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Situational boundary conditions of digital stress: Goal conflict and autonomy frustration make smartphone use more stressful

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Abstract
Mobile connectivity can negatively affect smartphone users by eliciting stress. Past research focused on stress-inducing potentials of smartphone use behaviors and, recently, on the cognitive-motivational engagement with online interactions. However, theoretical perspectives as the mobile connectivity paradox and the IM³UNE model further suggest that digital stress effects may be conditional. A preregistered experience sampling study ($n = 123$; 1,427 use episodes) investigated relationships of cognitive-motivational (online vigilance) and behavioral (communication load, media multitasking) smartphone use patterns with perceived stress and introduced two situational boundary conditions (goal conflict, autonomy need dissatisfaction). Results demonstrate that online vigilance can induce stress directly and via increasing communication load. Goal conflict and autonomy need dissatisfaction moderated the influence of online vigilance and media multitasking on stress. Findings are discussed in the context of effect directionality and the need to further investigate boundary conditions in digital well-being research.

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Mobile digital devices such as smartphones facilitate permanent connectedness by removing temporal and spatial constraints from mediated communication and media consumption (Vorderer & Kohring, 2013). Their deep integration into daily routines and social life can have a variety of positive outcomes, yet may also have detrimental effects on psychological well-being (Meier & Reinecke, 2021; Schneider et al., 2022).

One prominent example for negative effects of mobile connectivity is stress experiences elicited by smartphone use, often referred to as digital stress (Hall et al., 2021; Hefner & Vorderer, 2016). Digital stress has been previously defined as an individual's reaction to situational demands originating from the use of information and communication technology that are subjectively perceived as challenging or exceeding available coping resources, such as cognitive capacity (Lazarus & Folkman, 1984; Reinecke et al., 2017).

Past research has shown that smartphone use can indeed elicit stress (Vahedi & Saiphoo, 2018). For example, earlier research found that specific smartphone use *behaviors*, such as communication load (i.e., the number of sent and received messages) and media multitasking (i.e., the simultaneous engagement in two or more media activities) were linked to stress experiences (LaRose et al., 2014; Mai et al., 2015; Reinecke et al., 2017). More recently, research has begun to also consider the *cognitive and motivational drivers* of digital stress. For example, previous research found links between online vigilance and stress (Freytag et al., 2021; Hall et al., 2021). Online vigilance is an increased cognitive and motivational engagement with online interactions (Klimmt et al., 2018; Reinecke et al., 2018). It has been linked directly and indirectly to digital stress, the latter via fostering smartphone use patterns, such as communication load and media multitasking, that can, in turn, drive stress (Freytag et al., 2021; Hall et al., 2021; Hefner & Vorderer, 2016; Reinecke et al., 2018).

While previous research indeed suggests that online vigilance is directly and indirectly linked to digital stress, past studies face two central limitations. First, past findings are inconsistent: while communication load and media multitasking were identified as significant predictors of stress in some investigations (Hall et al., 2021; Mark et al., 2014; Reinecke et al., 2017), other studies did not fully replicate those relationships (Freytag et al., 2021). This lack of consistency may be at least partly due to a *theoretical* limitation of previous research: the failure to consider the situational boundary conditions in the relationships of online vigilance, smartphone use, and stress. Two recent theoretical models addressing the relationship between mobile digital communication and well-being, the *mobile connectivity paradox* (Vanden Abeele, 2021) as well as the *Integrative Model of Mobile Media Use and Need Experiences* (IM³UNE; Schneider et al., 2022), emphasize the conditional nature of this relationship: depending on situational appraisals, mobile media demands such as incoming connection cues can be either perceived as rewarding and conducive to basic needs or as need-frustrating, resource-taxing, and stressful. It is therefore essential to identify the situational moderators that intensify or ameliorate the effects of smartphone use on stress (Schneider et al., 2022). The current study thus aims at two central theoretical pursuits: by integrating the digital stress literature with the theoretical propositions of the mobile connectivity paradox (Vanden Abeele, 2021) and the IM³UNE model (Schneider et al., 2022), we introduce goal conflict and autonomy need dissatisfaction as two central situational boundary conditions for the emergence of digital stress. Our study will hence (a) contribute to theory synthesis and (b) help to elucidate the contingency of digital stress.

A second shortcoming of existing research is that, *empirically*, previous research is limited by its focus on the *between-person* relationships of cognitive-motivational and behavioral predictors of digital stress. An investigation of the *within-person* associations between online vigilance, smartphone use, and stress over an extended period of time with real-world, situational data is largely missing. It is thus unclear whether online vigilance does indeed lead to demanding smartphone behaviors in specific situations, and whether this in turn increases stress. Moreover, such a situational approach is crucial to understanding situational boundary conditions as they occur in daily life (Vanden Abeele, 2021). We therefore aim to extend previous studies addressing the between-person predictors of digital stress with an in-situ research design to further investigate situational, within-person dynamics of digital stress.

In the following sections, we will delineate our theoretical model by reviewing previous empirical findings on stress related to smartphone use. We will extend this view by discussing the situational contingencies of digital stress based on central tenets of the mobile connectivity paradox and the IM³UNE model (Schneider et al., 2022; Vanden Abeele, 2021).

Stress appraisal in the context of smartphone use

Online vigilance as a predictor of digital stress

The integration of smartphones into daily routines may lead users to internalize a constant cognitive and motivational orientation towards online interactions (Bayer et al., 2016; Carolus et al., 2019). This mindset termed *online vigilance* is characterized by: (a) the cognitive *salience* of online connectedness, integrating online-related stimuli into users' thinking and feeling even when not using the smartphone; (b) *reactibility*—that is, a chronic attentional sensitivity to online-related cues combined with the motivation and readiness to act upon them; and (c) the motivation for frequently *monitoring* updates and ongoing events in the online sphere, often manifesting behaviorally as unprompted smartphone checking (Klimmt et al., 2018; Oulasvirta et al., 2012; Reinecke et al., 2018).

