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Assessing OS-level automation for digital self-control interventions

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ABSTRACT

Research on Digital Self-Control Tools (DSCTs)—mobile applications designed to support self-control over technology use—faces barriers related to technical complexity, operating-system constraints, and privacy. This paper investigates OS-level automation as a lightweight and privacy-centric approach to implementing and distributing digital self-control interventions without writing code. First, grounding our analysis in a state-of-the-art taxonomy of digital self-control strategies, we assess the extent to which iOS Shortcuts can function as a modular intervention toolkit. Our findings show that it can reproduce 75% of intervention features found in contemporary DSCTs, while enabling novel capabilities such as feature-level, context-aware, and multi-device interventions. Second, we report a between-subject study ($N=193$) investigating how intervention distribution strategies influence participant privacy perceptions in digital wellbeing experiments. We conclude the paper by discussing how emerging AI technologies could further amplify this approach – grounding our discussion in a concrete instance from our feasibility assessment in which an on-device AI model was already used to generate intervention content – and by outlining how AI-assisted authoring could lower barriers to creating personalised interventions.

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digital wellbeing; trigger-action programming; iOS shortcuts

1. Introduction

Public and scholarly debates have increasingly drawn attention to the unintended consequences of pervasive digital technologies (Foer 2016), with smartphones often positioned at the centre of concerns about distraction, overuse, and wellbeing (Coughlan 2019; Tran et al. 2019). In response, the HCI community has emphasised the need to design technologies that better support people in maintaining healthier digital habits and achieving digital wellbeing (Burr, Taddeo, and Floridi 2020), fuelling sustained interest in Digital Self-Control Tools (DSCTs) (Monge Roffarello and De Russis 2022). These tools—typically implemented as mobile applications—aim to help individuals regulate their interactions with other apps by offering mechanisms such as activity monitoring, timers, and access restrictions (Lyngs et al. 2019). Despite their promise, advancing DSCT design and evaluating such systems in user studies remain difficult (Monge Roffarello and De Russis 2022). Developing mobile DSCTs routinely demands substantial technical expertise and frequently bumps up against platform-imposed limitations, especially on iOS. Consequently, researchers often resort to workarounds such as Android's Accessibility APIs (Cho et al. 2021) to

implement desired features. At the same time, end users express concerns about installing third-party DSCTs, largely due to the sensitive nature of the behavioural data these apps require, including detailed usage histories (Ko, Choi, et al. 2015; Kovacs, Wu, and Bernstein 2018).

Motivated by emerging research that explores lightweight approaches to digital self-control (Purohit, Barev, et al. 2023; Purohit, Bergram, et al. 2023; Purohit and Holzer 2021; Scott 2023), this work examines whether Apple's built-in automation environment—iOS Shortcuts (Apple Inc. 2023)—can serve as a technically viable platform for implementing and distributing digital self-control interventions directly at the OS level. Because Shortcuts allows the composition of trigger-action rules without the need for conventional software development, it may offer a practical alternative to purpose-built DSCT apps. Such an approach has the potential to ease long-standing technical barriers, bypass restrictions that hinder third-party tools, and reduce privacy-related friction during installation. If validated with non-technical users, such an approach could also broaden participation in DSCT research by enabling scholars with limited programming experience, including those in clinical and behavioural fields, to prototype

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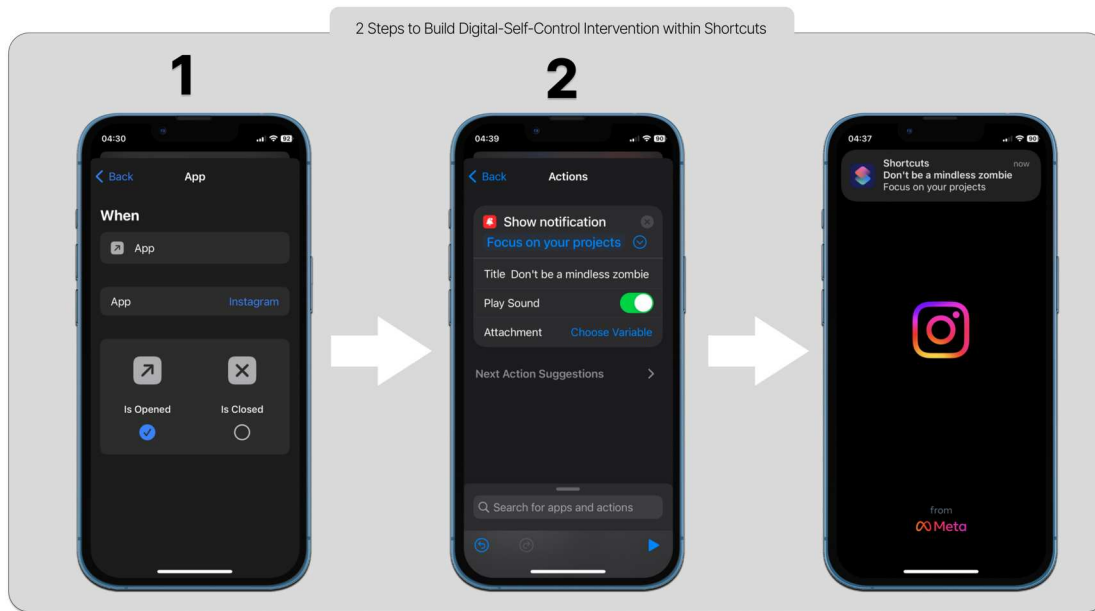


Figure 1. This paper investigates the technical feasibility of using iOS Shortcuts to prototype digital self-control interventions and examines privacy perceptions during their distribution. The figure exemplifies our approach, showing the steps in iOS Shortcuts to implement a notification that prompts users to focus on their projects upon opening Instagram.

and test interventions more readily. Evaluating this potential remains an important direction for future work (Figure 1).

Our first step was to evaluate how far iOS Shortcuts can go in reproducing the functionality commonly found in DSCTs. Using the intervention taxonomy proposed by Lyngs et al. (2019), we attempted to implement an instance of each of the 24 design features included in the taxonomy using only the capabilities offered within the Shortcuts ecosystem on an iPhone. This first step of our work demonstrated that 18 of the 24 features (75%) could be operationalised without resorting to external software. These findings suggest that Shortcuts can cover a substantial portion of contemporary DSCT design space. Moreover, the platform's native integrations offer avenues for overcoming several longstanding DSCT limitations, including improved context-awareness, opportunities for feature-level interventions, compatibility across Apple devices, and the ability to combine multiple intervention strategies within a single system.

Beyond implementation feasibility, we also sought to understand how interventions created with Shortcuts might best be introduced to participants in empirical studies. Since privacy concerns often prevent individuals from installing DSCTs (Kovács 2019; Purohit, Barclay, and Holzer 2020), the moment of onboarding is particularly sensitive. To probe this issue, we conducted a between-subjects study with 193 participants comparing two ways of distributing a Shortcuts-based intervention: providing a fully

prepared Shortcut versus asking participants to recreate it themselves using a step-by-step guide. Despite both groups having access to the same underlying logic, those who imported a pre-built intervention reported higher privacy concerns and perceived risks. In contrast, manually rebuilding the Shortcut appeared to enhance transparency and trust, suggesting that participation in constructing the intervention may mitigate early-stage attrition.

In sum, this work contributes in two primary ways. First, it offers a systematic examination of how far iOS Shortcuts can be leveraged to construct a broad range of digital self-control interventions, thereby assessing the technical potential of OS-level automation as a methodological resource for digital-wellbeing research. Second, through an empirical study, it identifies distribution practices that can support more privacy-sensitive onboarding of such interventions, highlighting the benefits of involving participants directly in the construction process. We discuss future opportunities and open challenges related to enabling both researchers and everyday users to design their own DSCTs, pointing toward a more democratised ecosystem for digital self-regulation. Furthermore, we discuss the role of AI in this context, grounding our analysis in a concrete example from our feasibility assessment – an intervention that leverages Apple's on-device AI model to dynamically generate motivational content – and outlining how AI-assisted authoring could further support end-user development of digital self-control interventions

by, e.g. recommending relevant Shortcuts, generating rule structures from natural-language descriptions, or adapting interventions to behavioural patterns in a privacy-conscious manner.

2. Background and related work

2.1. Digital self-control

Terms like overuse (Lee et al. 2014), compulsive use (Tran et al. 2019), and addiction (Lanette et al. 2018) are nowadays often associated to smartphone use, with researchers developing dedicated psychological scales to measure the extent to which users are bounded and addicted to their mobile devices (Kwon et al. 2014). While a significant portion of this discussion may be speculative, especially when connecting everyday behaviours like technology use to addiction (Lanette et al. 2018), there exists a substantial body of evidence suggesting that frequent and excessive smartphone use can adversely affect daily activities and ongoing tasks (Ames 2013; Lanaj, Johnson, and Barnes 2014), leading people to experience mental health problems (Lanaj, Johnson, and Barnes 2014), lower opportunities of good social interactions (Turkle 2011). Leveraging ‘attention-capture’ design patterns, such as infinite scrolling and video autoplay, existing services like social media and video-streaming platforms risk undermining user agency and hampering self-control (Lukoff et al. 2021; Monge Roffarello, Lukoff, and De Russis 2023). Overall, end users themselves would change their negative digital habits in favour of more productive online or offline activities (Lee et al. 2014; Monge Roffarello and De Russis 2021b; Tran et al. 2019). Therefore, it is not surprising that a new research area in HCI is emerging around the topic of ‘digital wellbeing,’ defined by Burr, Taddeo, and Floridi (2020) as *‘the impact of digital technologies on what it means to live a life that is good for a human being in an information society’* (p. 2313). In this complex landscape, several Digital Self-Control Tools (DSCTs) have been proposed to support users in self-regulating the usage of distractive apps or websites. As summarised by recent reviews (Lyngs et al. 2019; Monge Roffarello and De Russis 2022), in particular, most of these tools take the form of dedicated mobile apps, providing users with a range of intervention strategies to control smartphone use, from self-monitoring supports (Lyngs et al. 2019) to the possibility of setting up digital nudges (Purohit, Barclay, and Holzer 2020). DSCTs are not the only approach to promoting digital wellbeing. Researchers and practitioners have also explored platform-side interventions, such as redesigning attention-capture patterns and removing dark

patterns (Monge Roffarello, Lukoff, and De Russis 2023), digital literacy and mindfulness-based programs aimed at changing users’ relationship with technology (Lukoff et al. 2018), and educational solutions aiming at teaching users how to achieve digital wellbeing (Roffarello and Russis 2023). We focus on DSCTs because they represent the most actionable user-side approach: unlike platform redesign, they do not depend on cooperation from service providers, and unlike educational interventions, they provide immediate, in-context behavioural support.

