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A Digital Nudge-Based Intervention to Interrupt Instagram Usage

Randomized Controlled Pilot Study

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Abstract: *Background*: Overuse of smartphones can have harmful health effects. Particularly, overuse of social media apps are related to problematic forms of smartphone use because individuals find it difficult to finish their smartphone session (e.g., on Instagram). *Aims*: This randomized controlled pilot study aims at examining effects and intervention characteristics of a digital nudge-based intervention aiming to interrupt Instagram usage. *Method*: A total of 70 Instagram users (47% female; M_{age}: 31 years) were enrolled and randomly assigned to the intervention (n = 33) or control group (n = 37). Across 14 days, the intervention group received notifications from a pool of 80 messages (e.g., stimulating reflection on smartphone use), whenever Instagram was used for 3 minutes. Self-reported problematic smartphone use as well as time of overall smartphone use and Instagram use were assessed via five weekly online questionnaires. *Results*: The longitudinal sample comprised 40 participants. Significant reductions in self-reported problematic smartphone use were observed in both groups, but no significant changes were found for the time of smartphone and Instagram use. The intervention had a minor relevance for six participants who received less than 7 notifications across 14 days. For 17 participants, the number of notifications ranged between 12 and 139, with a median duration of closing Instagram after 6:44 minutes (range: 1:06 to 23:47 minutes). *Limitations*: A small convenience sample was investigated and findings do not generalize to the general population. *Conclusion*: High interindividual differences were found in how the intervention worked providing insights for future nudge-based interventions.

Keywords: social media apps, Instagram usage, digital detox, randomized controlled trial, problematic smartphone use

A total of 6.64 billion people worldwide own a smartphone (Turner, 2022). The smartphone has become people's everyday companion with many advantages for daily life functioning and entertainment (Stevic et al., 2022). Many of the positive aspects arise from the regular use of social media platforms such as Facebook, Twitter, or Instagram (Ryan et al., 2014). However, there are also problematic forms of smartphone use that pose risks to physical and mental health (e.g., Elhai et al., 2017). The term *problematic smartphone use* is defined as a lack of competence to self-regulate one's smartphone use, which is related to negative daily life consequences (Billieux, 2012; see Elhai et al., 2017, for a systematic review). Previous studies found that social media use in particular is linked to problematic smartphone use (e.g., Rozgonjuk et al., 2020).

Instagram and Problematic Smartphone Use

One of the most frequently used social media platforms worldwide is Instagram (DataReportal, 2024). The characteristic of Instagram to view new content and feel connected with other people at any moment (i.e., via the smartphone) provides a lot of advantages, but also goes along with health risks. Due to Instagram's visual-based content and the potential for a positivity bias, Instagram users tend to experience higher levels of upward social comparison, along with detrimental effects on self-esteem, body image and disordered eating, compared to other social networking sites (Faelens et al., 2021; Ulvi et al., 2022; Valkenburg, 2022). Furthermore, the systematic

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review by Adeyanju et al. (2021) indicates that Instagram use intensifies depressive symptoms compared to non-users or users of other social networking sites. However, the negative effects of Instagram consumption are influenced by various factors, such as the type of content, contextual factors, users' susceptibility to social media use, as well as their motivation and emotional state (Valkenburg et al., 2021).

The review by Reinecke and colleagues (2022) posits that individuals' self-regulation is key for associations between well-being outcomes and the use of social media platforms. The authors provide a systematic categorization of self-regulation determinants, including features from the media platform, social factors, and user characteristics (Reinecke et al., 2022). For the example of Instagram, features such as endless content playback can support the development of scrolling habits leading to prolonged Instagram usage or so-called *infinite scrolling* (Montag et al., 2019). While people scroll mindlessly through Instagram, the algorithm provides funny or entertaining content in an irregular rhythm, making it even more difficult to leave the app (Montag et al., 2019). Additionally, rewarding elements (e.g., receiving "likes") get users to consume more content than they intended and undermine their self- regulation (Aalbers et al., 2022; Reinecke et al., 2022). Due to the social features of Instagram to connect with other people and learn about their daily lives (e.g., the story feature), users can experience a feeling of fear of missing out when not using Instagram (FOMO; Elhai et al., 2018; Reinecke et al., 2022). It has to be noted that both positive and negative emotions arise when scrolling through Instagram, however, in individual cases, it can trigger or amplify symptoms of illness (de Segovia Vicente et al., 2024) contributing to problematic smartphone use. Moreover, there is evidence that the quantity of Instagram use is related to problematic smartphone use (Rozgonjuk et al., 2020).

Digital Interventions to Tackle Problematic Smartphone Use

In the past years, technology companies started to respond to people's need to self-regulate their smartphone behaviors by providing digital tools, such as a focus or relaxation mode or screen time monitoring, however, these tools are insufficiently studied in terms of their effectiveness (Purohit & Holzer, 2021). Although screen time monitoring is welcomed by many people, actual behavior changes to reduce screen time are rarely taken (Zimmermann, 2021).

Another intervention approach is to disconnect from the smartphone by executing digital detox, a planned technology-related free time (Nassen et al., 2023; Radtke et al., 2022). While some studies report positive effects of digital detox, others find no or even negative effects (Radtke et al., 2022; Schmuck, 2020). Further approaches focus on, for instance, manipulating the display in grayscale (Holte & Ferraro, 2020), leaving the smartphone out of reach (Ward et al., 2017), or providing a psychological training program (Keller et al., 2021; Kent et al., 2021).

