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Habitual social media and smartphone use are linked to task delay for some, but not all, adolescents

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Abstract

There is a popular concern that adolescents' social media use, especially via smartphones, leads to the delay of intended, potentially more important tasks. Automatic social media use and frequent phone checking may especially contribute to task delay. Prior research has investigated this hypothesis through between-person associations. We advance the literature by additionally examining within-person and person-specific associations of *automatic social media use* and *mobile phone checking frequency* with each other and *task delay*. Preregistered hypotheses were tested with multilevel modeling on data from 3 weeks of experience sampling among $N = 312$ adolescents (ages 13–15), including $T = 22,809$ assessments. More automatic social media use and more frequent phone checking were, on average, associated with more task delay at the within-person level. However, heterogeneity analyses found these positive associations to be significant for only a minority of adolescents. We discuss implications for the media habit concept and adolescents' self-regulation.

Lay Summary

Teens often unnecessarily delay tasks they intend or need to get done. It is believed that task delays are more common in situations when teens use social media on their smartphones (e.g., Instagram and Snapchat). We studied whether this was the case, particularly when they use social media automatically (i.e., without thinking about it) and check their phones frequently. Over the course of 3 weeks, we asked 312 teens (13- to 15-year-olds) several times per day in different situations how much they had used social media without thinking, how frequently they had checked their phone, and whether they did what they had intended to do in the last hour. Our findings show that those teens who delayed tasks more often also used social media more automatically but did not check their phones more frequently than their peers. Teens were particularly likely to delay tasks in hours during which they checked their phones more often or during which they used social media more automatically than usual. Our study suggests that these results differ from teen to teen, depending on who they are and how they use social media and smartphones.

Keywords: social media, mobile phone, habits, procrastination, adolescents, experience sampling, person-specific approach

Task delay—not doing what one intended to do—is a common concern for young people and can be linked to worse mental health and academic performance (e.g., Klingsieck, 2013; Reinecke et al., 2018b; Steel, 2007). Using mobile social media such as Instagram, Snapchat, or TikTok is often described as a potent distraction, supposedly driving task delay among youth (e.g., Marker et al., 2018; Meier et al., 2016; Schnauber-Stockmann et al., 2018). Yet, evidence of such an effect is scarce and limited in at least four ways¹: First, whether and how mobile social media use contributes to task delay *among adolescents* remains untested. Second, the available evidence on mobile social media use and task delay is largely limited to *between-person* associations, that is, differences between individuals. Almost no studies have investigated *within-person* associations, which would illuminate an important aspect of such a media effect (Valkenburg et al., 2016). Third, how much the within-person associations differ from adolescent to adolescent (Beyens et al., 2020)—that is, to what extent they are *person-specific*—remains unclear. Finally, most research on task delay has either investigated mobile social media use as “screen time” or “problematic/addictive use.” Yet, both approaches have received extensive

criticism of late, leading many to ask for a *conceptual alternative* (see Meier, 2022, for extended discussion).

The present study addresses all four gaps. We draw on the well-established concept of *media habits* (e.g., Anderson & Wood, 2021; Bayer et al., 2022; Bayer & LaRose, 2018; LaRose, 2010; Tokunaga, 2016) to investigate how adolescents' mobile social media use relates to their task delay in daily life. Specifically, this study explores two central aspects of mobile social media habits—*automaticity of social media use* and *frequency of mobile phone checking*. We test, first, how these two aspects of habitual media use relate to each other and, second, how they relate to task delay among adolescents, both between- and within-person. Finally, we follow recent calls to use “N-of-1 designs [to] determine whether automaticity operates differently in different people” (Kwasnicka et al., 2018, p. 233) and investigate the above-described associations for each specific adolescent (e.g., Aalbers et al., 2022; Siebers et al., 2021).

In doing so, we aim to better understand for how many adolescents the automaticity of social media use and frequency of mobile phone checking are, or are not, linked to task delay. Preregistered hypotheses and research questions

were tested on data from a 3-week-long experience sampling study among $N = 312$ adolescents, including $T = 22,809$ assessments. We apply multilevel modeling to disentangle between-person, within-person, and person-specific ($N = 1$) associations.

Two sides of mobile social media habits: automaticity and frequency

Habits refer to “implicit associations that people learn as they respond in ways that are rewarded” (Bayer et al., 2022, p. 1; see also Mazar & Wood, 2018; Wood & R nger, 2016). Specifically, *media habits* arise from cognitive associations between various *cues* (e.g., notifications, social media icons, and boredom) and rewarded media use responses (e.g., getting likes from peers) (Anderson & Wood, 2021; Bayer & LaRose, 2018; LaRose, 2010). If users regularly repeat rewarded behaviors (e.g., checking the phone for messages) after certain cues (e.g., receiving a notification), they acquire a stronger memory representation of this behavioral script (Mazar & Wood, 2018; Wood & R nger, 2016). The “active ingredient” (Gardner et al., 2012, p. 1) of this script—that what makes habits unique compared to other scripts—is the degree of *automaticity* with which the acquired habitual behavior is initiated and/or executed (Bayer et al., 2016b). Such automaticity is characterized by goal independence (e.g., initiating social media use without clear intentions), lack of conscious awareness during habit performance (using social media without thinking about the behavior), high cognitive efficiency (using social media without much cognitive cost), fast processing (reading and understanding social media messages quickly), and cue-dependency (social media use is initiated through triggers such as notifications, boredom, etc.), though not all facets have to co-occur (Mazar & Wood, 2018).

Importantly, doing something automatically (e.g., opening social media apps without thinking) is not the same as doing it *frequently* (e.g., using social media several times a day) (LaRose, 2010; Mazar & Wood, 2018). Yet, due to learning mechanisms, automaticity of a behavior is partially determined by how often a person has repeated the behavior in the past (e.g., Lally et al., 2010; Schnauber-Stockmann & Naab, 2019). After this habit acquisition phase, how automatically a person engages in the behavior on average reflects their acquired person-level *habit strength*. Habit strength is, in turn, related to how frequently a habitual response is executed in the future: The stronger the habit, the easier cues can activate a habitual behavior, hence the more often it can be executed habitually (Mazar & Wood, 2018; Wood & R nger, 2016). Accordingly, while automaticity and frequency of use are two distinct sides of media habits, they are conceptually and empirically linked (Bayer & LaRose, 2018; LaRose, 2010).