2.2. Technical and privacy barriers in digital self-control tools

While a recent meta-analysis (Monge Roffarello and De Russis 2022) demonstrated that DSCTs have a short to medium-term impact on technology-usage behaviour, the same work—together with several other studies (Kovacs, Wu, and Bernstein 2018; Lyngs et al. 2019; Monge Roffarello and De Russis 2019)—also highlights that innovating interventions for digital self-control and evaluating their effectiveness in human subject research is challenging (Monge Roffarello and De Russis 2022).

On the one hand, researchers are starting to warn that DSCTs are contradictory by nature, as they are a third-party technology that disincentivises the usage of other technology (Lukoff et al. 2021; Monge Roffarello and De Russis 2022), creating an ambiguity that leads to privacy and manipulation concerns (Widdicks 2020). As DSCTs interact with sensitive information like smartphones’ usage history, privacy-protecting measures become fundamental (Monge Roffarello and De Russis 2022) and demanded by the end users (Ko, Choi, et al. 2015; Kovacs, Wu, and Bernstein 2018). Indeed, as reported by Rooksby et al. (2016), ‘data about everyday device use can reveal much about someone’s life, to the point that it raises privacy concerns’ (p. 293). Consequently, how to conduct user studies with DSCTs while minimising users’ privacy concerns is still an open challenge, and prior work highlighted the need for researchers to take ethical and privacy considerations more seriously when evaluating these technologies (Monge Roffarello and De Russis 2022). Adopting a research-oriented perspective, this paper focuses on perceived privacy risks and concerns at ‘installation time,’ i.e. when digital wellbeing researchers distribute a digital self-control intervention to their participants at the beginning of a research experiment.

On the other hand, researchers often experience technical barriers in creating their DSCTs, as developing these tools require extensive programming skills and the usage of ‘unconventional’ methods to overcome the

restrictions posed by the hosting operating systems (Kollnig, Datta, and Van Kleek 2021). For example, research investigating DSCTs for iOS devices remains infrequent (Lyngs et al. 2019) due to Apple’s stricter platform limitations, such as restricted access to usage statistics and app blocking (I. Kim et al. 2017; Monge Roffarello and De Russis 2019). Moreover, Android DSCTs often make use of accessibility APIs to overcome technical barriers and control the usage of other apps (Cho et al. 2021), misusing these important programming interfaces for another scope. Independently from the operating system, DSCTs are also particularly vulnerable to software aging (Schwartz et al. 2021) and operating system updates (Kollnig, Datta, and Van Kleek 2021). In an attempt to mitigate the above issues, this paper extends prior work (Purohit and Monge Roffarello 2025) by proposing an alternative approach to support researchers in creating and testing interventions for digital self-control, exploiting OS-level task automation tools like iOS Shortcuts.

2.3. Task automation through trigger-action programming

HCI research has a long-standing interest in enabling users to automate digital tasks, particularly on mobile devices. Recent platforms such as iOS Shortcuts (Apple Inc. 2023) and Android Rules (9to5Google 2022) have broadened the reach of Trigger-Action Programming (TAP), a paradigm in which users specify rules that automatically execute actions in response to defined triggers. Early systems like iCAP (Dey et al.

2006) demonstrated the value of TAP for prototyping context-aware applications, and subsequent work has shown its effectiveness as an end-user development approach across domains ranging from smart homes (Ur et al. 2014) to the broader Internet of Things (Corno, De Russis, and Monge Roffarello 2019).

Apple’s Shortcuts app—pre-installed on iPhones, iPads, and Mac computers—enables users to construct automations that span devices and applications. Shortcuts are built by assembling ‘actions,’ each representing an individual task, into linear sequences that function much like simplified programs. These actions can interact with Apple services, device settings, content stored locally or in the cloud, and, when supported, with third-party apps. Combined with ‘automation’ triggers (e.g. launching an app or arriving at a location), Shortcuts allow users to craft personalised workflows such as sending reminders, modifying system settings, or transforming content. This expressive yet accessible model places TAP within reach of a wide range of users and has made Shortcuts a promising environment for prototyping behaviour-change interventions.

Nevertheless, our preliminary analyses of iOS Shortcuts show that these tools are often under-exploited. Specifically, we performed a web scrape of 6590 shortcuts shared on RoutineHub (Skyground Media Inc. 2023), one of the most popular online catalogs for the Apple’s automation tool, as of June 4, 2023. We found that most of the shared automation have a top-level category that falls into *Development Tools* (795), *Entertainment* (716), *Productivity* (666), *Utilities* (654), or *Photo & Video* (464). The same trend is reflected in the most

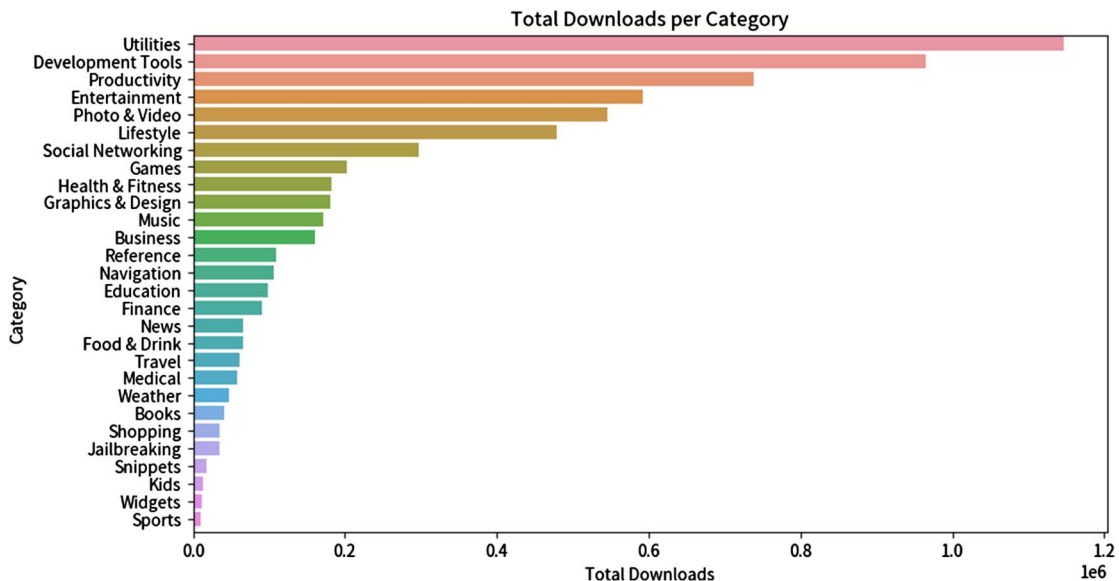


Figure 2. Most downloaded categories on RoutineHub as of June 4, 2023.

downloaded shortcuts: as shown in Figure 2, users are typically interested in automatising tasks related to *Utilities* and *Development Tools*, focussing on actions they perform on their devices daily.

Only recently have scholars begun exploring Shortcuts as a platform for building digital self-control interventions. Prior work has demonstrated, for example, that Shortcuts can be used to implement lightweight timers that interrupt prolonged social media use or to track time spent within specific apps (Purohit, Bergram, et al. 2023; Purohit and Holzer 2021). Building on these early efforts, our study investigates the broader feasibility of Shortcuts as a TAP-based environment for DSCT development. In doing so, we consider how such tools might complement traditional app-based approaches, by offering users and researchers more transparent and controllable paths to shaping their digital behaviours.

3. Assessing iOS shortcuts for digital self-control

This Section evaluates the extent to which iOS Shortcuts can serve as a practical TAP platform for prototyping and deploying digital self-control interventions. We envision three primary user groups for this approach, each with different technical backgrounds and motivations. First, digital wellbeing researchers with programming experience, who may use Shortcuts to rapidly prototype interventions before committing to full app development. Second, researchers from non-technical disciplines such as clinical psychology or behavioural science, who could potentially leverage the visual, no-code interface of Shortcuts to design and test interventions without relying on software engineering collaborators. Third, end users engaged in what has been termed ‘self-nudging’ (Reijula and Hertwig 2022), who may create personalised interventions tailored to their own digital habits. The feasibility assessment that follows is most directly relevant to the first group, as it was conducted by collaborators with prior programming experience. Drawing on established DSCT features from the research literature, we attempted to reproduce a diverse set of interventions using only Apple’s native automation environment, examining both feasibility and implementation complexity. To promote transparency and enable replication, we have made available a collection of videos and QR codes that document the essential steps for each implemented intervention at: https://osf.io/yu5m8/?view_only=c71e492d663248128767842679d3d074. These resources illustrate how to detect Instagram launch and close events, capture and store usage information, and present usage timers to users.

3.1. Methodology

To examine how effectively iOS Shortcuts can support the development of digital self-control interventions, three researchers—together with an experienced community contributor from Reddit—collaboratively designed a series of prototypes using only the capabilities available within the Shortcuts ecosystem. We deliberately avoided third-party applications to ensure that our findings reflected what researchers could accomplish solely with OS-integrated tools. For methodological structure, we adopted the taxonomy of DSCT intervention strategies proposed by Lyngs et al. (2019), which synthesises 24 design features across four categories: blocking/removing, self-tracking, goal advancement, and reward/punishment. This taxonomy has been widely used in digital wellbeing research (Davis et al. 2023; Lyngs et al. 2022; Monge Roffarello and De Russis 2022) and offers a comprehensive view of the existing DSCT landscape. Our goal was to attempt an implementation of each design feature using Shortcuts, drawing inspiration from prior DSCT literature. We selected Instagram as the target app due to its well-documented propensity to elicit habitual engagement (Monge Roffarello and De Russis 2021b) and because it has received comparatively less research attention than platforms such as Facebook (Purohit, Barev, et al. 2023).

We began by sketching action flows for each target intervention, decomposing them into smaller steps that could be expressed through available Shortcuts actions—a process aligned with core principles of computational thinking (De Santo et al. 2022; Farah et al. 2020; Kelly and Gero 2021). These conceptual flows were then translated into functional trigger-action workflows on iPhones. As is typical of end-user programming environments, the development process was iterative: implementing each intervention required testing, debugging, and refining the logic until it behaved reliably. Each collaborator independently produced an implementation, after which the group met regularly to discuss design decisions and challenges encountered. For every intervention, we assessed whether the resulting Shortcut matched the intended design feature within the taxonomy. We also categorised each implementation by perceived difficulty based on the number of required actions: five or fewer (low), between six and nine (medium), and ten or more (high). We note that these difficulty ratings are subjective and may be influenced by individual differences in programming experience. In particular, all researchers involved in the study had prior experience with programming or automation tools. The difficulty ratings therefore reflect expert assessments and may not

generalise to non-technical users. A formal usability evaluation with non-expert users remains necessary to validate them.

