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Social networks, especially on mobile interfaces, can potentially undermine users' digital wellbeing promoting passive and excessive use. Previous attempts to support users' self-control either focus on *restricting* use, e.g., through usage timers and blockers, or *removing* functionality, e.g., by hiding recommendations. In an attempt to avoid these generic and drastic methods, this paper builds on the idea of using nudging mechanisms to make users recognize those design patterns in a social network app that are deliberately adopted to capture attention, the so-called Attention-Capture Damaging Patterns (ACDPs). Being engineered to make users lose their sense of time and control, we hypothesize that making them visible can trigger conscious decisions and more meaningful usage sessions.

Thanks to a co-design study with six mobile users, we designed two nudges for two different ACDPs commonly used on mobile social networks - infinite scroll and pull-to-refresh. Then, we implemented the two nudges in a mobile app, asking 17 users to try them in a 2-week exploratory study. Results show that the implemented nudges made participants feel more in control of their social media use and partially impacted their quantitative smartphone behaviors. Overall, our work points to exploring alternative – less intrusive – nudging methods to support users in self-regulating their smartphone use.

CCS Concepts: • **Human-centered computing** → **Social networks**; **Social media**; **Smartphones**; *Empirical studies in HCI*.

Additional Key Words and Phrases: deceptive design patterns, attention, technology overuse, digital wellbeing, nudging

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## 1 INTRODUCTION

While smartphones have become an integral part of our lives, they are also increasingly perceived as a potential threat to individuals and society's digital wellbeing [22], especially when it comes to social networks. Their (over)use, e.g., when users end up mindlessly scrolling social media newsfeeds [28], has been found to cause a variety of problems, from undermining users' sense of agency and control [18] to creating problems for social interaction [16]. Social media's ability to capture users' attention is not accidental but is often a design decision, with designers that often deliberately adopt Attention-Capture Damaging Design Patterns (ACDPs) [25], like infinite scroll and content autoplay, to exploit people's psychological vulnerabilities and maximize users' time spent. In response, users can nowadays take advantage of external tools – often called Digital Self-Control Tools (DSCTs) [19, 24] – to self-regulate their social media use. Typically, such external apps allow users to check their usage statistics and define usage timers and blockers, e.g., to use Instagram for 30 minutes per day maximum. From the earliest DSCTs, these technologies have expanded their popularity and functionality in the market and the HCI research community. Nevertheless, such an approach has been found to be ineffective, as DSCTs focus on indiscriminately *restricting* use only, thus also blocking needed content [17, 24].


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In an attempt to avoid generic and drastic self-control strategies, this paper speculates that the first step in promoting people's digital wellbeing on social networks is to give users the opportunity to *understand* and *recognize* why using social media is so compelling to the point of creating compulsive behavior. In particular, being engineered to make users lose their sense of time and control, we hypothesize that making ACDPs "more visible" may trigger conscious decisions and more meaningful usage sessions without restricting nor removing interaction possibilities. Such an awareness, through which the public could see "viral engagement" social media as harmful to society, could also promote a mass shift in consumer sentiment thus setting the stage for longer-term systemic changes [24].

To first explore how to nudge users into making more deliberate decisions when using a social network on a smartphone, we first conducted a co-design study with six mobile users. We asked participants to a) provide their insights and experiences regarding their use and overuse of social network mobile apps, and b) ideate, in a sketching exercise, a set of nudges for increasing their awareness about ACDPs and improving their sense of agency. Stemming from the collected findings, we implemented two nudges for the mobile applications of Instagram, TikTok, and Facebook, targeting two of the most common ACDPs exploited by social media, i.e., infinite scroll and pull-to-refresh. *Nudges* can be defined as any element of a system that steers users towards specific (hopefully good) behaviors without forbidding any interaction options [27]. In our work, the first implemented nudge – targeting the infinite scroll mechanism – is a floating widget representing a speedometer that reflects the intensity of the user's scrolling: the more the user scroll, the more the speedometer displays a high velocity. The second nudge, instead, is a widget containing refresh icons that becomes red the more the user performs pull-to-refreshes compulsively. We finally conducted an exploratory in-the-wild study during which we asked 17 users to try the two widgets for two weeks. Qualitative and quantitative metrics collected during the study demonstrate that using nudges impacted scrolls and refreshing behaviors, and helped participants perceive themselves as less smartphone-dependent. Although we did not find significant variations in the overall time spent on the target mobile apps, this may suggest that participants used their Instagram, TikTok, and Facebook apps with a greater sense of agency and control.