The constant cognitive preoccupation and alertness characterizing online vigilance require cognitive resources and reduce the availability of coping resources, which may result in subjective stress experience (Warm et al., 2008). Indeed, online vigilance has repeatedly been associated with stress in previous research (Carolus et al., 2019;

Freytag et al., 2021; Hall et al., 2021). Past findings indicate that especially the salience dimension of online vigilance positively predicts stress and negatively predicts affective well-being (Freytag et al., 2021; Johannes et al., 2020; Johannes et al., 2018). While reactibility and monitoring seem to reflect temporal increases in cognitive demands that can induce stress, salience may more constantly occupy cognitive resources and, thus, more strongly predict stress (Freytag et al., 2021). Based on past findings linking online vigilance to stress, yet suggesting the benefits of distinguishing between its dimensions, we propose that:

H1: Online vigilance in the form of (a) salience, (b) reactibility, and (c) monitoring is positively related to perceived stress.

The mediating role of communication load and media multitasking

While online vigilance might directly predict stress, it may also drive specific smartphone use behaviors which are stress-inducing. Smartphones are most commonly used for online communication in the form of text messaging and social networking (Mihailidis, 2014). The amount of online communication in the form of overall amounts of online messages sent and received that users engage with is termed *communication load* (Reinecke et al., 2017). Online vigilance can be expected to increase communication load by fostering the salience of online communication in the smartphone user's mind and, thus, motivating the initiation of new online conversations. Fast reactibility to online stimuli and the monitoring of online interactions, moreover, add to communication load (Freytag et al., 2021; Klimmt et al., 2018).

The engagement with larger amounts of online communication as a result of high online vigilance might, in turn, increase stress. Communication load requires smartphone users to invest time and cognitive resources to process online communication. When the situational demands associated with communication load exceed available coping resources—for example, because users do not have sufficient time to read and reply to online messages next to other tasks—users might experience stress (Lazarus & Folkman, 1984). A significant relationship between communication load and perceived stress was reported in the majority of previous research (Hall, 2017; LaRose et al., 2014; Reinecke et al., 2017; Thomée et al., 2011), while a series of three studies with different survey designs did not find a significant link (Freytag et al., 2021). Evidence for the stress-predicting role of communication load is, however, further provided by intervention studies which demonstrate the stress-reducing potential of decreasing communication load by batching smartphone notifications. These findings support the idea that communication load relates to stress through straining cognitive coping resources, such as attention (Fitz et al., 2019; Kushlev & Dunn, 2015). We thus propose that:

H2: Communication load is positively related to perceived stress.

H3: Online vigilance in the form of (a) salience, (b) reactibility, and (c) monitoring indirectly increases perceived stress via communication load.

Online vigilance may foster smartphone use behavior not only by increasing overall amounts of online communication, but also by altering *how* users engage in smartphone behaviors. Smartphone users are likely to cope with the high salience of and approach motivation towards mobile connectivity by engaging with online communication and content more often, irrespective of secondary activities (Hefner & Vorderer, 2016; Klimmt et al., 2018). When simultaneously engaging in two or more media activities, this behavior is referred to as *media multitasking* (Ophir et al., 2009). Multitasking can be caused by both external or self-imposed interruptions from a main activity (Mark et al., 2014). Particularly users high in reactibility are sensitive towards external interruptions in form of incoming smartphone notifications. Self-interruptions might be fostered through the salience (e.g., task-irrelevant thoughts) and monitoring of online interactions (e.g., checking one's smartphone for updates). Therefore, online vigilance is likely to increase multitasking behavior.

Multitasking, in turn, can be expected to foster stress by straining cognitive capacities and coping resources. Multitasking requires the switching between multiple tasks, challenging working memory capacities and negatively affecting cognitive performance (Baumgartner et al., 2014; Ophir et al., 2009). Regarding computer use, logging and physiological data demonstrate that multitasking is associated with decreases in heart rate variability and increases in arousal, suggesting that multitasking is related to increased physiological stress (Mark et al., 2014; Wetherell & Carter, 2014; Yeykelis et al., 2014). Self-report data, too, suggest media multitasking to be positively related to stress (Freytag et al., 2021; Reinecke et al., 2017). We therefore expect for multitasking with smartphones:

H4: Media multitasking is positively related to perceived stress.

H5: Online vigilance in the form of (a) salience, (b) reactibility, and (c) monitoring indirectly increases perceived stress via media multitasking.

The moderating role of goal conflict and autonomy need dissatisfaction

Recent theoretical developments suggest that the assumption of unconditional effects of online vigilance and smartphone use on stress provide an incomplete picture of the ambivalent relationship between mobile digital communication and well-being (Schneider et al., 2022; Vanden Abeele, 2021). Rather than expecting mobile media demands and usage patterns to be inherently good versus bad, Schneider et al. (2022) suggest that the effects of mobile digital communication on well-being are contingent on situational appraisals. The same mobile media demands (e.g., the urge to monitor social media activities or the number of incoming messages) that are perceived as positive and beneficial in one situation may be perceived as threatening and detrimental in another situation and by the same user, "strongly depend[ing] on appraisal processes and personal coping resources" (Schneider et al., 2022, p. 4). We propose that such contingencies in the relationship between mobile digital communication and well-being extend to the context of digital stress. Bayer et al. (2016) highlight that stress reactions only occur when mobile media demands are perceived to exceed one's coping resources. Situational contexts are therefore relevant to consider in their influence on the occurrence of stress.

To identify situational factors that may moderate the relationship of smartphone use with stress, we turn to the theoretical propositions of the mobile connectivity paradox (Vanden Abeele, 2021) and the IM³UNE model (Schneider et al., 2022), both of which make predictions concerning central boundary conditions of potential effects of mobile digital communication on well-being. First, the IM³UNE model identifies self-control, the ability to override or interrupt actions that conflict with current goals, as an influential moderator. In the situational context, self-control is triggered by the appraisal of *goal conflict* (Hofmann & Kotabe, 2012).

