Exploring Trigger-Action Programs for Designing Self-Control Tools in Mobile Devices

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Mattia Chiarle
mchiar2@uic.edu
University of Illinois Chicago
Chicago, Illinois, USA

Alberto Monge Roffarello
Politecnico di Torino
Turin, Italy
alberto.monge@polito.it

Debaleena Chattopadhyay
debchatt@uic.edu
University of Illinois Chicago
Chicago, Illinois, USA

ABSTRACT

Individuals may spend three to five hours interacting with their smartphone screens daily. Many of them want to reduce their screen time but fail–despite the many digital wellbeing tools currently available. For example, digital self-control tools (DSCTs) support user self-control of digital device use through awareness of usage patterns or letting users set time limits for specific websites, but their effectiveness in the long term remains little explored. We conducted 7 focus groups with 39 participants to investigate the use and non-use of current DSCTs in mobile devices. We further explored user attitudes about trigger-action programming (TAP, if-this-then-that rules) in designing customized DSCTs and elicited their preferences via a sketching session during the focus groups. Data analysis was grounded in the framework of the Habit Alteration Model. Findings show how nuanced individual self-control needs can be met with TAPs. Two smartphone design prototypes are presented to demonstrate our study findings.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; **HCI theory, concepts and models**.

KEYWORDS

HCI, Digital wellbeing, DSCTs, TAP, Mobile devices

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1 INTRODUCTION

In the last few years, smartphones have become pervasive in our everyday lives. We can do everything with them, from keeping in touch with our friends and families to using them as entertainment. An unwanted consequence is constantly looking at these devices, even when we do not need to. As a result, many people started having unhealthy behaviors, such as smartphone overuse, which eventually led to the need for digital wellbeing [20]. This excessive and uncontrolled usage causes many alarming consequences, such as health problems in adolescents and young adults [21] and reduced work engagement due to sleep interference [12].

The concept of digital wellbeing was introduced by Google in 2018 [8]. This new part of each individual's wellbeing targets our usage of the technology and our relationship with it. It can be achieved either autonomously, relying on our willpower, or through the assistance of external tools, named Digital Self-control Tools (DSCTs). Each DSCT implements some interventions, like application timers [8] or usage reminders [10], which, in different ways, should help users achieve their desired type or amount of usage.

Unfortunately, some studies revealed that, although effective in the short term, users abandon most interventions in the long term [11]. We explored the user perception and experience with DSCTs and tried to understand whether TAP could be an alternative approach for end users. This paradigm would enable full customization, allowing them to design interventions that fit their needs.

As highlighted by some studies [17], when studying or analyzing DSCTs, using a behavioral theory to support your findings is fundamental. For this reason, we analyzed different theories. Eventually, the most relevant for us, considering our goal of enforcing a long-term change in the users and the outcomes of the study, was the Habit Alteration Model [16].

The primary revelation for us was that EUD could address many of the weaknesses of the currently available DSCTs, improving their effectiveness and supporting permanent behavioral changes in the users. DSCTs are highly critical because blocking users' actions causes a lot of friction [16]. If they are not precisely built upon users' needs, the friction will soon become unbearable, leading to the abandonment of the tool. With EUD, the users themselves design the interventions and the application behavior. This choice should create a higher level of commitment, increasing the efficacy period of the DSCT.

Google was probably the first big company to grasp the criticality of smartphone-related problems. In 2018, it introduced the Digital Wellbeing suite on Android. It was the first digital wellbeing mechanism directly integrated into a mobile operating system. One month later, Apple introduced similar tools in iOS 12 [2].

In the last few years, two contrasting trends have occurred. On one side, Digital Self-Control Tools (DSCTs) have become more relevant. On the other hand, an increasing number of companies have begun studying and including mechanisms in their products to maximize the time users spend on their applications. The most commonly adopted strategy is implementing Attention-Capture Damaging Patterns [14] in the interface. They are nasty design decisions aimed at inducing the users to make unwanted decisions that

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favor the company, such as spending more time on some applications. Examples of those patterns are infinite scrolling or autoplay.