Our results are promising and worth further exploring in more extended and systematic studies, e.g., with the inclusion of a control group. We conclude the paper by discussing the opportunities for exploring alternative – less intrusive – nudging methods to support users in self-regulating their smartphone use.

## 2 BACKGROUND AND RELATED WORK

### 2.1 (Mobile) Social Media and Digital Wellbeing

In the contemporary Attention Economy [7], tech companies adopt designs and system functionality that exploit users' psychological vulnerabilities to grab users' attention and maximize the time spent by people on their digital platforms, especially on social media mobile apps [18]. Drawing inspiration from the traditional definition of "dark patterns," i.e., interfaces that intentionally manipulate users into performing actions that go against their best interests [8], researchers named these mechanisms as Attention-Capture Damaging Patterns (ACDPs) [25]. The possibility of scrolling *infinitely* a social network interface, or the opportunity to refresh *compulsively* the same interface hoping for new exciting posts to be consumed, are just two examples of how mobile social networks may capture users into a trap of continuous and passive use. These and other ACDPs – from the guilty pleasure recommendations that pervade most of the contemporary social media to the neverending autoplay of the following video on YouTube – manipulate users into spending attention sacrificing their sense of control and agency [18], in ways that they often regret [5]. On social networks that can be ubiquitously accessed through a mobile interface, in particular, these manipulative design patterns have the potential to

induce what Baughan et al. [3] called "zone states": phenomena of normative dissociation during which users experience an unconscious absorption in personally meaningless activities with little to no intrinsic value.

The problems mentioned above explain why researchers and the public consider smartphones and social media a significant threat to people's digital wellbeing – defined as a construct envisioning a good relationship between individuals and technology in an information society [4]. Mobile devices are often a source of distraction for ongoing tasks [2], making users more stressed and less productive [20, 21]. Specifically, social media on smartphones are perceived as potentially problematic by users themselves, who have described a variety of compulsive and excessive behaviors – like mindlessly scrolling social media newsfeeds [28] – in several previous experiments and studies [1, 16, 23, 28]. Tran et al. [28], in particular, proposed a descriptive model of the compulsive smartphone checking cycle, demonstrating that users fall into compulsive use almost automatically and with minimal awareness to fill moments of downtime.

### 2.2 From Digital Self-Control Tools to Nudging Mechanisms

Aiming to support users in self-regulating their use of digital services like social networks, researchers in the HCI community have proposed and evaluated several Digital Self-Control Tools (DSCTs) [19, 24]. DSCTs for smartphones, in particular, are dedicated mobile apps allowing users to monitor their usage statistics and define interventions like usage timers and lock-out mechanisms [22]. In most, if not all, of these tools, such interventions can be generically applied to any mobile app installed on a smartphone. NUGU [12] and Lock n' LoL [11], for example, allow users to define time limits for specific apps during group activities like studying. Instead, LocknType [10] first asks users to define a blocklist of mobile apps to be regulated and then forces users to perform an unnecessary task, e.g., manually copying a 30-digits number, before allowing them to access those apps. Although DSCTs can have a medium impact on the short-term [24], one of the reasons why they are often not effective in the long term is the fact that they are (nearly) always "self-programmed," meaning that users alone are forced to understand what the causes of their digital wellbeing issues, and, at the same time to decide what is an appropriate strategy to intervene on their unwanted behaviors, e.g., by selecting a proper time threshold for a usage timer [24]. Another reason that hinders the effectiveness of contemporary DSCTs is that today's digital services offer a mix of useful features and ACDPs, making it hard to apply a uniform logic for all service uses without a nuanced understanding of feature-level usage behaviors [5]. In other words, applying an intervention that limits the usage of an entire app may also interfere with the features of that app that are not necessarily a threat to the users' digital wellbeing [17], and, at the same time, it does not address the root cause issues, i.e., the internal ACDPs within an app [18].

