Videoconference Fatigue Exploring Changes in Fatigue after Videoconference Meetings during COVID-19

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Abstract

In response to the COVID-19 global health pandemic, many employees transitioned to remote work, which included remote meetings. With this sudden shift, workers and the media began discussing videoconference fatigue, a potentially new phenomenon of feeling tired and exhausted attributed to a videoconference. In the present study, we examine the nature of videoconference fatigue, when this phenomenon occurs, and what videoconference characteristics are associated with fatigue using a mixed methods approach. Thematic analysis of qualitative responses indicates that videoconference fatigue exists, often in near temporal proximity to the videoconference, and is affected by various videoconference characteristics. Quantitative data was collected each hour during five workdays from 55 employees who were working remotely because of the COVID-19 pandemic. Latent growth modeling results suggest that videoconferences at different times of the day are related to deviations in employee fatigue beyond what is expected based on typical fatigue trajectories. Results from multilevel modeling of 279 videoconference meetings indicate that turning off the microphone and having higher feelings of group belongingness are related to lower post-videoconference fatigue. Additional analyses suggest that higher levels of group belongingness are the most consistent protective factor against videoconference fatigue. Such findings have immediate practical implications for workers and organizations as they continue to navigate the still relatively new terrain of remote work.

Keywords: Fatigue; Work meeting; Videoconference; COVID-19; Remote Work

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The onset of COVID-19 and the months-long shutdown accelerated the long-predicted trend of remote work (Niles, 1975; Raghuram et al., 2019). At its peak, one estimate reported that 70% of American workers operated remotely at least some of the time in April 2020 (World at Work, 2020), requiring workers to engage in remote meetings. While many workers have returned to their brick-and-mortar locations, others have not and continue to rely on remote meetings to complete their tasks, creating an urgency for scholars to research the implications of this context. One specific phenomenon in this context that emerged is *videoconference fatigue*[1], which is the degree to which people feel exhausted or tired attributed to engaging in a videoconference. Recent evidence suggests that videoconferences are more fatiguing than in-person meetings because of increased sustained attention (Spataro, 2020). Reports of the videoconference fatigue phenomenon contrast with research that suggests people prefer remote meetings. For example, individuals believe in-person work meetings are an ineffective use of time (Geimer et al., 2015) and cause end-of-day fatigue (Luong & Rogelberg, 2005), whereas videoconferences are viewed as more efficient (Lantz, 2001), shorter in duration (Denstadli et al., 2012), and are associated with higher performance on complex group tasks than in-person meetings (Rosetti & Surynt, 1985). Videoconference fatigue could reduce these and other benefits, especially since lower employee energy is related to lower job performance and higher voluntary turnover (Wright & Cropanzano, 1998) and is an indicator of reduced employee well-being (Bliese et al., 2017). Thus, to examine how to minimize this potentially negative outcome, we employ a mixed methods research design to explore the nature of videoconference fatigue,

[1] This has also been referred to as "Zoom fatigue" in reference to the virtual meeting interface Zoom (e.g., Fosslien & Duffy, 2020; Jiang, 2020), but for future generalizability, we do not refer to it by its colloquial name.

investigate temporal aspects of videoconference fatigue, and analyze relationships between videoconference characteristics and videoconference fatigue.

Through our examination, we contribute to scholarship in multiple ways. First, we utilize Attention Restoration Theory (ART; Kaplan, 1995) to provide a new theoretical lens to understand why individuals experience videoconference fatigue. ART is useful for this investigation because 1) it explicitly recognizes that fatigue is caused by sustained attention and 2) it provides unique insights beyond theories using work characteristics to explain how to minimize fatigue (Quinn et al., 2012). Second, we identify the nature of videoconference fatigue and differentiate it from overall work fatigue and other specific fatigue constructs (e.g., citizenship fatigue, compassion fatigue), highlighting the distinctiveness of this construct. Third, we assess the temporal nature of videoconference fatigue by replicating the non-linear daily trajectories of fatigue during a workday (Hülsheger, 2016) and discovering that deviations from an individual’s normal daily fatigue trajectory can be caused by videoconferences at specific time points. Previous research suggests that work meetings are related to end-of-day fatigue (e.g., Loung & Rogelberg, 2005; Rogelberg et al., 2006). We extend this body of research to show *when* videoconferences are more fatiguing. Explicitly integrating time into our exploration provides a novel contribution (e.g., Shipp & Cole, 2015) that advances our understanding of human energy changes throughout the workday. Fourth, we challenge a common assumption that there is a “typical meeting,” which has often resulted in assessing meetings as having an average, stable influence on employee well-being. Instead, we take Rogelberg et al.’s (2006) view that “meetings differ among themselves in several ways” (p. 95). This affords a more dynamic evaluation of the phenomenon and extends the meetings literature by capturing meeting-level differences. Drawing from ART (Kaplan, 1995), we focus on how participants can alter their videoconference-related behaviors (i.e., muting oneself, turning off video, etc.) *in each meeting* and experience varying levels of group belongingness that may lessen videoconference fatigue. These contributions have practical implications for organizations and workers because discovering ways to manage videoconference fatigue can reduce negative work-related outcomes of fatigue (e.g., job performance, citizenship behaviors; Sonnentag, 2015).

