost all participants kept some work-related and targeted notifications, such as "Email", "SMS" and "Messenger", active in Week 2, as seen in table 5.1. Precisely, because they felt they could not turn them off due to others expecting them to respond.

A feature that can also be considered an external constraint is the "seen" feature a lot of communication apps have implemented. Multiple participants highlight that it is not generally perceived as acceptable to not answer a message once it is "seen", forcing the participants to act faster than they would have otherwise. At the same time, this is an example of manipulation and coercion in that it inadvertently forces the recipient to respond. Additionally, they mention that there is just a general expectation that you will respond promptly, driven by the pervasive connectivity and instant communication culture facilitated by smartphones. Another motivation for the participants to respond to these messages is the fact that they fear that they might miss out on a given message that could be important (FOMO).

These examples highlight a broader issue regarding the lack of control users have over their digital environments and other people's expectations. The user also cannot control other people's expectations when they act on notifications. Nevertheless, none of the participants claimed that someone else told them that they could not turn off these notifications from "Messenger", "Snapchat" etc. so perhaps the idea of a social expectation is, as we would like to term it, a sort of "internal constraint" imposed on the participants by themselves. The Autonomy framework fails to consider this, but the study, (Aranda and Baig 2018), acknowledges this notion when discussing negative behavioural cycles related to smartphone use. Our definition of internal constraints is similar to what they describe

as an "externally reinforced cycle of social obligation". This obligation likely stems from a genuine concern, that they will receive urgent and important messages on "Messenger" that they might have to respond to as soon as possible. The study, (Cho et al. 2020) proposed a solution for this by letting the sender of the message determine the importance thereof. However, we argue that it is not always appropriate for the sender to assess the urgency of a message. For example, when participant P4 receives numerous irrelevant messages from his group chat on "Messenger" it must be assumed that the sender finds them relevant as they could have chosen to not send the message or only send the message directly to the relevant person. This scenario illustrates that the sender's perception of urgency may not align with the recipient's priorities or needs. Therefore, allowing the recipient to control which notifications are urgent ensures they only receive truly relevant alerts, reducing unnecessary interruptions and enhancing their ability to manage their own time and attention effectively.

- All the participants feel compelled to answer messages promptly.

- The "seen" functionality on messaging applications and FOMO cultivate a culture that encourages the participants to react to messages promptly.

- While the aforementioned culture is described as an external constraint we argue that some of these expectations are internal constraints, as they are often self-imposed

6.6 Challenges in Notification Management: Freedom from Constraints

All of the participants expressed a lack of options and motivation when it comes to sorting their notifications. It is either too cumbersome or seemingly not possible. Specifically, the Intentional Reducer, explains that she finds it impossible or too difficult to sort notifications when she wishes to distinguish between targeted and non-targeted notifications from the same application.

However, we discovered that while it is often possible to sort notifications, the accessibility of these settings varies greatly. For example, although we eventually found the option to turn off notifications on "Snapchat", navigating the settings was challenging, as described by P3. The difficulty is such that participants may perceive it as an impossible task.

The inability to manage notifications effectively not only disrupts the user experience but also infringes upon the user's sense of autonomy. When users are bombarded with unwanted notifications, their attention is constantly diverted because they have to rate the importance of every notification they receive. The current notification systems in many applications do not offer user-friendly customization options, leaving users at the mercy of default settings that may not align with their preferences. The participants P5 and P6 also argue that, while they acknowledge the positive effects of turning off certain notifications, they find it too cumbersome to enable these notifications for each application on

their phone. (Visuri et al. 2019) propose ML as a solution for handling and managing the overwhelming load of notifications.

Even so, it is complex since the types of notifications pertinent to a user are highly subjective as applications might have multiple different types of notifications, which vary in relevancy for the user. P3 explains this as "Snapchat" sends both targeted and non-targeted notifications, which is misleading as it draws unnecessary attention to her smartphone. Furthermore, the same type of notifications might also be experienced differently by the user. An example is P5, who states that "Vivino" sales notifications are disturbing unless it is a good offer. So a possible solution should be able to discern not only the different types of notifications an application sends but also the content which the notifications send. This subject has also been explored by (Visuri et al. 2019), which used ML and user reporting on the relevancy of the content of notifications and the timing of notifications through ML to tailor the notifications that users receive.

