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Permanently Online—Always Stressed Out? The Effects of Permanent Connectedness on Stress Experiences

Anna Freytag [1]*, Katharina Knop-Huelss [1], Adrian Meier [2], Leonard Reinecke [3], Dorothée Hefner[1], Christoph Klimmt[1], Peter Vorderer[4]

1 Department of Journalism and Communication Research, Hanover University of Music, Drama and Media, Hanover, Germany
2 Amsterdam School of Communication Research (ASCoR), University of Amsterdam, Amsterdam, Netherlands
3 Department of Communication, Johannes Gutenberg University Mainz, Mainz, Germany
4 Institute for Media and Communication Studies, University of Mannheim, Mannheim, Germany

Concerns have been expressed that permanent online connectedness might negatively affect media user's stress levels. Most research has focused on negative effects of specific media usage patterns*, such as media multitasking or communication load. In contrast, users'* cognitive orientation *toward online content and communication has rarely been investigated. Against this backdrop, we examined whether this cognitive orientation (i.e.,* online vigilance *with its three dimensions salience, reactibility, monitoring) is related to perceived stress at different timescales (person, day, and situation level), while accounting for the effects of multitasking and communication load. Results across three studies showed that, in addition to multitasking (but not communication load), especially the cognitive salience of online communication is positively related to stress. Our findings are discussed regarding mental health implications and the origins of stress.*

Keywords: Permanent Connectedness, Online Vigilance, Stress, Communication Load, Multitasking, Diary Studies, Day-Reconstruction-Method, Multilevel Modeling

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Only a short time ago, connecting to the Internet and interacting through technologies were activities that required planning, scheduling, and the arrangement of specific equipment (Ling, 2018). Today, this situation has been reversed so that around the globe being *permanently online* and *permanently connected* (POPC) has become an integral part of many people's everyday life (Vorderer, Hefner, Reinecke, & Klimmt, 2018). This permanent access to peers, media content, and online services

*Corresponding author: Anna Freytag; e-mail: anna.freytag@ijk.hmtm-hannover.de

via the (mobile) Internet comes along with many advantages: the possibility to always retrieve information or the opportunity to be in touch with beloved others can strengthen feelings of belonging, (social) support, and peace of mind (e.g., Oh, Ozkaya, & LaRose, 2014; Valkenburg & Peter, 2009).

At the same time, concerns have been voiced about the detrimental effects of permanent availability and connectivity (e.g., Turkle, 2017). Numerous studies have demonstrated that new communication demands arising from digital information and communication technologies (ICTs) are associated with high levels of stress both in the context of work (e.g., Barley, Meyerson, & Grodal, 2011; Eppler & Mengis, 2004; Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008) and leisure time (e.g., LaRose, Connolly, Lee, Li, & Hales, 2014; Lee, Chang, Lin, & Cheng, 2014; Misra & Stokols, 2012; Murdock, 2013; Reinecke et al., 2017). Stress is a crucial risk factor for a number of severe negative health outcomes such as anxiety, depression, sleep disturbances, irritability, concentration problems, psychomotor change, and even cardiovascular mortality (e.g., Bergdahl & Bergdahl, 2002; Kivimaki, 2002). Given the high risk associated with stress, there is an urgent need to explore the role of permanent connectedness for the causation, intensification, and continuation of stress.

Most studies on such "digital stress" have thus far focused on investigating the stress potential of specific *media usage patterns* like media multitasking (i.e., the simultaneous performance of multiple tasks, whereby at least one activity is media-related; e.g., Mark, Gudith, & Klocke, 2008; Mark, Wang, & Niiya, 2014; Misra & Stokols, 2012; Reinecke et al., 2017). Such overt media usage patterns can tax situational cognitive resources, increase situational demands, reduce coping capacity, and may thus be associated with stress experiences (e.g., Thomée, Härenstam, & Hagberg, 2012, for a recent review, see Wilmer, Sherman, & Chein, 2017). Current findings suggest, however, that media users not only established specific usage patterns of permanent connectedness but also developed cognitive structures that guide and drive their mobile phone use and their respective digital communication behavior (Reinecke et al., 2018). To theoretically explicate these psychological structures and *cognitive orientations* that underlie constant connectedness, Klimmt et al. (2018) recently introduced the concept of *online vigilance*. Reinecke et al. (2018) provided an empirical substantiation of the construct and detected individual differences in users' (a) constant thinking about online communication, online content, and online events (*salience*), (b) their motivation to instantly react to incoming connection cues (*reactibility*), and (c) their tendency to actively observe online content and activities (*monitoring*). The current contribution rests on the assumption that this three-dimensional construct of online vigilance plays an important role in the development of stress as it describes the cognitive, attentional, and motivational structures underneath permanent connectedness.

Although there is empirical evidence for a positive correlation of concepts related to online vigilance, like phone attachment or the fear of missing out (FoMO), with stress (e.g., Beyens, Frison, & Eggermont, 2016; Konok, Pogány, & Miklósi, 2017;

Reinecke et al., 2017; Rogers & Barber, 2019), prior research has not yet systematically investigated the role of the cognitive orientation toward online content and communication and its interplay with usage behaviors for stress experiences in daily life. This is a central limitation as stress research suggests that both exposure and response to stressful events are crucially affected by users' cognitive and motivational orientations and dispositions (Bolger & Zuckerman, 1995; Cohen, 1985; Lazarus, 1993).

Therefore, we investigate online vigilance as a potential source of stress over and above the role of ICT usage patterns. In doing so, we contribute to theory building on the emergence of digital stress by extending the scope of potential stress-inducing factors to permanent connectedness as a cognitive orientation toward online content. This perspective promises to align research on digital stress with long-established insights from conventional (offline) stress research (e.g., Bolger & Zuckerman, 1995). In the following, we will first develop theoretical propositions on how media usage patterns that result from permanent connectedness (i.e., communication load and multitasking) relate to stress and subsequently outline how the facets of online vigilance (i.e., salience, monitoring, and reactibility) as a cognitive orientation may contribute to stress experiences. Our hypotheses will be tested through a research program of three empirical studies. Each study was designed to focus on a specific level of temporal resolution in the investigation of permanent connectedness and stress experiences. Finally, we conclude by highlighting the role of different stress factors in times of permanent connectedness.

Stress as a result of permanent connectedness

To understand why digital ICTs may have a negative impact on our stress balance, we need to consider how stress develops. According to psychological research and the *transactional model of stress*, stress develops as "an unfavorable person-environment relationship" in which situational demands exceed available coping resources (Lazarus & Folkman, 1984, p. 63). Consequently, *digital stress* is most often understood as an aversive condition elicited by environmental demands that materialize through ICTs that exceed media users' coping capacity (Hefner & Vorderer, 2017).

Stress-inducing media usage patterns resulting from permanent connectedness

Because online communication applications are now accessible almost anytime and anywhere, users are challenged to navigate a staggering amount of interpersonal and mass communicative information. As technological innovations allow for an interactive and high-speed flow of information, these demands from ICTs may exceed users' cognitive resources and can thus be associated with considerable stress (Wilmer et al., 2017). Two comparatively well-researched ICT usage patterns represent potential sources of demands: (a) communication load (i.e., the frequency of

incoming and outgoing messages) and (b) media multitasking (i.e., media use simultaneously to other activities; e.g., Misra & Stokols, 2012; Reinecke et al., 2017). In the following, we will explain how these two usage patterns may result from permanent connectedness and relate to digital stress.

On the one hand, being "always-on" entails a high number of messages and notifications sent and received during the day. When *communication load*—the number of messages sent and received—increases to such an extent that these messages can no longer be properly processed or that other situational demands (e.g., relevant tasks) can no longer be adequately met, stress can occur (Reinecke et al., 2017). This ICT-induced lack of fit between individual resources and situational demands is often experienced as a form of *communication overload*, that is, a feeling of being overburdened with communication demands (Misra & Stokols, 2012). Communication overload in the context of work-related online communication is associated with increased levels of stress (e.g., Barley et al., 2011; Kushlev & Dunn, 2015). These work-related findings also transfer to private contexts. A number of studies suggest that communication load resulting from nonwork-related ICT use significantly correlates with stress in all age groups (LaRose et al., 2014; Misra & Stokols, 2012; Reinecke et al., 2017). We thus assume:

H1: Communication load is positively associated with perceived stress.