Digital wellbeing has become increasingly relevant in the HCI field in recent years. This trend is due, among the factors, to the increasing number of people who realize their excessive and unhealthy smartphone use. Studies also proved that this issue is strictly related to health problems in adolescents and young adults [21] and reduced work engagement due to sleep interference [12].

Some studies redesigned existing platforms. Ulrik Lyngs et al. [13] did it for Facebook to contrast the Problematic Facebook Use (PFU), while Zhang et al. [22] proposed Chirp, an alternative Twitter client.

Ko et al. [11] had a motivation similar to our study. They realized users often have difficulties maintaining their strategies to limit smartphone usage. To improve this aspect, they designed NUGU, an application based on the social cognitive theory. The social learning and competition aspects included in the application allow the users to compare themselves with their friends. In this way, they should be motivated to use their smartphones less. Thanks to a comparison with an alternative version of NUGU, which missed the last feature, they observed that the social aspect motivated users to set goals in more contexts and with longer goal time.

Monge Roffarello et al. [17] performed a systematic review and meta-analysis of DSCTs. In it, they examined 62 papers (filtered out from a starting base of more than 4800) related to digital wellbeing, classifying them based on different factors. They then evaluated the existing DSCTs. The most interesting insight is that, analyzing all the studies that included a withdrawal phase (i.e., a phase in which the users remove the interventions), the behaviors formed when the tool is active tend to disappear when they do not use it anymore. This trend can be explained by DSCTs primarily being based on self-monitoring.

We also analyzed previous work in the EUD field because, as previously described, we consider it a promising paradigm that could improve DSCTs. We immediately realized that, among all the EUD techniques available, Trigger-Action Programming was the most interesting for us. Not only does the concept of rules go well with DSCTs' interventions, but it is also considered one of the most intuitive EUD paradigms available [7, 18], and it is widely used by popular applications such as Alexa [1] and IFTTT [9]. For those reasons, we focused on it.

Many studies about it, mainly in the IoT field, propose new interfaces or mechanisms to simplify the rule creation [4–6]. Other studies, instead, focused on the evaluation of existing platforms[19].

2 METHODS

2.1 Research Questions

As we mentioned, some studies, like [11], suggest that DSCTs tend to be abandoned in the long term. Inspired by the past research reported in Section **??**, we ran a qualitative user study to understand why it happens and propose a solution to this problem. Our goal was to directly know from the users why they quit using their DSCTs and what they need from them. Our research questions are the following.

- Do people find current DSCTs helpful? In which ways?
- What other DSCTs and interventions may users find helpful?
- Can TAP support unsatisfied user needs in DSCTs?

As we previously described, we hypothesize that the currently available DSCTs are effective in the short but not in the long term. Our first question seeks to explore the user experience with those tools to understand if our hypothesis is correct and in which measure. The second aims to know the real user needs in the digital wellbeing field. Typically, users have a list of commercial applications available and pick the one that better fits their current needs. However, their interventions are purposely general enough to attract as many users as possible; thus, finding an application that fully satisfies their needs is rare. During the study, we tried to understand what the users would need if the available options or technologies did not limit them. Lastly, we tried to understand if EUD, particularly TAP, could allow users to customize DSCTs in a more profound way. To answer this question, we gathered the user experience with rule-based interfaces or applications, or, if they did not have any, their easiness and intuitiveness perception about them.

2.2 Study Structure

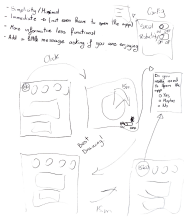
We held 7 focus groups. They had, on average, between 5 and 6 participants (M = 5.57, SD = 2.7), and the average duration was 1 hour 27 minutes (M = 87.71, SD = 40.5 minutes). First, we proposed a screening questionnaire to the potential participants, which helped us filter out the users who were not interested in and did not need DSCTs. If they were eligible, we asked them to compile a demographic questionnaire, which allowed us to collect demographic data useful for the study and to send their smartphone usage statistics for the two weeks preceding the focus group.

We then held the focus group, online or in person (depending on the participants' location and availability). At the beginning, after a short introduction by the interviewer, we asked some warm-up questions, like if they knew about DSCTs and if they ever used them. We designed them to understand participants' baseline and break the ice with them. Then, we moved to the main questions. In the definitive version of the study, we had four main questions supported by a PowerPoint presentation that contained examples of existing interfaces. We included it because it helped the users to better understand the topics we discussed. The examples were essential, especially for the question related to TAP.