Attention Restoration Theory

ART is a theory about human energy that explains how energy is depleted specifically by sustained attention, which is the effort required to focus attention and process information (Kaplan, 1995). A critical contribution of ART is that it proposes that individual actions like "being away", "effortless attention", and "compatibility" can minimize fatigue or even replenish depleted energy in ways not explicitly described in other human energy frameworks (Quinn et al., 2012). Previous research 1) drew upon the work interruptions literature to explain that work meetings are fatiguing because they increase time demands or work hassles (e.g., Loung & Rogelberg, 2005; Rogelberg et al., 2006), or 2) utilized affective events theory (AET; Weiss & Cropanzano, 1996) to examine positive or negative attitudes caused by meetings as a discrete work event (Rogelberg et al., 2010). However, these previous frameworks are inadequate for this investigation for several reasons. First, the work characteristics framework does not capture characteristics specific to videoconferencing (e.g., mute), whereas ART provides a key insight in recognizing that energy is influenced by more than typical work demands and resources (Quinn et al., 2012). Second, AET is a broad theory used to explain relationships between affect with work attitudes and behaviors, but some have argued that AET fails to explain how, when, and why work events trigger emotional responses (Ashton-James & Ashkansay, 2005). Instead, ART allows us to explore that videoconferences are associated with fatigue because of increased sustained attention (how), during certain times of day (when), and are influenced by specific videoconference characteristics (why).

The Nature of Videoconference Fatigue

The construct of videoconference fatigue was absent from our collective vocabulary until March 2020 when many U.S. professional workers began working from home due to the COVID-19 pandemic (Google Trends, https://bit.ly/3oe8PW6). Soon after, news contributors popularized the term through stories reporting how meeting participants felt exhausted following a videoconference, describing the phenomenon as “the impression of feeling overly drained after a period of meeting over a videoconference tool” (Nardi, 2020). Because our first contribution in this study is a conceptual one, we generate a testable and falsifiable definition of the phenomenon. Thus, we define videoconference fatigue as *the degree to which people feel exhausted, tired, or worn out attributed to engaging in a videoconference*.

Videoconference fatigue naturally fits within the broader domain of human energy, which is an affective construct expressing an individual’s level of emotional activation (Quinn et al., 2012). Fatigue is the affective state of unpleasant deactivation (Yik et al., 2011) commonly described as feeling exhausted or tired (Quinn & Dutton, 2005). Videoconference fatigue is conceptually similar to the more general construct of work fatigue, yet it is different from work fatigue in at least two ways. First, work fatigue is caused by general job demands (e.g., role overload, time demands) as well as non-work demands that spill over into work time (Frone & Tidwell, 2015). Conversely, the causes of videoconference fatigue are importantly more specific than general job demands, such as avoiding distractions from technology and paying greater attention due to fewer nonverbal cues. Second, videoconference fatigue is temporally distinct. Work fatigue is conceptualized and measured as an end-of-workday feeling (Winwood et al., 2005), whereas videoconference fatigue is conceptualized as a near-term feeling attributed to a specific event (i.e., a videoconference). Similar to other fatigue-related constructs such as citizenship fatigue (Bolino et al., 2015) and compassion fatigue (Joinson, 1992), the antecedents of videoconference fatigue are distinct and not related to other work demands. However, videoconference fatigue is different from these constructs because of its distinct temporal nature. For example, compassion fatigue is the result of cumulative and prolonged experiences (Coetzee & Klopper, 2010), whereas videoconference fatigue can occur after just one event. In sum, we propose that videoconference fatigue is similar to other fatigue constructs, but it has distinct antecedents and a unique temporal structure—thus making videoconference fatigue a unique phenomenon that merits further study.

Temporal Considerations of Videoconference Fatigue

One temporal element that distinguishes videoconference fatigue from related constructs is event timing, which is a key aspect of understanding the theoretical relationships between constructs (Mitchell & James, 2001). Event timing is critical because an experience during a certain time period can change an individual's fatigue state. Figure 1 provides different visual representations of how event timing can influence fatigue. Figure 1a considers a change in fatigue from a previous time point, such as how walks or relaxation exercises during employee lunch breaks reduce fatigue states (de Bloom et al., 2017). If changes in fatigue states are considered over a longer time period, a trajectory or pattern can be discovered (Figure 1b). Indeed, research has shown that, in general, individual feelings of fatigue change throughout the day in a nonlinear pattern, such that fatigue decreases in the first few hours and then steadily increases (Thayer, 1987). Another temporal consideration is how an experience alters this typical fatigue trajectory. This approach considers the shape of changes in fatigue over time (Figure 1c).