As another promising intervention approach, just-in-time adaptive interventions (JITAIs; Nahum-Shani et al., 2016) are tailored, technology-delivered interventions at opportune situations when an individual is most susceptible to an intervention (Wang & Miller, 2020) and have been shown to be effective in other behavior change settings (e.g., Conroy et al., 2020). JITAIs could be applied in the smartphone use setting by detecting the problematic situation of the individual (e.g., when starting endless scrolling) and intervening in real-time (e.g., providing a tailored message in the same moment). Similar to JITAIs, *digital nudges* are established intervention measures applied in the context of problematic smartphone use (Caraban et al., 2019). Digital nudges are low-threshold options that are intended to change individuals' behaviors in a desired direction, but always leave the user the option to choose (Thaler & Sunstein, 2009). Based on the digital nudge approach and using a just-in-time component, this study introduces a digital nudge-based intervention to interrupt Instagram usage.

The Present Digital Nudge-Based Intervention

Based on recommendations from Purohit and Holzer (2021), the digital nudge-based app *INSTARUPT* was developed, sending notifications to Instagram users after 3 minutes of continuous Instagram use. The time interval of 3 minutes was chosen to not annoy participants while only briefly using Instagram (<3 minutes). On the other hand, the notification after 3 minutes of continuous Instagram use should serve as a prompt to reflect on current Instagram use, potentially leading to (soon) closing it and thus reducing the time spent on Instagram or on the smartphone in general.

Hypotheses and Research Questions

Closing the gap that digital nudge-based apps are widely used, but often lack an evaluation (Mathews et al., 2019), this pilot study was planned to gather first evidence on effectiveness and examine characteristics of the intervention app *INSTARUPT* targeting the interruption of continuous Instagram usage through digital nudges. Findings from this pilot study can be used as learning experiences to design future nudge-based interventions and evaluation studies. Based on previous evidence on correlates of smartphone use (e.g., Elhai et al., 2017), the following study outcomes should be examined: (a) problematic smartphone use, (b) time of overall smartphone use, and (c) time of Instagram use, leading to three hypotheses.

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When compared to a no-intervention control condition (control group), participants provided with the *INSTARUPT* app (intervention group) are assumed to report stronger decreases in problematic smartphone use (Hypothesis 1, H1), time of overall smartphone use (Hypothesis 2, H2), and time of Instagram use (Hypothesis 3, H3).

Also, the characteristics of the intervention should be investigated in order to inform the design and content of future digital interventions on problematic smartphone use. The following exploratory research questions focus on only the intervention group.

Research Question 1 (RQ1): How often are participants having Instagram sessions of 3+ minutes and thus are notified by the digital nudges?

Research Question 2 (RQ2): How high is the success rate of closing Instagram within 5 minutes (cf. Dingler & Pielot, 2015) after receiving the notification?

Research Question 3 (RQ3): Does the success rate vary by different times of day (i.e., morning, afternoon, evening, night)?

Research Question 4 (RQ4): Does the success rate vary by different types of notifications (e.g., reflection notifications such as 'What do you feel in your body right now?' vs. micro habit notifications such as 'Just one push up, let's do it!')?

Research Question 5 (RQ5): How did the participants perceive the digital nudges?

Methods

This pilot study reports primary findings from a randomized controlled trial (RCT) testing a digital intervention to interrupt Instagram usage. The study was conducted between June and July 2022 and a convenience sample of adults from the general population was examined. Ethics approval for this study was granted by the Ethics Committee of the Department of Education and Psychology, Freie Universität Berlin (registration number: 012/2022).

Sample and Procedures

Study participants were recruited using English-based texts distributed via social media, email lists (e.g., addressing university students), and flyers. Inclusion criteria were a minimum age of 18 years, the ability to speak and understand the English language, owning an iPhone with iOS 15 or higher (due to technical circumstances of having the app set up for iPhones with iOS 15+ only), having an Instagram profile, and perceiving oneself as a regular Instagram user. In addition, participants needed to enable the screen time recording function on their smartphones. As an incentive for full study participation, participants received a 3-month premium membership for the app Wellspent, which was provided free of charge and unconditionally by the cooperation partner Wellspent GmbH. Psychology students of the Freie Universität Berlin additionally received course credits for full study participation.

Initially, 100 persons were assessed for eligibility, but 30 persons did not respond to subsequent reminders. A remainder of $N = 70$ participants registered for the study with their email addresses, provided informed consent and participated in the baseline assessment ("T" = Time; T1). In order to minimize potential question-behavior effects (Wilding et al., 2016) and to use measures from the week prior to study participation, recordings from the screen time app (preinstalled on iPhones) for the 7 days prior to the baseline questionnaire (T1) were used. That is, the Week 1 description in this study refers to the 7 days before T1 and is thus listed as "Week 1/T1." Analogous descriptions are used for the other assessments (see Figure 1 for the study design). Using a simple ("flipping a coin") randomization procedure, participants were assigned to the intervention group ($n = 33$) or no-intervention control group ($n = 37$). No blinding procedures were applied. Participants from the intervention group received study app-based notifications aiming to interrupt continuous Instagram sessions throughout an intervention period of 14 days, whereas the control group did not use the study app and received no intervention. Participants from the intervention group were asked to download and set up the study app, which was done by $n = 23$ participants (out of 33: 70%). Of these, $n = 17$ participants had sufficient (i.e., more than 6 observations across 14 days; Bolger & Laurenceau, 2013) study app-measured data points on Instagram notifications enabling a behavioral data analysis of intervention functions. As assessments referring to the intervention period, participants received questionnaires at 7 days (Week 2/T2) and 14 days (Week 3/T3) following baseline. Follow-up assessments were conducted at 21 (Week 4/T4) and 28 days (Week 5/T5) following baseline. Figure 2 provides a CONSORT flowchart.