In the present study, we investigate frequency and automaticity at two key levels of media analysis: device and type of application (Meier & Reinecke, 2021). Specifically, we address the interplay between adolescents’ *mobile phone checking frequency* and their *social media use automaticity*. While social media are among the most popular applications, mobile phones are the devices via which adolescents typically access social media (e.g., van Driel et al., 2019). The device thus represents the primary “gateway” to automatic social media use (Bayer & LaRose, 2018; Schnauber-Stockmann et al., 2018); it is a rather stable context in which application-specific

habits are acquired (Schnauber-Stockmann & Naab, 2019). Moreover, checking the phone for messages is a common behavioral expression of a social media habit and “a manifestation of the societal rule for connectedness” (Bayer et al., 2016a, p. 135). Studying social media habits without considering mobile phone checking would omit a crucial aspect of adolescents’ current media use. We therefore extend prior research by examining two sides of mobile social media habits among adolescents: their social media automaticity and mobile phone checking frequency.

Between- and within-person associations of automaticity and frequency

As argued above, media use automaticity and media use frequency should be positively related at the *between-person* level. Indeed, one survey found that young adults who text more frequently also text more automatically ($r \approx 0.45$) (Bayer & Campbell, 2012). Similar moderate between-person correlations were observed for Facebook and Twitter usage frequency and automaticity (Anderson & Wood, 2021), as well as for phone checking automaticity and average duration of phone use among young adults (Meier, 2022). Yet, whether adolescents who use social media applications more automatically also check their mobile devices more frequently remains unclear. Because such evidence would lend further support for basic tenets of the media habit concept, we test the following hypothesis:

H1: Adolescents with higher social media automaticity than their peers will check their phones more frequently than their peers (i.e., positive between-person association).

We can further ask whether automaticity and frequency are associated *within persons*. That is, do adolescents who use social media more automatically within a certain timeframe (i.e., the last hour) also check their phones more frequently during that time? Studies on media habits are surprisingly silent on such within-person associations. However, drawing on (media) habit theory (LaRose, 2010; Wood & R nger, 2016) and the sociocognitive model of connectedness (Bayer et al., 2016a), we can assume that habitualized behavior is situationally triggered by certain cues. Specifically, the sociocognitive model theorizes that certain technical (e.g., notifications), mental (e.g., boredom and stress), temporal, and spatial cues trigger habitual connection via mobile and social media. Since these cues clearly vary from moment to moment, we can expect checking frequency and automaticity to vary considerably from moment to moment, too.

Whether automaticity and frequency also *co-vary* within a person is less clear. Assuming that phone checking frequency is a behavioral expression of adolescents’ mobile social media habit, we might expect that during a timeframe in which adolescents use social media more automatically than they typically do, they will also check their mobile devices more often. This could, for instance, be explained by mind-wandering. If an adolescent uses social media more automatically in one moment, and then goes on to do something else, they might experience that their thoughts drift back to social media, and thus automatically check their phones again. Indeed, prior research has found a link between mind-wandering and such phone monitoring behavior, albeit only at the between-person level (Johannes et al., 2018). Alternatively, using social media

automatically could also be linked to high momentary engagement in online conversations (Bayer et al., 2016b), which may elicit subsequent response expectations. Rapid successions of automatic social media use and immediately checking the phone again could be explained by adolescents expecting reciprocity (e.g., likes or private messages), which is both normative in interpersonal conversations and common on social media (French & Bazarova, 2017). To summarize, while a within-person link between social media automaticity and phone checking frequency appears plausible, it remains untested. We thus posit:

H2: At occasions when adolescents use social media more automatically than they usually do, they will check their phones more frequently (i.e., positive within-person association).

Mobile social media habits as drivers of adolescents' task delay

Media habits make it exceedingly difficult to self-control one's media use, especially in a digitalized, always-on society (for reviews, see Anderson & Wood, 2021; Bayer et al., 2022; Bayer & LaRose, 2018; Reinecke & Meier, 2021). Frequent phone checking and automatic social media use have been repeatedly viewed as rather problematic, unhealthy, or even "addictive" habits that almost necessarily conflict with numerous tasks in daily life, especially for youth. One explanation is that automatic use makes users overlook goal conflicts. Automatic use happens largely unconsciously, without ensuring compatibility with other tasks (Bayer et al., 2016b; Reinecke & Meier, 2021). Accordingly, media habit strength has been linked consistently to deficient self-regulation, albeit only at the between-person level (e.g., Bayer & LaRose, 2018; Reinecke & Meier, 2021; Tokunaga, 2016).

A key phenomenon indicating such deficient self-regulation is *task delay*, often studied as a central facet of *procrastination*, that is, irrational delay (Klingsieck, 2013; Steel, 2007). To procrastinate means "to voluntarily delay an intended course of action despite expecting to be worse off for the delay" (Steel, 2007, p. 66). Accordingly, procrastination consists of three components: (a) task delay, defined as a gap between intention and action, (b) volition, in the sense of delaying something unnecessarily, and (c) irrationality, the expectation of negative consequences due to the delay. In the present study, we focus on the first component, task delay, because "the intention-action gap is the core of the procrastination phenomenon" (Klingsieck, 2013, p. 26). Recently, psychological research has renewed its focus on task delay as the central behavioral component of procrastination (e.g., Krause & Freund, 2014; Shin & Grant, 2021) and observed task delay to be strongly related to more comprehensive trait measures of procrastination (e.g., Wessel et al., 2019).

Procrastination is a common problem for adolescents and young adults: It is linked to impaired physical and mental health (Reinecke et al., 2018b), maladaptive coping and stress (Reinecke et al., 2018a), decreased academic performance (Kim & Seo, 2015), and lower relationship satisfaction with parents (Reinecke et al., 2018b). Avoiding the delay of important tasks (e.g., homework) can therefore be characterized as an important self-regulatory challenge for adolescents.

From a developmental perspective, the association between mobile social media habits and task delay may be stronger among adolescents than adults, as adolescents' executive functions and self-regulatory capabilities are not yet fully developed (Blakemore & Choudhury, 2006). In addition, adolescents might be more susceptible to social rewards (Blakemore & Mills, 2014), which are readily provided by social media (e.g., likes) and permanently available via mobiles (e.g., notifications). These social rewards drive the acquisition and repeated activation of mobile social media habits (Anderson & Wood, 2021). Given adolescents' higher reward susceptibility, mobile social media use could thus be more habitualized and harder to control for adolescents compared to adults, resulting in more frequent goal conflicts and, hence, task delay. Yet, very little research has examined the link between mobile social media habits and task delay or procrastination among adolescents (cf. Supplement I on the OSF: <https://osf.io/y4q5x>).