For example, Hülsheger (2016) found that an employee's psychological detachment recovery experiences and sleep quality the previous evening changed the shape of the fatigue trajectory. However, during the workday, specific events at certain times can alter fatigue, and these alterations may be minor deviations (Figure 1d) or statistically significant deviations (Figure 1e) from one's expected trajectory. For example, the popular press suggests videoconferences later in the day may be more fatiguing (Williams, 2020). Therefore, we ask:

Research Question 1: When does videoconference fatigue occur?

Videoconference Characteristics Associated with Videoconference Fatigue

ART posits that individuals can reduce levels of fatigue in a few ways (Kaplan, 1995). One possibility is by detaching from events that demand attentional resources. Referred to by ART as a sense of "being away," videoconference attendees may enable one of the following features to "detach": muting oneself, turning off one's webcam, or not looking at one's own video mirrored on-screen. ART also highlights that "compatibility" with one's environment (i.e., higher belongingness) and "fascination" or being in engaged in a task (i.e., higher *voluntary* attention; Kaplan & Berman, 2010) can minimize fatigue. However, it is unclear what videoconference characteristics have stronger relationships with fatigue. For example, turning off the webcam should be related to lower fatigue because it provides relief from having to be "on" the entire meeting (i.e., higher detachment being related to lower fatigue). With this line of thinking, we could expect that using the webcam more often would be related to higher fatigue. Yet, using the webcam more often could also be related to lower fatigue because it can foster a personal connection among meeting attendees. Due to this lack of clarity, we explore:

Research Question 2: What videoconference characteristics are related to fatigue?

Method

We used a mixed methods approach combining quantitative and qualitative data collection to provide methodological triangulation by coupling measurement precision and authenticity of context (Turner et al., 2017). In order to obtain a diverse sample of employees working remotely during the COVID-19 pandemic, we employed multiple recruitment strategies. First, study participation invitations were sent via email through two young professional networking groups in different metropolitan cities in the southeastern United States. Second, we used the online panel Prolific to sample additional participants (Porter et al., 2019). Management scholars have used online panels to recruit a diverse sample of working adults in previous work meetings research (e.g., Shanock et al., 2013; Allen et al., 2018; Rogelberg et al., 2006) and in population sampling during the COVID-19 pandemic (e.g., Luchetti et al., 2020). Previous experience sampling studies have also used multiple recruitment strategies such as personal and professional networks, snowball sampling, and online panels (e.g., Lanaj et al., 2020; Trougakos et al., 2020). To be eligible, participants had to (a) be located in the Eastern US time zone (EDT/UTC-5; required so all surveys were sent during the same working hours), (b) work from home in some capacity due to the COVID-19 pandemic, (c) be 18 years old or older, (d) work at least 20 hours per week, and (e) have remote work meetings planned for the week of data collection. Individuals recruited through professional networks were incentivized with electronic gift cards. Participants received $5 for completing the qualitative survey, $5 for completing at least 10% of the quantitative surveys, $15 for completing at least 50% of the quantitative surveys, and each survey completed was an entry into a lottery system for one of two $100 gift cards. Individuals recruited through Prolific received an average payment rate of $21.40/hour. This study was part of a larger data collection and the procedure was deemed exempt by Old Dominion University IRB #1598432 titled Videoconference Fatigue.

A total of 69 participants met the study eligibility criteria and consented to participate. These individuals were then contacted and had approximately five days to complete an initial demographic survey. Participants were removed from the dataset before analysis if they had low response rates (completed fewer than 50% of all quantitative surveys, $N = 10$) or if their work conditions did not change significantly due to the COVID-19 pandemic (working from home only "a little", $N = 1$; worked from home most or all of the time before the pandemic, $N = 3$)[2]. The final sample consisted of 55 individuals working in a wide range of industries (i.e., legal services, banking and finance, engineering, health care, education, information technology). The majority of participants were male (58.2%) and White (72.7%). On average, participants were 33.60 years old ($SD = 9.05$), spent 3.31 ($SD = 1.37$) years in their current job, and worked 43.82 ($SD = 6.50$) hours per week. Quantitative data was collected in 1-week phases from April 30 – May 22, 2020. Qualitative data was collected September 2020[3].