However, a wider range of options regarding filtering notifications does not necessarily align with the interests of the application designers. Their main objective with notifications is likely to compel users to access their applications. This leads to misleading notification design that raises concerns about freedom from manipulation and coercion, as users are being subtly tricked into engaging more than they intend.

- All participants found it either too cumbersome or too complex to filter notifications effectively.

- Generally targeted notifications are desired more than non-targeted notifications, causing demand for the ability to distinguish between these types of notifications within the same application.

- Non-targeted notifications can be important, causing demand for better options such as through ML (Visuri et al. 2019), to sort these notifications effectively.

- The inability to sort targeted and non-targeted notifications causes the participants' attention to be diverted.

6.7   Profiles summarised

Throughout the study, participants' handling of notifications and their reactions to disabling them revealed insights into their smartphone use. The Satisfied Minimalist maintained a stable usage pattern, choosing to keep a few essential notifications active to meet social expectations. Intentional Reducers varied in their success with reducing notifications, with some experiencing frustration and others adapting well. The Indifferent Reducers showed a nuanced approach, with selective notification management based on personal and social needs. Overall we found that the participants' profiles and motivation beforehand did not significantly affect their experience with turning notifications off. However, the profiles significantly influenced how many notifications the participants were

willing to turn off, which we believe primarily affected the different outcomes during week 2. The Intentional Reducers seemed most motivated and were willing to turn off almost all notifications, which resulted in them experiencing the most change from week 1 to week 2. The two other groups were not as willing to disable notifications and left the most important notifications turned on. This, however, resulted in them having the most success with the study, which could indicate that the best solution to not be negatively affected by notifications and the lack of them, is to find a balance where the user only enables the most important ones.

6.8   Design implications

Our study also suggests that ML may not necessarily be the best solution, as assessing the importance of notifications is very complex. It would for example be difficult for ML to determine whether a specific message in a group chat is relevant to the user or not, as it would typically require knowledge of the users, the senders, and the context and content of the message. This indicates that the most optimal solution would be for humans to assess the importance of the notifications they receive themselves. However, this creates a paradox because the user would still need to deal with all notifications, including the irrelevant ones.

If ML on its own is not a complete solution, and the sender rating the urgency of a notification is not either, what could then be the solution? We already discussed how the solution needs to involve the recipient of the notifications, but without them having to deal with all the incoming notifications.

Overall, one of the most evident things during the study was that people's attitudes, notifications, and the situations in which people receive notifications are different. Therefore, it is difficult to come up with a static solution that works for everyone at all times. A solution should thus be flexible and adaptable to different people's preferences. When implementing these design implications, the profiles' motivation for altering their current use should be considered. The Satisfied Minimalist and The Indifferent Reducers are less interested in adopting designs and changes that require user involvement than The Intentional Reducers.

- Automatisation of notification management through ML could be used for non-targeted notifications but should involve more complex user labelling such as notification category.

- The importance of targeted notifications can not only be determined by the sender, as suggested by (Cho et al. 2020).

There is a push for more ethical design, particularly in the EU, which calls for changes to the design principles used by companies in today's attention economy, such as misleading, addictive designs, and dark patterns (Yakimova 2023). Our study has revealed the significant impact of notifications on individuals' autonomy. Although participants are aware that

notifications affect their autonomy, many find it too difficult to manage them effectively.

"Big Tech" companies make it challenging to turn off and manage notifications, as they are not incentivized to reduce user engagement (Yakimova 2023). Therefore, we argue that the responsibility for notification management should not rest solely on individuals.

- The user should not have the sole responsibility for healthy notification management. EU, companies and organisations should push for designs that support it.

- It should be easily accessible for the user to manage their notifications.