Conflicts between smartphone use and other goals arise because media use represents a frequent desire in everyday life that is hard to resist (Hofmann et al., 2012). Individuals tend to turn to media for gratifications such as intrinsic need satisfaction (Oh et al., 2014), as a distraction, or to procrastinate less enjoyable tasks (Aalbers et al., 2021). In fact, giving in to media use despite other, conflicting goals—most often related to productivity and professional achievement—is a frequent form of self-control failure (Du et al., 2019; Reinecke & Hofmann, 2016). Accordingly, the IM³UNE model (Schneider et al., 2022) identifies trait self-control as a central moderator of the relationship between mobile digital communication and well-being. Self-control is activated on the situation level by the perception of goal conflict (Hofmann & Kotabe, 2012), which makes goal conflict an important situational boundary condition for digital stress. While online vigilance, communication load, and media multitasking may not necessarily lead to stress at all times, smartphone use episodes that elicit goal conflict can be particularly likely to induce stress. Goal conflicts interfere with expectations about one's own coping resources and self-control capacities, resulting in threat appraisal that is perceived as stressful (Lazarus & Folkman, 1984). Indeed, past research has found that online vigilance was perceived as particularly bothersome in situations when the cognitive preoccupation with online interactions conflicted with current goals (Mihailidis, 2014).

When it comes to communication load and media multitasking, similar interactions with goal conflict may occur. This is, for example, the case if a smartphone user receives a lot of online messages from a friend while at work. Availability norms and expectations to reply fast may impose a goal conflict between socially desired behavior and professional achievement (Halfmann & Rieger, 2019). Similarly, if media multitasking is, for instance, initiated by smartphone notifications that interrupt other tasks, it may evoke goal conflict (Mehrotra et al., 2016). An example could be a situation in which the primary task of searching for information online is interrupted by incoming notifications from a social media app. For this type of situation, when engagement in smartphone use concomitates with goal conflict, the IM³UNE model implies online vigilance, communication load, and media multitasking to induce stress, whereas the same smartphone use patterns may be appraised as less threatening and elicit weaker stress experiences in other situations where they do not co-occur with goal conflict (Schneider et al., 2022). Therefore, it is hypothesized that:

> **H6:** Goal conflict moderates the relationship between (a) online vigilance, (b) communication load, (c) media multitasking and perceived stress, such that higher goal conflict increases the effects on stress compared to lower goal conflict.

A second situational boundary condition of digital stress addressed in the stress literature as well as in the mobile connectivity paradox and the IM³UNE model is the *dissatisfaction of the need for autonomy* (Schneider et al., 2022; Vanden Abeele, 2021), which represents one of the three innate, basic needs underlying human motivation, functioning, and well-being (Ryan & Deci, 2000). Individuals are satisfied in their need for autonomy when they can freely engage in an activity that is in line with their values and current needs. The dissatisfaction of the need for autonomy, in contrast, occurs when individuals perceive their behavior to be externally regulated and controlled—for instance, through external or internalized pressures (Ryan & Deci, 2000).

The relationship between mobile digital communication and autonomy need (dis)satisfaction follows a paradoxical pattern, suggesting that "while ubiquitous connectivity can support autonomy, it can also challenge that very experience" (Vanden Abeele, 2021, p. 934). Accordingly, mobile digital communication has undeniable benefits for users' autonomy—for example, by connecting users to important others or providing instantaneous access to various gratifications (Schneider et al., 2022; Vanden Abeele, 2021). Conversely and importantly in the context of digital stress, smartphone use has the potential to frustrate the need for autonomy—for instance, when social pressures to be permanently available become salient (Halfmann & Rieger, 2019; Meier, 2018). Availability pressures represent an external behavior regulation that limits the individual's flexibility and autonomy in terms of when and how to react to messages (Bayer et al., 2016; Mai et al., 2015). Alternative terms including "entrapment" (Hall, 2017; Hall & Baym, 2012) and "tethering" (Mihailidis, 2014) illustrate that smartphone use can be perceived as frustrating one's autonomy. Due to this paradoxical relationship between mobile digital communication and autonomy, creating an "equilibrium between the individual benefits and drawbacks" (Vanden Abeele, 2021, p. 938) represents a central challenge for users. Similarly, the IM³UNE model identifies the satisfaction versus dissatisfaction of the need for autonomy as a relevant mechanism underlying mobile media effects on well-being (Schneider et al., 2022).

We thus suggest that similar to goal conflict, autonomy need dissatisfaction should moderate the effect of smartphone use on stress, by altering the underlying appraisal process. Perceived situational controllability and autonomy represent central coping resources that can ameliorate the stress response (Lazarus & Folkman, 1984). In situations of smartphone use in which individuals feel frustrated in their need for autonomy, on the other hand, stress reactions may increase (Lazarus & Folkman, 1984). Indeed, qualitative findings suggest that reduced autonomy moderates stress appraisals in reaction to online communication (Reinke et al., 2016). Longitudinal quantitative evidence further demonstrates a link between autonomy need dissatisfaction in online communication as well as in multitasking with perceived stress and negative affect (Bachmann et al., 2019; Meier, 2018). Thus, online vigilance, communication load, and media multitasking might be perceived as particularly stressful in situations in which they co-occur with autonomy need dissatisfaction:

H7: Autonomy need dissatisfaction moderates the relationship between (a) online vigilance, (b) communication load, (c) media multitasking and perceived stress, such that higher autonomy dissatisfaction increases the effects on stress compared to lower autonomy dissatisfaction.

The conceptual model is visualized in Figure 1. In accordance with the theoretical and empirical goals of the present study, all hypotheses are aiming at and were tested with regard to situational, *within-person* effects. However, as our statistical analyses also provide estimates of the *between-person* effects, those were exploratively inspected as well.