Between- and within-person associations of habits and task delay

Social media automaticity and phone checking frequency may be linked to adolescents' task delay both at the between- and within-person levels. From a dual-systems perspective, humans engage in automatic behavior in many life situations, and the more automatic a behavior is on average (i.e., the stronger the habit) the more difficult it is to control (Reinecke & Meier, 2021; Schnauber-Stockmann et al., 2018). It thus takes additional self-regulatory effort to inhibit or override strongly automatic responses, compared to less automatic ones (Wood, 2017), and adolescents may not always be able to muster this self-regulatory effort. Instead, when using social media automatically, they may often do so despite conflicts with other tasks (e.g., academic duties). Over time, such brief moments of goal conflicts due to automatic use (e.g., during an afternoon of homework) may accumulate and hence facilitate task delay (e.g., not starting or completing homework). Adolescents with a stronger mobile social media habit should experience such goal conflicts, and hence task delay, more often. Indeed, existing studies among adults found a moderate positive link between automatic media use and irrational task delay at the between-person level (see Supplement I: <https://osf.io/y4q5x>).

We can further expect this positive between-person association to extend to phone checking frequency and task delay. Various studies found that young adults who use mobile and social media more frequently also report slightly more task delay (e.g., Aalbers et al., 2022; Meier, 2022; see also Supplement I: <https://osf.io/y4q5x>). Yet, as argued above, automatic social media use may be predictive of task delay above and beyond overt usage patterns: Automatic social media use—rather than the mere frequency of phone checking—should make it particularly difficult for adolescents to detect goal conflicts and hence avoid task delay (Reinecke & Meier, 2021). Advancing prior research, we thus compare the associations of phone checking frequency with task delay to those found for social media automaticity:

H3: Adolescents who have (a) higher social media automaticity and (b) who check their phones more frequently than their peers will delay tasks more often than their peers (i.e., positive between-person associations).

While repeated irrational task delay (i.e., procrastination) has mostly been studied as a trait (Steel, 2007), it can also be understood as a behavior that varies from moment to moment (Klingsieck, 2013). Hence, we can extend the theoretical link outlined above to the within-person level: In situations in which adolescents use social media more automatically and check their phones more frequently than they usually do, they should experience more goal conflicts and thus task delay (Reinecke & Meier, 2021). To our knowledge, only two studies have tested this (see Supplement I: <https://osf.io/y4q5x>), both lending support for a within-person link: In a day reconstruction study, Schnauber-Stockmann et al. (2018) found that in situations in which adult participants used their phones more automatically than they usually do, they also reported higher procrastination. An experience sampling study by Aalbers et al. (2022) further supports a link between mobile social media use and procrastination: At occasions when university students reported higher total phone use, higher use of social media apps, or more fragmented use (i.e., sequential closing and opening of different apps) than usual, they also delayed more tasks. Given these theoretical and empirical links, we hypothesize:

H4: At occasions when adolescents (a) use social media more automatically and (b) check their phones more frequently than they usually do, they will delay tasks more (i.e., positive within-person associations).

Media habits as person-specific

Beyond distinguishing between- and within-person associations, authors have repeatedly called for more nuanced investigations that acknowledge the heterogeneous and person-specific nature of media use and its impact on adolescents (e.g., Beyens et al., 2020; Valkenburg et al., 2016). Accordingly, the associations described above may show considerable person-specificity—they may “differ from adolescent to adolescent” (Beyens et al., 2020). The main question, however, is not whether there *are* differences in associations between adolescents; rather, it is unclear *to what extent* these differences exist and *how they are distributed*.

Methods that explore effect heterogeneity and person-specificity have also been proposed as an important next step to better understand habits and their consequences (Kwasnicka et al., 2018). Yet such methods have so far only been applied to investigate how habits are *formed* (e.g., Lally et al., 2010), not how they are *performed* once acquired. It is thus largely unclear how the situational associations of social media automaticity with phone checking frequency and task delay vary from adolescent to adolescent. It is quite plausible that automatic social media use and phone checking repeatedly create goal conflicts for adolescents, thus facilitating task delay (see H4). Yet, for some adolescents, such habits may be largely inconsequential: An adolescent may, for instance, still be able to successfully work on their intended task despite the occasional habitual look at their phone. Person-specific analyses among university-age students by Aalbers et al. (2022) support the former view: The vast majority of participants reported higher levels of task delay when they spent more time on their phones, with overall little effect heterogeneity. Still, given the general lack of person-specific evidence on adolescents' mobile social media habits and task delay, we ask:

RQ1: To what extent do the within-person associations of (a) social media automaticity and phone checking frequency, (b) social media automaticity and task delay, and (c) phone checking frequency and task delay differ for each individual adolescent?

Methods

This study is part of a larger project investigating the psychosocial consequences of social media use among adolescents (<https://osf.io/uxnm8/>). Design and sampling plan of the project were preregistered before data collection (<https://osf.io/327cx>). The larger project consists of two 3-week experience sampling method (ESM) bursts scheduled 6 months apart, two pre-ESM surveys, and 16 biweekly surveys (<https://osf.io/n8v9f/>). The current study uses data from the second ESM burst, collected in June 2020. At this time, mandated school closures due to COVID-19 had just ended after 2.5 months in The Netherlands. The data for this study have not been analyzed in prior publications. Hypotheses H1–H4, RQ1, and the analysis plan of the current study were preregistered prior to analyzing the data (<https://osf.io/squ69>).² The analysis scripts and materials of this study are available on the OSF (<https://osf.io/vru5x/>).

Participants

Participants were adolescents in grades 8 and 9 (i.e., ages 13–15) at a large secondary school in The Netherlands. The school was selected because of its diversity in educational tracks. We invited 745 students at this school to participate (i.e., all students in the 8th and 9th grades = 32 classes). Of these students, 400 (54%) obtained active parental consent to participate in the study, and 388 students (52%) provided informed assent themselves. In the second ESM burst, a total of 312 students participated (57% girls; $M_{\text{age}} = 14.63$, $SD = 0.70$). Data from all 312 participants were included in the analyses. Most participants (96%) self-identified as Dutch and were born in The Netherlands. Participants were from different educational levels: 37% in prevocational secondary education, 33% in intermediate general secondary education, and 29% in academic preparatory education. The sample is representative of adolescents in The Netherlands concerning educational level, sex, and ethnicity (Statistics Netherlands, 2020).

The sample size rationale was preregistered as part of the larger project and before collecting the data (<https://osf.io/jfzrw/>). For the larger project, which was developed to estimate a wide variety of research questions and analytical strategies, a priori power analyses using Monte Carlo simulations indicated that a sample size of 300 participants would suffice to reliably detect small effect sizes with a power of 0.80 and significance level of 0.05 (<https://osf.io/ar4vm/>).