However, not only the amount of online communication but also its context can challenge the individual's cognitive capacities. In addition to communication load, *media multitasking* is a second usage pattern that has been a central subject of prior digital stress research. Media multitasking refers to the simultaneous performance of multiple tasks that require cognitive capacities, whereby at least one task is media-related (Wang & Tchernev, 2012). While multitasking is not a new phenomenon, current technological developments have certainly increased its occurrence in everyday life (Hefner & Vorderer, 2017; Vorderer & Kohring, 2013). Individuals frequently engage in multitasking via today's ICTs (e.g., smartphones and social media), such as browsing through a news feed while sitting and eating at the dinner table or having two conversations at the same time, one face-to-face and the other via mobile messengers (e.g., Moreno et al., 2012; Yeykelis, Cummings, & Reeves, 2014). Several studies provide evidence of a relationship between such multitasking and perceived stress in both work-related and private contexts (e.g., Mark et al., 2008, 2014; Misra & Stokols, 2012; Reinecke et al., 2017).

As usage patterns, media multitasking and communication load are undoubtedly related. It is plausible to assume, for example, that increases in incoming communication content (i.e., communication load) result in an increased likelihood for media multitasking (e.g., because notifications trigger smartphone use in the presence of other ongoing activities). Nevertheless, both are distinct constructs with clearly distinguishable defining characteristics. While communication load may result from the active behavior of the individual user (e.g., sending messages) but also from events triggered by other users (e.g., receiving messages) or platforms (e.g.,

receiving automated notifications), media multitasking *always* entails active usage behavior by the individual user, either deliberately initiated (e.g., writing a long-planned email to a friend while watching TV) or automatically cued (e.g., responding to an incoming message during an ongoing conversation). Furthermore, while communication load can occur independently of other activities, multitasking is, per definition, limited to situations where ICTs are used simultaneously with other activities. In other words, while communication load primarily refers to *how much* communication takes place, media multitasking describes *in which context* (in the presence or absence of a second activity) ICT usage is performed. In the present study, both communication patterns are thus addressed as separate potential sources of stress.

Despite the conceptual differences between both constructs, the central assumptions underlying a potential relationship between stress and multitasking as well as communication load, respectively, are similar. The permanent switching between tasks associated with multitasking taxes attention and cognitive capacity (David, 2018). As these central executive resources are limited (Lang, 2000), media multitasking can easily exceed and exhaust users' situational coping capacities and thus act as a potential stressor. Both media usage patterns, communication load and media multitasking, thus limit situational resources, which can increase the likelihood of experiencing stress (Lazarus, 1993). Based on the research and reflections described above, we assume:

H2: Media multitasking is positively associated with perceived stress.

Direct and indirect links between online vigilance and stress

While H1 and H2 primarily aim to replicate findings from previous research, a major aim of the present study was to extend this line of research by exploring the role of users' "permanently online" mindset as an additional driver of ICT-related stress. Stress research has clearly demonstrated the importance of cognitive and motivational dispositions in the context of stress perception (e.g., Bolger & Zuckerman, 1995; Lazarus, 1993). For instance, individual attributes, such as locus of control, self-esteem, or perfectionism, have been shown to affect an individual's stress level (e.g., Abouserie, 1994; Dunkley, Zuroff, & Blankstein, 2003). Also reflecting on the importance of cognitive and psychological factors for the emergence of stress, Cohen (1985) stated that the "meaning of a stimulus configuration is generally more important than its physical properties in producing stress effects" (Cohen, 1985, p. 65). In the context of digital stress, this implies that the individual importance attributed to online communication and content is more relevant for triggering stress than simply being online or communicating online. Prior findings on the role of cognitive orientations for stress thus suggest that individual differences in ICT-specific cognitive dispositions may increase the risk for perceived ICT-related stress (a) through increases in stress-inducing usage patterns or (b) by increasing the users' susceptibility to stress directly and independent from overt usage

patterns. Prior research on ICT-related stress, however, has largely failed to address such individual or situational differences in communication-centered cognitive orientations and their interplay with usage behavior in the emergence of digital stress. The role of individual and situational differences in ICT-specific *cognitive and motivational user orientations* is consequently currently not well understood. Building on recent work by Reinecke et al. (2018), we will thus develop theoretical assumptions on how the three facets of *online vigilance* (i.e., salience, monitoring, and reactibility) may contribute to stress experiences. For this purpose, we will first review the concept of online vigilance and its cognitive, attentional, and motivational components in more detail and then discuss its links to stress.

Online vigilance as the cognitive and motivational dimension of permanent connectedness

Being permanently connected has not only caused new behaviors and habits but has likewise changed the cognitive structures of many users (Klimmt, Hefner, Reinecke, Rieger, & Vorderer, 2018). An increasing number of users report to be constantly alert to respond to online notifications and their mobile devices (Smith, 2015). Some even perceive guilt, anxiety, or stress to respond and to be available to others via mobile devices (entrapment, Hall, 2017).

The psychological processes of permanent connectedness, alertness, and constant preoccupation with online content can be defined as *online vigilance* (e.g., Johannes et al., 2018; Reinecke et al., 2018; Throuvala, Griffiths, Rennoldson, & Kuss, 2020). The concept of online vigilance suggests that ICT users show individual differences on three dimensions: "(1) their *cognitive focus* on permanent, ubiquitous online connectedness; (2) their chronic *attention* to and continuous integration of online-related cues and stimuli into their thinking and feeling; and (3) their *motivational disposition* to prioritize options for online communication over other (offline) behavior" (Reinecke et al., 2018, p. 2). In other words, it can be characterized as an approach motivation and the cognitive orientation toward online connectedness and its affordances (Schneider & Hitzfeld, 2019). While online vigilance represents a trait variable, it also shows considerable intra-individual variability and underlies situational fluctuation. As a consequence, even users with high trait levels of online vigilance, while showing a strong disposition for sustained attention to online cues and content, do not continuously focus on online content and communication but go through phases of higher versus lower levels of situational vigilance. Furthermore, the defining cognitive, attentional, and motivational processes of online vigilance are represented to varying degrees within its three subdimensions (e.g., the cognitive orientation component is particularly strongly represented in the salience subdimension, whereas the attention component corresponds particularly strongly with the monitoring subdimension). However, cognitive, attentional, and motivational components are of high relevance for all three subdimensions, which will be described in more detail below.

Building on this, online vigilance is first characterized by a persistent cognitive connection to online communication. This becomes evident from users' ongoing

thinking and reflection about their online interactions and messages, even when they are not currently using a communication device (Klimmt et al., 2018; Tanis, Beukeboom, Hartmann, & Vermeulen, 2015). How one's mind is cognitively preoccupied with online communication is therefore described by the *salience* dimension of online vigilance (Reinecke et al., 2018). Second, as the smartphone provides many positive experiences in daily life (e.g., satisfying social interactions), reacting promptly to smartphone notifications is connected to obtaining positive gratifications (Wang & Tchernev, 2012) and avoiding social sanctions (e.g., consequences of responding late to messages; Mai, Freudenthaler, Schneider, & Vorderer, 2015). Connection cues, such as incoming messages or notifications, thus signal immediate rewards and users are likely to develop attention habits, such that the reward-related stimuli automatically and chronically capture their attention whenever they occur (Anderson, 2016; Reinecke et al., 2018). Therefore, an "always-on" mindset not only implies being "permanently on call" (Halfmann & Rieger, 2019) but also includes the impulse to immediately acknowledge and process incoming messages (or other cues, such as app notifications). This also becomes evident by considering how many smartphone users seem unable to ignore their devices when receiving a message (Cahir & Lloyd, 2015). The dimension of *reactibility* hence describes the extent to which online notifications are prioritized over stimuli and activities in the offline environment (Klimmt et al., 2018). Third, vigilant smartphone users aim to monitor what is happening online on a regular basis. Their goal is to always be up-to-date about their online social sphere (Oulasvirta, Rattenbury, Ma, & Raita, 2012) and to stay connected to both the constant stream of incoming content (e.g., their Instagram feed) and private messages during the day (Crawford, 2009, p. 528). Therefore, the third dimension of online vigilance, *monitoring*, describes the motivational disposition to conduct frequent, small acts of mobile device checking (Reinecke et al., 2018), which provide a sense of perpetual contact to individual partners, entire networks, and eternally updating streams of information (Mascheroni & Vincent, 2016, p. 312).