Intervention

Participants from the intervention group received a 14-day intervention providing them with situational notifications whenever their Instagram session extended 3 minutes, which was carried out via the study app (adapted from Purohit & Holzer, 2021). This digital intervention aimed to nudge a person towards self-regulation regarding their Instagram usage, possibly leading to a (soon) closing of Instagram. The installed study app measured continuous

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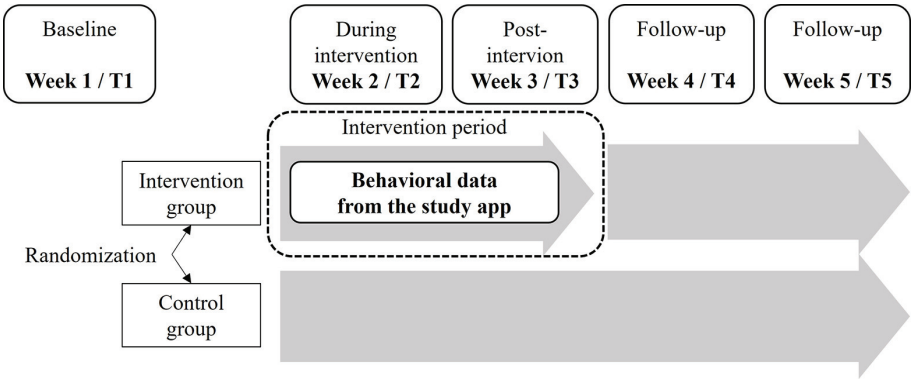

Figure 1. Study design with five measurement points in time and a 14-day intervention period.

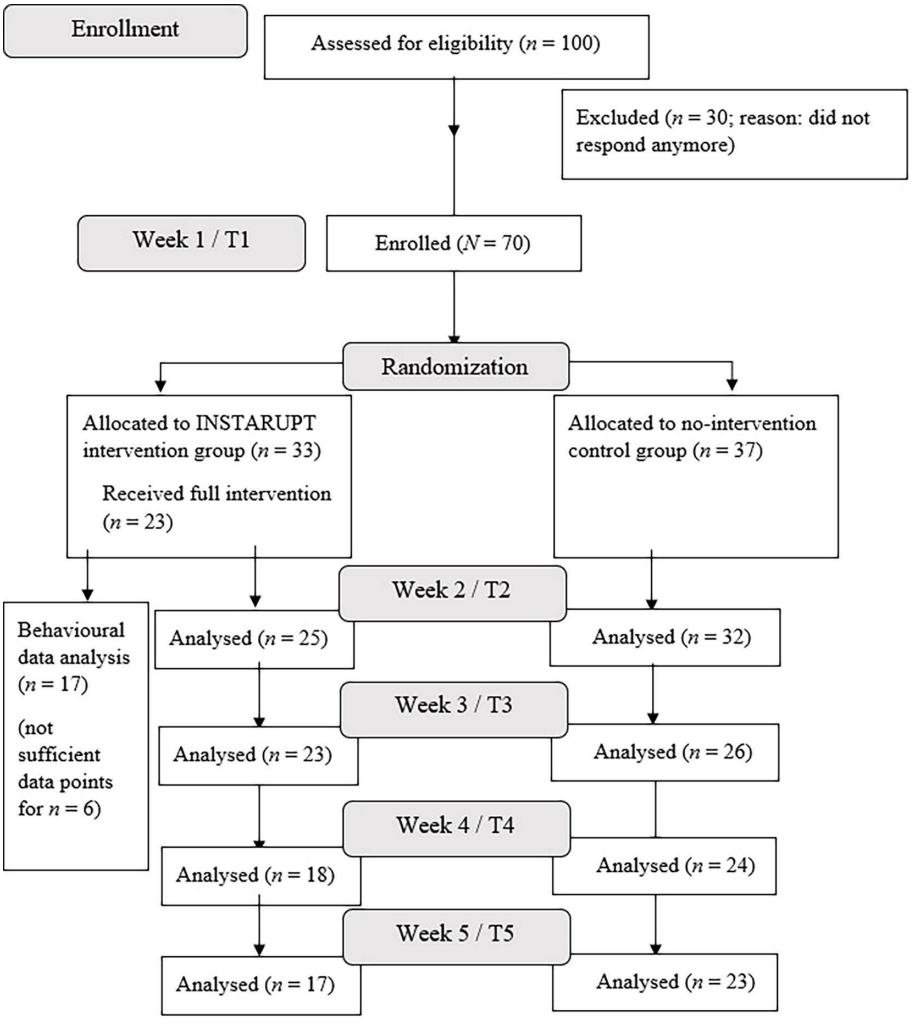

Figure 2. CONSORT flowchart showing group allocation and participant attrition. "T" = Time.

use of Instagram (i.e., not switching to other apps) for each participant from the intervention group, which made it possible to display a notification after three minutes of continuous Instagram use. For Instagram sessions of less than three minutes, no notification was provided. As part of a master thesis project, different notification texts were

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prepared by THS and CR in an 80-item list, which was pretested in group sessions of volunteers not participating in this pilot study. For each Instagram session of 3+ minutes, a notification text was randomly selected and provided to the participant. Each item contained a short sentence or question that fell into one of four types of notifications: (a) a generic text, (b) a suggestion to perform a micro habit, (c) a reflection question, or (d) a surprising text. Each of the four types contained 20 different notification items. Generic notifications included general information or instructions such as "Let's take a break." Micro habit suggestions encouraged participants to engage in an alternative activity instead of smartphone usage (e.g., "Just one push up, let's do it!"). Reflection questions such as "What do you feel in your body right now?" are aimed at a reflection on one's physiological and emotional state or one's current behavioral goal. The surprising text contained out-of-context or even funny messages (e.g., "Mark Zuckerberg is watching you!"). The classification of these four types of notifications and their random provision to participants (also measured by the study app) allowed us to analyze the success rate of each type.