3.2. Findings

Table 1 provides an overview of our results, showing each DSCT feature from the Lyngs et al. taxonomy, the corresponding intervention we attempted to recreate using iOS Shortcuts, the research source that informed the chosen intervention, and the assessed difficulty of implementing it within the Shortcuts environment.

Across all categories, we were able to successfully implement Shortcuts-based approximations for 18 of the 24 design features, yielding a coverage rate of 75%. The subsequent sections describe our observations by category, highlighting where Shortcuts proved sufficient, where workarounds were needed, and where technical barriers made implementation infeasible.

3.2.1. Blocking/Removing

The blocking/removing category includes interventions designed to limit access to distracting applications or to remove features that encourage prolonged engagement (Lyngs et al. 2019). Using iOS Shortcuts, we were able to reproduce 5 of the 7 features in this category, leveraging automations that trigger when Instagram is opened and actions that redirect, delay, or constrain app access.

3.2.1.1. Feature minimisation. Feature minimisation aims to introduce friction around functions that may entice or distract users (Lyngs et al. 2022). Typical examples include suppressing the newsfeed, muting notifications, or dimming visual elements (Kovács 2019). Drawing on the approaches of Holte, Giesen, and Ferraro (2023) and Zimmermann and Sobolev (2023), we implemented an intervention that switches the device display to gray-scale whenever Instagram is opened. This colour desaturation serves as a subtle barrier discouraging continued use. In iOS Shortcuts,

Table 1. Overview of the Study 1 results. For each feature in the Lyngs et al. (2019) taxonomy, we developed a digital self-control intervention using iOS Shortcuts, inspired by research-based DSCTs (*main reference*).

DSCT Feature	Category	Intervention	Main Reference	Difficulty
Feature minimisation	Block/removal	Turn the smartphone into gray-scale when the user opens Instagram.	Holte, Giesen, and Ferraro (2023)	Low
Effortful task to override	Block/removal	Lock the smartphone screen when the user opens Instagram, forcing them to enter the smartphone's PIN.	Park et al. (2018)	Low
Block	Block/removal	Redirect to the home screen whenever the user opens Instagram.	J. Kim, Jung, et al. (2019)	Low
Time limit for use	Block/removal	Allow Instagram access only between 9 AM and 6 PM.	Hiniker et al. (2018)	Medium
Time lag before launch	Block/removal	Introduce a 10-second delay before launching Instagram.	Kovács, Wu, and Bernstein (2018)	Low
Uninstallation prevention	Block/removal	X	N/A	X
Pay to override	Block/removal	X	N/A	X
Record history	Self-tracking	Log how many times Instagram is opened.	Purohit, Bergram, et al. (2023)	Medium
Visualise usage	Self-tracking	Display Instagram usage metrics: openings, time spent, and remaining time before limit.	Kovács, Wu, and Bernstein (2021)	High
Display a timer	Self-tracking	Notify users when they have been on Instagram for 5 min.	Monge Roffarello and De Russis (2019)	Medium
Set time/activity goals	Goal advancement	Define a time objective for Instagram use when the app is opened.	Shen, Shen, and Chia (2019)	Medium
Goal reminders	Goal advancement	Notify users when they reach their Instagram usage limit.	Okeke et al. (2018)	Medium
Motivational quotes	Goal advancement	Show a random motivational quote whenever Instagram is accessed.	Foulonneau, Calvary, and Villain (2016)	Medium
Compare behaviour w/ goal	Goal advancement	Allow users to track time spent on Instagram relative to their goal.	I. Kim et al. (2017)	Medium
Redirect activity	Goal advancement	Redirect users to the reminders app when they attempt to access Instagram.	Inie and Lungu (2021)	Low
Praise/blame/please/annoy	Reward/Punish	Send a notification blaming users who exceed their Instagram usage limit.	Collins et al. (2014)	High
Gain points/streaks	Reward/Punish	Grant points when Instagram use stays within the goal limit.	Ko, Yang, et al. (2015)	High
Lose points/streaks	Reward/Punish	Deduct points if Instagram use exceeds the goal limit.	Liu et al. (2014)	High
Unlock achievements	Reward/Punish	X	Zhou, Rau, and Liu (2021)	X
Social sharing leaderboards	Reward/Punish	X	Ko et al. (2016)	X
Points as life forms	Reward/Punish	X	Liu et al. (2014)	X
Real-world reward/punishment	Reward/Punish	X	Park et al. (2021)	X

Note: *Difficulty* indicates implementation complexity based on the number of required actions.

this was realised via the *Colour Filters* action, paired with two automations that detect Instagram's launch and exit (low difficulty, i.e. ≤ 5 actions).

3.2.1.2. Effortful task to override. This feature introduces a deliberately effortful step that users must complete before accessing the target app (Lyngs et al. 2022). Prior work has, for instance, required entering a 10-digit code before access is granted (J. Kim, Park, et al. 2019). Inspired by Park et al. (2018), we created an intervention that immediately locks the smartphone when Instagram is opened, requiring the user to re-enter their device PIN before proceeding. On iOS Shortcuts this behaviour was achieved through the *Lock Screen* action, triggered by an automation monitoring Instagram's opening event (low difficulty, ≤ 5 actions).

3.2.1.3. Block. Blocking interventions prevent the user from opening the target application altogether (Lyngs et al. 2022), e.g. by disabling access at certain times of day (Ko, Choi, et al. 2015). Mirroring strategies from Ko, Choi, et al. (2015) and J. Kim, Jung, et al. (2019), we created an intervention that instantly redirects users to the home screen whenever Instagram is

launched (see Figure 3). Within iOS Shortcuts, this was implemented using the *Open* action configured to open the home screen whenever the corresponding automation detected Instagram's launch (low difficulty, ≤ 5 actions).

3.2.1.4. Time limit for use. This design feature constrains how often and when an app may be opened (Monge Roffarello and De Russis 2022). Prior studies have limited daily app time (Hiniker et al. 2018) or restricted access to particular hours (Lyngs et al. 2019). Taking inspiration from Hiniker et al. (2018), we built an intervention that permits Instagram access only between 9:00 and 18:00. Attempts outside this window trigger the 'block' routine described above, sending the user back to the home screen. Implementing this in iOS Shortcuts required checking the current time before conditional execution (medium difficulty, $5 < \text{actions} < 10$).

3.2.1.5. Time lag before launch. Rather than fully blocking the app, this feature introduces a delay before the target application opens, discouraging impulsive checking behaviours (Lyngs et al. 2019; Monge Roffarello and

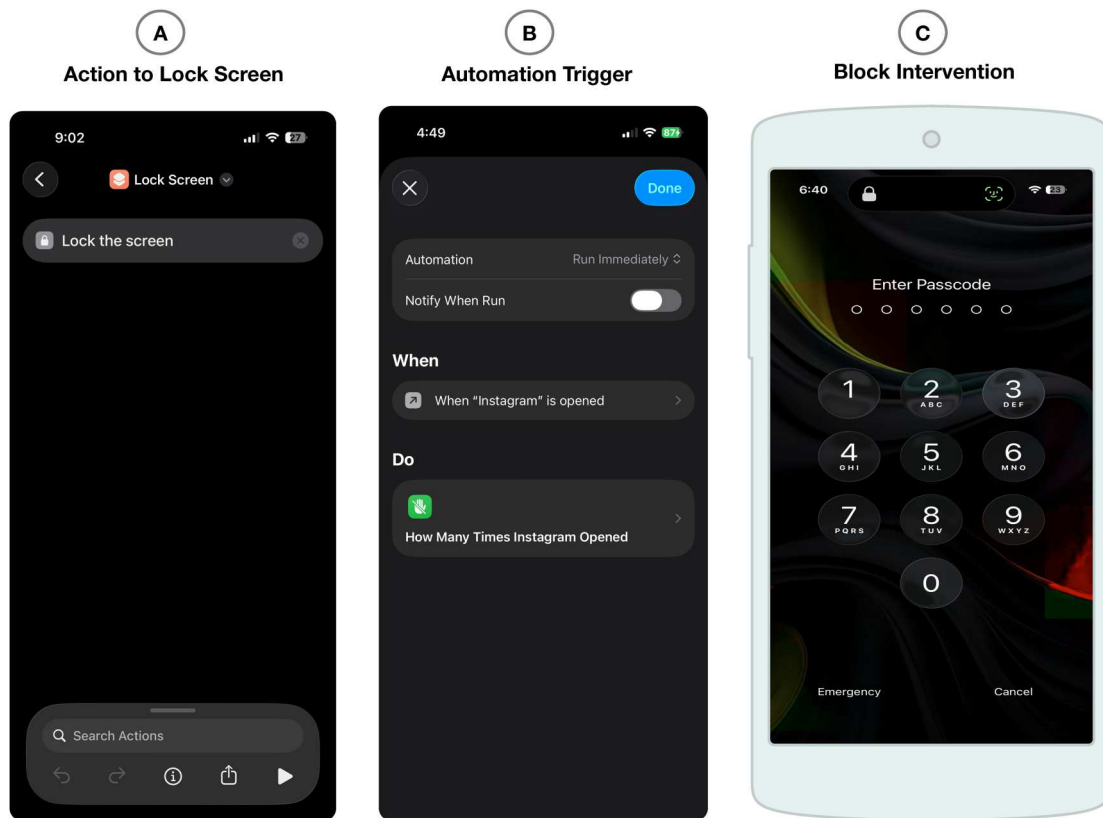


Figure 3. Blocking digital self-control intervention implemented via iOS Shortcuts. The intervention consists of three components: (A) a screen-locking action; (B) an automation trigger that activates when Instagram is opened; and (C) a block intervention that requires the user to enter a passcode before continuing, thereby increasing the effort required to access the app.

De Russis 2022). Similar delay-based strategies have been applied to websites (Kovacs, Wu, and Bernstein 2021, 2018; Purohit, Barclay, and Holzer 2020; Schwartz et al. 2021). Following Kovacs, Wu, and Bernstein (2018), we implemented a 10-second delay before Instagram launches. Because iOS Shortcuts cannot directly pause the standard app-opening event, we created a dedicated shortcut placed on the home screen that waits 10 s (via the *Wait* action) before opening Instagram. Users access Instagram via this shortcut instead of the native icon (medium difficulty, $5 < \text{actions} < 10$).

In the block/removing category, we were unable to reproduce *uninstallation prevention* and *pay to override*. The goal of uninstallation prevention is to stop users from removing the intervention entirely—for instance, by blocking the deletion of a DSCT—which would necessitate root-level access on the device. Implementing pay to override would similarly require users to make a monetary payment to bypass a blocking period, implying reliance on external payment services.