Method

The hypotheses were tested based on data from a 7-day experience sampling (ESM) study that was preregistered in the Open Science Framework (OSF)at https://osf.io/y2wsg. The study was approved by the Ethics Review Board of the University of Amsterdam.

Participants and procedure

Following guidelines for ESM designs recommending sample sizes of at least $n = 100$ with $t = 30$ (Silvia et al., 2014), 130 participants were recruited between April and May 2020 through the behavioral science lab facilities of the University of Amsterdam and through personal networks.[1] Participants had to be at least 16 years old and smartphone users. Individuals could choose to be compensated with research credits, €10 in cash, or no reward. Participation entailed completion of three study parts:

1. On day 1, participants completed an intake survey which assessed trait variables.
2. On the five following days, signal-contingent experience sampling was conducted using the app ExpiWell.
3. On day 7, an exit survey assessed control variables.

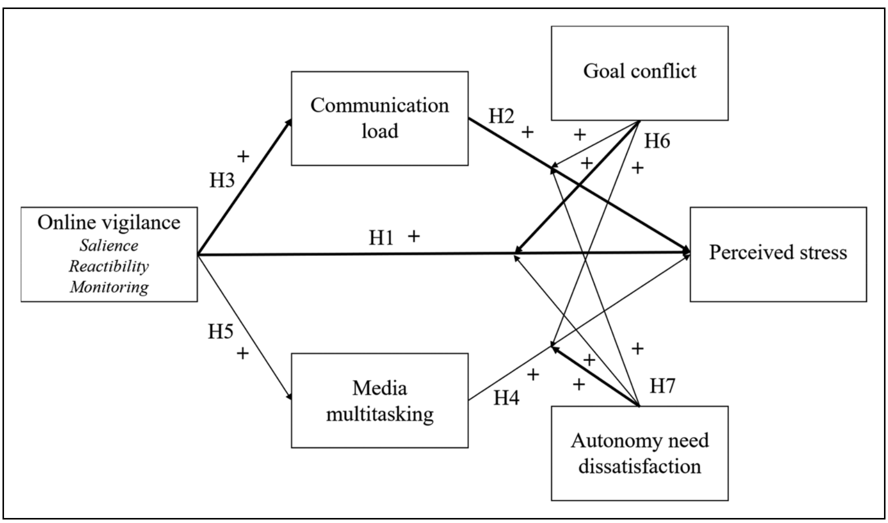

Figure 1. Conceptual model. *Note:* Bold lines represent (partially) confirmed hypotheses.

In the ESM phase, participants received six ESM surveys a day between 09:00 and 21:00 that were sent out semi-randomly across three parts of the day (i.e., two surveys per morning, midday, and evening, respectively). Each survey expired after 60 min. If participants had not completed a survey 30 min after the initial notification, they received a reminder. The surveys assessed situational variables with 12 questions and took a median of 56.88 s to complete. If participants reported that they did not use their smartphone during the last 60 min, the surveys assessed only perceived stress and the salience dimension of online vigilance. On average, participants responded to 59% of surveys ($M = 17.72$, $SD = 7.97$), resulting in a total of 2,179 data points. Smartphone use episodes were reported in 65% of those cases—that is, for 1,427 data points. A software bug in the ExpiWell app influenced the response rate by allowing some participants to answer only one out of the two ESM surveys scheduled for a part of the day and led to a—most likely unsystematic—loss of data points (for more information on the missing data, see the OSF).

The 130 participants who completed the intake survey were predominantly young ($M = 23.27$, $SD = 5.77$), female (78%), and university students (76%). A total of 128 participants proceeded with the ESM surveys. As preregistered, we excluded three cases of full ESM surveys that were completed in under 20 s and two cases of ESM surveys that demonstrated a variance of zero on all continuous measures. One ESM outlier survey was excluded that contained impossibly high values for smartphone use duration and communication load. Four participants had to be excluded as their data at intake could not be linked to the ESM data. The final sample size for the multilevel analysis was $n = 123$. The exit survey was completed by 106 participants.

Measures

All constructs included in the hypotheses were measured at state level in the ESM surveys, referring to the last 60 min, respectively.[2] A full description of all measures is available in the OSF at https://osf.io/hm2q7/.

Online vigilance. Three items on a scale from 1 (*does not apply at all*) to 7 (*fully applies*) were adapted from Reinecke et al. (2018) to assess the three dimensions of online vigilance (e.g., "During the last 60 minutes, I was often thinking about what was happening online, even when I was not using my smartphone"; salience: $M = 2.30$, $SD = 1.36$; reactibility: $M = 3.58$, $SD = 2.14$; monitoring: $M = 2.73$, $SD = 1.59$).

Communication load. Participants estimated how many online messages they had sent and received during the last 60 min, respectively (adapted from Reinecke et al., 2017; $r = .70$, $p = .000$; collapsed index: $M = 10.21$, $SD = 22.26$). As the index captured absolute numbers of sent and received messages, it demonstrated a much higher variance and skew than the other measures. It was thus transformed by its square root before further analysis.

Media multitasking. A single item based on Baumgartner et al. (2017) was used to measure media multitasking on a scale from 1 (*none of the time*) to 5 (*all of the time*):

"While using your smartphone during the last 60 minutes, how much of the time did you simultaneously engage in another media activity on a digital media device other than your smartphone (e.g., listening to music, watching video content, sending messages, using social network sites on your computer or tablet)?" ($M = 2.22$, $SD = 1.41$).

Goal conflict. A single item measuring goal conflict on a scale from 1 (*does not apply at all*) to 7 (*fully applies*) was adapted from Halfmann et al. (2021): "During the last 60 minutes, I have experienced a conflict between my use of the smartphone and another activity (e.g., working, studying, social interaction, working out)" ($M = 2.49$, $SD = 1.80$).