Currently, Android defaults to sending notifications from all newly installed apps. This conditions users to become dependent on their notifications. Users should have the right not to be disturbed, and achieving this should be easier. Our research shows that once users turn off notifications, they turn very few of them back on. This suggests that people need a reason to realize that notifications are often unnecessary. A notification-free baseline would make users more critical of which apps they allow to send notifications, inadvertently forcing organizations to simplify notification management. This approach encourages a more mindful and selective use of notifications, enhancing the overall user experience by reducing unnecessary interruptions. This solution would particularly suit The Satisfied Minimalist and The Indifferent Reducers, who may be less inclined to embrace change if it involves a significant amount of manual effort on their part.

- A notification-free baseline would make the user more critical of which apps they allow to send them notifications.

- A notification-free baseline would force organisations to make notification management easier, as it would be their responsibility to argue for the relevance of their notifications.

Notifications are essential for informing users of new messages and updates without constant checking. Especially targeted notifications help facilitate more fluent communication between users even though they are not together. The participants explain that they often do not mind when they get interrupted by targeted notifications because they often find them useful.

- Notifications can be useful and people should still receive notifications that are important to them (often targeted notification).

6.9 Limitations

In this project, we have faced certain limitations and potential sources of inaccuracies. Firstly, the framework we are working within, autonomy, is not directly related to notifications, but smartphone usage in general. This, in itself, is not a problem, as it is our purpose to connect the aspects of the framework to notifications by way of the diary and interviews. However, in the diary, we made sure to cover all aspects of the autonomy framework, but this meant that some of these aspects turned out to be irrelevant with regard to notifications in particular. Alienated desires, related to "technological seduction" caused by recommendation algorithms, were particularly difficult for participants to reflect on daily. Consequently, there was limited data on this. Similarly, adaptive preferences, which involve how smartphone users have adapted to using certain features like payment applications instead of card payments, were also challenging for participants to reflect on. It was also clear that the questions for these two aspects in our diary study appeared to elicit responses based on general observations beyond the two-week period rather than the intended daily reflections. This likely indicates that the questions were too challenging for participants to consider daily. However, it is important to remember that the framework was not made with notifications in mind so it is only natural that we find some of the aspects to relate to more general smartphone usage rather than to notifications in particular.

Finally, we did not include the indirect effect on capabilities in our diary study, as we felt that two weeks was insufficient to gain valuable insight into this aspect. With more time, we might be able to observe the potential indirect effects of turning off notifications. This leads to another point, namely that it can be argued that the two-week study could have benefited from being a week longer in one or both parts of the study. Obviously, the bigger the sample size, the better and more precise results we would get. Additionally, this approach would have helped us mitigate the "Hawthorne Effect," where participants change their behaviour because they know they are being observed. This effect is particularly strong at the beginning of a study, as participants are more aware of their actions. This also meant that the way we examined the aspect of working memory on participants might be flawed since the study is only concerned with the participants' smartphone usage and their ability to remember this use. Working memory is very complex and it is nearly impossible to conclude on it through this type of study. We present findings related to working memory in our results, but due to uncertainties, we do not discuss the findings further. Namely, it can be argued that their memory is affected during the time when they have an increased awareness. For instance, P6 reported feeling hyperaware of their usage during the first week of the study. This heightened awareness is expected, but in a self-report study like this, participants need to maintain a conscious awareness of their actions throughout. Another issue was that P6, in particular, transitioned from this initial hyperawareness into participant fatigue. It should be noted that P6 was already content with his use prior to the study, and therefore this might have been an issue with motiva-

tion instead. Nevertheless, extending the duration of the study might have helped ensure more consistent behaviour from week 1 to week 2 of the study. On the other hand, since many participants reported fatigue with the experiment during week 2, this might well be an indication that the study was already slightly too long or that the burden placed upon the participants was too great. Furthermore, we asked the participants to provide quantitative data from "StayFree". Unfortunately, not all of the participants were willing to provide their quantitative data, as they felt this was too sensitive. This could have been used throughout the interviews to compare their diary answers to data on their actual behaviour, to see if these align. 12 questions can be argued to be a lot for a diary study and having to fill out each of these questions every day is a lot of work. However, it was necessary to cover each aspect of the autonomy framework. Before the conception of the study, we anticipated that there might be numerous questions, which is why we limited it to just two weeks and emphasised that the participants only answered questions when there was something significant to report. Since all of the participants managed to answer the questions adequately for the whole duration, this suggests that this was the right duration for the study. However, as the study progressed, the conciseness of the questions became evident. Some participants provided very brief responses or simply answered yes or no. Fortunately, we addressed this issue with follow-up interviews at the end of each week. This allowed us to seek further clarification on any answers that needed more detail.