3.2.2. Self-tracking

Self-tracking interventions aim to record and surface behavioural data—such as the frequency or duration of

app use—to support reflection and self-regulation (Lyngs et al. 2019). Using Shortcuts, we were able to implement all three features in this category, including logging app openings, tracking time spent within Instagram, and displaying simple usage timers.

3.2.2.1. Record history. Recording history provides users with basic logging capabilities, such as counting how often an app is opened (Monge Roffarello and De Russis 2022), measuring time spent within an app (Okeke et al. 2018), or monitoring how much usage remains before a daily limit is reached (Whittaker et al. 2016). Building on Purohit, Barev, et al. (2023), we carried out an intervention that records each time Instagram is opened directly into the JSON file stored on the phone's local storage (refer to Figure 4). This was achieved in iOS Shortcuts by creating an automation triggered whenever Instagram is opened, followed by actions that store the current date and increment the total number of launches (medium difficulty, i.e. $5 < \text{actions} < 10$). We note that iOS Shortcuts' automation triggers distinguish between 'Is Opened' and 'Is Closed' events based on foreground state transitions. If Instagram remains running in the

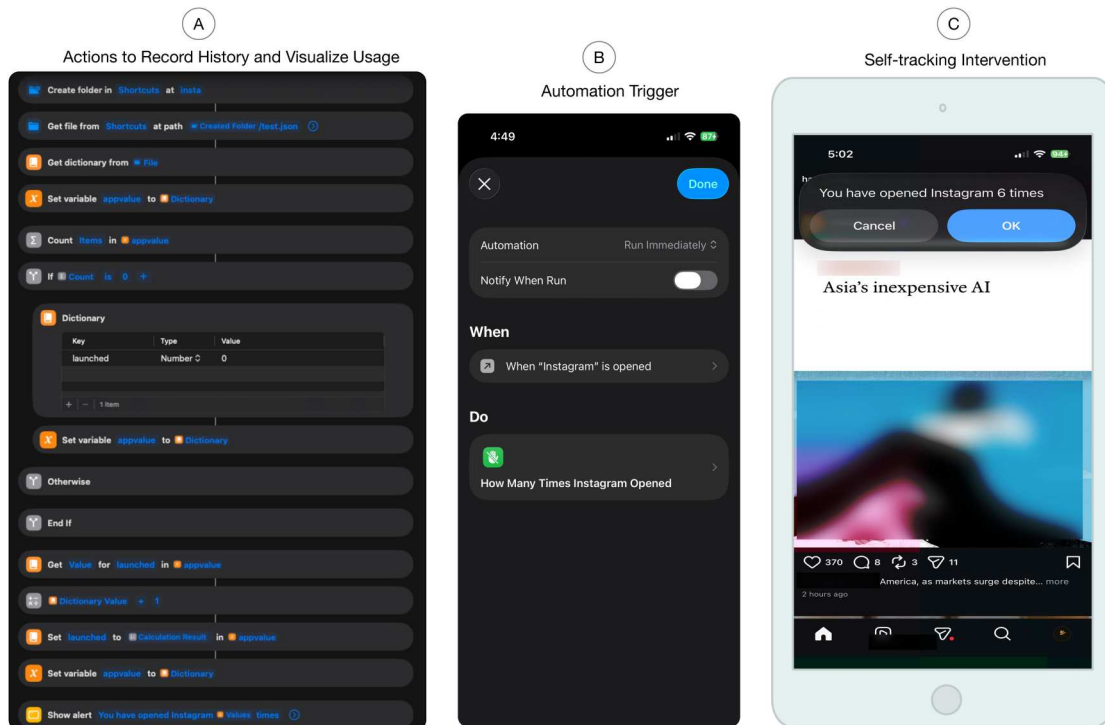


Figure 4. A self-tracking digital self-control intervention implemented using iOS Shortcuts. (A) The sequence of Shortcut actions that records each Instagram launch by updating a local usage history and computing the cumulative number of openings. (B) An automation configured to run automatically whenever Instagram is opened, triggering the Shortcut without additional user interaction. When activated, (C) the intervention overlays Instagram with a notification informing the user how many times they have opened the app, providing immediate feedback on usage behaviour.

background and the user returns to it, iOS fires a new ‘Is Opened’ event, which does increment the launch counter. This behaviour is consistent with our design intent, as returning to a backgrounded app represents a distinct usage session from a digital self-control perspective.

3.2.2.2. Visualise usage. This feature allows users to inspect previously collected data and, in some cases, receive real-time feedback on their behaviour (Monge Roffarello and De Russis 2022). For instance, Okeke et al. (2018) employed haptic cues to immediately inform users of their ongoing usage duration while simultaneously logging activity. Inspired by Kovacs, Wu, and Bernstein (2021), we created an intervention that displays up-to-date information about a user’s Instagram behaviour, including number of sessions, elapsed time, and remaining time before the daily limit. Implementation in iOS Shortcuts required two complementary automations (detecting Instagram’s opening and closing) combined with actions for data tracking and on-screen presentation (high difficulty, i.e. actions ≥ 10).

3.2.2.3. Display a timer. This feature relies on a running timer to provide live, moment-to-moment feedback on app usage (Monge Roffarello and De Russis 2022; Purohit and Holzer 2021). For example, Monge Roffarello and De Russis (2019) integrated a timer within the Socialise app to alert users when they had been using an application for an extended period. Drawing on both Purohit and Holzer (2021) and Monge Roffarello and De Russis (2019), we implemented a similar mechanism in iOS Shortcuts: users receive a notification after spending five consecutive minutes on Instagram, and the countdown automatically stops if the app is closed before the five-minute mark (medium difficulty, i.e. $5 < \text{actions} < 10$).

3.2.3. Goal advancement

Goal-advancement interventions support users in setting, monitoring, and staying aligned with their usage goals (Lyngs et al. 2019). We were able to replicate all seven features in this category using Shortcuts, including prompting users to set time limits, reminding them when goals are reached, and comparing actual behaviour with intended targets.

3.2.3.1. Set concrete time goals and set activity goals. These two DSCT features let users define explicit objectives, either as a maximum amount of time they wish to spend in an app or as alternative activities to pursue online or offline. For instance, Shen, Shen, and Chia (2019) allowed users to specify concrete time targets

to address problematic smartphone use. Building on Shen, Shen, and Chia (2019), we used iOS Shortcuts to create an intervention that asks users to set a time goal each time they open Instagram. This was implemented with the *Menu* action, attached to an automation triggered by Instagram’s launch, giving users a choice of time budgets between 30 and 120 s (medium difficulty, i.e. $5 < \text{actions} < 10$).

3.2.3.2. Concrete goal reminder and value/general goal reminder. These reminders reinforce either specific or higher-level goals by notifying users once a predefined limit has been exceeded, typically via haptics or system notifications. For example, Okeke et al. (2018) used vibration cues to signal that a time limit had been reached. Inspired by Collins et al. (2014) and Okeke et al. (2018), we implemented a timer-based intervention in iOS Shortcuts that alerts users when they hit their Instagram usage cap. Concretely, automations detect when Instagram opens and closes, Timer actions start and reset the countdown, and a *Show Notification* action surfaces the alert (medium difficulty, i.e. $5 < \text{actions} < 10$).

3.2.3.3. Motivational quotes. Motivational quotes aim to strengthen users’ confidence, motivation, and sense of agency (Bedrov and Bulaj 2018). For example, Foulonneau, Calvary, and Villain (2016) displayed persuasive statements such as ‘*Less time on your smartphone means more time with loved ones, better focus on your work, or simply peace of mind*’. Adopting a similar strategy, we created an iOS Shortcuts intervention that shows a randomly selected quote whenever Instagram is opened (Figure 5). This was achieved through the Use of on-device model action: when Instagram is launched, a request is made to Apple’s on-device AI model to generate a demotivational quote, which is then displayed via a notification. Notably, this intervention represents a concrete instance of AI-assisted content generation within a TAP-based DSCT, demonstrating that AI can already play a role in dynamically producing intervention content without requiring cloud processing or external APIs (low difficulty, ≤ 5 actions). We return to the broader implications of AI for DSCT development in Section 5.4.

3.2.3.4. Compare behaviour w/ goal. This feature helps users assess how their actual behaviour aligns with their stated goals (Monge Roffarello and De Russis 2022). For example, Chisler, Volkova, and Pyshkin (2016) exposed both goals and current progress, while I. Kim et al. (2017) showed remaining time directly in the notification shade. Inspired by I. Kim et al. (2017), we designed

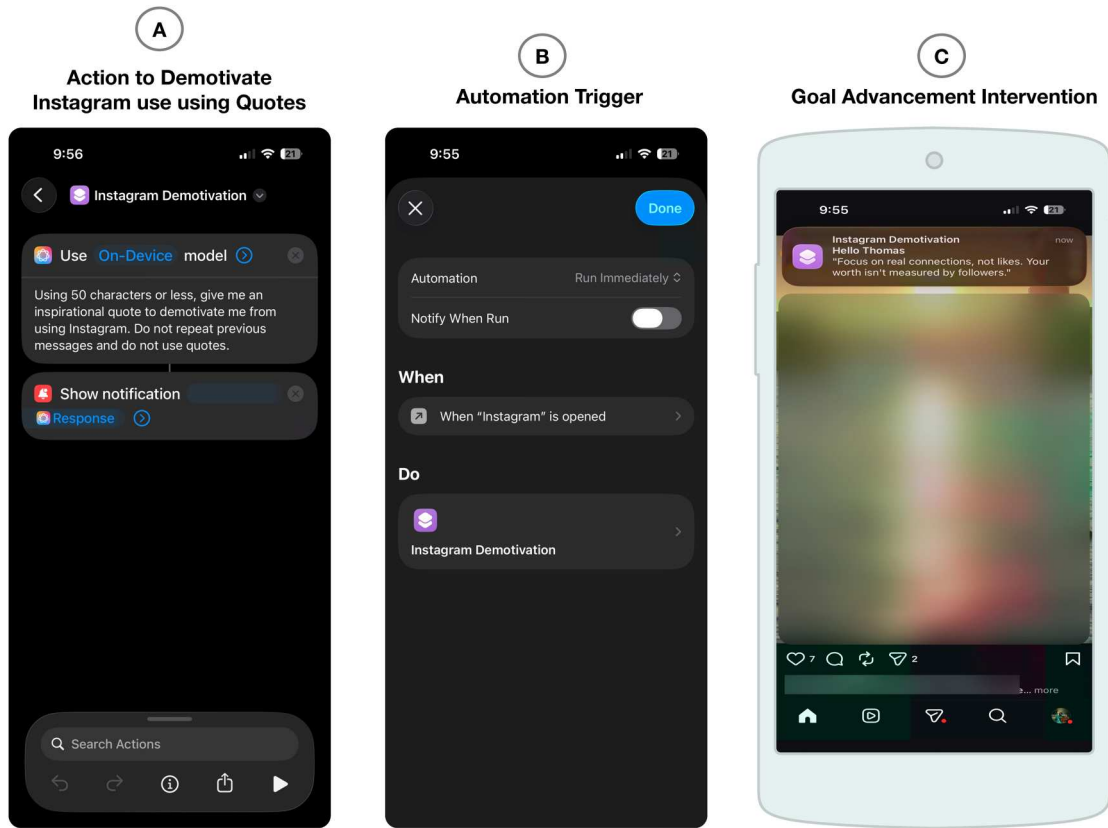


Figure 5. Goal-advancement digital self-control intervention implemented via iOS Shortcuts. (A) A ‘demotivation’ shortcut generates and displays a brief quote aimed at discouraging Instagram use; (B) a personal automation triggers this shortcut whenever Instagram is opened; and (C) the resulting notification overlays the app, reminding the user of their goals before they continue browsing.

a shortcut that lets users monitor their progress toward an Instagram time goal. The shortcut can be invoked on demand or triggered automatically when Instagram is opened. In iOS Shortcuts, the logic is: when Instagram starts, log the start time; when it closes, log the end time, compute the session duration, and then display the remaining time relative to the user’s goal (medium difficulty, i.e. $5 < \text{actions} < 10$).