The online vigilance construct has overlaps to or is related with several other concepts in the field, such as the FoMO (Przybylski, Murayama, DeHaan, & Gladwell, 2013), phone attachment (Konok, Gigler, Bereczky, & Miklósi, 2016), telepressure (Barber & Santuzzi, 2017), habitual media use (LaRose, 2010), problematic Internet or problematic phone use (Tokunaga & Rains, 2016), and smartphone addiction (Müller, Glaesmer, Brähler, Woelfling, & Beutel, 2014).

Particularly three of these related concepts have previously been used to investigate strong involvement with online content and communication and must thus be conceptually differentiated from online vigilance: *FoMO*, *media habits*, and Internet or smartphone *addiction*. FoMO has been described as the "pervasive apprehension that others might be having rewarding experiences from which one is absent" (Przybylski et al., 2013, p. 1841). To cope with the desire to stay continually connected with what others are doing, individuals engage with social media content (Beyens et al., 2016; Przybylski et al., 2013). But also thinking about or monitoring

online content and reacting quickly to online notifications can represent efforts to deal with the feeling of missing rewarding experiences that others have. FoMO has thus been conceptualized as well as empirically established as a predictor of online vigilance in previous research (Reinecke et al., 2018).

The construct of habits refers to "automatic associations between cues and actions that form through repetition" (LaRose, 2010, p. 199). Media habits thus describe largely unconscious and automatic forms of media use behavior triggered by environmental cues. While some facets of the online vigilance construct, such as frequent checking behavior associated with the monitoring subdimension, are often highly habitualized (Oulasvirta et al., 2012), other facets, such as cognitive engagement with and attention to online communication associated with the salience component, appear less compatible with the habit construct (Reinecke et al., 2018). In their conceptual explication, Reinecke et al. (2018) proposed that online vigilance "encompasses both goal-directed forms of behavior and attention as well as automatic responses to connection cues and attention allocation" (p. 6). The concept thus goes significantly beyond the relatively narrow view on automatically triggered forms of media use captured by habits (Klimmt et al., 2018).

Furthermore, online vigilance shows some overlap with classical symptoms frequently discussed in the context of Internet addiction or smartphone addiction (e.g., Müller, Dreier, & Wölfling, 2017). This overlap is particularly apparent in the salience dimension of online vigilance since cognitive preoccupation with online content is frequently considered a central indicator of Internet addiction (Tokunaga & Rains, 2016). However, while cognitive preoccupation in the context of Internet addiction refers to extreme and pathological phenomena, such as "obsessive thoughts" (Davis, 2001, p. 193), salience within the online vigilance construct refers to a more mundane "general cognitive orientation to and attention for the online environment in everyday life" (Reinecke et al., 2018, 7). Behavioral addiction literature has recently moved away from conceptualizations of media addictions based on symptoms such as preoccupation (Kardefelt-Winther et al., 2017), since these tend to "overpathologize" normal, everyday life media use behavior (Billieux, Schimmenti, Khazaal, Maurage, & Heeren, 2015, p. 119). Instead, several authors propose to rely on significant functional impairments as the central defining feature of media and other behavioral addictions (Kardefelt-Winther et al., 2017). While such pathological forms of online communication (i.e., "Internet addiction") are associated with major functional impairments and show a very low prevalence in the general population (e.g., Müller et al., 2014), online vigilance, in contrast, is a common everyday phenomenon observable in large numbers of Internet users and presumably only associated with mild forms of negative effects, such as digital stress (Reinecke et al., 2018), rather than severe functional impairment.

In summary, both mobile devices as well as the new digital environment shape people's mindset toward thinking of and being constantly responsive to online contexts. The inclusion of one's online environment in cognitive structures may vary between people and situations, but increases the overall complexity in daily life

since users now operate simultaneously in multiple online and offline contexts and need to processes information that would not be salient (or similarly obtrusive) in a purely offline setting (Vorderer et al., 2018).

Direct effects of online vigilance on stress experiences

There are several theoretical arguments for a strong relationship between online vigilance and perceived stress. First, we can expect a *direct effect* of online vigilance on stress. Most importantly, maintaining a high level of online vigilance over time requires the expenditure of cognitive capacities. Salience, for instance, goes hand in hand with a constantly occupied mind. By occupying cognitive resources, cognitive preoccupation with online communication corresponds to a quickly exceeded cognitive capacity, increasing the risk of stress. A recent study by Johannes et al. (2020), for instance, showed that salience of online content is negatively associated with affective well-being and life satisfaction, particularly when thoughts are negative, and Du, Kerkhof, and van Koningsbruggen (2019) found that smartphone users with a strong salience were more likely to fail to control their social media use while having other important goals.

The other dimensions of online vigilance, reactibility, and monitoring, too, demand cognitive resources since they put media users in constant alertness. These dispositions keep media users permanently ready to check what is going on online and to react to incoming cues immediately. Due to this "standby mode," cognitive resources are allocated and reserved for online activities nonstop, which reduces the remaining available resources that might then be rapidly drained and no longer available for coping processes. According to stress theory and research, sufficient cognitive resources for coping processes are, however, crucial for the prevention and mitigation of stress (Lazarus, 1998). In this context, we assume that online vigilance can either solely trigger stress by overdemanding an individual's cognitive resources or can bind such a significant amount of resources that stress reactions emerge when additional demands occur. In other words, when people are mentally occupied with online communication, this may either stress them directly or they will be stressed faster when they encounter challenging situations, such as work demands or interpersonal conflict, due to lacking coping resources.

Research has shown that people differ in their general degree of online vigilance (Reinecke et al., 2018) and that people experience more or less general life stress than others (Cohen, Kamarck, & Mermelstein, 1983). Notwithstanding these interpersonal differences, we assume that different situations will lead to different degrees of online vigilance or stress. We thus suggest to differentiate inter- and intrapersonal differences, and consequently person and situation levels of both online vigilance and stress for accurately investigating the direct interdependencies theorized above. Based on the theoretical considerations

concerning the relationship between online vigilance and stress, we pose the following hypotheses:

H3: Person-level differences in (a) salience, (b) monitoring, and (c) reactibility will be positively associated with perceived stress.
H4: Situation-level differences in (a) salience, (b) monitoring, and (c) reactibility will be positively associated with perceived stress.

Indirect effects of online vigilance on stress experiences

The proposed mechanisms between online vigilance and digital stress are not suggested to operate independently from the previously elaborated media usage patterns (communication load and media multitasking). Rather, the individual mindset of users (online vigilance) will likely affect how people arrange their online environment and how communication partners interact with them (Klimmt et al., 2018; Reinecke et al., 2018; Utz, 2018). Therefore, we further assume that online vigilance will have an *indirect effect* on stress via communication load and media multitasking. Media users with a high salience of online communication have their online interactions and messages mentally top of mind. Combined with chronic attention to message cues (monitoring) and a strong motivational disposition to prioritize options for online communication over other behaviors (reactibility), people high in online vigilance will likely have a higher communication load than people low in online vigilance.

For multitasking, we can assume a similar mediating effect. Media users who are highly focused on online content and online communication options and who are ready to react to incoming cues as quickly as possible will more likely engage in media multitasking and are thus more likely to be confronted with their limited and already strained cognitive resources. As we expect that users with high levels of online vigilance are constantly willing to allocate additional resources to ICTs, no matter what their main activity currently is, it is likely that online vigilance is positively associated with media multitasking behavior.

In summary, users for whom online communication is highly salient and who are highly attentive and reactive to its cues will likely report high degrees of stressful communication load and multitasking. We thus expect that online vigilance can also affect perceived stress levels by promoting and intensifying permanent connected media usage patterns. In addition to the hypotheses presented above, we therefore propose an indirect effect of online vigilance on stress via communication load and media multitasking:

H5: (a) Salience, (b) monitoring, and (c) reactibility will be indirectly positively associated with stress via communication load.
H6: (a) Salience, (b) monitoring, and (c) reactibility will be indirectly positively associated with stress via multitasking.