Measures

Study Outcomes

Similar to a previous evaluation study (Keller et al., 2021), three outcomes were used to examine the effects of the study app including one health-relevant outcome (i.e., problematic smartphone use) as well as two outcomes on the quantity of smartphone usage: time of overall smartphone use and time of Instagram use. All outcomes were assessed weekly between T1 and T5.

Problematic smartphone use was assessed using an adapted 8-item version of the MPPUS-10 (Foerster et al., 2015). The phrase "In the past 7 days, …" was followed by statements such as "… I have used my smartphone to make myself feel better when I was feeling down." Participants responded to the items on a scale from 1 (= *not true at all*) to 6 (= *exactly true*). For the baseline assessment, the internal consistency of the scale was Cronbach's $\alpha = 0.85$.

Objective data on *daily minutes of overall smartphone use* as well as *Instagram use* were provided by participants based on the recordings of their screen time app. Guided by specific instructions on how to find the screen time recordings, participants entered the time (hours and minutes) of their daily overall smartphone use and daily Instagram use in the questionnaire for the past seven days. Thus, the score of daily minutes of overall smartphone use and Instagram use corresponded to the retrospective report on problematic smartphone use ("In the past 7 days, I have …") across Week 1/T1 to Week 5/T5. We then computed a weekly score of averaged daily minutes of overall smartphone use and Instagram use across the past 7 days. Univariate outliers ($z > 3.29$) were winsorized to 1 unit higher than the highest valid value with $z < 3.29$ in the distribution (Tabachnick & Fidell, 2007).

Behavioral Data from the Intervention App

Only for participants receiving the intervention, the following behavioral data was measured for each Instagram session via the study app: Instagram opening and closing time stamps, duration of the session, and daytime category (i.e., morning, afternoon, evening, night). Additionally, for Instagram sessions of at least 3 minutes, the study app randomly sent a notification, for which the type of notification was measured (generic, micro habit, reflection, surprising). Based on findings from Dingler and Pielot (2015) that the majority of people return to attentive states within 5 minutes after being inattentive (e.g., habitual scrolling through Instagram), a binary Instagram closing *success rate* was operationalized (1 = closing Instagram within 5 minutes after notification reception; 0 = not closing Instagram within 5 minutes).

Feedback from Participants on the Intervention App

At the end of the Week 3/T3 questionnaire, participants from the intervention group responded to questions on the intervention app. These include "Was the content of the intervention useful to you?" [yes or no], "On a scale from 1 to 5 (with 1 being "not effective at all" and 5 being "very effective"), how effective do you feel was the digital nudging for you?," "What helped you the most during the intervention?," "What did you like about the intervention?," and "Was there anything that caused frustration during the intervention? (If yes, please describe in more detail.)"

Covariates

The list of covariates included participants' age, gender (female = 1; male = 0), and education (1 = university degree; 0 = school degree).

Data Analysis

Present analyzes were conducted using SPSS 29 and Mplus 8.1 (Muthén and Muthén, 2017). The latter software was used to run multilevel models for binary outcomes. When using Mplus, a full information maximum likelihood procedure was applied to account for missing data.

To examine whether the intervention group vs. control group (i.e., randomization check) and the longitudinal vs. the dropout sub-sample (attrition analysis), *t*- or χ^2-tests were run for baseline variables. Moreover, separate *t*-tests were computed to investigate within-group changes between T1 and T5, followed by repeated-measures ANOVAs modeling time × group changes in study

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outcomes between T1 and T5. In subsequent sensitivity analyzes, analogous repeated-measures ANOVAs controlled for covariates.

Furthermore, behavioral data from the intervention group was analyzed. For Instagram sessions of at least 3 minutes, for which each participant from the intervention group received a notification, descriptive data on the number of notifications as well as the daytime category and type of notification were analyzed. Descriptive information of the binary 5-minute Instagram closing success rate variable was computed for each intervention day and changes over time were plotted. Using Mplus and a dataset with notifications nested within persons, we applied logistic multilevel models to predict the Instagram closing success rate. As predictors, the daytime category (Model A1; with night as the reference) and type of notification (Model A2; with reflection notifications as the reference) were tested in separate models. To examine changes in the Instagram closing success rate over 14 intervention days, a linear time trend was added in models A1 and A2 and computed as a random effects predictor. Preliminary analyzes showed that models did not converge, when modeling further random effect predictions.