3.2.3.5. Redirect activity. This DSCT feature routes users to a more beneficial activity or service before (or instead of) granting access to a potentially distracting app or website (Monge Roffarello and De Russis 2022). For instance, Inie and Lungu (2021) built a Chrome extension that diverted users to a learning platform when they navigated to distracting sites. In a similar vein, we created an iOS Shortcut that redirects users to the Reminders app whenever they attempt to open Instagram. Technically, this was implemented by using the *Open* action configured for the Reminders app and binding it to an automation that fires on Instagram’s launch (low difficulty, i.e. ≤ 5 actions).

3.2.4. Reward/Punish

Reward-and-punishment mechanisms aim to influence behaviour by providing positive or negative feedback when users meet or violate their goals (Lyngs et al. 2019). Using Shortcuts, we were able to construct three of the seven features in this category, including earning or losing points and sending motivational or corrective notifications. More complex gamified interventions—such as achievements or leaderboards—remained infeasible due to Shortcuts’ limited support for graphics, external APIs, or persistent multi-user data.

3.2.4.1. Praise/blame/please/annoy. This DSCT feature aims to provide evaluative feedback, either commending users for meeting their goals or criticising them when they fall short (Monge Roffarello and De Russis 2022). For instance, Collins et al. (2014) used negatively framed feedback in RescueTime, such as ‘17% less productive than usual and you are 31% less focussed.’ Inspired by Collins et al. (2014) and the RescueTime interface, we implemented an intervention that delivers a blame-framed notification when users do not achieve

their target. In iOS Shortcuts, we configured two automations—one on Instagram launch and one on exit—allowing users to specify a daily Instagram time limit. If this goal is not respected, a reproachful notification is sent the following day (high difficulty, i.e. actions ≥ 10).

3.2.4.2. Gain points/streaks. This feature uses gamification to shape behaviour by awarding points when users successfully adhere to their goals (Monge Roffarello and De Russis 2022). Ko, Choi, et al. (2015), for example, informed users of the number of points they would earn upon meeting their objectives. Following this idea, we created a shortcut that lets users define how many points they will receive when they achieve a particular goal. In iOS Shortcuts, we again employed two automations—triggered on Instagram’s opening and closing—along with actions that update and store point totals in a JSON-encoded dictionary, persisted locally on the device for later inspection (high difficulty, i.e. actions ≥ 10).

3.2.4.3. Lose points/streaks. Complementing the previous mechanism, this feature leverages point loss as a deterrent, discouraging users from exceeding their self-imposed limits (Monge Roffarello and De Russis 2022). Liu et al. (2014) similarly introduced feelings of loss when users diverged from desired behaviour. In our adaptation, points are subtracted whenever users surpass their daily Instagram goal. Using iOS Shortcuts, we defined two automations—on app start and app close—that run actions to update and store point values in a dictionary, serialised as a JSON file on the device for future reference (high difficulty, i.e. actions ≥ 10).

In the reward/punish category, we were unable to replicate *unlock achievements*, *social sharing leaderboards*, *points represented as life forms*, and *real-world reward/punishment*. The first three mechanisms rely on more elaborate forms of gamification to influence user behaviour. Prior examples include systems that escalate in difficulty or reward level based on user performance (Zhou, Rau, and Liu 2021, *unlock achievements*), leader-board rankings that compare users’ self-regulation outcomes (Ko et al. 2016, *social sharing leaderboards*), and metaphorical representations such as virtual plants that deteriorate when users exceed their limits (Liu et al. 2014, *points represented as life forms*). Implementing such designs would require graphical elements and access to external APIs, which exceed the capabilities of iOS Shortcuts.

Conversely, *real-world reward/punishment* seeks to shape behaviour through tangible incentives or penalties—for instance, requiring users to forfeit money

when surpassing usage boundaries (Park et al. 2021). These approaches, especially those involving monetary transactions or micro-incentives, depend on integrations with third-party payment or service infrastructures, making them infeasible within the constraints of the Shortcuts platform.

4. Using iOS shortcuts in digital wellbeing research studies

This Section explores how iOS Shortcuts-based interventions can be introduced to participants in digital wellbeing experiments. A key challenge in DSCT research is that privacy concerns at installation time can deter participation and increase early-stage attrition. How interventions are distributed to participants – that is, the specific procedure through which participants receive and set up an intervention on their device – may influence these initial privacy perceptions. We therefore ask the following research question:

RQ. How does the distribution modality of a Shortcuts-based digital self-control intervention (manual recreation vs. importing a pre-built version) affect participants’ perceived privacy concerns and perceived privacy risks?

To investigate this question, we conducted an online between-subjects experiment comparing two distribution strategies, detailed below.

4.1. Methodology

4.1.1. Tested intervention

For the experimental component of our study, we first created a Shortcuts-based intervention implementing the ‘Time Limit for Use’ feature from the Lyngs et al. taxonomy. The intervention used Siri to verbally alert participants once they had spent two minutes on Instagram (Figure 6). This threshold reflects common usage patterns in which people intend to ‘quickly check’ an app but are drawn into extended browsing (Woolley and Sharif 2022). We selected a voice-based alert rather than a visual notification to avoid familiarity effects from similar notifications in existing apps and to introduce a slightly more intrusive—and thus more noticeable—form of feedback. Prior work on smart speakers suggests that voice cues may heighten perceptions of privacy sensitivity (Lau, Zimmerman, and Schaub 2018), making them particularly relevant for evaluating initial user reactions.

To develop the intervention on iOS Shortcuts, we first created a shortcut called ‘Instagram Open’ to be

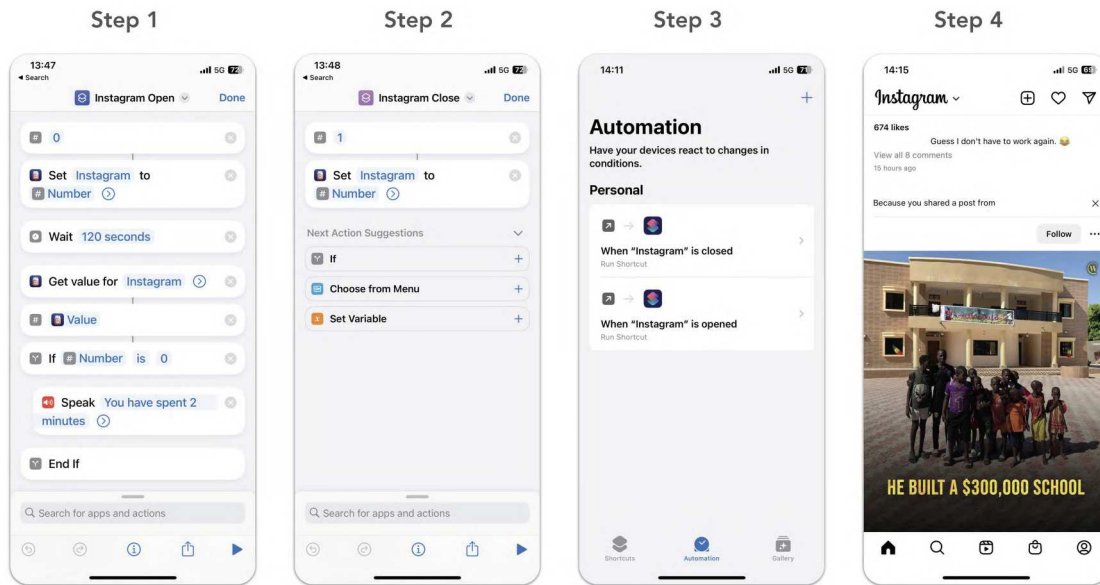


Figure 6. Digital self-control intervention delivered through a voice-based Shortcut.

executed as long as Instagram is opened (Step 1, [Figure 6](#)). The shortcut starts a timer for 120 s and, if the user has not closed Instagram within 2 min, it reproduces an audio message to inform the user that they have already spent 2 min on Instagram. The ‘Instagram Close’ shortcut (Step 2, [Figure 6](#)), instead, is used to reset the timer if the user closes Instagram before the 2-minutes threshold. As shown in [Figure 6](#), Step 3, we next associated the two shortcuts to two different automation based on two conditions: (1) when a user opens Instagram (execute the ‘Instagram Open’ shortcut) and (2) when they close Instagram (execute the ‘Instagram Close’ shortcut). Whenever the user opens Instagram, the intervention starts working automatically (Step 4, [Figure 6](#)).

4.1.2. Distribution modalities

To address our research question, we compared two common TAP distribution models that represent contrasting levels of participant involvement in the setup process: *manual re-creation*, in which participants reconstruct the intervention following a guided tutorial, and *reuse*, in which participants import a pre-built intervention. We use the term ‘distribution’ to refer to the procedure through which a researcher delivers a digital self-control intervention to study participants, encompassing both the technical mechanism (e.g. QR code import vs. step-by-step construction) and the degree of participant agency during setup.