Study 1

Study 1 aimed at a first cross-sectional test of our central hypotheses. For this purpose, a representative quota-sample of Internet users from Germany was recruited. In an online survey, person-level indicators of both the cognitive orientation toward online content and communication (online vigilance) as well as media usage patterns resulting from permanent connectedness (communication load, multitasking) were assessed and their relationship with perceived stress was tested.

Method

Sample and procedure

A stratified sample of 3,203 German Internet users was recruited via a commercial online access panel operated by the market research company respondi. Of those invited panelists, 1,202 followed the link to the online survey and 1,145 (95.26%) completed the survey between 3 and 15 December 2015. A total of 124 respondents were removed due to straightlining (lack of response variance in matrix questions) or implausible completion speed (cf., Leiner, 2019), resulting in a final sample of 1,024 Internet users (51.7% male) between the age of 18 and 82 years ($M = 44.23$; $SD = 14.55$). The sample is representative of the general population of Internet users in Germany in terms of age, gender, educational level, and occupational status.

Measures

Online vigilance was measured with the 12 items of the Online Vigilance Scale (OVS, see Table 1; Reinecke et al., 2018). Participants responded to the items (e.g., "My thoughts often drift to online content") on a 5-point Likert-scale ranging from 1 "does not apply at all" to 5 "fully applies". All three subscales showed high internal consistencies ($\alpha_{salience} = .91$, $\alpha_{reactibility} = .87$, and $\alpha_{monitoring} = .90$). Following Reinecke et al. (2017), the average daily number of sent and received social media messages was openly assessed as an indicator of *communication load* ($r = .63$, $p < .001$). *Multitasking* was measured with six items (e.g., "How often do you use the Internet while simultaneously being in a conversation with another person?", for all items see Table SA1) adapted from Reinecke et al. (2017). Participants responded on a scale from 1 "never" to 5 "very often" (Cronbach's $\alpha = .79$). Three items (e.g., "In the last month, how often have you felt you were unable to control the important things in your life?") from the Perceived Stress Scale (Cohen et al., 1983) were used to assess *perceived stress* (see Table SA1). Participants responded on a scale from 1 "never" to 5 "very often" (Cronbach's $\alpha = .67$).

Results

Means, standard deviations, and zero-order correlations for all studied variables are presented in Table SA2. All person-level indicators of the cognitive orientation toward online content and communication (i.e., salience, monitoring, reactibility) and

Table 1. OVS: Items, Results, and Reliability of Three Subdimensions per Study

Dimension	Item	Study 1	Study 2	Study 3
Salience	My thoughts often drift to online content.			
	I have a hard time disengaging mentally from online content.[a]			
	Even when I am in a conversation with other people, I often think about what is happening online right now in the back of my mind.			
	Often online content occupies my thoughts, even as I am dealing with other things.[b]			
	Scale mean (SD)	1.73 (.88)	1.89 (.87)	1.74 (0.72)
	Cronbach's alpha	.91	.86	.83
Reactibility	When I receive an online message, my thoughts drift there immediately.			
	When I receive an online message, it triggers an impulse in me to check it right away.			
	When I receive an online message, I immediately attend to it, even if I am engaged in other things at that moment.			
	When I receive an online message, I immediately give it my full attention.ab			
	Scale mean (SD)	2.45 (.96)	2.86 (.92)	2.66 (0.79)
	Cronbach's alpha	.87	.86	.76
Monitoring	I constantly monitor what is happening online.ab			
	I often feel the urge to make sure I know what is happening online.			
	I often start certain online applications, so I don't miss out any news.			
	I always keep an eye on what is happening online at the moment.			
	Scale mean (SD)	2.13 (1.0)	2.47 (.96)	2.46 (0.91)
	Cronbach's alpha	.90	.89	.83

Notes: All items were assessed on a scale from 1 (no agreement) to 5 (full agreement).

1Means reported for Study 2 represent person-level results from the screening questionnaire at Day 1. Items used within the daily questionnaires of Study 2 are marked with a.

2Means reported for Study 3 represent person-level results from the screening questionnaire. Items used for the assessment of the episodes of Study 3 are marked with b.

media usage patterns (i.e., communication load, multitasking) showed significant positive correlations with perceived stress. Hypotheses 1, 2, 3, 5, and 6 were tested based on a structural equation model (SEM) computed with the AMOS 23 software and the maximum likelihood method. Our data did not meet the assumption of multivariate normality (Mardia's normalized estimate of multivariate kurtosis = 709.02, *c.r.* = 334.53). As recommended for the analysis of non-normal data (Byrne, 2010), all hypotheses were thus additionally tested using bootstrapping. Ninety-five percent bias-corrected confidence intervals were computed for all parameters reported in Figure 1 based on 5,000 bootstrap samples with replacement. All significant statistical relationships reported below were confirmed with the bootstrapping method. The model (Figure 1) showed an acceptable fit to the data with $\chi 2(216) = 710.54$, $p < .001$, CMIN/$df = 3.290$, CFI = .961, RMSEA = .047, 90% CI = (.043, .051), and SRMR = .036.

H1 and H2 supposed a positive relationship between perceived stress and communication load and multitasking, respectively. While the data did not show a significant association between communication load and stress ($\beta = .06$, $p = .062$) and H1 was rejected, multitasking was positively related to perceived stress ($\beta = .28$, $p < .001$), thus supporting H2.

The second part of the model tested the direct effects of person-level online vigilance on perceived stress predicted in H3. As predicted in H3a, the salience dimension of online vigilance was positively related to perceived stress ($\beta = .17$, $p = .017$), whereas monitoring ($\beta = -.01$, $p = .865$) and reactibility ($\beta = .02$, $p = .646$) did not show significant associations with stress. H3b and H3c were thus not supported by the data.

The last part of the model tested the indirect effects of online vigilance on perceived stress via communication load and media multitasking predicted in H5 and H6, respectively. Of the three online vigilance dimensions, only monitoring ($\beta = .27$, $p = .002$) was significantly related to communication load. To test the mediation effects predicted in H5a–H5c, the indirect effects of the three online vigilance dimensions of perceived stress via communication load were bootstrapped with 5,000 bootstrap samples with replacement using the maximum likelihood method and biased-corrected CIs. However, the analysis yielded no significant indirect effects, and H5 was rejected.

In contrast to the findings for communication load, all three dimensions of online vigilance were significantly associated with multitasking (see Figure 1), which, in turn, was positively related to perceived stress (see results for H2). Supporting H6a–H6c, bootstrapping analyses revealed positive indirect effects of salience ($\beta = .064$, $p = .002$, 95% CI = [.023, .134]), monitoring ($\beta = .139$, $p < .001$, 95% CI = [.077, .225]), and reactibility ($\beta = .027$, $p = .037$, 95% CI = [.001, .061]) on perceived stress via multitasking.