Results

Sample Characteristics, Randomization, and Attrition Analyses

Randomization to both groups was based on $N = 70$ enrolled individuals (33 women, 37 men) with a mean age of 30.73 years ($SD = 8.99$, range: 18–59 years). Most participants were Germans (73%), with the remainder coming from other countries such as Turkey (4%), Australia (3%), Columbia (3%), and Trinidad and Tobago. Based on the response scale from 1 (= *not true at all*) to 6 (= *exactly true*) of the problematic smartphone use measure, 37% of the sample (24 out of 65 participants) showed mean values between 3.5 and 6.0, that is, they agreed or rather agreed to statements reflecting problematic forms of smartphone use. Thus, the majority of the sample disagreed or rather disagreed with these statements. Further sample characteristics for the intervention group ($n = 33$) and control group ($n = 37$) are displayed in Table 1. A subsample of $n = 40$ participants (out of 70: 57%; i.e., dropout rate: 43%) completed the study at Week 5 with 17 participants from the intervention and 23 participants from the control group. The randomization check (χ^2- and t-tests) and attrition analysis revealed no unique between-condition differences in baseline variables, indicating a successful randomization and no selective dropout.

Effects on Study Outcomes

Repeated-measures ANOVAs showed significant reductions in problematic smartphone use (H1) for both the intervention and control group (Table 2). While a large effect size ($d = 1.12$) was found for the reduction in the intervention group, a medium-sized effect ($d = 0.74$) was observed in the control group, however, no significant time × group effect was detected ($\eta^2 = .001$). Albeit nonsignificant, time of overall smartphone use (H2); decreased in the intervention group from Week 1 to 5 by an average of 23 minutes per day ($d = 0.30$; i.e., small effect), whereas it increased in the control group by an average of 30 minutes per day ($d = -0.26$; i.e., small effect in the opposite direction). When comparing both conditions, the effect size of the time × group interaction ($\eta^2 = .071$) reflects a medium-sized effect. Regarding the time of Instagram use (H3), the intervention group ($d = -0.02$; i.e., negligible effect) and the control group ($d = -0.38$; i.e., small effect reflecting an increase) revealed a nonsignificant change over time. A small effect size ($\eta^2 = .039$) was found for the time × group interaction. In sensitivity analyzes controlling for age, gender, and education, the patterns of time × group effects were confirmed for problematic smartphone use ($\eta^2 = .003$; negligible effect), time of overall smartphone use ($\eta^2 = .076$; i.e., medium effect), and Instagram use ($\eta^2 = .044$; i.e., small effect).

According to a posthoc power analysis, the present pilot study lacks statistical power (i.e., power of .63) when attempting to find a time x group interaction of small effect size ($f = 0.15$) using a repeated-measures ANOVA and given characteristics of the present sample (2 groups, 5 measurements, $n = 40$ with longitudinal data).

Behavioral Data from the Intervention Group

For $n = 23$ participants setting up the study app, behavioral data was assessed by the study app summarized in Table 3. The intervention had a minor relevance for 6 participants (out of 23: 26%) as they had not more than 6 Instagram sessions of 3+ minutes across 14 days. For $n = 17$ participants, sufficient behavioral data points were available for longitudinal analysis (see below; Bolger & Laurenceau, 2013). Regarding RQ1, a sum of 1.040 notifications was sent to these 17 participants across 14 days, with an average of 61 notifications per participant (range: 12–139). Most of these 1.040 notifications were sent in the morning (29%) and afternoon (33%), whereas a lower proportion was sent in the evening (20%), and night (18%). The type of notification sent to participants was determined randomly, resulting in a similar proportion of generic (24%), micro habit (26%), surprising (25%), and reflective (25%) notifications.

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Table 1. Demographic characteristics per group

Variables	Intervention group n = 33 *M* (*SD*) or *n* (%)	Control group n = 37 *M* (*SD*) or *n* (%)
Age (in years)	28.61 (7.20)	32.62 (10.06)
Gender		
Female	19 (58%)	14 (38%)
Male	14 (42%)	23 (62%)
Education		
School degree	10 (30%)	9 (24%)
University degree	23 (70%)	28 (76%)
Employment		
Student	13 (39%)	10 (27%)
Employed	14 (42%)	23 (62%)
Self-employed/freelancer	5 (15%)	3 (8%)
Currently not working	1 (3%)	1 (3%)
Problematic smartphone use scale at baseline [1 = *not true at all* to 6 = *exactly true*]		
Missing value	2	3
1.0 to $\leq$ 3.5	21 (68%)	20 (59%)
3.5 to 6.0	10 (32%)	14 (41%)

Note. *M* = Mean. *SD* = Standard deviation.

On the personal level, the average duration of closing Instagram after receiving a notification ranged from 1:06 minutes to 23:47 minutes, with a median of 6:44 minutes. Based on prior evidence (Dingler & Pielot, 2015), closing Instagram within 5 minutes after notification reception was operationalized as a successful Instagram closing (i.e., giving some time for reflection, but ending the session within 5 minutes). On a personal level, the average 5-minute Instagram closing success rate ranged between 25% and 77% (RQ2; Table 3).

Figure 3 displays the success rate for n = 17 participants with sufficient longitudinal data points over 14 intervention days (Panel A) and by different daytimes and types of notifications (Panel B). Logistic two-level models revealed a nonsignificant linear time trend across the 14 intervention days, indicating a similar 5-minute Instagram closing success rate over time (Table 4). Moreover, Model A1 (RQ3; Table 4) with "night" as the reference category showed nonsignificant associations between the success rate and different daytimes. Regarding types of notifications and using reflective notifications as the reference category (RQ4; Model A2; Table 4), micro habit (*OR* = 0.67) and surprising (*OR* = 0.64) notifications were related to a lower success rate, whereas nonsignificant differences between reflective and generic notifications (*OR* = 0.78) were found. Descriptive findings indicated that reflective notifications were the notification type with the highest average success rate (54%; Figure 3).

How Did Participants Perceive the Intervention App?