4.1.2.1. Manual Re-Creation. In TAP environments, constructing trigger-action rules by hand typically

requires users to work through guided, wizard-style interfaces that connect specific triggers to corresponding actions (Desolda, Ardito, and Matera 2017). Prior research in web and IoT personalisation shows that this method offers users fine-grained control over the resulting behaviour, though it may be demanding for individuals without technical expertise (Corno, De Russis, and Monge Roffarello 2020b; Huang and Cakmak 2015). We emphasise that the goal of this study was not to assess whether participants could independently design novel interventions from scratch, but rather to investigate how the process of setting up an existing intervention affects privacy perceptions. This distinction is important: in a typical digital wellbeing experiment, researchers design the intervention and then distribute it to participants, who are asked to install and use it. As such, we adopted a manual re-creation workflow. Participants were given a detailed, step-by-step tutorial explaining how to rebuild the intervention described in Section 4.1.1. The tutorial consisted of 15 steps and guided participants through the creation of both the ‘Instagram Close’ and ‘Instagram Open’ shortcuts, as well as the process of linking these to their corresponding automations¹.

4.1.2.2. Reuse. In contrast, reusing existing trigger-action rules involves activating rules that have already been authored either by the platform or by other users (Corno, De Russis, and Monge Roffarello 2020b). In the area of web and IoT personalisation, recommender systems that propose pre-built rules have been introduced to reduce the complexity associated with the

manual creation process (Corno, De Russis, and Monge Roffarello 2020a, 2020b; Mattioli and Paternò 2021). This strategy also aligns with patterns seen in commercial TAP tools: for instance, the homepage of IFTTT (IFTTT 2023) prominently displays ready-to-use rule suggestions, whereas the interface for composing new rules manually is relegated to a secondary menu. To examine the reuse strategy in our study, we provided participants with the fully assembled intervention described in Section 4.1.1, noting that it had been prepared in advance by the researchers. Participants simply scanned a QR code to import the intervention onto their iPhone. Nevertheless, they were instructed to inspect the imported shortcut, with access to the same level of detail that was available in the manual re-creation condition.

4.1.3. Procedure and participants

To examine how different distribution methods for iOS Shortcuts-based digital self-control interventions influence users' privacy perceptions, we conducted an online between-subjects experiment with 193 participants recruited via Prolific. Eligibility criteria required that participants be native English speakers, iPhone users, and Instagram users with a minimum daily usage of 10 min. We recruited general end-users rather than researchers for two reasons. First, the study's focus is on privacy perceptions at installation time, which represent a barrier for any user population that engages with DSCTs – not only researchers but also the participants they recruit for their studies. Understanding how distribution modality affects these perceptions is therefore relevant regardless of whether the person installing the intervention is a researcher or a study participant. Second, recruiting a sufficient sample of digital well-being researchers with iPhones and active Instagram use would have been impractical given the niche nature of this population. The final sample consisted of 164 participants identifying as female (85%), 25 as male (13%), and 4 as non-binary or another gender identity (2%). Participants reported between 2 and 24 years of education ($M = 14.5$, $SD = 3.97$), and ages ranged from 18 to 59 years ($M = 25.1$, $SD = 7.898$). After recruitment, participants were redirected from Prolific to an anonymous Qualtrics survey, informed that the study involved evaluating a digital self-control intervention, and randomly assigned to either the *manual re-creation* or *reuse* condition.

In the *manual re-creation* condition, participants reconstructed the intervention on their own device using a step-by-step tutorial and then tested it on Instagram for 10 min. To verify correct implementation, a manipulation check was included, asking participants to describe what occurred during their Instagram

session. In the *reuse* condition, participants instead received a pre-built version of the intervention, which they imported via a QR code before testing it for the same duration.

4.1.4. Measures

Following the testing phase, all participants completed a survey assessing two dimensions of privacy-related reactions: **perceived privacy concerns (PCON)** and **perceived privacy risks (RISK)**. Both constructs were measured using established scales from the literature on a seven-point Likert format (7 = Strongly disagree; 1 = Strongly agree). Items were adapted from Xu et al. (2011) by substituting the term 'website' with 'voice intervention':

- – I am concerned that the information I submit to this voice Intervention could be misused (PCON1);
- – I am concerned that others can find private information about me from this voice Intervention (PCON2);
- – I am concerned about providing personal information to this voice intervention, because of what others might do with it (PCON3);
- – I am concerned about providing personal information to this voice intervention because it could be used in a way I did not foresee (PCON4);
- – In general, it would be risky to give personal information to this voice intervention (RISK1);
- – There would be a high potential for privacy loss associated with giving personal information to this voice intervention (RISK2);
- – Personal information could be inappropriately used by this voice intervention (RISK3);
- – Providing this voice intervention with my personal information would involve many unexpected problems (RISK4).

Internal consistency was excellent for both scales, with Cronbach's alpha values of $\alpha = .96$ for PCON and $\alpha = .95$ for RISK. Because several items were negatively phrased, reverse coding was applied to standardise the directionality of responses, ensuring consistent scoring and supporting the reliability and validity of the resulting measures.

4.2. Results

To address our research question regarding the effect of distribution modality on privacy perceptions, we first conducted Levene's tests to assess equality of variances

Table 2. Results of Levene's test evaluating variance equality between the manual re-creation and reuse conditions for the privacy concerns (PCON) and privacy risks (RISK) measures.

	F	df	p
PCON	6.169	1	0.014
RISK	5.657	1	0.018

Table 3. Average privacy concerns (PCON) and privacy risks (RISK) scores collected in the two study conditions.

	Group	N	Mean	SD	SE
PCON	Manual re-creation	85	3.871	1.808	0.196
	Reuse	108	4.664	1.604	0.154
RISK	Manual re-creation	85	4.338	1.671	0.181
	Reuse	108	4.782	1.451	0.140

(Table 2). As homogeneity was violated for both measures, we proceeded with Welch's *t*-tests.

Table 3 and Figure 7 show the collected average scores, while Table 4 reports the results of the conducted Welch's *t*-tests.

Concerning perceived privacy concerns (PCON), mean scores differed between conditions: manual re-creation ($M = 3.871$, $SD = 1.808$) and reuse ($M = 4.664$, $SD = 1.604$). A Welch's *t*-test revealed a significant difference between conditions, $t(169.27) = -3.181$, $p < .001$, with a medium effect size ($d = 0.465$, Table 4, first row). Participants in the reuse condition reported higher privacy concerns, suggesting that guided manual re-creation of a digital self-control intervention in iOS Shortcuts is associated with lower perceived privacy concerns at installation time.

Participants in the reuse condition also reported higher privacy risks (manual re-creation: $M = 4.338$, $SD = 1.671$; reuse: $M = 4.782$, $SD = 1.451$), suggesting that guided manual re-creation is associated with lower perceived privacy risks at installation time. A Welch's *t*-test indicated a significant difference between conditions, $t(167.13) = -1.941$, $p = .027$, with a small effect size ($d = 0.284$, Table 4, second row).

Table 4. Results of the Welch's *t*-tests conducted to investigate differences in terms of perceived privacy concerns (PCON) and risks (RISK) between the two study conditions.

	t	df	p	Cohen's d
PCON	-3.181	169.27	<.001	0.465
RISK	-1.941	167.130	0.027	0.284

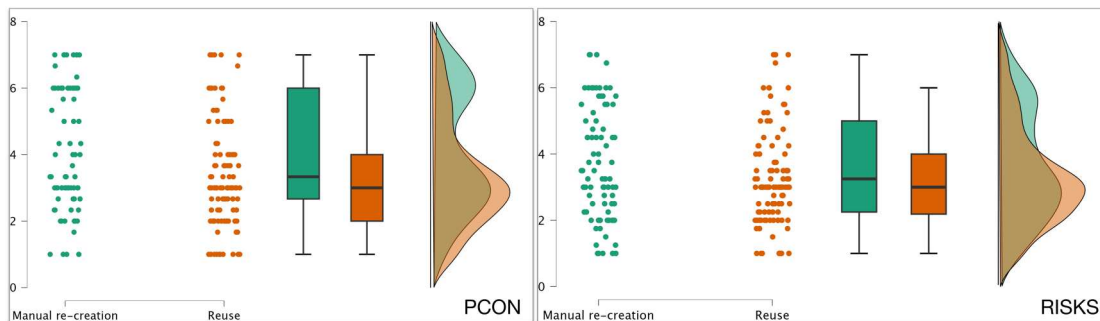
Overall, our findings confirm what has been theorised in the context of digital nudges. While receiving pre-built nudges is often perceived as deceptive (Bongard-Blanchy et al. 2021; Lavi 2018; Vugts et al. 2020), developing these interventions—an approach that has been named 'self-nudging (Reijula and Hertwig 2022)'—empowers users to take charge of their own decision environments (Lorenz-Spreen et al. 2020) and exercise their sense of agency (Vugts et al. 2020).

5. Discussion

Our analysis provided evidence on how automation tools like iOS Shortcuts can aid in developing and assessing digital self-control interventions in the digital-well-being research domain. In this section, we discuss the implications of our work for digital wellbeing researchers and end users, respectively.

5.1. Implications for digital-wellbeing researchers

The development of Digital Self-Control Tools (DSCTs) presents unique challenges, especially on mobile ecosystems, often demanding a high level of programming proficiency. In this section, we discuss the potential implications of our two studies for digital wellbeing researchers. We stress that these are derived implications based on (1) the technical feasibility demonstrated in Section 3 and (2) the privacy perception findings from Section 4 – not empirical claims about researcher adoption. The usability of this approach by non-technical researchers has not been tested in this

**Figure 7.** Distribution of participants' scores. PCON – Perceived privacy concern and RISKS – Perceived privacy risks.

work and represents an important direction for future research.

Researchers in the digital wellbeing research area creating DSCTs must possess the technical knowledge and programming skills to design and implement interventions that effectively address issues related to digital wellbeing. Furthermore, technical barriers and restrictions posed to third-party applications force academic researchers to follow time-consuming and error-prone strategies, from using ‘unconventional’ methods, e.g. the usage of Accessibility APIs in Android (Cho et al. 2021), to recreating a digital service from scratch (Lukoff et al. 2023). Our work offers initial evidence that an integrated OS tool for task automation like iOS Shortcuts has the technical capacity to reproduce a substantial portion of DSCT intervention features (Section 3) and that the way such interventions are distributed can significantly affect participants’ privacy perceptions (Section 4). In what follows, we discuss the potential implications of these findings for digital-wellbeing researchers, while acknowledging that the usability of this approach by non-technical researchers has not yet been empirically validated.