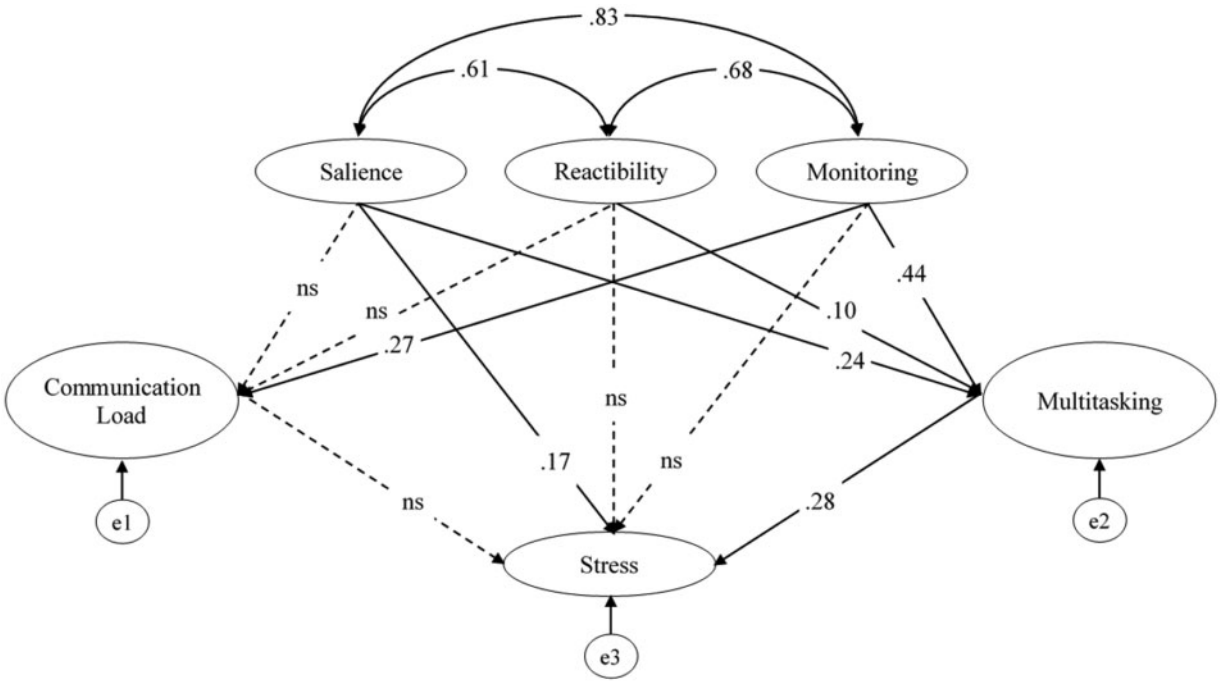

Figure 1 Study 1: SEM testing the association of online vigilance, communication load, multitasking, and perceived stress, $\chi 2(216) = 710.54$, $p < .001$, CMIN/$df = 3.290$, CFI = .961, RMSEA = .047, 90% CI = (.043, .051), and SRMR = .036. Scores in the figure represent standardized path coefficients significant at $p < .05$.

Discussion

Study 1 provides first empirical evidence for the importance of both media usage patterns and the cognitive orientation toward online content and communication as sources of digital stress. Replicating the results of previous research (Misra & Stokols, 2012; Reinecke et al., 2017) and underlining the central role of media usage patterns associated with permanent connectedness, the results demonstrated that multitasking was significantly related to perceived stress. In contrast to earlier studies, however, no significant relationship was found between communication load and stress. Furthermore, Study 1 demonstrates that the cognitive orientation toward online content and communication in the form of online vigilance is also associated with perceived stress. While all three dimensions of online vigilance showed positive zero-order correlations with stress, only the association with salience remained significant when all three dimensions were used as simultaneous statistical predictors of perceived stress and the effects of communication load and multitasking were controlled for. This suggests that the permanent cognitive preoccupation with online content and communication is the most stress-inducing subcomponent of online vigilance.

Finally, Study 1 not only demonstrates that the cognitive orientation of permanently connected users has a statistical effect on perceived stress beyond that of usage patterns addressed in previous research; the results also suggest that this cognitive orientation may predispose individuals to engage in stress-inducing usage patterns. In our model, all three dimensions of online vigilance were positively related to multitasking, which resulted in significant indirect statistical effects on perceived stress. In contrast to the direct statistical effects on stress where salience showed the strongest association, monitoring was the vigilance dimension most strongly related to stress via multitasking. Overall, this suggests that cognitive orientations and media usage patterns show complex interactions and that different dimensions of online vigilance are connected to digital stress via different direct and indirect routes. However, the contribution of Study 1 is limited in two important ways. First, the data collected in Study 1 are cross-sectional and thus do not provide a test of the direction of the reported statistical relationships. Second, the self-report measures used in the study have a low temporal resolution as they assess all relevant constructs at a person level. Given that both ICT use and stress vary strongly across situations, it is unlikely that the person-level data used in Study 1 can sufficiently account for the dynamic interplay of these variables. Study 2 and Study 3 address these limitations by testing the relationship between online vigilance, ICT use, and stress on the day and episode level, respectively.

Study 2

Study 2 built upon our first study, but surveyed participants via a diary study and thus focused on an additional temporal dimension. By means of an online diary,

both person- and day-level indicators of the cognitive orientation toward online content and communication (online vigilance) as well as media usage patterns (communication load, multitasking) were assessed and, again, their relationship with perceived stress was tested.

Method

Sample and procedure

In June 2016, student smartphone users were invited to participate in an online diary study consisting of an intake questionnaire and five end-of-day online diary surveys on five consecutive weekdays. The intake questionnaire assessed person-level measures (i.e., person-level online vigilance), while the diaries asked about participants' daily experiences (i.e., day-level online vigilance, communication load, multitasking, perceived stress). Participants were asked to fill in each diary after 5 p.m. on the respective day. Eighty-four student recruiters enrolled in Communication courses at the University of Mainz, Germany, invited participants from their personal networks via a link to the study. Seven hundred and fourteen people completed the initial intake questionnaire and could then sign-up for the diaries. Data were deemed eligible if participants had completed the intake questionnaire and at least the Monday and Friday diary. Accordingly, data from $N = 531$ students (66% female, $M_{age} = 22.59$ years, $SD = 2.44$) and $N = 2{,}326$ diary entries could be used in the following analyses. This constitutes the final sample. Compliance was high, with 67% of this final sample filling in all five diaries.

Measures

We used the same 12-item scale as in Study 1 to assess participants' person-level *online vigilance* (see Table 1). This scale was measured at person level in the first online diary and referred to participants' *overall* online cognitions and motivations. Internal consistency was $\alpha_{salience} = .86$, $\alpha_{reactibility} = .86$, and $\alpha_{monitoring} = .89$. Additionally, we measured each vigilance dimension at day level with one item: "Today, I had a hard time disengaging mentally from online content" for *salience*, "Today, when I received online messages, I immediately gave them my full attention" for *reactibility*, and "Today, I constantly monitored what was happening online" for *monitoring*. We again followed Reinecke et al. (2017) and asked participants to estimate the number of sent and received messages via instant messenger (IM; e.g., WhatsApp, Snapchat), which we refer to as *communication load IM*. Additionally, we asked them to estimate the number of sent and received messages and notifications on social network sites (SNS; e.g., Facebook, Instagram), which we refer to as *communication load SNS*. These four items were measured on the following scale: 1 = "0," 2 = "1–2," 3 = "3–5," 4 = "6–10," 5 = "11–20," 6 = "21–50," 7 = "51–100," and 8 = ">100." As daily measures of sent and received messages correlated highly for both IM ($r = .78$) and SNS ($r = .68$), we collapsed them into two mean indices (see Table SA3 for detailed items). *Multitasking* (i.e., using the Internet while talking to other people, spending time with one's partner, using other

media, or sitting in university lectures) was measured with seven items based on Reinecke et al. (2017) at day level on a scale from 1 "never" to 5 "very often" (see Table SA3). Internal consistency was subpar with an overall $\alpha = .62$, likely indicating that multitasking during the various activities did not necessarily co-occur on the same day. However, we nonetheless formed an overall mean-level indicator of this scale, as including each item separately would have inflated the Type I error rate in subsequent analyses. Three items from the Perceived Stress Scale (Cohen et al., 1983) were used to assess *perceived stress* at day level (see Table SA3, overall $\alpha = .79$). Participants responded to this measure on a scale from 1 "not at all" to 5 "very strongly."

Results

Means, standard deviations, and zero-order correlations for all variables are presented in Tables SA4 and SA5. As responses at day level (Level 1) were nested within participants (Level 2), we conducted multilevel regression analyses using the *R* package *lme4* (Bates, Mächler, Bolker, & Walker, 2014) to test H1–H4. To facilitate interpretation of the intercepts, all Level 2 variables (i.e., the three online vigilance dimensions) were centered around their sample means (i.e., grand mean-centered), while Level 1 variables were centered around their respective person means (i.e., group mean-centered). To estimate the variances explained by between-person variation and daily variation in day-level predictors more accurately and to provide accurate estimates of indirect effects, the person means of Level 1 variables were re-entered as predictors in the regression analyses (see Zhang, Zyphur, & Preacher, 2009). These person means were again grand mean centered as they represent Level 2 variables. H5 and H6 were tested with a 1-1-1 multilevel mediation analysis (i.e., predictor, mediator, and outcome were all measured at level 1) as suggested by Zhang et al. (2009). We used the *mediation* package (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014) and Quasi–Bayesian confidence intervals from 2,000 Monte Carlo simulations to estimate average indirect effects and determine *p*-values.