Procedure

The project was approved by the Ethics Review Board of the Faculty of Social and Behavioral Sciences at the University of Amsterdam. During the second ESM burst, participants completed the ESM surveys using the *Ethica Data* application on their own mobile phones, including Android and iOS devices. For three consecutive weeks, they were notified via the app to complete six surveys per day at random time points within a fixed time interval. ESM sampling was tailored to

participants' school and weekday/weekend routines, so that they, for instance, did not receive surveys during class or while sleeping in. Participants received a beep prompt on their phones each time a new survey was available. Five to ten minutes later, an automatic reminder was sent if the survey was not completed yet. Participants could respond within a 30-min window after receiving the notification. For the first (morning) and final (evening) survey of the day, the response window was extended to 1 or 2 hr, respectively, to account for travel time to school and time spent on evening activities. A detailed overview of the entire notification scheme including response windows can be found on the OSF (<https://osf.io/vkr4u/>). For additional information on the data collection procedure of the larger project, see OSF (<https://osf.io/327cx>).

The ESM study consisted of 126 assessments (i.e., 3 weeks \times 7 days \times 6 assessments per day). The number of assessments was determined based on the fact that a minimum of 50–100 assessments per participant is recommended to conduct person-specific ($N=1$) analyses (Chatfield, 2016; Voelkle et al., 2012). To obtain at least 50–100 assessments per participant, we took a conservative approach and scheduled a total of 126 assessments. Together, the final sample of $N=312$ participants of this study completed $T=22,809$ out of a total of 39,168 assessments (i.e., 58% compliance³), with an average of 73.11 ($SD=34.96$) assessments per participant (Range 1–126; $Mdn=80.50$). Hence, data quantity is sufficient to conduct person-specific analyses.

Each survey of the second ESM burst consisted of 19–32 questions and lasted about 2 min, depending on the moment of the day (e.g., evening surveys included end-of-day questions). Each ESM survey included the questions of interest to this study—that is, adolescents' automatic social media use, phone checking frequency, and task delay.

Measures

Social media automaticity

To measure adolescents' automatic social media use, we used one item from the Self-Report Behavioral Automaticity Index (SRBAI; Gardner et al., 2012). Participants were asked to respond to the question “To what extent did you go on social media without thinking in the past hour?” using a 7-point scale ranging from 1 (not at all) to 7 (completely), with 4 (a little) as the midpoint. Participants were asked to respond to this item concerning all social media they had used in the past hour, such as Instagram, WhatsApp, Snapchat, Facebook, and Twitter.

The SRBAI has been used in several prior studies to measure automaticity in mobile and social media use (e.g., Bayer & Campbell, 2012; Meier, 2022; Schnauber-Stockmann et al., 2018). It contains only the automaticity items from the broader, multi-faceted Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003), which is the most common self-report measure in habit research (Bayer & LaRose, 2018; Rebar et al., 2018). Both the SRBAI and the SRHI have demonstrated convergent validity with other (behavioral) measures of habit strength (Gardner et al., 2012; Rebar et al., 2018; Verplanken & Orbell, 2003).

Following the recommendation by Naab et al. (2019) to use a limited number of SRHI items in ESM studies, we selected a single item to achieve a compromise between participant burden, construct validity, and predictive validity (see also Aalbers et al., 2019; Song et al., in press). As Allen et al. (2022, p. 1) note, “when a construct is unambiguous or

narrow in scope, the use of single items can be appropriate and should not necessarily be considered unsound.” The SRBAI is a one-dimensional measure of habit automaticity and is adequately represented by the “without thinking” item as supported by multiple prior studies that consistently find a high factor loading for this item (Bayer & Campbell, 2012; Bayer et al., 2016b; Meier, 2022; Meier et al., 2016; Schnauber-Stockmann et al., 2018). We reformulated the item to fit the ESM format and the context of this study (i.e., referring to social media use in the last hour).

Phone checking frequency

Like previous studies (e.g., Ohme et al., 2021; Wilcockson et al., 2018), we measured the frequency of adolescents' mobile phone checking using one item. In each ESM survey, adolescents were asked to respond to the question “How many times have you checked your phone in the past hour?” They could respond using a Visual Analog Scale ranging from “0 times” to “more than 50 times.” We reformulated the item to fit the ESM format.

Task delay

In each ESM survey, adolescents were asked to respond to the question “To what extent have you done what you intended to do in the past hour?” using a 7-point scale ranging from 1 (not at all) to 7 (completely), with 4 (a little) as the midpoint. This reverse-scored item captures the behavioral core of procrastination—the intention-action gap (Klingsieck, 2013; Steel, 2007). The item content corresponds with the most used procrastination self-report measure, the General Procrastination Scale (GPS; Lay, 1986; Sirois et al., 2019). Similar items from the GPS have been used in prior ESM research (e.g., Aalbers et al., 2022). We used this reverse-coded wording to measure task delay—rather than an item measuring procrastination more directly—because this question was easier to respond to for adolescents and in an ESM context. For an extended rationale for the choice of our three measures, see Supplement II on the OSF (<https://osf.io/58nkh>).

Analytical strategy

Multilevel models

As preregistered (<https://osf.io/squ69>), we tested four hypotheses (H1–H4) and one research question (RQ1) using multilevel modeling in *Mplus* version 8.6 (Muthén & Muthén, 2017). We estimated two two-level models in which repeated momentary assessments (ESM surveys) are nested within adolescents: one model to test associations between automatic social media use and frequency of mobile phone checking (*Model 1*; testing H1, H2, and RQ1a), and another to test associations of automatic social media use and frequency of mobile phone checking with task delay (*Model 2*; testing H3, H4, RQ1b, and RQ1c). At the within-person level, predictors were specified as time-varying covariates (i.e., within-person associations). At the between-person level, the correlations of the latent means were investigated (i.e., between-person associations). In addition, we included between-person variances around the within-person associations of the three variables (i.e., random effects) to investigate RQ1. In all models, we accounted for effects of time by including the notification number of the day (1–6) and type of day (weekday vs. weekend day) as controls. This detrending is helpful to interpret within-person associations as correlated fluctuations

irrespective of the time of day or type of day (Wang & Maxwell, 2015).