Participants received nine hourly surveys each workday (9:30 a.m. – 5:30 p.m.) for five consecutive working days (Monday – Friday), as well as a before-work survey available from 6 a.m. – 9 a.m. All surveys had a time limit expiration such that participants could only complete a survey during a specified time (e.g., 9:30 a.m. – 10:29 a.m.). Table 1 provides information about all measures used in this study. We chose an interval-contingent design that sent a survey each hour because it is considered less intrusive than a random signal-contingent approach, is more appropriate for questions related to temporal phenomena, and minimizes the chance of noncompliance found in event-contingent designs because the routine survey schedule lessens

[2] We removed these individuals because it is possible that those who worked remotely pre-COVID-19 engaged in videoconference meetings and had already developed strategies to prevent or reduce videoconference fatigue. Including them could potentially suppress our ability to detect the phenomenon.

[3] We thank our reviewers for recommending a qualitative data collection to enhance our conceptualization of videoconference fatigue, improve our theorizing, and augment the practical implications of our research.

participant's burden of remembering to complete a survey after each videoconference event (Fisher & To, 2012). A 5-day study design was chosen to minimize participant burden caused by completing hourly surveys[4]. Participants completed a total of 1,746 surveys during the week, participated in an average of 5.75 videoconference meetings across all five days, and when analyzed by day, individuals participated in zero videoconferences on 42.6% of the days, participated in one videoconference on 26.7% of the days, and participated in two or more videoconferences on 29.8% of the days.

We solicited responses to three open-ended questions: 1) You indicated that you have heard of "Zoom fatigue" or "videoconference fatigue." In your own words, please describe this phenomenon[5]; 2) Teleconferences are meetings held only over the phone, whereas videoconferences include the element of video (e.g., Zoom, Teams, Skype, FaceTime). Please describe your experiences meeting in-person vs. videoconference vs. teleconference. Do you feel the same or different during and after meetings of different modes? In what ways and when?; and 3) How have you changed the way you approach videoconference meetings since March 2020 (e.g., setting them at different times, using/not using your webcam or video)?

Results

Qualitative Exploration

To enhance our understanding of videoconference fatigue, we conducted a thematic analysis (Braun & Clarke, 2006). Specifically, we engaged in an inductive analysis following Braun and Clarke's (2012) six-phase approach wherein we analyzed the responses to all questions and allowed themes to emerge from the data. In line with this procedure, we relied on

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[4] See similar rationale for a 3-day interval-contingent study in French & Allen, 2019.

[5] This first question was only displayed if they indicated in a previous question that they had heard of "videoconference fatigue" or "Zoom fatigue."

our theory (ART) to inform theme aggregation. Thirty-nine participants provided usable qualitative responses (70.9% response rate). All authors met to consensus build around a definition of videoconference fatigue informed by responses to the first question. Three authors independently developed themes across the questions, then reconciled differences in themes and theme descriptions. Three major themes emerged. To provide additional support for the themes, two graduate students independently coded responses using the themes provided. We estimated inter-rater agreement by theme (Kurasaki, 2000). Agreement among the original and the two students' coding ranged from 77% to 97%, supporting the original themes (Krippendorff, 2013).

The first theme included psychosomatic and psychological descriptions of the videoconference experience, which included feeling exhausted, fatigued, tired, drained, or worn out. As one respondent wrote about videoconferences, "Tired of being in them, extra tired after being in them." Another wrote that videoconference meetings "can be taxing on the mind and spirit." Overall, 92.9% of respondents mentioned a psychosomatic or psychological manifestation of fatigue when answering the first open-ended question, providing preliminary evidence of this unique experience.

The second theme captured the concept of time as it related to videoconferencing. This included the frequency of meetings such as being in videoconferences "all day," "all the time," or "back-to-back." Participants also referred to the length of videoconferences (e.g., "for extended periods"), when videoconferences were held (e.g., "Most of my [videoconferences] are in the mornings"), and how their energy waned throughout the day because of videoconferences (e.g., "I am also teaching 100% virtual. In the morning I feel great, and ready to go, but by lunch, I can't stand staring at a computer screen"). Another participant mentioned that they "prefer to schedule [videoconferences] more towards the start of my workday as opposed to the end of the workday." Overall, participants provided insight about when videoconference fatigue occurred (RQ1), noting that it happened after multiple videoconference meetings, because of extended durations of screen time while videoconferencing, or due of the time of day of videoconferences.