The results of the multilevel regression analyses are reported in Table 2. Communication load was not related to stress, neither for IM nor SNS use and neither at person nor at day level, leading us to reject H1. Both person-level ($b = .23$, $p = .004$) and day-level ($b = .15$, $p < .001$) differences in multitasking were positively related to daily stress. We thus accept H2. To test H3, we included the person-level measure of the three online vigilance dimensions (i.e., the OVS) at Level 2 to compensate for the low content validity and reliability of the three vigilance single-items measured at Level 1 (which were also included at Level 2 in the form of group means). Results concerning H3 show that only the four-item salience subscale of the OVS was positively related to stress ($b = .13$, $p = .021$), but not the group means of day-level salience, reactibility, or monitoring. We thus only find partial support for H3a and reject H3b and H3c. Furthermore, day-level variation in

Table 2. Study 2: Multilevel Regressions Predicting Communication Load, Multitasking, and Stress from Online Vigilance Dimensions

	Comm. load IM		Comm. load SNS		Multitasking		Stress	
	Model 0	Model 1	Model 0	Model 1	Model 0	Model 1	Model 0	Model 1
Fixed effects								
Intercept	5.06***	5.06***	2.08***	2.08***	2.08***	2.08***	2.46***	2.46***
	(0.05)	(0.05)	(0.04)	(0.04)	(0.02)	(0.02)	(0.04)	(0.03)
L2 predictors								
Salience		−0.07		−0.06		0.07*		0.13*
		(0.08)		(0.07)		(0.03)		(0.06)
Reactibility		0.19**		−0.09		0.05		−0.01
		(0.07)		(0.06)		(0.03)		(0.05)
Monitoring		−0.10		0.19**		0.07*		0.07
		(0.07)		(0.06)		(0.03)		(0.05)
Salience (gm)		−0.02		0.10		0.10*		0.14
		(0.11)		(0.09)		(0.04)		(0.07)
Reactibility (gm)		0.14		−0.02		0.09**		0.03
		(0.09)		(0.07)		(0.03)		(0.06)
Monitoring (gm)		0.26*		0.31**		0.05		−0.08
		(0.12)		(0.10)		(0.05)		(0.08)
Comm. load IM (gm)								−0.03
								(0.03)
Comm. load SNS (gm)								−0.00
								(0.04)
Multitasking (gm)								0.23**
								(0.08)
L1 predictors								
Salience		−0.03		−0.00		0.04**		0.05*
		(0.03)		(0.03)		(0.01)		(0.03)

(*Continued*)

Table 2 (continued)

	Comm. load IM		Comm. load SNS		Multitasking		Stress	
	Model 0	Model 1	Model 0	Model 1	Model 0	Model 1	Model 0	Model 1
Reactibility		0.10***		0.08***		0.09***		0.01
		(0.02)		(0.02)		(0.01)		(0.02)
Monitoring		0.14***		0.05		0.04*		0.03
		(0.03)		(0.02)		(0.01)		(0.03)
Comm. load IM								−0.01
								(0.02)
Comm. load SNS								0.03
								(0.02)
Multitasking								0.15***
								(0.04)
Random effects								
Var: id (Intercept)	1.24	1.13	0.81	0.68	0.22	0.14	0.54	0.47
Var: Residual	0.58	0.55	0.52	0.51	0.18	0.16	0.54	0.53
Goodness-of-Fit								
AIC	6559.46	6438.82	6146.07	6058.59	3570.43	3243.62	6047.90	5975.89
Deviance	6553.46	6414.82	6140.07	6034.59	3564.43	3219.62	6041.90	5939.89
Log-likelihood	−3276.73	−3207.41	−3070.04	−3017.30	−1782.21	−1609.81	−3020.95	−2969.94
ICC	0.68		0.61		0.55		0.50	
Marginal R^2/Conditional R^2	0.00/0.68	0.07/0.70	0.00/0.61	0.10/0.61	0.00/0.55	0.22/0.59	0.00/0.50	0.08/0.51
L2-R^2 (Snijders and Bosker)		0.09		0.15		0.33		0.14
L1-R^2 (Snijders and Bosker)		0.05		0.02		0.09		0.02

Notes: $N = 531$ persons; $N = 2{,}326$ diary entries;
$^{***}p < 0.001$,
$^{**}p < 0.01$,
$^{*}p < 0.05$;
Model 0: null model with random intercept; Model 1: random intercept and fixed slopes model with predictors at Level 2 (person) and Level 1 (day); method of estimation: maximum likelihood; Level 2 (L2) predictors are grand-mean centered; Level 1 (L1) predictors are group-mean centered. gm = group mean, reintroduced at Level 2.

salience was positively related to stress ($b = .05$, $p = .046$), while reactibility and monitoring were not.

Finally, we turned to H5 and H6, which predicted mediation effects of the three vigilance dimensions on stress via communication load (H5) and multitasking (H6). A series of 1-1-1 mediation analyses showed that multitasking significantly mediated the effects of day-level salience ($b = .006$, $p = .009$), reactibility ($b = .014$, $p < .001$), and monitoring ($b = .005$, $p = .015$) on stress, supporting H6. No evidence for mediation effects via communication load was found, neither for IM nor SNS. We thus reject H5. Overall, our model explained 14% of between-person differences as well as 2% of daily differences in stress.

Discussion

Study 2 provides additional support from a large daily diary study that inter- as well as intraindividual variation in multitasking increases stress experiences in daily life. Consistent with Study 1, we found no evidence that communication load is related to stress, whereas multitasking showed both person- and day-level associations. Beyond usage patterns, we again tested the three online vigilance dimensions as potential additional stressors. Consistent with Study 1, all dimensions—both when measured at person level and day level (aggregated across all five days)—showed positive zero-order correlations with stress (aggregated across all 5 days; see Tables SA4 and SA5). However, in the multilevel regression model (Table 2), only between-person as well as daily differences in salience were positively related to stress when controlling for the other vigilance dimensions as well as usage patterns. Finally, and again consistent with Study 1, multitasking emerged as a mediator of the effects of all three vigilance dimensions on stress, albeit with very small effects. Communication load did not mediate the relationship between online vigilance and stress. Further research is thus required to establish a clearer picture of whether online vigilance increases the likelihood for students to engage in digital communication parallel to various other activities (e.g., during conversations or in class), which in turn would contribute to the perception of having had a stressful day.

As limitations of Study 2, we note the reliance on a convenience sample of students, biased toward female participants as well as only coarse measurement of communication load and the three vigilance dimensions at day level. While multitasking was measured with more items, the seven-item day-level measure showed low internal consistency. Moreover, all constructs showed relatively high ICCs, indicating a high proportion of between-person variance in the day-level measurements. Participants' responses on the diary measures were thus rather stable across the 5 days, pointing toward a retrospection bias and the need to measure stress at an even more fine-grained temporal resolution.

Study 3

The purpose of Study 3 was to provide the previously called-for fine-grained temporal resolution of online vigilance and stress dynamics by testing the relationship between these two constructs over the course of a day. As iterated before, we assume that online vigilance and stress should vary between persons, but also across situations. We, therefore, conducted an online survey that employed the day reconstruction method (DRM; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004) to achieve an even higher level of detail in measuring our constructs of interest and to account for person-level and situation-level effects on stress.

Method

Choice of method and procedure

The DRM allows to collect data with high temporal resolution and has been used in diverse psychological studies on people's behaviors, cognitions, affects, and experiences (Dockray et al., 2010; Kahneman et al., 2004; Ludwigs, Henning, & Arends, 2019). The unique feature of this method is that it assists respondents in creating structured memories of the previous day (Kahneman et al., 2004). In contrast to a global self-report, self-report as prompted by the DRM is therefore not based on memorable episodes but on specific episodes of "yesterday" and should thus introduce less memory bias (Kahneman et al., 2004). Participants are first asked to divide the experiences of the preceding day into a sequence of episodes. Subsequently, they are asked to respond to questions of interest for each of these predefined episodes.