Based on feedback on the intervention app from 21 participants (RQ5), 13 out of 21 (62%) stated that the content of the app was useful to them. Six out of 21 (29%) felt that the app was at least somewhat effective, whereas 7 persons (33%) were undecided and 8 persons (38%) found the app (rather) ineffective. Regarding the question of what helped most during the intervention phase, 6 participants emphasized the helpful notifications of the intervention app, while 3 participants highlighted a positive impact of the questionnaire (i.e., reflecting on smartphone use). When asked about what they liked most about the intervention app, 6 participants responded that the notifications were seen as funny and friendly. Also, one person gave the feedback "I liked that it was very low effort." In contrast, two participants stated that they found the notifications annoying.

Discussion

This pilot study aimed at gathering first evidence on effectiveness and examining characteristics of the digital nudge-based intervention *INSTARUPT*, which sent notifications to users whenever their Instagram session exceeded 3 minutes in order to interrupt Instagram usage. Using a randomized

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Table 2. Descriptive statistics and effects on study outcomes

	Week 1		Week 2		Week 3		Week 4		Week 5		Week 1–5: Within-group effects	
	n	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*t* test	Effect size (95% *CI*)
Problematic smartphone use [1–6]												
Intervention group	31	3.03 (1.00)	25	2.89 (0.88)	23	2.52 (0.94)	18	2.50 (0.92)	17	2.33 (0.79)	$t(15) = 4.47$ $p < .001$	$d = 1.12$ (0.48; 1.74)
Control group	34	3.33 (1.06)	32	2.97 (1.08)	26	2.74 (0.98)	24	2.61 (1.07)	23	2.70 (0.94)	$t(22) = 3.41$ $p = .003$	$d = 0.71$ (0.25; 1.16)
Time of smartphone use (min/day)												
Intervention group	29	301 (111)	25	287 (87)	22	280 (99)	17	263 (93)	17	278 (86)	$t(14) = 1.16$ $p = .267$	$d = 0.30$ (−0.23; 0.81)
Control group	33	278 (87)	31	306 (107)	26	291 (130)	24	309 (133)	23	308 (95)	$t(22) = -1.25$ $p = .225$	$d = -0.26$ (−0.67; 0.16)
Time of Instagram use (min/day)												
Intervention group	29	58 (32)	25	60 (42)	22	58 (48)	15	65 (51)	16	66 (52)	$t(14) = -0.07$ $p = .948$	$d = -0.02$ (−0.52; 0.49)
Control group	33	59 (37)	32	63 (41)	26	74 (54)	24	72 (44)	23	74 (39)	$t(22) = -1.81$ $p = .084$	$d = -0.38$ (−0.80; 0.05)

Note. Week 1: Baseline. Weeks 2–3: Intervention period. Weeks 4–5: Follow-up period. *M* = Mean. *SD* = Standard deviation. [1–6] refers to the response scale of the variable. Non-significant time × group effects for problematic smartphone use ($\lambda = .99$, $F(1, 37) = 0.16$, $p = .736$, $\eta^2 = .003$), time of smartphone use ($\lambda = .93$, $F(1, 36) = 2.76$, $p = .105$, $\eta^2 = .071$), and time of Instagram use ($\lambda = .96$, $F(1, 36) = 1.45$, $p = .237$, $\eta^2 = .039$).

controlled trial design with an intervention and control group, changes in the outcomes of problematic smartphone use, time of overall smartphone use, and time of Instagram use were examined. To gain insights into future nudge-based interventions, characteristics of the intervention were explored and included information on participants' notification reception, their closing of Instagram (by daytime and type of notification), and their perception of the intervention in general.

Intervention Effects on Study Outcomes

According to a post-hoc power analysis, present findings on intervention effects need to be interpreted with caution due to the lack of statistical power. We found that problematic smartphone use decreased in both the intervention and control group (i.e., nonsignificant time × group effect), confirming findings from a previous study (Keller et al., 2021). As the no-intervention control group also showed reduced levels of problematic smartphone use, we might have observed question-behavior effects (Wilding et al., 2016) due to repeatedly asking questions about participants' smartphone use. This is confirmed by open-ended responses from some participants, stating that the reflection on one's smartphone use already had an impact on their behavior. Albeit nonsignificant, a medium-sized effect of between-group differences for the time of overall smartphone use was found in favor of the intervention group, which is in line with a recent meta-analysis examining interventions on screen time reduction (Radtke et al., 2022). The improvements within the intervention group correspond to an average reduction of smartphone time by 23 minutes per day between Week 1 and Week 5. No relevant improvements were found for the time of Instagram use. Possibly, the present intervention failed to additionally provide real-time feedback on participants' Instagram usage per day, which was shown as an effective mean in a recent study (Purohit et al., 2023).

Characteristics of the Digital Nudge-Based Intervention

A total of 23 participants (out of 33: 70%) from the intervention group downloaded the study app and received the full intervention. Of them, six participants received a low number of notifications (<7 across 2 weeks) from the study app due to rarely exceeding 3 minutes per Instagram session. Thus, the intervention did not fit the Instagram use patterns of these 6 participants (out of 23: 26%). Future studies could recruit a "sample in need" by adding a certain threshold on a person's Instagram usage to the inclusion criteria.