Recent and valuable research efforts [13, 17, 18, 29] partially solved some of the above issues by targeting specific social media ACDPs, by proposing what have been called commitment interfaces [17]. These tools modify or recreate an existing social media interface to promote users' sense of agency and control by exploiting different technical compromises. Nevertheless, even commitment interfaces still focus on *removing* functionality. For example, GreaseDroid [13] can remove stories and the notification icon from Twitter, while SwitchTube [17] is an alternative to YouTube that allows users to activate a focus mode in which recommended videos are hidden. Other researchers have approached smartphone overuse prevention from a mindfulness and goal-oriented approach: the MindPhone app by Terzimehić et al. [26], for example, asks users to define a specific usage intention whenever they unlock their smartphones. Although effective, these solutions require a lot of effort from their users. This paper aims to explore a complementary approach to the aforementioned solutions. Specifically, our goal is to promote and support users' awareness of those ACDPs that cause unconscious digital habits – hypothesizing that making ACDPs "more visible" may trigger conscious decisions and more meaningful usage sessions. Such an awareness, through which the public could see "viral engagement" social media

as harmful to society, could also promote a mass shift in consumer sentiment, thus setting the stage for longer-term systemic changes [24]. To teach our goal, we exploit the concept of nudges. Nudges have been defined by Thaler and Sunstein [27] as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives." The objective of nudges is to support users in making their own choices [9] – that is, to exercise their own agency. In our work, in particular, we implemented two different nudges for helping users recognize sessions of infinite scrolling and compulsive refreshing behaviors on social media.

## 3 NUDGES FOR ATTENTION-CAPTURE DAMAGING PATTERNS

### 3.1 Co-Design Study

We conducted a co-design study to explore with end users their experiences regarding their use and overuse of social network mobile apps and to ideate nudges for contrasting ACDPs on mobile interfaces collaboratively.

*3.1.1 Participants.* We recruited six smartphone users through convenience and snowball sampling. Participants (four males and two females) had a mean age of 26.67 (SD = 10.98). Three were master's degree students in computer engineering; one was a master's degree in statistical sciences; one was a law student; the last was a history student. One participant out of six declared to be a non-expert in technology, but none of them had ever heard something about dark patterns or nudges. Participants had to sign an informed consent form before participating in the study.

*3.1.2 Methodology.* We carried out a co-design session lasting 1.5 hours during which a researcher interacted with participants following the four steps defined by the Double Diamond design model [6], i.e., discovery, definition, development, and deliver. Another researcher supervised the session by taking notes. In the discovery phase, which aims at scoping the work, participants were initially instructed with some basic concepts related to digital wellbeing, ACDPs, and nudges, and they were introduced to the study's goal, i.e., designing nudges for ACDPs. Furthermore, they were asked to write down a list of five mobile apps with the highest number of ACDPs in their opinion. Then, in the definition and development phases, participants started proposing and creating nudges with the help of the researcher in a collaborative way, producing different low-fidelity prototypes exploiting papers and pens. Finally, the produced prototypes were analyzed and finalized in a final debriefing session (deliver phase).

*3.1.3 Results.* During the co-design session – particularly in the deliver phase – participants agreed on the following:

- a set of three social networks, i.e., **Instagram**, **TikTok**, and **Facebook**, that they perceived as a threat to their own digital wellbeing, as the usage of these mobile apps often escapes their capacity for self-control;
- two ACDPs that are common on the three selected apps and that participants typically experienced, i.e., **infinite scroll** – the mechanism through which more content automatically and continuously loads at the bottom of the app as long as the user makes a scroll [25], – and **pull-to-refresh** – the (animated) reload of the newsfeed after a swipe that may or may not reveal new content [25].

Figure 1 (a) summarizes the two most promising nudges, according to the participants, for contrasting infinite scroll and pull-to-refresh. Each nudge includes a floating widget on top of the used social network and a textual pop-up when the user clicks the widget icon. Both the widgets are categorized in three different levels, representing *normal*, *consistent*, and *excessive* interactions.