Model settings

We used Bayesian estimation with uninformative priors to obtain standardized parameters as well as p -values and credible intervals for each single person's within-person association (Schoorman et al., 2016). This also allowed for latent person mean centering, as recommended by McNeish and Hamaker (2020). The between-person associations were based on latent person means, and within-person and person-specific associations were based on latent person-mean centered scores. We ran a minimum of 5,000 iterations of the Bayesian Markov Chain Monte Carlo algorithm. To exclude the possibility of a premature stoppage problem (Schultzberg & Muthén, 2018), in a second step, we doubled the number of iterations. Additional details on convergence criteria can be found in the preregistration (<https://osf.io/squ69>).

Inference criteria

Following the procedure of McNeish and Hamaker (2020), we report the Bayesian credible intervals and Bayesian p -values for all parameters of interest. The between-person (H1, H3a, and H3b) and within-person (H2, H4a, and H4b) hypotheses were preregistered to be rejected if the 95% credible intervals of the standardized effects contained 0. The research questions (RQ1a–c) concerning between-person differences in the within-person associations were answered, first, based on whether the 95% credible intervals for the unstandardized random effects contained 0 (i.e., whether there was significant heterogeneity). Second, the person-specific effect estimates were considered relevant if they passed a smallest effect sizes of interest (SESOI) threshold: Person-specific associations were considered positive if $\beta \geq 0.05$, negative if $\beta \leq -0.05$, and nonexistent to very small if $-0.05 < \beta < 0.05$. The SESOI of $|0.05|$ was based on results from similar previous studies (e.g., Siebers et al., 2021), a recent meta-review on social media effects (Meier & Reinecke, 2021), and methodological recommendations on effect sizes in longitudinal autoregressive studies (Adachi & Willoughby, 2015). Person-specific associations were considered statistically significant if their 95% credible intervals did not contain 0.

Results

Descriptive statistics and correlations

Based on the 22,809 ESM observations (see Table 1), adolescents reported to check their phones on average 5 times in the past hour ($SD = 6.10$, range 0–50+) and opened social media applications to a moderately automatic degree ($M = 2.68$, $SD = 1.86$, range 1–7). Task delay levels were similarly

moderate ($M = 2.94$, $SD = 1.75$, range 1–7), and comparable to procrastination levels found in previous studies among adults (see Supplement I: <https://osf.io/y4q5x>). Between-person correlations indicate that adolescents who used social media more automatically than their peers also reported more frequent phone checking ($r = 0.43$) and more task delay ($r = 0.44$). Task delay was also slightly more common among adolescents who checked their phones more often ($r = 0.18$). All three variables showed positive within-person correlations in the small to moderate range ($r = 0.08$ – 0.19). Intraclass correlations (ICCs) indicate that 43% of the variance in phone checking, 61% in social media automaticity, and 39% in task delay were explained by differences between adolescents.

Hypothesis tests (H1–H4)

All multilevel models converged well and before 5,000 iterations as all Potential Scale Reduction (PSR) values were close to 1 (PSR = 1.001), the density plots looked smooth, and the trace plots did not contain trends, spikes, or other irregularities. Model convergence was still successful after doubling the number of iterations, and results did not deviate from the models with 5,000 iterations. Results are displayed in Table 2. Confirming H1, between-person findings from Model 1 showed that social media automaticity was, on average, positively related to phone checking frequency ($\beta = 0.46$, $p < .001$). Based on the unstandardized estimate, this means that adolescents who scored one unit higher on the social media automaticity scale than their peers, did on average $b = 2.8$ more phone checks per hour than their peers. Confirming H2, within-person findings from Model 1 further showed that social media automaticity was, on average, positively related to phone checking frequency ($\beta = 0.18$, $p < .001$). During hours when adolescents used social media more automatically than usual, they also checked their phones more often (roughly $b = 0.8$ more checks per hour, per automaticity unit increase).

Between-person findings from Model 2 confirmed H3a but not H3b: The fixed effects showed that adolescents who, on average, used social media more automatically than their peers also reported higher task delay ($\beta = 0.44$, $p < .001$), but adolescents who checked their phones more often than their peers did not report more task delay ($\beta = 0.004$, n.s.). Within-person findings from Model 2 confirmed both H4a and H4b: Adolescents reported more task delay at occasions when they (a) used social media more automatically ($\beta = 0.09$, $p < .001$) and (b) checked their phones more frequently ($\beta = 0.05$, $p < .001$) than they usually did. Unstandardized estimates show that a one-unit increase in automatic social media use translated into a $b = 0.11$ unit increase in task delay, whereas one additional check of the phone translated into a $b = 0.02$ unit increase in task delay in the past hour.

Table 1. Descriptive statistics, within-person correlations, between-person correlations, and intraclass correlations (ICCs)

Study variable	Descriptives				Correlations ^{a,b}			ICC
	N_{obs}	M	SD	Range	1.	2.	3.	
1. Phone checking frequency	22,110	5.17	6.10	0–50+	–	0.18	0.08	0.43
2. Social media automaticity	22,015	2.68	1.86	1–7	0.43	–	0.13	0.61
3. Task delay	22,117	2.94	1.75	1–7	0.18	0.44	–	0.39

^a Within-person correlations depicted above, between-person correlations below the diagonal.

^b All correlations $p < .001$.

Table 2. Model parameters of the fixed and random effects models

Fixed effects	Model 1			Model 2		
	<i>b</i>	β	95% CI	<i>b</i>	β	95% CI
Within-person						
Time → Frequency	0.309	0.108***	[0.096, 0.120]			
Day → Frequency	0.074	0.016	[-0.012, 0.045]			
Automaticity → Frequency (H2)	0.771	0.179***	[0.159, 0.198]			
Time → Task delay				0.012	0.015*	[0.003, 0.027]
Day → Task delay				0.025	0.018	[-0.010, 0.046]
Automaticity → Task delay (H4a)				0.114	0.092***	[0.070, 0.112]
Frequency → Task delay (H4b)				0.015	0.050***	[0.031, 0.068]
Between-person						
Automaticity → Frequency (H1)	2.767	0.458***	[0.361, 0.545]			
Automaticity → Task delay (H3a)				0.331	0.439***	[0.329, 0.533]
Frequency → Task delay (H3b)				0.001	0.004	[-0.115, 0.121]
Random effects						
Automaticity → Frequency (RQ1a)		σ^2	95% CI		σ^2	95% CI
Automaticity → Task delay (RQ1b)		0.914***	[0.717, 1.177]		0.080***	[0.063, 0.102]
Frequency → Task delay (RQ1c)					0.002***	[0.001, 0.003]
Other variances (residual)						
Within-person		σ^2	95% CI		σ^2	95% CI
Frequency		20.590***	[20.214, 20.994]			
Task delay					1.706***	[1.673, 1.737]
Between-person					0.962***	[0.819, 1.141]
Task delay						

Note. *bs* are unstandardized effects. β s are standardized effects using STDY for the categorical and STDYX for the continuous variables. Day of the week is coded as 0 for weekdays and 1 for weekend days. *p*-values represent one-tailed Bayesian *p*-values, and 95% CIs are Bayesian credible intervals (McNeish & Hamaker, 2020).