Autonomy need dissatisfaction. A single item based on Meier (2018) as well as on Sheldon and Hilpert (2012) was used to assess autonomy need dissatisfaction on a scale from 1 (*does not apply at all*) to 7 (*fully applies*): "While using my smartphone during the last 60 minutes, I felt pressured to use my smartphone, e.g., to be available, to check updates, or to keep scrolling" ($M = 2.42$, $SD = 1.57$).

Perceived stress. A single item was used to measure stress on a scale from 1 (*not at all*) to 7 (*completely*): "During the last 60 minutes, how stressed did you feel?" ($M = 2.55$, $SD = 1.52$).

Additional control measures included *age*, *gender*, and the *average daily smartphone screen time* of the last week.

Data analysis

The data, analysis script, and descriptive analyses including means, standard deviations, and zero-order correlations of all variables can be found in the OSF at https://osf.io/hm2q7/. To account for the data structure of observations (level 1) nested within persons (level 2), we conducted multilevel modelling in *R* (version 4.0.4) using the *lme4* package (version 1.1-27.1). We centered all continuous predictors for easier interpretability of intercepts and to create unbiased estimates of the respective influence of level 1 and level 2 variance on the dependent variables in within-between models (Bell et al., 2019). Level 2 predictors were grand-mean centered around their sample means. Level 1 predictors were group-mean centered around their respective person means. The person means were then reintroduced to the multilevel regressions as grand-mean-centered level 2 variables to accurately estimate indirect effects and to compare within-person and between-person effects (Hox, 2010).

P-values for multilevel models were obtained through bootstrapped likelihood ratio tests. Following Snijders and Bosker (2012), we calculated Pseudo R^2 values separately for level 1 and level 2. The *mediation* package (version 4.5.0) and Quasi-Bayesian confidence intervals from 2,000 Monte Carlo simulations were used to test indirect effects (1-1-1 mediation) and to determine *p*-values of indirect effects (Zhang et al., 2009). We included the control variables age, gender, and average daily smartphone screen time in all analyses. The categorical variable gender was effect coded with "male" as the reference category.

For the preregistered confirmatory analysis, we inspected those observations that reported smartphone use during the last hour ($n = 1{,}427$ of $n = 123$ participants). The intraclass correlation indicates that 30% of the variance in situational stress can be explained through interindividual differences, indicating that more variance may be explainable on the situational level and that multilevel modelling is appropriate. All models were specified to include a random intercept and fixed slopes.

Results

In a first model we tested if within-person differences in the three dimensions of online vigilance as well as communication load and media multitasking are direct predictors of perceived stress (H1, H2, H4). Detailed results are presented in Table 1. Confirming H1a, within-person differences in salience predicted stress ($b = 0.14$, $p = .001$). Interestingly, the differences in salience between persons also had a considerable effect on stress ($b = 0.60$, $p = .001$). On the other hand, neither within-person differences in reactibility nor monitoring were significantly related to stress, which leads us to reject H1b and H1c. While within-person variations of communication load positively predicted stress ($b = 0.05$, $p = .021$), confirming H2, no significant relationship was found for media multitasking and stress on the within-person level, rejecting H4. The predictive power of the model was low at the situational level with 4% of explained variance in situational stress. At the person level, the model explained 35% of variance in situational stress.

Multiple 1-1-1 mediation models were specified to test if the within-person relationships between the online vigilance dimensions and stress are mediated by communication load (H3) and media multitasking (H5) (see Table 2). Within-person variation in communication load mediated the relationship between salience and stress (average causal mediation effect [ACME] = .01, $p = .018$), while the average direct effect (ADE = .14, $p < .001$) and total effect (TE = .15, $p < .001$) remained significant. The relationship between reactibility and stress was mediated by within-person differences in communication load (ACME = .00, $p = .034$), with insignificant direct and total effects. The mediation effect, however, is notably small. Finally, within-person differences in communication load mediated the relationship between monitoring and stress (ACME = .01, $p = .023$). While the direct effect rendered insignificant, the total effect was significant (TE = .06, $p = .029$). In sum, H3 is confirmed. No indirect effects were found for within-person variation of the mediator media multitasking, rejecting H5 (also see Figure 1).

Next, an interaction model tested if the relationships proposed in H1, H2, and H4 are moderated by goal conflict (H6) and autonomy need dissatisfaction (H7) (see Model 2 in Table 1). The analysis revealed no within-person interaction, but a between-person interaction between goal conflict and salience ($b = 0.40$, $p = .016$). Between goal conflict and reactibility a within-person interaction emerged in predicting stress ($b = 0.06$, $p = .001$), but no within-person interaction effect was identified between goal conflict and monitoring. Therefore, H6a is partially confirmed. No within-person interactions were found between goal conflict and communication load nor media multitasking, rejecting H6b and H6c. Confirming H7c, results demonstrated a significant moderating effect of within-person differences in autonomy need dissatisfaction on the relationship between media

Table 1. Multilevel regressions predicting perceived stress.