As an integrated OS tool, iOS Shortcuts may grant researchers access to typically restricted data, settings, and sensors that most third-party platforms, including many DSCTs for Apple’s OS, cannot tap into. Furthermore, the tool could potentially allow researchers to devise their interventions through a visual interface, reducing the need for conventional software development – though this claim requires validation with non-technical researchers. One of the potential advantages of adopting this approach is the possible democratisation of DSCT development. If the accessibility of iOS Shortcuts is confirmed through usability studies with non-technical users, a broader range of researchers, including those from non-technical backgrounds, could participate in creating and evaluating digital self-control tools. This inclusivity has the potential to greatly enrich the field of digital wellbeing, which is inherently interdisciplinary, embracing a diverse range of perspectives and expertise. As a result, integrating platforms like iOS Shortcuts into DSCT development has the potential to simplify the process and open up new opportunities for interdisciplinary research and solutions that can positively impact people’s digital lives. Furthermore, our findings from section 4 suggest the opportunity of conducting digital-wellbeing research experiments in which participants are actively involved in the definition of the digital self-control interventions to be tested. Specifically, our results show that guided manual re-creation of a DSCT – in which participants follow a step-by-step tutorial and

can inspect all the components of the intervention – is associated with lower perceived privacy concerns and risks compared to importing a pre-built version. We note that this finding pertains to guided re-creation of an existing design, not to open-ended authoring of novel interventions. This intervention decomposition might be impossible to achieve with a third-party application, while tools like iOS Shortcuts naturally support it through their end-user programming nature. Although we must acknowledge that users’ privacy concerns may evolve while using a DSCT, we can hypothesise that minimising privacy concerns at installation can help reduce the attrition rate, one of the most critical aspects related to DSCTs use (Kovacs, Wu, and Bernstein 2018; Schwartz et al. 2021), which is typically very high at the beginning of a research trial (Eysenbach 2005). Historical trends indeed emphasise privacy concerns as a primary factor for user resistance towards installing digital wellbeing apps (Kovács 2019; Purohit, Barclay, and Holzer 2020). Our work confirms initial evidence suggesting that TAP tools such as iOS Shortcuts offer enhanced privacy control compared to third-party digital self-control apps (Purohit, Bergram, et al. 2023; Purohit and Holzer 2021).

5.2. Traditional DSCTs and beyond

The advantages of empowering researchers to create and evaluate their own interventions for digital self-control through TAP extend beyond replicating ‘traditional’ DSCTs, potentially overcoming DSCTs’ well-known limits. Here, we discuss how iOS Shortcuts may be used by digital-wellbeing researchers to close well-known gaps in contemporary DSCTs.

5.2.1. Multi-device interventions

Most contemporary DSCTs, including those innovated by the HCI research community (Lyngs et al. 2019; Monge Roffarello and De Russis 2022), are designed to work on a specific device. Given its ubiquitous nature and relation to digital wellbeing problems, in particular, the smartphone is undoubtedly the most common target for DSCTs. As users commonly engage with multiple devices simultaneously, prior work (Monge Roffarello and De Russis 2021a) warned that such a single-device conceptualisation might become an issue, suggesting that DSCTs should encompass the ability to target multiple devices. Such a multi-device perspective is crucial for comprehensively understanding individuals’ digital wellbeing (Monge Roffarello and De Russis 2021a) and preventing potentially misleading behaviours. Users, for example, can easily

circumvent a DSCT on their smartphones by using another device (Lascau et al. 2019). This situation can cast doubts on the validity of the data collected during a field study. Solutions like iOS Shortcuts – which are integrated within a unique ecosystem, e.g. Apple – potentially allow researchers to straightforwardly ensure that their interventions for digital self-control are seamlessly delivered across diverse devices, e.g. iPhones, iPads and MacOS computers. In other words, developing a DSCT with iOS Shortcuts naturally allows researchers to achieve three important features that should characterise multi-device solutions for digital self-control (Monge Roffarello and De Russis 2021a), i.e. data synchronisation across different devices, intervention adaptation to different devices, and cross-device notifications.

5.2.2. Feature-level interventions

Most of the contemporary DSCTs on smartphones work as ‘screen-time tools’: users define a time limit for their usage sessions, and the tool enforces this limit (Lyngs et al. 2022). In other words, these interventions globally target the entire smartphone or selected apps. Unfortunately, such an approach runs the risk of indiscriminately blocking access to content and features *within* apps that users may still find valuable (Lukoff et al. 2023), e.g. educational videos on YouTube (Lukoff, Lyngs, and Alberts 2022). As reported by Cho et al. (2021), in particular, social media nowadays encompass a combination of features that range from quasi-essential to addictive (e.g. direct messages *vs.* infinitely scrollable feed), making the implementation of a one-size-fits-all intervention strategy unsuitable. Unfortunately, OS restrictions make the task of developing feature-level interventions through third-party DSCTs prohibitive: Lukoff et al. (2023), for example, were forced to recreate a new video-streaming app from scratch in an attempt to minimise the impact of recommendations on YouTube. Platforms like iOS Shortcuts potentially allow researchers to implement feature-level interventions targeting specific interaction patterns. For example, the possibility to act and personalise smartphone scrolling could be adopted to counter one of the most common ‘attention-capture’ design patterns, i.e. infinite scrolling (Monge Roffarello, Lukoff, and De Russis 2023). Furthermore, the possibility to integrate third-party apps in the developed automation potentially opens the way to define interventions that act on specific apps’ features and UI elements, simplifying the task of creating what Lukoff et al. (2023) called ‘adaptable commitment interfaces.’ In that respect, we hope that app manufacturers will embrace such a possibility, integrating more products into iOS Shortcuts and

exposing automation that may benefit people’s digital wellbeing.

5.2.3. Intervention combinations

One of the main challenges to ensure that DSCTs are effective is to reduce their degree of attrition (Kovacs, Wu, and Bernstein 2018; Schwartz et al. 2021). As they over-restrict users, users may abandon DSCTs because the settings of the DSCT do not match their expectations or are too aggressive. However, behavioural theories suggest that changing behaviour and forming new habits is linked to repetition (Pinder et al. 2018): discontinued use of DSCTs causes a changed behaviour to slowly return to its pre-intervention level (Klasnja, Consolvo, and Pratt 2011). As suggested by Schwartz et al. (2021), a possible way to minimise attrition while increasing DSCTs’ effectiveness is to adopt an *obligatory bundling of interventions* pattern, forcing users to adopt a bundle of interventions instead of focussing on a single intervention alone. For example, a user that defines an app block may be suggested to also adopt an alternative intervention that makes notifications slightly less attention-grabbing in particular circumstances. This would reduce the risk of the failure of one particular intervention. Similarly, Kovacs, Wu, and Bernstein (2018) successfully demonstrated that rotating different intervention strategies increases DSCTs’ effectiveness. The possibility of defining multiple trigger-action rules in iOS Shortcuts opens the way to create DSCTs that simultaneously include different intervention strategies. Furthermore, rotating intervention strategies can be easily implemented in iOS Shortcuts, e.g. by associating different interventions to a randomly generated number.²

5.2.4. Context-based interventions

The way people use technology is closely tied to their intended use and current context. From a digital wellbeing perspective, engaging in passive scrolling on Facebook before bedtime is likely more problematic than engaging in a conversation with a friend on the same platform (Lukoff et al. 2018). Consequently, researchers have long agreed on the importance of developing context-aware DSCTs that can adapt to the current situation and needs of the user (Lyngs et al. 2019; Monge Roffarello and De Russis 2019, 2022). One of the challenges characterising the DSCTs research area is precisely the *adaptability* of the developed intervention strategies (Monge Roffarello and De Russis 2022). Prior work, for example, highlighted that interventions should adapt to the target device or service (Rooksby et al. 2016), to the current users’ activities (Monge Roffarello and De Russis 2021b), and even to their

current usage patterns (Hiniker et al. 2015; J. Kim, Jung, et al. 2019). We consider the trigger-action programming paradigm of iOS Shortcuts as a promising strategy to include context within digital self-control interventions, as interventions like feature minimisation or time lags can be associated with different contextual triggers. For example, an Instagram usage timer could be triggered depending on the time of the day or the current user's location, e.g. by exploiting the smartphone's sensor. The same strategy could also be adopted to counter unwanted re-visitation patterns (Jones et al. 2015; Monge Roffarello and De Russis 2021b), when the planned usage of an app, e.g. checking a WhatsApp notification, triggers the (unwanted) usage of another app, e.g. mindlessly scrolling on Instagram. In general, exploiting a trigger-action programming paradigm to define digital self-control interventions would naturally allow researchers to target smartphone habits, i.e. recurrent usage patterns performed under stable contextual cues (Monge Roffarello and De Russis 2021b).

5.3. Towards the end-user development of digital self-control interventions

Our work focussed on investigating the practicability of using iOS Shortcuts as a research tool, with a particular focus on how to create and distribute interventions to start a digital wellbeing experiment. Our second study showed that manually recreating an intervention reduced participants' privacy concerns compared to importing a pre-built one. This finding suggests a promising direction – namely, exploring whether end users could be empowered to create personalised interventions tailored to their specific requirements – though this would require further investigation of users' ability to author interventions independently. This would allow them to become creators of DSCTs rather than just consumers, potentially increasing the interventions' effectiveness. For instance, the capability to incorporate multiple actions within a shortcut could empower users to seamlessly integrate a variety of intervention strategies. Additionally, the availability of contextual triggers opens up the potential to associate these strategies with specific situations and use cases.

At the same time, our investigation indicates that such an approach requires additional exploration and research effort to be successfully adopted. In our second study, participants could follow a detailed step-by-step tutorial to recreate the intervention. This guided approach was deliberate: our research question focussed on privacy perceptions during distribution, not on participants' ability to design interventions independently. Whether non-technical users could author novel

interventions without guidance – and whether doing so would yield similar privacy benefits – remains an open question. We must acknowledge that TAP, despite its conceptual simplicity, may still require a learning curve for non-technical researchers and end users, especially when used in an uncontrolled setting. The experiments conducted by Huang and Cakmak (2015), for example, demonstrated that users often misinterpret the behaviour of trigger-action programs, while Brackenbury et al. (2019) identified ten classes of common programming bugs in TAP related to control flow, timing, and inaccurate user expectations. We can expect similar problems in our context, where implementing the high-difficulty interventions described in section 3 requires the creation of more than 10 actions each, as well as the usage of different automations, e.g. to intercept when Instagram has been opened and closed, respectively.