The final theme included in-meeting causes of videoconference fatigue (RQ2) and ways in which participants tried to reduce this feeling. Notably, 87.2% of participants mentioned positive and negative aspects of one characteristic unique to videoconferences as opposed to other meeting types: the use of video/the webcam. One major cause of fatigue was the effort required to sustain attention during a videoconference. One participant wrote that they "get tired of feeling like they have to have their attention at 100 percent and continually staring into the camera the entire meeting." Another participant wrote that "I do feel more tired after videoconference meetings especially if my camera is on, because I feel that expectation to look at the camera all the time to pay attention." Other challenges included difficulty due to visual demands (e.g., paying more attention to attendees because of fewer nonverbal cues), technical problems (e.g., unable to hear someone clearly), or distractions such as other work. For example, one participant wrote, "I catch myself looking at my video, much more distracted, most of the time I end up working on something else while the call/video is running." Respondents also reported several ways they tried to manage videoconference fatigue during meetings including turning off their camera or enabling mute. As one participant put it, "I'm also more comfortable with opting to turn the camera off. I think I (and some of my colleagues) felt like we always had to be ON at first." Similarly, restructuring meetings by enacting rules to not do other work during meetings appeared to help participants pay attention more fully and experience less fatigue.

In addition to increased effortful attention, participants noted that the challenges associated with fostering personal connections during videoconferences also influenced fatigue.

For example, one participant wrote that “video conferencing is quite impersonal. [E]veryone just wants to get in and get out, log in and log off. [T]here's very little chatter before and after the meeting like there would be in real life.” Participants reported that turning on their webcam often helped to solve issues related to personal connection for themselves or for others. As two respondents wrote, “I have made a conscious effort to use video more often. For people not yet back to the office it helps them stay connected on a personal level,” and “videoconferences are good to see others and have a bit of a connection.” In all, the thematic analysis affords three key observations: 1) there is preliminary evidence that videoconference fatigue is a feeling of exhaustion caused by sustained attention during videoconferences, 2) time plays a role in attendees’ experiences of videoconference fatigue, and 3) there are various ways in which attendees try to alleviate videoconference fatigue and these methods are consistent with core ideas of ART.

Quantitative Exploration

Table 2 provides the means, standard deviations, and correlations of variables at the meeting level. Intraclass coefficients indicated that 51.0% of the total variation in fatigue was between-person variation (i.e., an individual difference in fatigue across people), 9.8% was between-day variation (i.e., differences in fatigue related to the day of the week), and 39.2% was within-day variation (i.e., fatigue variation occurring within each day). This amount of variation at different levels is evidence that a multilevel approach is appropriate. We tested our research questions using recommended practices (see Appendix A for details of our analytic approach).

Research Question 1 asked when videoconference fatigue occurs, and the qualitative responses suggested that this happens at various time points throughout the day. To examine this research question empirically, we first tested a series of nested models to determine if and how fatigue levels change throughout the day (Table 3). Based on prior research (e.g., Hülsheger, 2016) we specified and compared a linear latent growth model and a quadratic growth model[6]. Consistent with Hülsheger (2016), we found the quadratic growth model to be the best fitting model and resulted in a significant improvement in model fit over a linear growth model (scaled $\Delta\chi^2[4] = 32.07$, $p < .01$). Both the linear (coeff. = -.06, $p = .006$) and quadratic (coeff. = .02, $p = .000$) slope factors were significant indicating that fatigue initially declines in the morning and then increases throughout the afternoon and early evening (similar to Figure 1b).

Having established the overall trajectory of fatigue throughout the day, we then tested whether having a videoconference explained additional variance in fatigue at a given time point over and above the natural trajectory of fatigue. To do so, we regressed the observed value of fatigue onto the videoconference variable (i.e., yes/no videoconference) from that time point. We also ran models with 1) lagged effects (t – 1) to see if having a videoconference in the previous hour affects fatigue levels in the following hour, and 2) other work in the past hour to determine if videoconferences have a greater impact on fatigue than performing other work. Table 4 shows the results of these analyses. Model fit of all three models were acceptable (Model 1: $\chi^2[100] = 170$, CFI = .96, RMSEA = .05; Model 2: $\chi^2[180] = 306.04$, CFI = .95, RMSEA = .05; Model 3: $\chi^2[172] = 293.26$, CFI = .95, RMSEA = .05). To aid our interpretation of the results we calculated the cumulative probability of significance for each coefficient using Bliese and Wang (2020) Formula 1. Cumulative probability of significance helps to address the limitations of relying on point estimates as it informs readers the probability of observing the results in a

[6] We compared model fit using the SB χ^2 likelihood ratio (Satorra & Bentler, 2010), as well as with differences in Akaike information criteria (AIC; Burnham & Anderson, 2004), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). We considered CFI values greater than .95 and RMSEA values lower than .08 to be indicative of good fit (Kline, 2016). Better fitting models are those with significant change in SB χ^2 and lower AIC values.