For those 17 participants receiving the full intervention and showing frequent use of Instagram, the level

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Table 3. Summary of behavioral data of 23 participants from the intervention group

Participant	Sum of notifications	Morning notifications	Afternoon notifications	Evening notifications	Night notifications	Median of closing Instagram after notification (min: sec)	% of successfully closing Instagram within 5 minutes
1	1	0	1	0	0	–[a]	–[a]
2	1	0	1	0	0	–[a]	–[a]
3	1	0	1	0	0	–[a]	–[a]
4	2	2	0	0	0	–[a]	–[a]
5	2	1	0	0	1	–[a]	–[a]
6	6	1	1	1	3	–[a]	–[a]
7	12	0	4	6	2	6:44	50%
8	13	6	5	0	2	17:37	31%
9	13	5	6	2	0	1:06	69%
10	15	1	9	1	4	22:13	33%
11	26	11	4	7	4	16:48	31%
12	35	7	5	16	7	2:28	77%
13	35	7	12	7	9	6:01	49%
14	42	9	13	12	8	2:58	67%
15	56	15	25	7	9	23:47	25%
16	59	14	19	13	13	8:39	34%
17	74	24	34	11	5	5:12	49%
18	95	40	20	7	28	9:47	39%
19	97	31	21	23	22	2:19	70%
20	107	29	34	19	25	8:22	42%
21	110	29	47	18	16	15:09	33%
22	112	33	41	23	15	5:52	42%
23	139	42	41	39	17	3:06	58%

Note. [a]Not analyzed due to insufficient data points.

of notifications sent across 14 days ranged between 12 (i.e., approximately one notification per day) and 139 (i.e., approximately 10 notifications per day), revealing large differences between participants. The app-measured duration of Instagram closing (range: 1:06 to 23:47 minutes; median: 6:44 minutes) also highlights large interindividual differences in terms of closing Instagram after notification reception. The average success rate of closing Instagram within 5 minutes (cf. Dingler & Pielot, 2015) ranged between 25% and 77% and did not significantly change across 14 intervention days. This reflects that the average intervention effect did not wear off across 14 days (e.g., due to reactance; Lukoff et al., 2022), however, it has to be noted that descriptive success rates were lower at the end of the intervention period (Figure 3, Panel A). While the Instagram closing success rate was not predicted by the time of day, we observed differences for the type of notifications in favor of reflection notifications with an average success rate of 54%. Reflection notifications, such as "What do you feel in your body right now?," may be practical, easy to execute in respective situations, and can serve as stopping cues interrupting habitual Instagram usage (Gardner et al., 2023). Micro habit notifications, such as "Just one push up, let's do it!," might be less practical in daily life. Reflection notifications also worked better than surprising notifications (i.e., out-of-context or funny texts such as "Mark Zuckerberg is watching you!"), which is not directly related to one's current situation. A future study could test different sets of notifications using an experimental variation of the type of notification. Another option would be to test the effect of smartphone use-related notifications in a future study, where users can self-set the type of notifications based on their needs and preferences.

Feedback from participants on the intervention app indicated a mixed pattern. There was a narrow majority (13 out of 21: 62%) finding the app useful, with only 6 participants explicitly reporting that the notifications were helpful. We also observed the negative effects of the notifications as two participants found them annoying. These observations might also explain that the intervention group was not significantly superior to the control group. When designing future nudge-based interventions, researchers could consider letting the user choose their own schedule and type of notifications.

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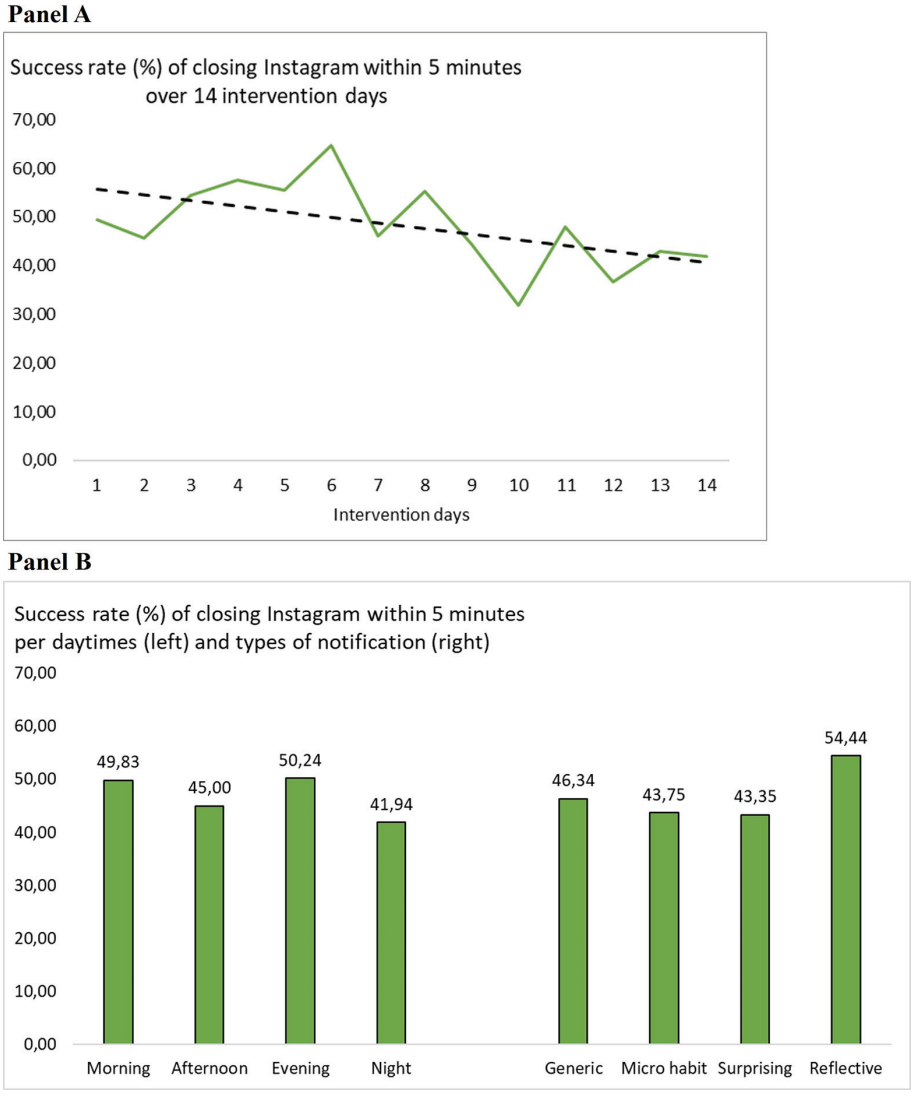