Sample

Totally, 250 students from a university in Northern Germany participated in an online survey on media use. Calls for participation were circulated electronically via mail and internal online fora. In addition, we advertised the survey by displaying printed posters in diverse university facilities. As an incentive, a 10 EUR voucher of a major online webstore was offered to all individuals upon completion of the survey. After data cleaning, the final sample consisted of $N = 244$ students (52% female, $M_{age} = 23.17$ years, $SD_{age} = 3.45$). Participants structured their day of reference (their "yesterday") into a total of $M = 9.80$ episodes ($SD = 4.34$). They further reported $M = 5.17$ episodes with smartphone use ($SD = 2.87$), leading to a sample of 2,391 episodes, out of which 53% were smartphone use episodes ($N = 1{,}262$).

Measures

As in Studies 1 and 2, we used the 12-item OVS to assess person-level *online vigilance* (see Table 1). This scale was measured at person level before participants divided their previous day into episodes, thus again referring to participants' *overall* online cognitions and motivations. Internal consistency was $\alpha_{salience} = .83$, $\alpha_{reactibility} = .76$, and $\alpha_{monitoring} = .83$. Additionally, we measured each vigilance dimension at

episode level with one item: "Often online content occupied my thoughts, even as I was dealing with other things" for *salience*, "When I received an online message, I immediately gave it my full attention" for *reactibility*, and "I constantly monitored what was happening online" for *monitoring*. Salience was assessed in all episodes, while the items on *reactibility* and *monitoring* were only displayed when participants had used their smartphone at least once in the respective episode. The participants' *perceived stress level* was evaluated with one item ("I was under a lot of stress when I was dealing with the smartphone") measured on a scale from 1 "does not apply at all" to 5 "fully applies".

Results

Means, standard deviations, and zero-order correlations for all variables are presented in Tables SA6 and SA7. As responses at episode level (Level 1) were nested within participants (Level 2), we again conducted multilevel regression analyses using the *R* package *lme4* (Bates et al., 2014). Following the rationale of Study 2, all Level 2 variables (i.e., the three OVS dimensions) were centered around their sample means (i.e., grand mean-centered), while Level 1 variables were centered around their respective person means (i.e., group mean-centered). We again re-entered the person means of Level 1 variables (grand mean centered) in the regression analyses. The results of the multilevel regression analysis can be found in Table 3. Before we tested our hypotheses, we found that ICC = 51% of the variance in situational stress can be explained through the person level, indicating the appropriateness of hierarchical modeling. H3 postulated that online vigilance is positively related to stress. Our results show that interpersonal differences in media users' overall cognitive orientation toward online content and communication (measured with the complete OVS) were not significantly related to situational stress, disconfirming H3a–c. However, the group mean-centered situational measures (reintroduced at Level 2) of salience and monitoring were positively and of reactibility were negatively associated with situational stress, thus supporting H3a and H3b and not supporting H3c. Testing H4, the analyses revealed that for situational stress, only situational salience was a significant, positive predictor (cf., Table 3, Model 1). The more individuals thought about their online communication, the more stress they experienced at this moment. We thus find support for H4a but not for H4b and H4c. Overall, the predictive power of the model was rather low on the situation level, where 2% of variance in situational stress was explained by situation-level vigilance. In contrast, 28% of the variance in situational stress was explained by person-level vigilance. It appears that situational stress varied both across situations and between participants but was explained reasonably well by Level 2 predictors.

Discussion

Study 3 focused on the three online vigilance dimensions as potential stressors and tested the effect of person- and situation-level differences on situational stress. In

Table 3. Study 3: Multilevel Regressions Predicting Situational Stress from Online Vigilance Dimensions

	Model 0	Model 1
Fixed effects		
Intercept	1.57 (0.05)***	1.51 (0.04)***
L2 predictors		
Salience (trait)		0.11 (0.06)
Reactibility (trait)		0.04 (0.05)
Monitoring (trait)		0.02 (0.05)
Salience (gm)		0.47 (0.08)***
Reactibility (gm)		−0.12 (0.05)**
Monitoring (gm)		0.21 (0.06)***
L1 predictors		
Salience		0.11 (0.03)***
Reactibility		−0.03 (0.02)
Monitoring		0.04 (0.03)
Random effects		
Var: id (Intercept)	0.42	0.19
Var: Residual	0.41	0.41
Goodness-of-fit		
AIC	2887.85	2749.78
Deviance	2881.85	2725.78
Log-likelihood	−1440.92	−1362.89
ICC	0.51	
Marginal R^2/Conditional R^2	0.00/0.50	0.27/0.50
L2-R^2 (Snijders and Bosker)		0.55
L1-R^2 (Snijders and Bosker)		0.02

Notes: $N = 244$ participants; $N = 1{,}262$ episodes of smartphone use;
***$p < .001$;
**$p < .01$;
*$p < .05$;
Model 1 = random intercept and fixed slopes with predictors on Levels 2 (person) and 1 (situation); method of estimation: full information maximum likelihood; Level 2 predictors are grand-mean centered, Level 1 predictors are group mean centered, gm = group mean, reintroduced at Level 2.

accordance with Studies 1 and 2, salience was related to increased situational stress when controlling for the other vigilance dimensions. The effect was found both at the person level and the situation level, such that the extent to which individuals are mentally preoccupied with online communication *overall* and *in specific situations* relates to their situational stress levels. Replicating results from the first two studies, situation-level reactibility and monitoring did not play a role for situational stress. We did, however, find significant relationships between person-level differences in

reactibility, monitoring, and stress. This could be explained by the situation-specific measurement of stress used in this study. Perhaps, individuals that are asked to evaluate their overall stress level consider different situations or parts of their lives in comparison to when they are asked to go through their day situation by situation.

Some methodological limitations need to be considered. First, the DRM poses a cognitive strain on participants by requiring them to remember and reconstruct aspects of their preceding day (Reinecke et al., 2018). This strain might impede validity. Future research would benefit from using experience sampling methodology that allows assessing online vigilance and the co-occurring affect and cognitions in situ (e.g., Reinecke & Hofmann, 2016). Further, to reduce strain for participants, single items were used to measure perceived stress and the online vigilance's dimensions in specific situations. However, although the single items do not reflect the entire breadth of each dimension, they plausibly represent their respective conceptual cores. Consistent with Study 2, we also note the limitation of relying on a convenience sample of students.

General discussion

Across three studies, we investigated the stress potential of permanent connectedness. By not only examining multitasking and communication load as usage patterns but also including online vigilance as a potential stressor emerging from users' cognitive orientation to online content and communication, our aim was to extend the theoretical range of digital stress research. Overall, our studies yielded several consistent findings. Concerning the investigated usage patterns, findings consistently show that communication load did not relate to perceived stress. This contradicts previous studies that, for example, found the amount of daily email communication to increase stress (Barley et al., 2011). While communication load showed significant positive zero-order correlations with stress in Studies 1 and 2, this statistical relationship did not remain significant after controlling for online vigilance and multitasking. The results thus demonstrate that a high communication load does not necessarily contribute to the experience of high cognitive load per se, resulting in stressful "overload" of situational resources. This suggests that other factors may be more important predictors of stress than the mere number of messages sent and received or that other individual predispositions could buffer the strain from a high communication load. In a study by Reinecke et al. (2017), for example, communication load was more strongly related to stress for older users, suggesting that individual differences in media literacy or cognitive capacity may moderate the influence of communication load on stress. Alternatively, message characteristics, such as message content and the resulting communicative demands may play an important role in the stress potential of communication load. In contrast to communication load, however, multitasking was quite consistently related to higher levels of perceived stress. This result replicates previous findings

demonstrating a relationship between media multitasking and perceived stress (e.g., Mark et al., 2014; Misra & Stokols, 2012; Reinecke et al., 2017). Our findings thus lend support to the assumption that multitasking exceeds and exhausts users' working memory capacities and, consequently, their situational coping capacities. To further investigate the role of media multitasking and stress as well as the psychological processes involved, future research should focus on possible mediators in this causal relation, for example, working memory capacity.

Turning to the role of cognitive orientations for the emergence of stress, we found mixed patterns of relationships between the three dimensions of online vigilance and perceived stress. Salience, the constant thinking about online interactions and message content, emerged to be positively related to stress in all three studies. Regardless of whether a person's mind is occupied with thoughts about online communication in general, whether this only occurs on single days, or even in specific situations, a strong cognitive focus on online communication seems to co-occur with higher levels of perceived stress. Being "cognitively online" rather than present in the moment appears to go hand in hand with undesirable effects on media users' stress levels. These findings stand in contrast to the notion that individuals successfully cope with being permanently online by simply becoming used to this mental state (Hefner & Vorderer, 2017; Reinecke et al., 2017).