particular sample. Four patterns of results emerged. One pattern is that videoconference meetings between 10:30 – 11:30 a.m. (captured in the Time 3 survey) were related to higher levels of fatigue consistently in all three models. A second pattern is that videoconferences in the early afternoon between 1:30 – 2:30 p.m. were related to higher fatigue at Time 6 (2:30 p.m. survey) or a lagged effect at Time 7 (3:30 p.m. survey)[7]. A third pattern is that videoconferences between 3:30 – 4:30 p.m. were related to higher fatigue at Time 8 (4:30 p.m. survey) or a lagged fatigue effect at Time 9 (5:30 p.m. survey). These three patterns indicate that videoconferences are associated with fatigue levels higher than one's expected fatigue trajectory at different times of the day (as illustrated in Figure 1e), even after controlling for other work conducted in the past hour. Interestingly, a fourth pattern that emerged is a negative effect at Time 5 (1:30 p.m. survey) and lagged negative effect at Time 6 survey (2:30 p.m. survey), meaning that levels of fatigue were lower than the expected trajectory that can potentially be attributed to a videoconference.

Research Question 2 examined the relationships between videoconference characteristics and fatigue. For these analyses, data were used only if the participant had one videoconference since the last survey and if they completed the current as well as the previous survey. The final dataset for this analysis contained 279 observations. To justify multilevel modeling, we tested an unconditional model for post-videoconference fatigue (i.e., a model with no predictors) and then tested whether the change in the -2-log likelihood (i.e., deviance) statistic was significant when we add our predictors using a scale corrected chi-square test (Hox et al., 2017)[8]. The log likelihood comparisons were significant (ΔSB χ^2 (7) = 43.71, $p < .001$) and the AIC was

[7] This finding indicates that videoconferences may have a fatiguing effect immediately after or one hour after the videoconference. This is not the same as testing the cumulative effect of videoconferences, such as an accumulation effect of multiple videoconferences on fatigue. We did test the effect of the total number of videoconferences on fatigue at the end of the day. Total number of meetings was not statistically significant with end-of-day fatigue. Complete results of this analysis are available from the first author.

[8] A traditional chi-square difference test cannot be performed with the MLR estimator.

similarly reduced (ΔAIC = 26.45), thus indicating an improvement in fit over the null model when predictors are added. Multilevel regression results are provided in Table 5. Controlling for fatigue in the previous survey, turning the webcam off (γ = -.09, *p* = .08), watching oneself (γ = -.09, *p* = .29), attention during the meeting (γ = -.08, *p* = .25), and videoconference meeting duration (γ = .00, *p* = .98) had no statistically significant impact on post-meeting fatigue. However, muting one's microphone[9] (γ = -.09, *p* = .02) and perceptions of group belongingness had a negative relationship with fatigue (γ = -.21, *p* = .003). Collectively, these multilevel analyses support ideas within the ART framework that both psychological experiences (i.e., belongingness) and technology behavior (i.e., using mute) are related to lower levels of fatigue.

Post Hoc Analysis

However, it seems possible that these two characteristics could have a synergistic interaction (e.g., strengthening the relationship with fatigue) or a restricted variance interaction, such that as certain values of one characteristic changes (i.e., belongingness), other values on another characteristic (i.e., mute) become less plausible (Cortina et al., 2019). For example, an individual could feel a high level of group belongingness *and* be less likely to use mute (i.e., talk more), or an individual could have a low level of group belongingness *and* use mute for most of the meeting. In fact, perceptions of group belongingness and mute share a significant negative zero-order correlation (r = -.45, p < .01), indicating that perceptions of higher belongingness in

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[9] Readers will note that the correlation between microphone use and fatigue is not significant, indicating a type of suppression effect. We explored this further and determined that this significant weight for microphone use was what Friedman and Wall (2005) call enhancement, which is a form of suppression in which an independent variable is unrelated to the dependent variable but is related to other independent variables and increases total R^2 (i.e., $|\widehat{\beta}_1| > |r_{y1}|$ and $R^2 > r_{y1}^2 + r_{y2}^2$). This means that variance explained in Y goes down if this predictor is excluded. Friedman and Wall detail several ways in which R^2 can increase because of suppression and one of those ways is by suppressing irrelevant variance in another predictor. Although the sign of the weight may not mean much, as is generally the case in the presence of high collinearity, ΔR^2 is still meaningful. Friedman and Wall go so far as to say that "discarding variables with small or zero correlation with the criterion is not necessarily a good idea when maximum R^2 is desired" (p. 130) and also advocate that suppressor variables "should not be ignored" (p. 131). Thus, we interpret this relationship as our goal is to understand what contributes to (or reduces) videoconference fatigue.

this sample is associated with less muting, and lower belongingness is related to more muting. Given that theory (ART) and our empirical results suggest that higher levels of both belongingness and mute are related to lower fatigue, but that these characteristics may not co-occur at high levels, we tested the interaction of these two variables.