* $p < .05$; ** $p < .01$; *** $p < .001$.

Heterogeneity analyses (RQ1)

We continued by exploring the heterogeneity of the relationships among mobile social media habits and task delay. That is, we investigated to what extent the within-person associations of social media automaticity and phone checking frequency (RQ1a), social media automaticity and task delay (RQ1b), and phone checking frequency and task delay (RQ1c) differed from adolescent to adolescent. Results for Models 1 and 2 suggested that estimating random rather than fixed slopes significantly improved the respective model fit. Significant heterogeneity was present for the association of automatic social media use with frequency of phone checking (RQ1a: $\sigma^2 = 0.914$, $p < .001$), automaticity with task delay (RQ1b: $\sigma^2 = 0.080$, $p < .001$), and phone checking with task delay (RQ1c: $\sigma^2 = 0.002$, $p < .001$).

Figure 1 shows how the person-specific associations (β s) are distributed in the full sample (RQ1a–c). We report percentages on how many associations passed the $|.05|$ SESOI threshold and how many were significant based on the 95% CI. The person-specific associations of social media automaticity with phone checking frequency (RQ1a) ranged from $\beta = -0.56$ to $\beta = 0.71$ and those with task delay (RQ1b) from $\beta = -0.43$ to $\beta = 0.62$. Although these person-specific associations of social media automaticity were positive for most adolescents (phone checking; 86%, task delay: 70%), they only reached significance among some adolescents (phone checking: 31%; task delay: 23%). The person-specific associations between phone checking and task delay (RQ1c) ranged from $\beta = -0.36$ to $\beta = 0.45$ and were positive among just less than half of adolescents (45%) and significant among a minority of adolescents (13%).

Together, these results indicate that person-specific associations among all three variables (i.e., social media automaticity,

phone checking frequency, and task delay) were positive and significant for some adolescents (13%–31%) but positive and non-significant for most adolescents in our sample (45%–86%). As would be expected based on their conceptualizations and prior research, significant negative person-specific associations between these variables were very uncommon (<5%). All detailed percentages are reported in Supplement III (<https://osf.io/jz3xq>).

As non-preregistered analyses, we explored whether age, gender, and trait self-control (measured in the baseline survey) explained the variation in random slopes of all within-person associations. We only found one cross-level interaction for gender, showing that the positive within-person association between automaticity and checking frequency (main effect: $\beta = 0.179$, $p < .001$, see Table 2) was slightly weaker for boys than for girls (interaction effect: $\beta = -0.278$, $p = .021$). For details on the non-significant interactions, see Supplement III (<https://osf.io/jz3xq>).

Discussion

Habitual smartphone and social media use may affect adolescents' functioning particularly by facilitating the delay of intended tasks (e.g., homework). For adolescents, whose self-control capabilities are still developing and who are more susceptible to social rewards, resisting the constant temptation of checking WhatsApp, Snapchat, TikTok, or Instagram during task engagement is clearly a self-regulatory challenge (Blakemore & Choudhury, 2006; Blakemore & Mills, 2014; Reinecke & Meier, 2021). Yet, whether frequent phone checking and automatically accessing social media applications have any bearing on adolescents' task delay has not been examined so far. Using data from a large ESM study of middle adolescents and distinguishing between-person, within-person, and person-specific associations, we contribute

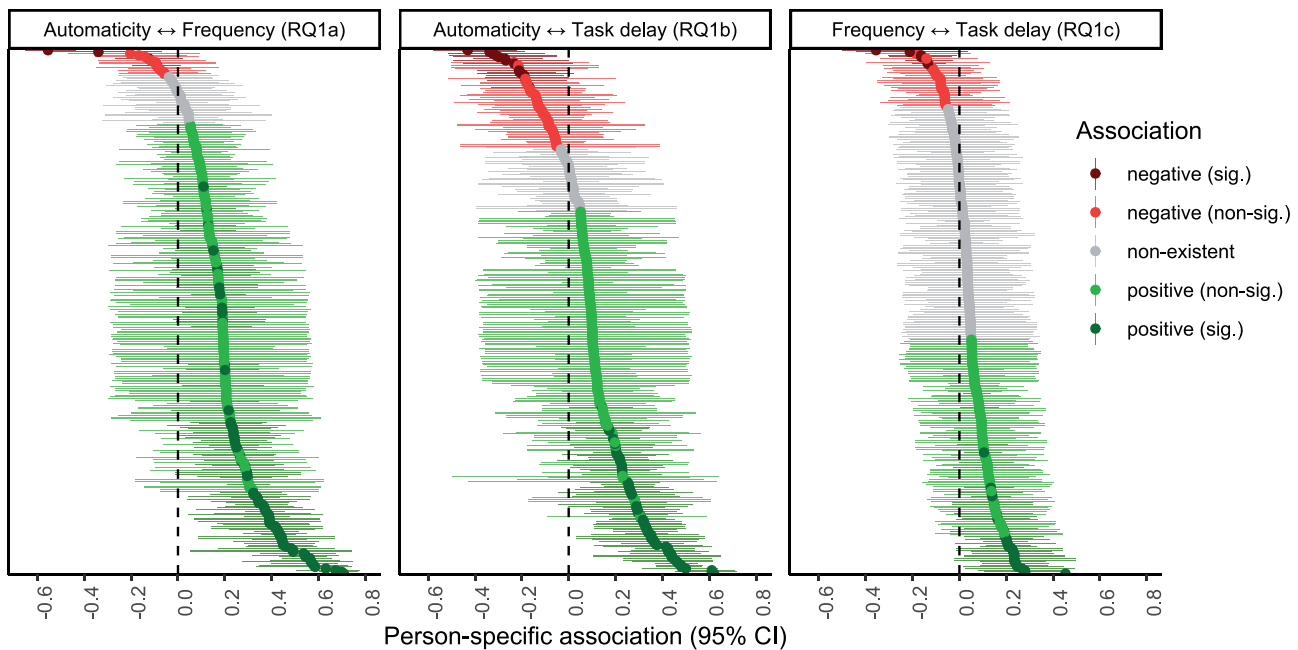


Figure 1. Distribution of the model-based person-specific effect sizes (β) for the associations between automaticity and checking frequency (left), automaticity and task delay (middle), and checking frequency and task delay (right). Red and green indicate positive and negative β values beyond a $|\beta| \geq 0.05$ SESOI threshold. Darker shades indicate statistical significance (i.e., the 95% CI does not include zero)

the first comprehensive study on adolescents' habitual mobile social media use and task delay, advancing prior research in several ways.