In the short term, the ability to share shortcuts on platforms like RoutineHub could allow researchers and end users to mitigate the learning curve collaboratively, by developing and sharing their own digital self-control interventions. Moving forward, we see an opportunity for the HCI community to simplify and democratise the creation of digital self-control interventions through TAP, making such an approach accessible to a wider range of users. Our work suggests two design directions for future TAP platforms that better support the creation of digital wellbeing interventions:

- In assessing iOS Shortcuts for digital self-control (Section 3), we found that the platform did not directly support common strategies in traditional DSCTs, which we replicated by employing several workarounds, e.g. creating local JSON files to store thresholds and time spent on apps. We see an opportunity for TAP platforms to natively model triggers and actions that may simplify the development of DSCT interventions, e.g. triggers based on usage statistics events and actions delivering usage timers and lockouts. These triggers and actions would necessitate a higher abstraction level than the current actions and automation within iOS Shortcuts. Recent research on high-level TAP in the IoT domain (Corno, De Russis, and Monge Roffarello 2019; Desolda, Ardito, and Matera 2017) could inform such a change in the underlying representation models.
- While iOS Shortcuts can minimise technical barriers for DSCT researchers (see Section 5.1), this advantage depends on two key factors. First, the specific capabilities of the Shortcuts platform itself. Second, the level of access external applications provide by exposing their custom actions and automation

functionalities. We envision future TAP platforms for digital wellbeing to be more integrated with third-party apps. For example, Lukoff et al. (2023) were recently forced to recreate a new video-streaming app from scratch in an attempt to minimise the impact of YouTube recommendations. Enhanced integration could simplify such kind of scenarios: although requesting YouTube to offer actions altering its interface may be unfeasible, researchers could work on packaging these actions into ad-hoc *patches*, as recently done by Kollnig et al. through GreaseDroid (Kollnig, Datta, and Van Kleek 2021), a community-driven app modification framework that enables non-expert users to disable dark patterns in mobile apps.

5.4. The role of AI

The rise of AI-powered end-user technologies offers new opportunities – and new challenges – for the development of DSCTs that are directly relevant to our work. Indeed, our feasibility assessment already includes one concrete instance of AI integration: the motivational quotes intervention (Section 3.2.3), which uses Apple’s on-device AI model to dynamically generate persuasive content each time Instagram is opened. This example demonstrates that AI can serve as an active component within TAP-based interventions, producing personalised content at runtime without requiring cloud processing or programming effort from the user. Starting from this observation, we discuss how AI could further support the end-user development of DSCTs along two dimensions: authoring support and adaptive intervention delivery.

First, AI systems can help lower the cognitive and technical barriers that still persist in TAP environments. Even though Shortcuts offers an accessible interface, many interventions—such as usage visualisations or multimodal combination strategies—still require complex sequences of actions, conditional logic, or data manipulation. Recent advances in natural-language programming suggest that AI assistants could translate user intentions (e.g. ‘warn me when I start doomscrolling late at night’) into valid and optimised action flows. This has been demonstrated, for example, in the IoT domain, where researchers have investigated how to transform high-level user intentions into concrete trigger-action rules for personalising ecosystems such as the smart home. Corno, De Russis, and Monge Roffarello (2021) introduced a conversational recommendation system capable of suggesting pertinent and context-aware IF-THEN rules based on abstract user

goals, such as “decrease the room temperature when I leave the room.” Similarly, Song et al. (2025) leveraged LLM-enhanced activity logs and personalised prompting to model and predict user behaviour in smart environments, while their earlier work (Song et al. 2024) proposed a deep learning framework able to infer potential user actions and generate fine-grained device automation sequences. Translating these developments to our domain, AI-facilitated authoring could thus bridge the gap between intention and implementation, making DSCT creation more inclusive and scalable for non-technical researchers and end users.

Second, as interventions become more tailored and context-sensitive, AI can support adaptive DSCTs that adjust dynamically to users’ habits. Prior work has emphasised the importance of context and timing in determining intervention effectiveness (Monge Roffarello and De Russis 2021b). AI models—particularly lightweight, on-device models—could infer usage patterns, identify moments of heightened vulnerability (e.g. late-night compulsive checks), or detect interaction signals associated with mindless engagement. When appropriately controlled and transparent, AI could enrich TAP by providing higher-level, semantically meaningful triggers (e.g. ‘when I seem bored scrolling’ or ‘when I resume a distraction loop’), going beyond simple app-opening events. This aligns with the notion of ‘fuzzy triggers’ envisioned by Ur et al. (2014) in the smart-home domain—i.e. triggers expressed at a high level of abstraction, whose detection typically requires machine learning techniques to interpret complex patterns of user behaviour.

It is worth noting that the on-device AI model used in our motivational quotes intervention exemplifies a privacy-compatible form of AI integration: the model runs locally, no behavioural data leaves the device, and the generated content is fully inspectable by the user within the Shortcuts editor. This stands in contrast to cloud-based AI approaches and suggests that on-device AI – which Apple has continued to expand through Apple Intelligence – may offer a particularly suitable foundation for privacy-conscious DSCT development. The decomposability of Shortcuts-based interventions, which our Study 2 showed to be beneficial for reducing privacy concerns, could extend to AI-generated components: users can inspect, modify, or replace the AI-generated output within the same TAP workflow.

On the other hand, embedding cloud-based AI models into DSCT creation raises concerns that partially contrast with the privacy-centric advantages of Shortcuts revealed in our study. AI-generated recommendations, predictions, or adaptive interventions

may depend on collecting and processing sensitive behavioural data. While Shortcuts currently retains a strong on-device, privacy-by-design philosophy, many AI-driven tools rely on cloud-based processing or require continuous monitoring to generate insights. This introduces a potential tension: although AI could dramatically increase the sophistication of user-created interventions, it risks reintroducing the privacy barriers that motivated our no-code, OS-integrated approach in the first place. Our findings described in Section 4 show that transparency during intervention creation meaningfully reduces perceived risk. Therefore, any AI augmentation for DSCTs must preserve interpretability, user inspectability, and the ability to decompose interventions into readable steps. Rather than replacing TAP or manual configuration, AI should act as a collaborator that enhances user agency—supporting the creation, explanation, and debugging of DSCT interventions without obscuring their functioning.

5.5. Limitations and future works

Our research has limitations that need to be acknowledged and also suggests opportunities for future work.

Overall, we only focussed on iOS Shortcuts, which is specific to Apple's ecosystem. The findings may not be directly applicable to other task automation tools or operating systems, limiting the generalizability of the research. Nevertheless, Android has its own rule-based automation system (i.e. *Android Rules* 9to5Google 2022), and future works could try to assess our findings in comparative studies. More importantly, our work had a short-term goal of investigating the practicability and challenges of using iOS Shortcuts as a research tool, with a particular focus on how to create and distribute interventions to start a digital wellbeing experiment. Therefore, our work did not delve into the value of using these interventions or their effectiveness. In future works, researchers could explore whether interventions delivered through platforms like iOS Shortcuts have a lasting impact on users' digital wellbeing, e.g. by conducting longitudinal studies tracking users' digital wellbeing over an extended period.

Regarding Study 1, our assessment of iOS Shortcuts' feasibility for DSCT development (Section 3) was carried out by researchers with prior programming experience. While we provide difficulty ratings for each intervention, these reflect expert assessments that may not transfer to non-technical users. A formal usability evaluation with researchers from non-technical disciplines (e.g. clinical psychology, behavioural science) is needed to determine whether iOS Shortcuts can

genuinely serve as a no-code research instrument for this audience.

Regarding Study 2, we acknowledge two additional limitations. First, we recruited general end-users via Prolific rather than digital wellbeing researchers. While the study's focus on privacy perceptions at installation time is relevant to any user population that might engage with a DSCT – including both researchers and their study participants – future work should examine whether researchers specifically exhibit different privacy perceptions, given their greater familiarity with research tools and data handling. Second, the manual re-creation condition involved guided reconstruction from a detailed step-by-step tutorial, not open-ended authoring of a novel intervention. This design choice was intentional, as it mirrors a realistic deployment scenario in which researchers provide participants with instructions for setting up a predefined intervention. However, it does not allow us to draw conclusions about users' ability to create interventions from scratch, a question that remains important for the broader vision of democratising DSCT development through TAP.

Regarding AI, while we presented one concrete instance of on-device AI integration within our feasibility assessment (the motivational quotes intervention), a systematic evaluation of how AI-assisted authoring affects the usability, quality, and effectiveness of TAP-based DSCTs remains an open question. Future work should investigate, for example, whether natural-language-to-Shortcut generation can reliably produce correct and effective interventions, and how users perceive and trust AI-generated intervention components.

Creating and evaluating interventions for digital self-control through iOS Shortcuts has also its own limitations as well. Prior work highlighted that the effectiveness of blocking strategies like usage timers and blockers depends on whether the user can achieve the right level of friction to override them (Lyngs et al. 2022; Monge Roffarello and De Russis 2019). While friction could be potentially introduced in various ways through the platform, such as by requiring users to solve mathematical quizzes (Perry 2024), we must recognise that users always have the option to disable a shortcut, as they typically would with a third-party DSCT. Furthermore, design flexibility is constrained by the capabilities of iOS Shortcuts. As discussed in Section 5.3, improved integration with third-party apps would enable researchers and end users to creatively implement interventions, especially gamified ones and those targeting apps' internal mechanisms such as recommendations and newsfeeds,

expanding beyond the delivery of textual notifications and pop-ups.

Finally, the second part of our work has two main limitations. First, we explored privacy concerns during the installation or creation process, i.e. at the beginning of a research experiment. We recognise that new concerns may arise *while using* a digital self-control intervention. Future works are needed to study these additional and evolving privacy aspects. Second, the involved sample was unbalanced towards female participants. While we acknowledge that this distribution might limit the generalizability of our findings, we believe this data, along with the associated results, can still offer a valuable complement to previous research in this field, which has often been skewed towards male participants (Offenwanger et al. 2021).

6. Conclusions

In recent times, the discussion surrounding the potential negative effects of excessive technology use, particularly on digital well-being and smartphone addiction, has gained significant attention. While DSCTs have emerged as tools to support users' self-control, developing and evaluating these tools is a challenging task for researchers, who need to possess programming skills and deal with technical constraints and privacy issues. This research explores the technical potential of iOS Shortcuts, an integrated Apple tool, as a means to address some of these challenges, assessing its capacity to reproduce common DSCT intervention features and investigating how distribution modality affects participants' privacy perceptions. Our findings demonstrated the tool's versatility in replicating a broad range of DSCT interventions and showed that manual re-creation of interventions, compared to importing pre-built ones, is associated with lower perceived privacy concerns and risks among participants. Furthermore, our work provides initial evidence that on-device AI models can already be integrated into TAP-based interventions, outlining how future AI-assisted authoring tools could further democratise the creation of digital self-control interventions while preserving the transparency and privacy advantages of the Shortcuts-based approach.

Notes

1. The tutorial is available at https://osf.io/ys5m8/overview?view_only=ae58f22f74c140758895bdd8c2085e3f.
2. <https://routinehub.co/shortcut/8563/>, last visited on September 11, 2023.

Author contributions

CRedit: **Aditya Kumar Purohit**: Conceptualization, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing; **Alberto Monge Roffarello**: Methodology, Supervision, Writing – original draft, Writing – review & editing.

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