Last, we ran a small co-design session. It was particularly influential in making the participants reflect deeper on their needs, providing more detailed insights concerning what emerged during the focus group. This outcome was also possible thanks to the group division, which fostered debates and group thinking. We got a lot of inspiration for the interventions people wanted, which were much more detailed than the ideas proposed during the main questions due to the more structured effort required. In it, we asked the users to list the most useful and needed interventions for them and to sketch the interface of a basic application that allows them to enforce the proposed interventions.

In the analysis, we won't distinguish between focus groups and co-design sessions because the measures collected were the same, i.e., qualitative data about the users' experience with DSCTs, their needs, and their thoughts about TAP.

The result of an online co-design session.



The result of an in-person co-design session.

Figure 1: Two interfaces realized during co-design sessions.

3 RESULTS

3.1 Participants

Our target population includes three categories: students, young adults, and adults. As multiple studies outlined, the populations most affected by digital wellbeing issues are students and young adults, so they have been our primary focus. However, we thought collecting adults' ideas and opinions could add value to our study and design decisions. As we have seen, DSCTs do not try to address only overuse issues but support users in their everyday smartphone usage. Even if adults usually use their smartphones in a more conscious way, they may still benefit from them while fighting against dark patterns.

We involved 39 participants overall. Twenty identified as males, seventeen as females, one as non-binary, and one preferred not to say. The participants ranged from 18 to 62 years old (M = 28.26, SD = 11.31). Thirty-six came from Italy, one from Palestine, one from Iran, and one from Brazil. Twenty-six were students, fourteen were workers, and one was unemployed (two participants identified as students and workers). Last, their technological familiarity (M = 3.95, SD = 0.91. One means very low, while five is very high) was at least average for all except one (who described it as low). As expected, the adults' technological familiarity (age M = 40.75, SD = 13.51. Technological familiarity M = 3.33, SD = 0.89) was lower compared to the students' (age M = 22.70, SD = 2.37. Technological familiarity M = 4.22, SD = 0.80). Last, they used their smartphones on average about 4:40 per day (M = 278.53, SD = 109.89 daily minutes).

After each focus group, the interviewer transcribed the answers using audio recordings. Overall, we recorded 10 hours and 14 minutes. To analyze the notes, we decided to use qualitative coding. In particular, we adopted the Reflexive Thematic Analysis, which aims to identify themes using open and organic coding [3]. Those themes helped us identify the most important outcomes of the focus groups. Table 1 summarizes the themes we extracted in our analysis.

One of the first things we realized is that whatever users can easily bypass is useless in the long term. Apple's option to ignore timers makes the intervention ineffective, as no one among the interviewed users respected it. For example, P26 has a timer for Instagram, which is useless for him. He rarely respects it (he seldom closes Instagram when he ends the available time). P3 also always presses the ignore button when she ends the time.

We also found an increasing popularity for usage awareness. Surprisingly, some users refuse to use blocking interventions because they want to be fully in control or think they have limited effectiveness. They believe awareness is the only way to change a behavior. We expected appreciation for those interventions but did not think some users would repudiate the blocking ones completely. P29, for example, said that using those tools "would be a personal defeat because I want to self-limit without depending on other applications (not to give more power to the phone)."

A surprising yet concerning aspect is how people normalized some highly unhealthy behaviors over time. P32 spends a lot of time on the phone, but she does something else in the meantime. It is as if her time has "a double channel." She has many games installed because she likes to use them while watching movies, which is obviously an unhealthy habit. The first step in solving a problem is admitting and understanding we have a problem, and DSCTs should support users in this.

Continuing to talk about the awareness issues, some users deactivated the usage statistics because they felt guilty about them. This behavior demonstrates how carefully we must design the DSCTs and their interventions. In this case, the intervention precisely hit its goal, i.e., creating a negative emotion inside the user about one of their behaviors. If not correctly calibrated, however, instead of being an aid, it becomes a bother, affecting its long-term efficacy and resulting in its abandonment.