	Model 0					Model 1					Model 2				
	b	*SE*	β	*p*	95% CI	b	*SE*	β	*p*	95% CI	b	*SE*	β	*p*	95% CI
Fixed effects															
Intercept	2.57	0.08	–	**<.001**	**[2.50, 2.65]**	2.44	0.18	–	**<.001**	**[1.64, 3.00]**	2.53	0.16	**–**	**<.001**	**[1.93, 3.11]**
Salience															
Between						0.60	0.15	0.30	**.001**	**[0.32, 0.90]**	0.21	0.16	0.11	.228	[−0.08, 0.54]
Within						0.14	0.03	0.10	**.001**	**[0.07, 0.20]**	0.08	0.04	0.06	**.042**	**[0.01, 0.15]**
Reactibility															
Between						0.05	0.06	0.04	.499	[−0.08, 0.18]	−0.05	0.06	−0.04	.487	[−0.18, 0.07]
Within						0.03	0.02	0.04	.124	[−0.01, 0.07]	0.02	0.02	0.03	.269	[−0.02, 0.06]
Monitoring															
Between						−0.03	0.12	−0.02	.784	[−0.27, 0.19]	−0.07	0.11	−0.04	.537	[−0.29, 0.15]
Within						0.05	0.03	0.04	.094	[−0.01, 0.11]	−0.03	0.03	−0.03	.353	[−0.09, 0.03]
Communication load															
Between						−0.00	0.06	−0.00	.969	[−0.12, 0.11]	−0.09	0.06	−0.08	.156	[−0.22, 0.02]
Within						0.05	0.03	0.05	**.021**	**[0.01, 0.10]**	0.02	0.03	0.02	.314	[−0.02, 0.07]
Media multitasking															
Between						0.06	0.11	0.03	.571	[−0.15, 0.26]	−0.09	0.10	−0.04	.424	[−0.28, 0.11]
Within						0.03	0.03	0.02	.294	[−0.03, 0.08]	−0.02	0.03	−0.01	.588	[−0.07, 0.04]
Autonomy need dissatisfaction															
Between											0.44	0.13	0.27	**.004**	**[0.17, 0.70]**
Within											0.08	0.03	0.07	**.008**	**[0.03, 0.14]**
Goal conflict															
Between											0.16	0.10	0.11	.135	[−0.05, 0.36]
Within											0.19	0.03	0.18	**.001**	**[0.14, 0.24]**
Salience × AUD															
Between											−0.20	0.15	−0.12	.227	[−0.51, 0.09]
Within											0.01	0.03	0.01	.793	[−0.04, 0.06]
Reactibility × AUD															
Between											0.05	0.08	0.04	.619	[−0.11, 0.21]
Within											0.02	0.02	0.03	.214	[−0.01, 0.05]

(Continued)

Table 1. (Continued)

	Model 0					Model 1					Model 2				
	b	*SE*	β	*p*	95% CI	b	*SE*	β	*p*	95% CI	b	*SE*	β	*p*	95% CI
Monitoring × AUD															
Between											−0.08	0.11	−0.05	.478	[−0.30, 0.13]
Within											−0.01	0.02	−0.02	.500	[−0.06, 0.03]
Communication load × AUD															
Between											0.13	0.07	0.13	.122	[−0.01, 0.26]
Within											0.00	0.02	0.01	.820	[−0.03, 0.04]
Media multitasking × AUD															
Between											0.16	0.15	0.08	.324	[−0.13, 0.46]
Within											0.05	0.02	0.05	**.039**	**[0.01, 0.09]**
Salience × GC															
Between											0.40	0.14	0.22	**.016**	**[0.12, 0.68]**
Within											0.03	0.02	0.04	.186	[−0.01, 0.07]
Reactibility × GC															
Between											0.01	0.06	0.01	.937	[−0.11, 0.13]
Within											0.06	0.01	0.10	**.001**	**[0.03, 0.08]**
Monitoring × GC															
Between											−0.18	0.09	−0.12	.074	[−0.36, −0.01]
Within											−0.03	0.02	−0.05	.080	[−0.07, 0.00]
Communication load × GC															
Between											−0.09	0.09	−0.07	.368	[−0.26, 0.08]
Within											−0.01	0.02	−0.02	.460	[−0.05, 0.02]
Media multitasking × GC															
Between											0.02	0.13	0.00	.915	[−0.26, 0.27]
Within											−0.04	0.02	−0.05	.063	[−0.07, 0.00]
Control variables															
Age (gmc)						−0.01	0.01	−0.04	.403	[−0.04, 0.02]	−0.00	0.01	0.00	.948	[−0.02, 0.03]
Gender (female)						0.08	0.20	0.03	.678[a]	[−0.27, 0.48]	−0.08	0.17	−0.01	.641[a]	[−0.35, 0.27]

(Continued)

Table 1. (Continued)

	Model 0					Model 1					Model 2				
	b	*SE*	β	*p*	95% CI	b	*SE*	β	*p*	95% CI	b	*SE*	β	*p*	95% CI
Gender (other)						0.36	0.79		.651[a]		0.30	0.65		.647[a]	
SST (gmc)						0.00	0.06	0.00	.946	[−0.11, 0.12]	0.07	0.05	0.06	.196	[−0.02, 0.17]
Random Effects															
σ2			1.62		1.54					1.42					
τ00			0.69		0.45					0.26					
Goodness-of-fit															
AIC			4943.918		4872.309					4761.225					
Deviance			4937.918		4838.309					4679.225					
log-likelihood			−2468.959		−2419.155					−2339.613					
ICC			0.30		0.22					0.16					
Df						14					38				
p						<.001					<.001				
Pseudo R^2 (L2)						.35					.62				
Pseudo R^2 (L1)						.04					.12				

Notes. $n = 123$ participants, $n = 1,427$ observations. AUD = autonomy need dissatisfaction; GC = goal conflict; SST = smartphone screen time; CI = confidence interval; AIC = Akaike information criterion; ICC = intraclass correlation coefficient. Fixed linear coefficients were estimated by maximum likelihood. Level 2 predictors are grand-mean centered (gmc), level 1 predictors are group-mean centered (cwc), with group mean reintroduced at level 2 (cmc). [a]Marked *p*-values are not bootstrapped. Explained variances (Pseudo R^2) were estimated according to Snijders and Bosker (2012).

Table 2. Multilevel mediation analysis predicting perceived stress.