Summary and contributions

As a first contribution, results on H1 and H2 lend support for a basic tenet of the media habit concept: Automaticity and behavioral checking frequency are strongly associated but distinct facets of mobile social media habits. Importantly, we show this positive association *across* two levels of media analysis (Meier & Reinecke, 2021): *Social media* automaticity was linked to *phone* checking frequency, supporting an inherent link between self-reported device-level behavior and application-specific cognition. While such interplay between device- and application-specific components of media habits has been theorized (Bayer et al., 2022), this study is among the first to demonstrate it. Importantly, this is not of purely academic interest but has clear implications for technology design and regulation: If social media companies truly want to reduce harm caused by the “addictive design” of their products (Anderson & Wood, 2021; Bayer & LaRose, 2018), they need to consider not just application-specific behaviors but also device-specific behaviors. Although results suggest that automatic social media use mattered more for adolescents' task delay than their phone checking frequency (see further below), device-level affordances (e.g., portability and constant availability) appear relevant to habit automaticity beyond application-specific design (e.g., infinite scrolling or likes) (Bayer et al., 2016a; Schrock, 2015).

Additionally, our results support the link between automatic social media use and phone checking frequency both between- (H1) and within-person (H2): Adolescents who, on average, reported to use social media more automatically than their peers also checked their phones more frequently than their peers (between-person). In addition, across the various daily life situations captured by this 3-week ESM study,

the more automatically adolescents used social media in the past hour, the more often they checked their phone during that time (within-person), with an average of 2.8 additional phone checks per unit increase in social media automaticity. This study is the first to demonstrate such a positive within-person relationship between the two sides of media habits (automaticity and frequency), thereby advancing our understanding of how the habit concept operates in situ.

As a third and most central contribution, the findings support the popular assumption that smartphones and social media are linked to adolescents' dilatory behavior. Overall, both between- and within-person findings show that mobile social media use matters for task delay. Specifically, results on H3 support that adolescents who, on average, used social media more automatically than their peers also reported more task delay than their peers (between-person). Interestingly, how often adolescents checked their phones was, on average, unrelated to their task delay (between-person). This finding is consistent with several prior studies: The way users, on average, engage with media (e.g., habit strength) has been demonstrated to matter more for psychological and behavioral outcomes than how often media are used (e.g., Bayer & Campbell, 2012; Meier, 2022). For instance, in a study similar to the present one, Aalbers et al. (2022) observed that university students' average levels of mobile social media use were unrelated to their average level of procrastination.

In contrast, the findings on H4 support a within-person association for both automatic social media use and phone checking frequency with task delay. That is, if an adolescent used social media more automatically than usual and checked their phone more often than usual in the past hour, they also reported that they did less of what they had intended to do during that time. Within-person, how automatically adolescents used social media was linked slightly more strongly to task delay than how frequently they checked their phones. This again suggests that the cognitive side of media habits (automaticity)

matters more for problematic outcomes than the behavioral side (frequency). Particularly the study's within-person evidence extends prior research, which so far has only investigated the association of adolescents' habitual media use and procrastination on the between-person level (see Supplement I: <https://osf.io/y4q5x>). The within-person evidence resonates with recent findings from a laboratory experiment and interview study among adolescents, which concluded that "whereas many smartphone and offline activities are deliberate and goal-directed, social media use in particular is almost always born out of habit or boredom," with opening and scrolling through social media frequently reported to be "almost an automatic, thoughtless act" (Griffioen et al., 2021, p. 9). Clearly, while phone checking can be an intentional and conscious decision for adolescents—even during homework tasks (e.g., to look something up or ask a friend for help)—the automatic nature of adolescents' social media use may be a particular driver of their task delay.

Finally, this study extends media habit research by exploring the heterogeneity of within-person associations between social media automaticity and phone checking frequency (RQ1a), social media automaticity and task delay (RQ1b), and phone checking frequency and task delay (RQ1c). Rather than investigating how habit *formation* can be person-specific (Kwasnicka et al., 2018), this study advances prior work by investigating how media habit *execution* and its *correlates* differ from person to person. Results on RQ1a show that for most adolescents (86%), engaging with social media more automatically than usual in the past hour also meant significantly more phone checks during that time (e.g., to check for responses, likes, or new messages), yet these positive associations only reached statistical significance among a third of adolescents (31%). This finding suggests that only for a minority of adolescents, the cognitive side of their habit (i.e., social media automaticity) was significantly correlated with reoccurring behavioral patterns around their mobile phone use (i.e., checking frequency). The high percentage of non-significant person-specific associations (68%) challenges the idea that social media automaticity and phone checking are necessarily part of the same habit for all adolescents. One explanation may be that device-checking behavior serves as a "gateway" to app-specific habits only for some users or specific social media apps (Bayer et al., 2022), which clearly deserves exploration in the future. However, we note that conclusions on person-specific associations based on the SESOI and significance tests differed. It will be up to future research to replicate the robustness of this finding with studies powered high enough to detect small person-specific effects. In the present study, we had sufficient power to detect person-specific effects of at least moderate size.

Whereas the person-specific associations of social media automaticity with task delay (RQ1b) were rather similar to those with phone checking (RQ1a), the associations between automaticity and task delay were more heterogeneous (RQ1c). For most adolescents, there was a positive association between automaticity and task delay (RQ1b) based on the SESOI (70%), yet the positive person-specific associations were only significant for about a quarter of the adolescents (23%). In contrast, less than half of the adolescents experienced a positive association between phone checking and task delay (RQ1c) based on the SESOI (45%), and these positive person-specific associations only reached significance for about one in eight adolescents (13%).

Overall, the person-specific results suggest that media habit automaticity may be more robustly associated with task delay than mere checking frequency (see also Figure 1). In addition, when basing our conclusion on only the significant person-specific effects, we find that automatic social media use and phone checking frequency are robustly related to task delay for only a minority of adolescents. This finding directly challenges popular concern around widespread "social media addiction" or "problematic phone use" among adolescents. Clearly, habitual mobile social media use does not equal problem outcomes or addiction and can be functional in some situations but dysfunctional in others (see Meier, 2022, for extended discussion). One explanation for this may be that adolescents experiencing no significant association have sufficiently high self-regulatory capabilities in most situations. Most adolescents in our sample may have been able to regulate their mobile social media use in ways that avoided task delay. For many adolescents, and in many situations, using social media automatically or checking the phone may be entirely inconsequential for task delay. Rather, it may simply represent intentional, unproblematic behavior (Griffioen et al., 2021). However, given the discrepancies between the SESOI- and 95% CI-based distributions of person-specific effect sizes, more research is needed to see whether these results replicate.