From the screening survey, 17 out of 19 users said they use their phones too much. However, this did not always reflect in their answers, and most did not acknowledge it or, if they did, did not want to take corrective actions. P27 does not use DSCT because he would consider it a defeat. "Even though they would be convenient, I do not think I am in such a bad situation to depend on these applications." Such a conception is alarming. As we know, there are many available interventions, and each comes with a different strength and theory behind it. Users should see those tools as something valuable that can support us and not as something used only by desperate people.

3.2 Why TAP would be helpful in DSCTs

The focus groups and co-design sessions helped us answer our original research questions. We listened to participants' experiences, understanding the strengths of the available solutions and their limits, and we took notes about what they would need. Based on that, we extracted some key insights that justify and support our hypothesis related to TAP in DSCTs.

Since the first focus group, it emerged that all the users have unique needs, often in contrast. Apart from the fact that they may need different interventions (awareness or blocking), they typically have slightly dissimilar needs even in the same group of interventions. It frequently occurred that a participant expressed which ideal intervention they would need, and immediately after, another said it would not work for them. TAP would enable full customization, thanks to the available triggers and actions. So, it would help users create interventions that precisely match their needs without relying on external solutions that do not always fit them.

Table 1: The most important themes

Label	Our definition of the label
Interventions used	Interventions users use/used
Ineffective intervention	Interventions that did not work for the users (i.e., they became useless)
Negative smartphone usage	Examples of negative smartphone usage (regretted sessions)
Long-term inefficacy	Why an intervention proved to be ineffective in the long-term
Long-term efficacy	Why an intervention was effective in the long-term or what it would need to have to achieve it
Different personal needs	Examples of contrasting needs (helpful something for one user is useless for another)
Unawareness about existing interventions	Users desire an intervention that already exists (but they do not know about it)
Unawareness about smartphone usage	The users are not aware of their smartphone usage
Positive TAP perception	Positive comments or usages of TAP
Difficulty with TAP	Difficulties in using applications that implement TAP

The discoverability of existing interventions is a pressing problem, too. Many participants in the focus groups said, "I wish something like this existed," or "I would need something like this," despite existing solutions being available. Thanks to the list of triggers and events, users can discover new and valuable interventions they did not know about. One could argue that it would be the same to search on the app store for the most popular keywords related to digital wellbeing and explore all the possibilities. However, almost no user does this for disparate reasons. Getting informed about new interventions by simply using an installed application they would have used anyway is far more convenient for them, and it is also more probable to happen.

One encouraging finding is that adults and students see TAP as intuitive and attractive. As previously discussed, some studies recognized TAP as the most effective EUD technique. However, we still wanted to ensure our participants shared this perception. Notably, when asked for opinions about that, all the negative comments we received were related to some applications and not to TAP itself. Most regarded home automation, with Alexa being our most famous example. However, they were positive when we asked the users to focus on the rule-creation process.

To conclude, since TAP enables full customization and adapts to changing user needs, it could improve the long-term efficacy of DSCTs if adequately designed. As we analyzed, the leading causes of abandonment are friction and ease of bypassing the intervention. Long-term efficacy requires total commitment, and the possibility of having interventions that perfectly fit your needs will help it. Furthermore, it becomes your choice what to activate (it is not just downloading an application anymore, but also creating the rules), which could make you want to follow it more strictly. This approach would require, in fact, two commitments from the user: downloading the application and creating the interventions. Each intervention is related to a higher level of consciousness, thus making the user more willing to respect it. If, at any time, the user feels the intervention is less effective, they will be able to modify or change it instead of altogether abandoning the DSCT.

3.3 Habit Alteration Model

A theoretical framework is needed to provide a theory to support our observations and to make informed design decisions. Indeed, our study provided much information to help us understand how to improve the existing DSCTs. Still, behavioral theories describe the most effective way to enforce a change in the users.

After another minor literature review phase, we understood the Habit Alteration Model [16] was suitable for us. The idea is to break bad habits by establishing new, healthier ones. A crucial intuition is that habits are the default behavior when people cannot or do not want to make effortful decisions about their behavior [15]. So, if we can break the old bad habits with new positive ones, we can introduce changes that will likely persist in the long term.