Standardized multilevel regression results indicated a statistically significant interaction term (see Appendix Table 1), which is visualized in Figure 2. Overall, this interaction shows that mute levels do not impact fatigue at high levels of group belongingness, indicating the importance of group belongingness to reduce videoconference fatigue. For individuals with low group belongingness, not using the mute function has a compensatory effect, meaning that meeting attendees who reported lower group belongingness but had their microphone on (i.e., less mute) experienced less fatigue post-meeting. Interestingly, the highest levels of fatigue occurred when individuals reported high use of mute and low levels of group belongingness, which we suspect is similar to findings that task disengagement is related to higher mental fatigue (Hopstaken et al., 2015).

Discussion

During the COVID-19 global pandemic, social distancing measures meant that many in-person meetings shifted to remote meetings, often held via videoconference. In this study, we examined the videoconference fatigue phenomenon, which we define as *the degree to which people feel exhausted, tired, or worn out attributed to engaging in a videoconference*. The extreme case of the COVID-19 pandemic, which caused many workers to shift to a virtual work environment, offers a unique opportunity to explore this phenomenon because extreme cases are advantageous when seeking evidence of previously subtle relationships (Chen, 2016).

Using a mixed methods design of qualitative open-ended responses and quantitative data from hourly assessments across one work week, our study resulted in three core findings that can influence the science and practice of meetings and enhance our theoretical understanding of fatigue. First, results of our thematic analysis suggest that videoconference fatigue is a unique construct. This experience, first reported by the media, was confirmed by 92.9% of the participants in our qualitative survey. Recognizing and naming this experience is important because videoconference meetings are generally viewed as beneficial (e.g., more efficient; Lantz, 2001; more productive; Rosetti & Surynt, 1985); pinpointing videoconference fatigue can hopefully help minimize reductions of these benefits. Additionally, although related to general work fatigue, the causes of videoconference fatigue are distinct from those of general work fatigue. Videoconference fatigue also tends to occur closer in temporal proximity to the experience (i.e., the videoconference), which is different from work fatigue (typically described as end of workday fatigue) and different from fatigue caused by prolonged experiences (e.g., citizenship fatigue). Because videoconference meetings may have distinct characteristics that influence fatigue, the existing meetings literature may not extend to videoconference meetings, thus highlighting the importance of scientific inquiry aimed at this phenomenon.

Second, we show that it is not simply the act of having a videoconference meeting that can alter fatigue, but *when* that videoconference occurs. Qualitative responses indicated that time played an important role in understanding videoconference fatigue, and the empirical analyses provided more precise examination as to when this occurs. Latent growth results indicate that videoconference meetings are associated with higher fatigue at certain times of the day, with more instances occurring later in the day. However, the relationship with lower fatigue at the mid-day time point (1:30 p.m.) suggests that videoconference meetings could be beneficial. It might be that a mid-day videoconference meeting reduces the after-lunch decrease in attention (Smith & Miles, 1986), or it could be that individuals reported lower fatigue because of an effective lunch break (Bosch et al., 2018). This unexpected finding warrants further research. These findings contribute to the overall understanding of worker fatigue and extends general ideas about employee fatigue trajectories occurring in a nonlinear pattern (Hülsheger, 2016) by demonstrating that specific events influence fatigue beyond the expected trajectory. Importantly, this contributes to our theoretical understanding of fatigue trajectories by examining how work events influence fatigue *throughout the day*, supplementing previous research on how work experiences alter energy levels over days (e.g., Chawla et al., 2019), months (e.g., Hatch et al., 2019), and years (e.g., Fan et al., 2019). Our use of latent growth analysis with time-varying covariates also provides a useful template for how future researchers can create similar models to understand how measures of a time-specific construct can influence temporal patterns of another construct. In addition, this finding highlights the need to include timing in organizational theorizing (Morgeson et al., 2015), as time itself can alter the relationships between other constructs (Shipp & Cole, 2015).

Third, this study utilized theoretical framing from ART, which provided new insights because it specifically identifies sustained attention as causing fatigue and proposes that "compatibility" and "being away" can reduce fatigue, ideas that are not explained in theoretical frameworks typically used in the meetings literature (e.g., work characteristics, AET). The qualitative responses highlighted that a variety of characteristics affect the degree of fatigue experienced, and the quantitative analyses tested the relations between some of these characteristics and fatigue. Combined, the findings from this study suggest that individuals can feel *less* fatigued when they experience a higher sense of belonging with fellow attendees or find ways to reduce attentional demands using videoconference technology (i.e., mute), which mirror ART's propositions. Testing the interaction of these two characteristics suggested that even if group belongingness is low, fatigue is also lower if the individual uses mute less (i.e., actively participates in the meeting). These finding highlight the importance of considering the impact of videoconference characteristics on employee well-being, especially when employees are physically distant from each other, and represents a particularly fruitful avenue for future research. Given ART's consideration of sustained attention and its suggestion that behaviors and activities that enhance compatibility or provide a sense of detachment can reduce the harmful effects of sustained attention, it is likely that ART will be a particularly useful framework for future inquiries regarding the relation between videoconference fatigue and well-being.