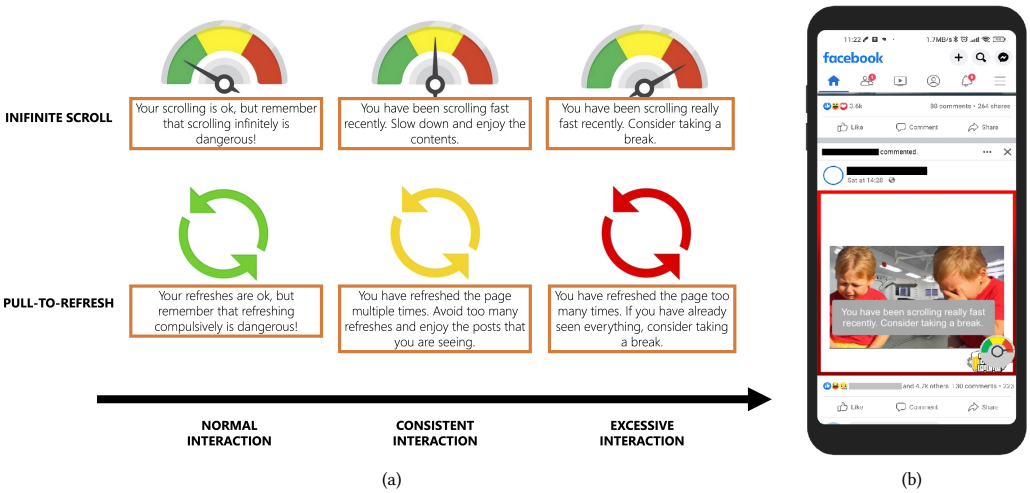


Fig. 1. A summary of the two nudges implemented for contrasting infinite scroll and pull-to-refresh ACDPs (a). Each nudge includes a floating widget and a textual pop-up appearing when the user clicks the icon (see (b) for a screenshot of *NudgeApp* highlighting excessive scrolling on Facebook).

For the infinite scroll mechanism, the floating widget is a speedometer that reflects the intensity of the user's scrolling. As long as the intensity of the scrolling increases, the speedometer displays a higher velocity, and the pop-up message changes. While the *normal interaction* message is just a reminder of infinite scroll problems, such a message becomes an invitation to slow down the interaction in the *consistent interaction* level and to take a break in *excessive interaction* level.

For the pull-to-refresh mechanism, the floating widget is a refresh icon that reflects how many refreshes of the page have been recently performed by the user, with the icon becoming red as long as the user starts to refresh the page compulsively. Pop-up messages resemble those used for the infinite scroll and range from a simple reminder (*normal interaction*) to the advice to take a break (*excessive interaction*).

### 3.2 The Nudge App

After conducting and analyzing the co-design session, we implemented the nudges of Figure 1 in an Android mobile application called *NudgeApp* by injecting fixed images into a transparent layout so that the widgets are displayed on top of the social network that the user is currently using. As an example, Figure 1 (b) shows a screenshot of the *NudgeApp* highlighting excessive scrolling on Facebook. All the implementation mainly relies on an Android accessibility service[1] which runs in the background and listens to the accessibility events raised by the operating system while the user is interacting with one of the monitored social networks. Thanks to such events, *NudgeApp* can detect when the user is scrolling the newsfeed or when the user is performing a swipe to manually reload it so that it can refresh the widget images accordingly. Thresholds for refreshing widgets and pop-up messages, i.e., to move between normal, consistent, and excessive interactions, have been defined empirically in a set of internal tests conducted within the research group.

[1]https://developer.android.com/reference/android/accessibilityservice/AccessibilityService, last visited on April 11, 2023.

*NudgeApp* also records all the user's sessions on Instagram, Facebook, and TikTok, as well as data on the visualized widgets (e.g., the moments in which they appear on the screen) in anonymous form for later analysis (see Section 4). For collecting these data, the app makes use of a Firebase database[2].

## 4 EXPLORATORY STUDY

To initially explore the effectiveness of the nudges implemented by *NudgeApp*, we conducted an exploratory in-the-wild study lasting two weeks, during which 17 participants were asked to install and freely use the application. Through the study, we were interested in investigating the following research questions:

**RQ1:** Do the implemented nudges impact how users interact with Facebook, Instagram, and TikTok?
**RQ2:** Do the implemented nudges impact how users perceive their addiction to smartphone?