We mapped all the desired interventions proposed by the participants into triggers and actions to show that, considering the outcomes of our study, TAP could successfully implement the most critical users' needs. We then linked each rule to one or more of the HAM strategies to prove that we can use rules to form new habits and, thus, permanently change user behavior. In Table 2, we reported the mapping and the related strategy for the most requested interventions during the study. If they are adopted and followed with dedication, they can indeed form new healthier habits, improving digital wellbeing. The second reason we think HAM is the best behavioral theory for our study is that both have the same goal. The primary motivation to improve the long-term efficacy of DSCTs is that, in this way, those tools can introduce behavioral changes likely to last in the long term. If those new behaviors become habits, the change will probably persist even when the DSCT is removed, and the tool will have achieved its goal.

3.4 Low-Fidelity Prototypes

Inspired by the outcomes of our study and the theoretical support provided by the HAM, we realized three low-fidelity prototypes of a mobile DSCT based on TAP. Out of them, two were the most promising ones.

The first design proposal, visible in Figure 2, is shaped upon the Dual Process Theory. We split the interface into two sections-one related to Type 1 (usage limitations) and one to Type 2 (usage awareness) processes. We consider the awareness interventions to belong to Type 2 processes because they do not impede the user in any way. Usage limitations are, instead, considered Type 1 interventions because they act on behalf of the user, impeding the unwanted automatic Type 1 processes.

Table 2: The rule mapping and HAM strategy for the most requested interventions

Intervention	Trigger	Action	HAM
An application timer without the option to ignore or change it during the day.	Usage time of an application or time of the day.	Block the application.	Train self-control.
Get notifications that tell you how much you have been using the application or the smartphone that day.	Usage time of the application.	Show a message.	Self-monitoring.
Usage reminders (like "10 minutes left") with timers.	Usage time of the application.	Show a message.	Just-in-time reminders.
A token-based timer. You can override the timer, but only a limited number of times.	Usage time of an application.	Block it.	Train self-control.

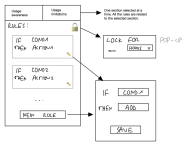


Figure 2: A rule-based DSCT, shaped upon the Dual-process theory.

Based on what emerged from the interviews, some users only want something to increase their awareness, while others think this wouldn't be enough for them and thus ask for something more substantial. This solution allows them to build the interventions that best fit their needs, using one or both sections.

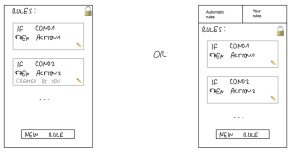


Figure 3: A rule-based DSCT, with an automated rule mechanism.

The second proposal (Figure 3) was inspired by what emerged in the interviews and the HAM. Like a mentor, the idea is to have an application that automatically learns and adjusts interventions based on the user's behavior and usage. Some rules are automatically created/edited, and the user can edit or create new ones. The solution on the left is the most essential one. It includes a list of all the active rules, highlighting the ones created by the user. Instead, the one on the right has two different pages, one for the automatically created rules and one for the user-created rules.

4 LIMITATIONS AND FUTURE WORK

Our work has some limitations. Despite our efforts, we could include only a limited number of participants who were not from Italy (3 out of 39). While their opinions and answers did not radically differ from the ones of the others, involving more people from other countries in the study would have allowed us to generalize the results further.

Also, although we found some encouraging signals of how DSCTs could benefit from TAP, our study did not investigate some lower-level details, such as which are the most needed triggers and actions in the digital wellbeing field or which could be the most effective interface for a TAP-based DSCT. It was a decision we made in the study design. Still, future research could start with our promising results and try to understand how to adopt them more practically.

5 CONCLUSION

Although the efficacy of our solution is yet to be tested, our study explores TAP as a promising solution in the digital wellbeing field, describes its potential advantages, and describes how it could solve some of the biggest DSCTs' criticalities. The previously described benefits, like the higher level customization, would make the user protagonist in their behavior change, designing themselves, with technological aid, their interventions. Only the user can know what they need, and we should support them rather than provide a premade solution. We hope this work can inspire a customization focus in the digital wellbeing field.

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