The findings for the other two dimensions of online vigilance, however, were less clear-cut. While we found positive zero-order correlations between reactibility, monitoring, and perceived stress across all three studies, these statistical relationships did not remain significant when controlling for salience, both at the person and the situation level. Considering that salience was the only online vigilance dimension consistently related to higher levels of stress, these findings could indicate that salience requires the most cognitive coping resources (Reinecke et al., 2018). When these resources are overstrained, feelings of stress emerge (Lazarus & Folkman, 1984). In other words, when people permanently dedicate a considerable part of their cognitive resources to online communication going on "in the back of their mind," they no longer have sufficient cognitive resources to deal with situational demands and, thus, feel stressed more quickly. These results are congruent to findings of Johannes et al. (2020), who found that high salience is related to lower levels of well-being, and point to the importance of cognitive processes for the onset of information overload. When media users are constantly mentally occupied with what is happening online, they cannot fully engage with other, simultaneous activities.

Consequently, we can assume that in situations of high salience, people are not mindful of their online media and smartphone use, but rather experience a form of mind-wandering. This would fit well with former findings of Johannes et al. (2018) who demonstrated that higher degrees of online vigilance are associated with more mind wandering and less mindfulness. Mind-wandering and reduced mindfulness, again, are related to decreased affective well-being and diminished satisfaction with life (Killingsworth & Gilbert, 2010). When controlling for salience, the motivation

to instantly react to incoming cues (i.e., reactibility) and the tendency to observe one's online sphere actively and constantly (i.e., monitoring) appear to be less critical for the emergence of digital stress. One possible explanation for this pattern of results may be found in differences regarding the context-specificity of the three online vigilance dimensions. While salience refers to a more general mental preoccupation that constantly puts the individual's cognitive resources under demand, reactibility and monitoring represent more temporal peaks in cognitive demand resulting from short instances of checking for or responding to messages. Whether these peaks in demand result in stress may be more context-specific than the cognitive demands resulting from salience. Future research will thus need to address the boundary conditions that moderate the influence of reactibility and monitoring on stress more systematically. It appears reasonable to assume, for example, that reactibility and monitoring may be relevant stress-triggers only in situations in which ICT use creates significant goal conflict with other tasks, obligations, or social interactions. Alternatively, salience, reactibility, and monitoring may represent a hierarchy of different subfacets of online vigilance with salience as a more basic cognitive preoccupation of Internet-related thoughts setting the stage for subsequent components of vigilance such as reactibility and monitoring. In this case, statistically controlling for salience as the main source of stress may simply leave no variance in stress that could be uniquely explained by reactibility and monitoring. Consequently, the null findings for reactibility and monitoring may also be a statistical artifact resulting from multicollinearity between the three related online vigilance dimensions. Future research should thus examine the temporal and causal relationships between salience, reactibility, and monitoring more closely.

Studies 1 and 2 tested the indirect link of online vigilance on stress via communication load and multitasking. While online vigilance was not related to communication load, and communication load had no effect on perceived stress, results for multitasking supported our assumption that higher degrees of salience, monitoring, and reactibility are associated with higher degrees of multitasking, which in turn was related to higher levels of stress. Thus, it appears that people's online mindset indeed affects how they arrange their communication environment. Especially users with chronic attention to message cues (monitoring) seem to be more likely to engage in multitasking. As they are constantly focused on their online channels, they are apparently also willing to continually allocate additional resources to ICTs regardless of their current main activity. Our results thus demonstrate that media users with a high online vigilance have their online conversations and communication channels mentally top of mind and, consequently, are more likely to be confronted with their limited and already strained cognitive resources, which, in the end, may increase stress.

These findings have important implications for research on digital stress as they demonstrate that the cognitive orientation of media users and their media usage patterns show important connections and have mutual effects on stress. The findings also contribute significantly to our understanding of the role of online vigilance

in the context of stress. In combination, the results show that while some facets of online vigilance (i.e., the salience dimension) are directly associated with stress, others (i.e., monitoring and reactivity) show only indirect statistical effects via multitasking. This suggests that while salience acts as a separate situational demand that increases the likelihood of stress experiences independent of actual ICT-use, monitoring and reactibility seem to be associated with *how* ICTs are used and may predispose users to more stress-inducing usage practices.

Methodological considerations

The combination of the three study designs applied results in a few methodological limitations beyond those of the individual studies already discussed above that need to be taken into consideration when interpreting the findings. First, all three studies relied on self-report data. Self-report measures of media use potentially suffer from inaccurate recall, biased heuristics, or a lack of motivation that may result in inaccurate and biased estimates of media exposure (De Vreese & Neijens, 2016). These limitations may be particularly pronounced within the current "always-on" media environment as mobile devices have vastly increased the opportunities for media use over the day with media use typically consisting of several short usage episodes, often representing automatic behavior rather than conscious media exposure decisions (Schneider, Reich, & Reinecke, 2018). To reduce these potential measurement biases, we have followed recommendations by Schneider et al. (2018) and used multiple methodological approaches (i.e., cross-sectional survey, diary data, day-reconstruction-method) to assess media usage patterns with different temporal resolutions among our three studies. Nevertheless, future research would strongly benefit from a combination of self-report data and behavioral usage observation (e.g., via tracking apps).

A second limitation refers to the fact that our nonexperimental data does not allow for causal inferences or a final evaluation of the direction of the observed effects. While stress was treated as a dependent variable in the present series of studies, a reverse direction of effects would be equally plausible. In fact, previous research suggests that excessive Internet use can represent a maladaptive attempt to cope with distress (e.g., Li, Zhang, Li, Zhen, & Wang, 2010; Müller et al., 2018). Future research thus needs to further investigate the reciprocal relationship between ICT use and stress. Furthermore, it is important to note that in Studies 2 and 3, the effects of person-level online vigilance on stress slightly differed, depending on whether the person level was operationalized via an overall trait measure (the full OVS) or as a person mean aggregate of situationally measured online vigilance. However, both measurement approaches have their respective advantages and complement each other in our studies: using full four-item scales for all three online vigilance dimensions provides greater concept validity, whereas forming person-level means from repeated day- or situation-level measures improve reliability. Future research should compare such measurement differences beyond online vigilance, as it

can be assumed that they apply to other phenomena of media and ICT use, as well. Finally, in contrast to Studies 1 and 2, Study 3 found a positive relationship between monitoring and stress as well as a negative relationship between reactibility and stress. We suggest that this inconsistency in findings should be interpreted with caution. Compared to Studies 1 and 2, the statistical power of Study 3 was lower. Given the small effect sizes, the inconsistent results found for reactibility and monitoring may thus be spurious.

Research outlook

Overall, the presented findings add to the existing literature on online behavior, mobile Internet use, and digital stress. We show that not only specific usage patterns such as multitasking but also a permanently connected mindset may have costs for users' cognitive capacity, resulting in more stressful experiences in daily life. The present study thus widens the perspective of previous research by suggesting that cognitive orientations such as online vigilance represent an additional source of "digital stress" beyond that of the well-documented effects of overt ICT usage patterns. Open questions remain, however, regarding the specific situational processes that connect ICT usage patterns and cognitive user orientations to the emergence of stress. It is largely unclear, for example, how ICT use interacts with the appraisal process underlying stress reactions. Overt usage patterns and online vigilance may either affect *primary appraisal*, that is, make it more or less likely that users detect harm, threat, or challenge in a given situation, suggesting an "unfavorable person-environment relationship" (Lazarus, 1993, p. 8), thus increasing the risk of experiencing stress. Alternatively, ICT use and ICT-related cognitive and motivational orientations may affect *secondary appraisal*, that is, increase or decrease the perceived availability of coping options in a specific situation (Lazarus & Folkman, 1984). We believe that further investigating those different sources of ICT-related stress and their mutual interactions may be a fruitful approach to extend our understanding of the promises and pitfalls of living in a permanently connected world.

Supporting Information

Additional Supporting Information may be found in the online version of this article.

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Data availability statement

The data and the questionnaires underlying this article are available in the Open Science Framework, at https://dx.doi.org/10.17605/OSF.IO/P2HBX.

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