### 4.1 Study Description

*4.1.1 Participants.* We recruited participants for the in-the-wild test through convenience and snowball sampling, exploiting internal mailing lists and sending private messages to our social circles. Participants were contacted by delivering a textual message containing the main information needed to participate in the study. In particular, the message described the study's goal and included a link to the consent form to be signed before starting the experiment. Furthermore, the text message was accompanied by a short tutorial showing how to install *NudgeApp* and a link to a short onboarding questionnaire. Through such a questionnaire, we recruited participants that a) demonstrated interest in improving their digital habits on smartphones and b) declared to use at least one of the three selected social networks, i.e., Facebook, Instagram, and TikTok, on their smartphones.

Overall, 21 users were eligible for the study, and 17 of them correctly completed the user study for its entire duration after having singed an informed consent. Participants (14 males and three females) were, on average, 24.82 years old (SD = 4.05). Most of them (11) were students, four were workers, and two declared to be unemployed. None of them previously participated in the co-design study described in Section 3.

*4.1.2 Methodology.* To complete the study, participants had to download and install *NudgeApp* and continue using their smartphones for the whole experiment. Meanwhile, *NudgeApp* started displaying the proposed nudges and collecting usage data.

To investigate **RQ1**, we focused on the following measures characterizing the usage of Facebook, Instagram, and TikTok: daily minutes spent, daily minutes of scrolling, and daily number of pull-to-refreshes. Furthermore, we triangulated these measures with data about the visualized widgets, e.g., to discriminate between scrolling in the *normal interaction* level and scrolling in the *excessive interaction* level.

To investigate **RQ2**, instead, we asked participants to complete, at the beginning and the end of the study, the Short Version of the Smartphone Addiction Scale (SAS-SV [15]). Depending on the SAS-SV score, the scale identifies different ranges of self-reported addiction for males and females. In particular, males are considered addicted if their score is greater than or equal to 32, while this threshold is set to 34 points for females. Furthermore, the scale also identifies a level associated with a high risk of addiction, represented by scores between 22 and 31 for males and between 22 and 33 for females.

[2]https://firebase.google.com/, last visited on April 11, 2023.

### 4.2 Results

*4.2.1 Impacts on Usage Behaviors.* By analyzing usage data, we found no significant variations in the daily minutes spent on Facebook, Instagram, and TikTok during the 14 days of the study. Some participants tended to use the three monitored platforms more in the first week of the study, others increased their usage towards the end of the experiment, and others had usage peaks on some days, e.g., on weekends.

However, Figure 2 shows that the implemented nudges slightly impacted the behaviors related to the two targeted ACDPs, i.e., infinite scrolls and pull-to-refreshes. Figure 2 (a), in particular, shows that the number of compulsive pull-to-refreshes (*excessive interaction* level, red line) decreased as the days passed. Similarly, Figure 2 (b) shows that the average daily minutes of scrolling in the *normal interaction* level increased as long as participants used the speedometer nudge.

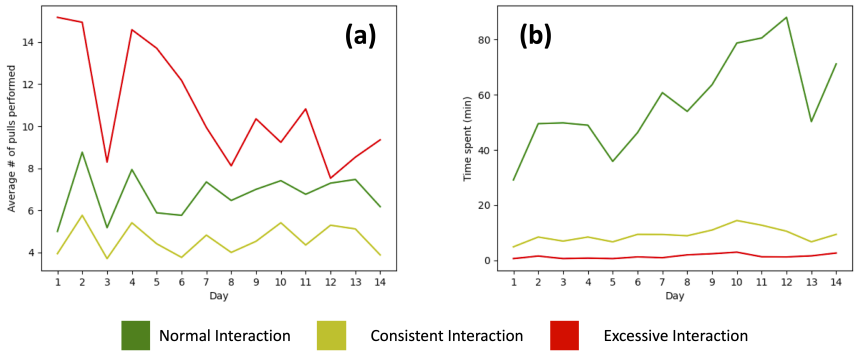


Fig. 2. Two charts summarizing how the implemented nudges impacted the average number of pull-to-refresh (a) and the daily minutes spent by participants in scrolling the social networks' newsfeeds.