Conclusion

In this thesis, we have explored how smartphone notifications impact user behaviour. Our findings reveal that non-targeted notifications predominantly cause disturbances, while targeted notifications tend to be interruptive. Particularly when users were interrupted during work or social interactions, their cognitive functioning and attention were negatively affected.

Participants also struggled with delaying gratification, which was tied to their habits and routines. These habits and routines were influenced by both external and internal triggers. The level of active resistance that participants felt was realistic to exert, such as turning off all notifications versus retaining communication and essential notifications, impacted these external and internal triggers. This indicates that disabling notifications from the user's primary messaging application cause an increase in internal triggers. Their ability to delay gratification also affected their incoherent motivational states. Although participants desired a certain level of usage, their actual usage often did not align, and we found no indication that turning off notifications resulted in a change in time spent on the smartphone. However, it did impact how often they unlocked their phones. A significant difference in incoherent motivational states was observed in that participants used their phones more on their terms when limiting notifications. Participants expressed difficulties with regard to sorting and filtering different types of notifications issued by applications. When receiving various notifications from a single application, participants preferred targeted notifications. They also felt that there were external constraints related to social norms about how messages are sent and received. We argue that some of these external constraints can be considered what we will refer to as "internal constraints". These are constraints that participants impose on themselves. Notifications can also be misleading for the users; participants experienced that they sometimes led them to use the application more than they wanted.

This thesis underscores the complex interplay between user autonomy, notifications, and social norms, highlighting the need for more user-centric notification management systems that better align with individual preferences and reduce unnecessary cognitive load. The design implications presented in this report can facilitate the shift from an attention economy-focused approach to one centred on ethical design, by granting the user a greater sense of autonomy over their smartphone use.

Based on this, we inferred the following design implications:

- Automation of notification management through ML could be used for non-targeted notifications but should involve more complex user labelling such as notification category.

- The importance of targeted notifications can not only be determined by the sender, as suggested by (Cho et al. 2020).

- The user should not have the sole responsibility for healthy notification management. EU, tech companies and organisations should push for designs that support the user.

- It should be easily accessible for the user to manage their notifications.

- A notification-free baseline would make the user more critical of which apps they allow to send them notifications.

- A notification-free baseline would force organisations to make notification management easier, as it would be their responsibility to argue for the relevance of their notifications.

- Notifications can be useful and people should still receive notifications that are important to them (often targeted notification).

Future works

Our study focused on participants aged 24-29, a demographic that has grown up in the digital age and is highly proficient in handling smartphones. This group's familiarity with digital technology sets them apart from older demographics, who may interact with smartphones differently.

It is also worth noting that a younger demographic might have produced significantly different results, as they may be less critical of technology or have it more deeply ingrained in their daily lives. To gain a more nuanced understanding of smartphone autonomy, it would be interesting and perhaps necessary to observe how different target demographics respond to this study.

In the future, it would be valuable to explore methods for filtering targeted notifications, as this involves complex dynamics. These dynamics encompass various factors that influence whether the recipient wants to receive a specific notification, such as social interactions, relationships between the sender and recipient, and the activities and moods of both parties. For example, a recipient might not want texts during a work meeting but would want them during a break.

Determining whether to send a notification can be challenging because activities, and thereby preferences, change frequently and vary from person to person. Investigating the use of status indicators, where recipients specify their activities and choose not to be disturbed by certain notifications during those times, could be beneficial. For instance, a user might not want notifications from family and friends during work hours but would still want to receive messages from their boss.

Apple devices already offer a "Do Not Disturb" function with different groups, but this solution requires significant manual effort and lacks nuance, as it's impractical to create a new group for every individual activity. Therefore, it is essential to explore this topic further and consider the potential of using ML to determine the user's activity and their notification preferences.

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