	ACME			ADE			TE		
		p	95% CI		*p*	95% CI		*p*	95% CI
Med.: Communication load									
Salience	.01	**.018**	[0.00, 0.02]	.14	**<.001**	**[0.07, 0.21]**	.15	**<.001**	**[0.09, 0.22]**
Reactibility	.00	**.034**	[0.00, 0.01]	.03	.106	[−0.00, 0.08]	.04	.079	[−0.00, 0.08]
Monitoring	.01	**.023**	[0.00, 0.02]	.05	.060	[−0.00, 0.11]	.06	**.029**	**[0.01, 0.12]**
Med.: Media multitasking									
Salience	.01	.190	[−0.00, 0.01]	.15	**<.001**	**[0.07, 0.21]**	.15	**<.001**	**[0.08, 0.22]**
Reactibility	.00	.190	[−0.00, 0.01]	.03	.089	[−0.00,0.07]	.04	.063	[−0.00, 0.08]
Monitoring	.01	.164	[−0.00, 0.01]	.06	**.040**	[0.00, 0.11]	.06	**.025**	**[0.01, 0.12]**

Notes. ACME = average causal mediation effect; ADE = average direct effect; TE = total effect. Predictors and mediators were centered within cluster. *p*-values determined with Quasi-Bayesian confidence intervals from 2,000 Monte Carlo simulations.

multitasking and stress ($b = 0.05$, $p = .039$), notably while there was no main effect of media multitasking on stress found in Model 1. As no within-person interaction effects were found between autonomy need dissatisfaction and neither the online vigilance dimensions nor communication load, H7a and H7b are rejected (visualizations of the interaction effects are available in the OSF). The interaction model explained 12% of variance in situational stress on the situation level and 62% of variance in situational stress on the person level.

Discussion

The central aims of the present study were (a) to replicate findings of previous studies that focused on between-person predictors of digital stress with an in-situ research design addressing the within-person dynamics of digital stress and (b) to provide a theoretical and empirical extension of previous research by accounting for the conditional nature of digital stress effects through the introduction of two central situational boundary conditions (i.e., goal conflict and autonomy need dissatisfaction) identified in the mobile connectivity paradox (Vanden Abeele, 2021) and the IM³UNE model (Schneider et al., 2022).

We first turn to our goal of *replicating* between-person effects found in previous digital stress research on the within-person level. Our results demonstrate a small within-person link between the salience dimension of online vigilance and stress, both directly and indirectly via communication load. Besides the influence of within-person variation in salience on stress, we also observed a moderate-size relationship of between-person differences in salience and situational stress. These findings indicate that individuals with higher levels of salience experience more stress, but also that in situations in which smartphone users experience more salience, their stress levels increase. Within-person variations in the other two dimensions of online vigilance, reactibility and monitoring, did not directly predict stress, but did so indirectly via communication load. This pattern of within-person results is in line with previous research identifying both salience (Freytag et al., 2021) as well as communication load (Reinecke et al., 2017; Thomée et al., 2011; Weinstein & Selman, 2016) as predictors of stress on the between-person level. It stands in contrast, however, with recent evidence that found no support for communication load as a predictor of stress (Freytag et al., 2021).

An additional discrepancy to past findings emerged with regard to media multitasking, which past research identified as a predictor of stress (Mark et al., 2014; Reinecke et al., 2017; Wetherell & Carter, 2014). We, however, found neither direct nor indirect effects of/via media multitasking on stress. Only in interaction with autonomy need dissatisfaction, it had a small within-person influence on stress. An explanation for the comparably weak role of media multitasking may lie in its narrow operationalization in the present study as the simultaneous engagement with smartphone use and another media activity. This differs from past operationalizations that include non-media secondary activities such as work or study that often conflict with media use (Reinecke & Hofmann, 2016). With a more inclusive operationalization of media multitasking, effects on stress and interactions with goal conflict and autonomy need dissatisfaction might have been more pronounced. Alternatively, emotional gratifications obtained from media multitasking could have alleviated smartphone-induced stress (Baumgartner & Wiradhany, 2021; Wang & Tchernev, 2012).

Overall, though, our findings replicate central patterns identified in previous digital stress research on the within-person level. Our study thus contributes to digital stress research by demonstrating that both within-person fluctuation in cognitive and motivational engagement with mobile digital communication (i.e., online vigilance) as well as more overt smartphone use behavior (e.g., communication load) are associated with increased situational stress. However, important questions concerning the processes underlying digital stress remain unanswered: the direct and especially the indirect effects found in the present study were small and their practical relevance for stress experience in daily life needs further exploration. Furthermore, the fact that only the salience dimension of online vigilance was directly related to stress is in line with previous research (Freytag et al., 2021; Johannes et al., 2020; Johannes et al., 2018), yet raises important questions pertaining to how salience and the other online vigilance dimensions relate to each other on both trait and state levels. Based on the available evidence, a hierarchy among the dimensions could be conceivable, in which salience might form the core of the online vigilance mindset, while reactibility and monitoring might represent motivational sub-manifestations of the cognitive preoccupation with online interactions. The situational interplay of the three dimensions of online vigilance thus remains an open question for future research.

Regarding our second central goal, our findings provide important theoretical and empirical *extensions* to the digital stress literature by demonstrating the importance of situational boundary conditions for the emergence of digital stress. By theoretically integrating the mobile connectivity paradox (Vanden Abeele, 2021) and the IM³UNE model (Schneider et al., 2022)—two recent models emphasizing the conditional nature of the effects of mobile digital communication on psychological well-being—we introduced goal conflict and autonomy need dissatisfaction as situational moderators of the effects of online vigilance and smartphone use behavior on stress. Both variables emerged as significant within-person moderators in our analyses. Autonomy need dissatisfaction showed a small interaction with media multitasking in predicting stress. Additionally, the appraisal of a conflict between smartphone use and other goals made the cognitive preoccupation with online interactions (salience) on the between-person level as well as the attentiveness towards them (reactibility) on the within-person level more stressful to users.