*4.2.2 Impacts on Perceived Addiction.* Figure 3 summarizes the answers to the SAS-SV questionnaires before (blue bars) and after (orange bars) the study.

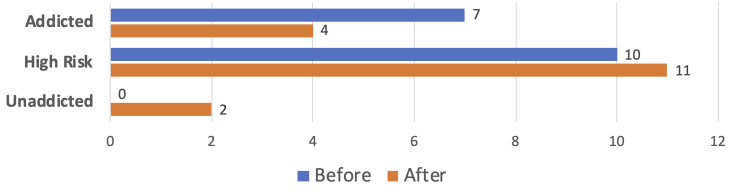


Fig. 3. SAS-SV results collected before (orange bars) and after (blue bars) the study, divided between unaddicted, high-risk, and addicted levels.

The chart suggests a slight impact of the implemented nudges on how participants perceived their smartphone addiction level, thus positively answering the second research question (**RQ2**). The number of unaddicted users, in particular, increased from 0 to 2, while the number of participants that self-reported an addiction level decreased from 7 to 4. In terms of aggregated results, the average SAS-SV score was 31.70 (SD = 7.04) before the study and 29.20 (SD = 5.631) after the study, with a global reduction of 2.5 points.

## 5 DISCUSSION

Contemporary solutions to support users in self-regulating mobile social media use either focus on restricting [19] or removing functionality [17], often exploiting generic and drastic strategies like interventions that indiscriminately block an entire app [22]. Recently, researchers have warned that these strategies are often not well aligned with users' preferences and needs, demonstrating their lack of effectiveness in the long term [24] and their high degree of attrition [14], e.g., because they often restrict or remove content that is not linked to digital wellbeing problems [17].

Our work demonstrates the feasibility of adopting a less-intrusive strategy that focuses on assisting users in understanding and recognizing why using social media is so compelling: knowing when deceptive and seductive Attention-Capture Damaging Patterns [25] are operating may activate the users' conscious memory system[3], motivating them in performing conscious decisions that may lead to more active and intentional usage sessions. Results extracted from the exploratory in-the-wild study reported in Section 4 confirm such a hypothesis for what concerns two of the most common ACDPs characterizing social media mobile apps: the speedometer the refresh icon widgets allowed users to reduce the scrolling intensity and the number of pull-to-refreshes, respectively. Furthermore, they lead participants to declare a lower self-reported degree of smartphone addiction at the end of the study. Overall, our preliminary findings suggest that using nudging strategies as a digital self-control strategy may be an effective strategy to support users' sense of agency and control when using social media [17, 18]. We consider this work as a starting point to investigate the effectiveness of other kinds of nudges targeting the variety of ACDPs identified in previous works [25].

*Limitations and Future Works.* Our work is subjected to two main limitations that may inform future works in this field. First, the generalizability of our findings is limited as the co-design and exploratory studies involved two relatively small samples of young adults only, with a bias towards male users. Future works would need to assess further our approach and the implemented nudges by involving larger and more diverse populations: less gender-biased populations or populations involving older generations, for instance, might have different digital habits and respond differently to the implemented nudges. Second, the results of the in-the-wild study should be considered according to the exploratory nature of the experiment, and more ecologically-valid studies are needed to confirm the promising results described in this paper. Future studies, in particular, would need to include a control group to determine which changes or outcomes are due to the intervention strategy instead of being due to some other variable.

## 6 CONCLUSIONS

In this paper, we investigated an approach towards digital self-control that focuses on promoting awareness of those design patterns that promote compulsive and excessive digital habits. To this end, we co-designed with six smartphone users two different nudges to promote awareness of two of the most problematic ACDP exploited on mobile social networks, i.e., infinite scroll and pull-to-refresh, and we implemented them in the form of floating widgets in an Android mobile app. An exploratory in-the-wild study with 17 participants shows evidence that nudges may be an effective strategy to support people using social networks with greater agency and control and open the way for further investigating nudging strategies to support users' self-control.

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