Limitations

Several limitations need to be considered. First, a downside of our study's general task delay measure is that it may have captured both *irrational* (i.e., true procrastination) and *rational* delays. Rational delay refers to situations in which a person strategically decides not to do what they had originally intended to do (e.g., to wait until more information or resources are available to complete a task). Our study cannot distinguish between irrational and rational task delay. However, prior research using task delay measures found that they correlate more strongly with irrational procrastination than rational delay (Wessel et al., 2019). Considering that during rational delay, not engaging in a task is what one ultimately intends to do (i.e., there is no intention-action gap), this finding is plausible. Moreover, a strength of focusing on task delay is that it represents a more "neutral" explanandum that does not conflate delay with perceived negative consequences, as is common in procrastination scales (e.g., Sirois et al., 2019). Hence, future research may benefit from following our approach and test whether media-induced task delay is truly associated with lower well-being and worse performance, or whether there are cases when using (social) media as "procrastinatory tools" that delay other tasks can also yield positive outcomes (e.g., increased creativity; Shin & Grant, 2021).

A second limitation concerns our measure of social media automaticity. While our single item was taken from an established habit measure (the SRBAI) and showed high factor loadings in prior studies (see Methods section), it still cannot capture automaticity as comprehensively as a multi-item scale and may be prone to some recall bias. Thus, construct and predictive validity may be increased in future studies by employing long-form automaticity scales or behavioral habit measures (e.g., Naab & Schnauber, 2016).

As a related third limitation, our phone checking measure may be particularly prone to over- or under-estimation, a bias commonly observed for self-reports of ephemeral media use

(Parry et al., 2021). Moreover, the between-person associations of phone checking frequency may be affected by inter-individual differences that our study did not account for, such as impulsivity, notification settings, or the size of one's social network. Similarly, within-person associations may have been affected by unobserved time-varying confounds (e.g., the types of tasks adolescents were currently engaged in).

Finally, we need to consider that this study was conducted just after the first COVID-19-related school closures in The Netherlands had ended. To explore whether the pandemic conditions might have resulted in a disruption of adolescents' social media habits, we compared the average time spent on social media in the first ESM wave among the same sample (November 2019: $M = 16.8$ min, $SD = 14.8$) of the larger project (see Methods section) with that in the second ESM wave (June 2020: $M = 14.6$ min, $SD = 12.0$). As we observe a slight reduction in social media use among the surveyed adolescents (paired t -test: $t = 2.8351$, $df = 303$, $p = 0.0049$), the findings might be affected by a potential disruption of their social media habits.

Implications and future research

Despite these limitations, our study advances research into social media habits and task delay and has several implications for theory building in this area. Specifically, we expand how the media habit concept has been studied so far by focusing on both automaticity and the central behavior of phone checking, and by taking a situational view. Our study contributes important evidence to the sociocognitive model of connectedness (Bayer et al., 2016a) but also points to the need for theoretical extension. The findings show (a) that there is considerable situational variance in habit automaticity and the focal "connective" behavior of phone checking, which indirectly supports the theorized fleeting nature of connection cues and their role for mobile and social media habit execution.

However, (b) our results also suggest that the outcomes of connection habits (e.g., task delay) depend on additional person-specific boundary conditions which are currently not incorporated in the model. The sociocognitive model theorizes situational (i.e., cues) and sociological (i.e., normative) influences on connection habits (cf. Bayer et al., 2016a), but it mostly ignores that connection habits may operate differently among users. Our findings suggest there is considerable room to infuse both the media habit concept (LaRose, 2010) and the sociocognitive model (Bayer et al., 2016a) with a differential susceptibility perspective (Valkenburg & Peter, 2013) that acknowledges the conditional and person-specific nature of habit *performance*, not just habit *formation*. Considering the observed effect heterogeneity, applying a differential susceptibility lens (Valkenburg & Peter, 2013) to social media use and its potentially problematic self-regulatory outcomes is prudent.

Identifying the dispositional, developmental, and social factors that explain for which adolescents social media habits contribute to problematic outcomes such as irrational delay will be a crucial task for future research. While prior research has mainly investigated trait self-control as an explanation for differential susceptibility to procrastinatory phone use (e.g., Meier, 2022; Schnauber-Stockmann et al., 2018; Troll et al., 2020), we found no evidence for a moderating role of trait self-control (see Results section and Supplement III: <https://osf.io/jz3xq>). Thus, other moderators may be relevant. For

instance, future research may instead want to consider person-level habit strength and the specific usage patterns and cognitions that are, or are not, part of the habit. In their recent review, Bayer et al. (2022) propose that social media habits could play out on several levels (e.g., device, platform, interface, and motor habits). Studies may gain deeper insight into the differential causes behind problematic habits by zooming in on these different levels and understanding how their sociotechnical affordances interact with users' predispositions (Ellison et al., 2022). Following this route may help improve social media experiences for those adolescents who are currently struggling with successfully self-regulating their usage. Ideally, future studies recognize that self-regulation is most effective when routinely following goal-directed behaviors and cultivating good habits (Inzlicht & Friese, 2021). Rather than demonizing habitual technology use, future research and sociotechnical interventions will benefit from leveraging the insights from this and related studies to help adolescents build healthy smartphone and social media habits and break problematic ones.

Supplementary material

Supplementary material is available at *Journal of Computer-mediated Communication* online.

Data availability

The anonymized dataset used for this study is available on Figshare: <https://doi.org/10.21942/uva.22153844.v1>.

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Open science framework badges

Open Materials

The components of the research methodology needed to reproduce the reported procedure and analysis are publicly available for this article.

Open Data

Digitally shareable data necessary to reproduce the reported results are publicly available for this article.

Preregistered

Research design was preregistered.

Notes

1. For a full synopsis of prior research ($k = 26$ publications), see Supplement I on the Open Science Framework (OSF): <https://osf.io/y4q5x>.

2. As deviation from our preregistration, we adapted the language in H3–H4 and RQ1 to refer more accurately to our main dependent variable as task delay rather than procrastination.
3. None of our three measures was significantly associated with compliance (task delay: $r = 0.092$, $p = .106$; phone checking frequency: $r = -0.076$, $p = .181$; social media automaticity: $r = -0.046$, $p = .415$).

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