Figure 3. Success rate of closing Instagram within 5 minutes after receiving a notification.

Strengths, Limitations, and Future Research

This pilot study has several strengths, including the investigation of a behavior change context with growing relevance for public health, testing an innovative just-in-time intervention component in a randomized controlled trial, and analyzing behavioral data from the digital intervention. However, some limitations need to be considered and amended by future research. First, 70 participants were enrolled in the study, with 40 of them providing longitudinal data, which led to a lack of power to detect small intervention effects. Although the dropout rate of 43% is normal for online-based studies (Eysenbach, 2005), strategies should be considered in order to further reduce dropout rates such as incentives or gamification elements. Second, the intervention was not a fit for a number of participants, who rarely showed Instagram sessions of at least 3 minutes. For a better tailoring of the intervention to people's needs, future research can consider using person-specific thresholds (e.g., by asking the user prior to the intervention) of Instagram use. Present inclusion criteria resulted in enrolling a sample of Instagram users (who used Instagram for an average of 58 minutes per day). Together with having recruited a sample with a low mean age and a high proportion of a university degree, the present findings do not generalize to the general population. Third, with respect to measurement, potential question-behavior effects need to be considered when interpreting present results, particularly for the self-report on problematic smartphone use, for which we also found a significant reduction in the control group (Wilding et al., 2016). Fourth, behavioral data on Instagram opening and closing was only available from the intervention group and no causal inference can be made

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Table 4. Estimates from logistic two-level models predicting the success rate of closing Instagram within 5 minutes after receiving a notification (binary outcome)

Binary outcome: Success rate of closing Instagram within 5 minutes			
Predictors	*B* (*SE*)	*p*	*OR*
Model A1: Daytimes as predictors			
Within-level			
Intercept	0.12 (0.33)	.724	–
Linear time trend	−0.05 (0.03)	.086	0.95
Morning (vs. night)	0.39 (0.20)	.052	1.47
Afternoon (vs. night)	0.24 (0.20)	.224	1.27
Evening (vs. night)	0.27 (0.22)	.222	1.30
Between-level			
Notifications per person	0.01 (0.01)	.374	
Model A2: Types of notifications as predictors			
Within-level			
Intercept	−0.42 (0.31)	.183	–
Linear time trend	−0.05 (0.03)	.071	0.95
Generic (vs. reflective)	−0.26 (0.19)	.174	0.78
Micro habit (vs. reflective)	**−0.40 (0.18)**	**.028**	**0.67**
Surprising (vs. reflective)	**−0.45 (0.19)**	**.015**	**0.64**
Between-level			
Notifications per person	0.01 (0.01)	.325	

Note. n = 17 participants and 1.040 observations. Unstandardized coefficients. *SE* = standard error. Time trend was centered on first measurement occasion. Random effects modeled for the intercept and the linear time trend (otherwise no convergence). Significant predictions in bold.

regarding the finding that reflection notifications showed the highest Instagram closing success rate. Future studies should measure and compare behavioral data across all groups. Finally, the decision to use the four types of notifications in this study and to display them 3 minutes after starting an Instagram session was not based on a theoretical framework and was determined in a rather arbitrary way. More evidence is needed to learn more about which type of messages are effective for which person and situational contexts. Previous studies already showed the importance of focusing on a smartphone user's needs (Purohit et al., 2023; Terzimehić et al., 2022). As an idea for future research, smartphone users could write down activities they want to execute, whenever situations of problematic smartphone use arise (Keller et al., 2021; Lukoff et al., 2022).

Conclusion

This pilot study tested a digital intervention (vs. a control group) aiming to interrupt Instagram usage, which followed a digital nudge approach by notifying participants after using Instagram for 3 minutes. With 40 participants remaining for longitudinal between-group comparisons, we documented a lack of statistical power. Effect estimates of between-group differences revealed a medium-sized effect for time of smartphone use and a low effect for time of Instagram use. Although the intervention group showed a reduction in self-reported problematic smartphone use with a large effect, the control group yielded similar reductions over time. Based on analyses of behavioral data from participants of the intervention group, the intervention seemed to not fit the Instagram use levels of 6 participants. For the remaining 17 participants, the number of received notifications ranged between 12 and 139, with a median duration of closing Instagram after 6:44 minutes (range: 1:06 to 23:47 minutes), highlighting large interindividual differences in how the present nudge-based intervention worked in a sample of Instagram users. As the literature shows high and increasing levels of social media app usage globally and provides evidence for a number of health risks, future research should further develop interventions targeting social media app use. Findings from the present pilot study may inform the study design of future nudge-based intervention studies.

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