We believe that the introduction of goal conflict and autonomy need dissatisfaction as situational boundary conditions of digital stress makes a number of contributions. First, it provides us with a larger understanding of the situational dynamics involved in the emergence of digital stress and extends the amount of explained variance in stress experience. While the main effects model explained 4% of level-1 variance in situational stress, mirroring past findings (Freytag et al., 2021), the interaction model was able to explain 12% of level-1 variance in situational stress. On level 2, the addition of the moderating factors increased explanatory power from 35% to 62% of explained variance in situational stress.

Besides this contribution, our findings have important theoretical implications. First, they manifest the *conditional* nature of digital stress effects and underline the need to further explore boundary conditions of digital stress. We believe that a conditional approach will considerably extend our understanding of why mobile digital communication is associated with stress in some situations and populations, but not in others, and may help to integrate and resolve the partly ambivalent findings of previous research.

With regard to the more global relationship between mobile digital communication and psychological well-being beyond digital stress, our findings lend support to the basic assumptions of the mobile connectivity paradox (Vanden Abeele, 2021) and the IM³UNE model (Schneider et al., 2022). Both perspectives underline the temporal variability of the connection between mobile digital communication and well-being and the central importance of accounting for boundary conditions of potential effects.

Finally, our results have practical implications for digital stress reduction. Given that online vigilance and communication load foster stress, a conscious management of flows of online communication seems important; for example, by reducing smartphone notifications or e-mail checking—strategies which can decrease stress both in work and private contexts (Fitz et al., 2019; Kushlev & Dunn, 2015). Furthermore, conflicts between digital media use and other goals as well as situations that frustrate users' need for autonomy should be prevented, as those contribute to stress. In the work context this could be implemented, for instance, in the form of designated smartphone breaks, reducing the interference of smartphone use with other tasks and providing autonomy over one's media use.

Nevertheless, relevant questions pertaining to the contingencies of smartphone use and stress deserve further investigation. In the present study, the two proposed moderators only showed small interaction effects with two predictors of stress on the within-person level. Furthermore, both proposed moderators showed significant direct relationships with stress (see Table 1) that were not accounted for in our hypothesized model. It could thus be argued that instead of or in addition to acting as moderators, goal conflict and autonomy need satisfaction may *mediate* the effects of online vigilance and smartphone use behavior on stress. Such mediation effects appear plausible as online vigilance, communication load, and media multitasking can be associated with decreased levels of autonomy and an increased risk for goal conflict (Reinecke, 2018; Schneider et al., 2022). Exploratory analyses revealed that goal conflict and autonomy need dissatisfaction mediate most relationships between the postulated predictors and stress (see OSF for detailed results). We believe that rather than calling the theoretical rationale for our moderation hypotheses into question, our findings underline the need for a better understanding of the key factors contributing to the within-person dynamics of digital well-being in various situations. To assess whether and how goal conflict and autonomy need dissatisfaction affect digital stress, studies with an even more granular temporal level, or experimental studies are needed that are able to clearly delineate the various roles these concepts play in eliciting digital stress.

Despite these insights, the present study faces some limitations. First, the constructs were measured with single items which can potentially decrease measurement validity and reliability. However, it represents an inherent necessity of experience sampling methodology to reduce response burden on participants. This can be partly compensated by statistical power stemming from high numbers of observations (see OSF for additional validity and reliability checks). More generally, self-report measures of media use quantity show considerable discrepancies to log-based measures (Parry et al., 2021).

While recall biases are likely to be reduced by the experience sampling methodology (Lucas et al., 2021), future studies in the context of digital stress might nevertheless benefit from the use of logging technology. Second, while the overall number of observations of smartphone use was high ($n = 1{,}427$), some participants provided only few observations ($M = 17.72$, $SD = 7.97$, range = 1–28 out of 30 surveys). Part of these missing values were related to software problems encountered with the ESM app (see Methods section). It is also possible, though, that some observations are missing systematically. For example, in situations in which participants felt stressed by their smartphone, they might have left survey prompts unanswered. This reduces the number of data points and potentially introduces bias to the observation of stress. A last limitation refers to causality and directionality of effects. While we conceptualized online vigilance, communication load, and media multitasking as predictors of stress, the opposite direction of effects with changed levels of smartphone use and online vigilance representing outcomes of situational attempts to cope with stress appears similarly plausible (Wolfers et al., 2020). To further explore causality, we inspected the lagged effects of our predictor variables on stress at the following prompt (hypothesized direction) and vice versa (non-hypothesized direction). Results demonstrate no significant lagged effects (see OSF for detailed results). However, our study design was not ideally suited for lagged analyses as lags between prompts varied in length, and digital stress effects may be too fleeting to be detected by the time lags applied in the present study. Testing the direction of effects and the presence of reciprocal effects between online vigilance, smartphone use, and stress thus remains an important task for future research.

Conclusion

Extending the previous focus on between-person associations, the present study applied a situational approach to demonstrate that within-person fluctuations in cognitive and motivational engagement with mobile digital communication (i.e., online vigilance) as well as more overt smartphone usage behavior (e.g., communication load and media multitasking) are associated with increases in perceived stress. We further elucidated the conditional nature of digital stress by introducing goal conflict and autonomy need dissatisfaction as two central situational boundary conditions to digital stress research. Our findings lend support to the basic assumptions of the mobile connectivity paradox (Vanden Abeele, 2021) and the IM³UNE model (Schneider et al., 2022), gathering relevant insights into stress as a negative outcome of mobile digital communication in everyday life.

Data availability

All data, materials, and analysis code underlying this article are available at https://osf.io/hm2q7/

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Notes

1. As the field phase fell into the period of the COVID-19 pandemic, we assessed several COVID-19-related control variables including perceived COVID-19-induced stress. An analysis of these variables does not provide evidence for any significant bias introduced by the pandemic on the central findings of our study. See all related measures and analyses in the OSF.
2. As the focus of the present paper is on the *situational* predictors and boundary conditions of digital stress, only state level variables are reported below and included for analyses. However, all constructs were also assessed at the trait level in the intake survey. Trait-level measures, data, and analyses are available in the OSF.

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