Practical Implications

Given that videoconferences are expected to continue beyond the COVID-19 pandemic, it is important to provide clear practical recommendations as to how videoconference fatigue can be reduced. We make several recommendations based on the results of our quantitative and qualitative analysis in Table 6. We also provide theoretical explanations of how these recommendations may affect fatigue as well as current evidence regarding their effectiveness.

Limitations and Future Directions

There are limitations of this study that provide avenues for future research. First, although we tested the most common recommendations for reducing videoconference fatigue, we were not able to test all possible ways through which one may reduce videoconference fatigue, such as whether efforts to foster personal connections at the beginning of the call through "chit chat" (Methot et al., 2020) may lessen fatigue (please see Table 6 for additional future directions). Second, although we found that the nonlinear trajectory of fatigue in a quadratic pattern was stable between individuals and days, this finding may only apply to the five consecutive workdays for employees with the ability to work remotely in a traditional (Monday-Friday) work week. Future research should explore changes in fatigue trajectories occurring throughout multiple weeks, longer periods of respite such as weekends (e.g., Hahn et al., 2012), and individuals with nontraditional work arrangements (e.g., Campion et al., 2020). Relatedly, a third potential limitation of this study is that we focused on post-meeting fatigue. This was a valuable inquiry, however, work on citizenship fatigue suggests that fatigue can accumulate in the long-term and affect whether someone engages in future citizenship behaviors (Bolino et al., 2015). Our participants suggested that videoconferencing may also have long-term effects: "People start to get tired of and dislike online videoconferences like Zoom" and "People have grown tired of such meetings." Future research should examine the long-term build-up of videoconference fatigue and whether this influences individuals' willingness to participate in future videoconferences, as well as their pre-meeting and in-meeting attitudes and behaviors. Fourth, though we focused on fatigue (i.e., low energy) because we were examining the videoconference fatigue phenomenon, investigating changes in vigor (i.e., high energy) is an important future research direction because fatigue and vigor deplete and replenish for different reasons and at different rates (Bennett et al., 2020). Lastly, we did not consider the effect of remote meeting content (e.g., the meeting topic) on videoconference fatigue; however, ART suggests that when individuals are intrinsically interested in meeting content, paying attention may come naturally and thus not be fatiguing (Kaplan, 1995). Therefore, we suggest that future research considers the moderating effect of meeting content on videoconference fatigue.

Conclusion

The COVID-19 pandemic has accelerated the long-predicted trend of remote work (Niles, 1975; Raghuram et al., 2019). Indeed, even as social distancing recommendations ease, a recent survey of CFOs found that 74% planned to permanently move some of their positions to remote positions (Gartner, Inc., 2020). Thus, remote work and videoconferences are likely to become more common. The term videoconference fatigue suggests that videoconferences harm employee well-being; however, results of our study suggest that there are aspects of videoconference meetings (e.g., group belongingness, mute, time of day) that alter fatigue. Videoconference meeting participants can use these strategies to reduce their fatigue.

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Table 1

Measures Used in Study

Variable	Number of items	Measure	Item	Scale anchors
Fatigue [a]	4	Profile of Mood Scales (POMS; McNair et al., 1971)	"Please indicate the extent to which you feel the following right now" Items: Fatigued, tired, exhausted, spent	6-point scale from "not at all" to "extremely
Attention	1	Davis and Yi (2004)	"I paid close attention during the meeting"	6-point scale from "strongly disagree" to "strongly agree"
Webcam off	1		"During your most recent meeting, how often did you turn off your webcam or hide your video screen?"	5-point scale from "never" to "all of the time"
Microphone off (mute)	1		"During your most recent meeting, how often did you use mute?"	5-point scale from "never" to "all of the time."
Watches self	1		"During the most recent videoconference, how often did you look at yourself on the screen?"	5-point scale from "never" to "all of the time."
Group belongingness	1	Work Group Integration scale (Kraut et al., 1998)	"Consider the individuals who were in your most recent meeting and rate your level of agreement: I feel part of the group"	6-point scale from "strongly disagree" to "strongly agree"
Meeting duration	1		"How long was your most recent meeting (in minutes)?"	
Work past hour	1		"Have you completed any work-related tasks in the past hour?"	
Videoconference meeting	1		"How many work meetings have you had since the last survey? What type of meeting was your most recent meeting? (videoconference, teleconference, electronic chat)"	

Note. All variables were measured in the hourly surveys (sent from 9:30 a.m. to 5:30 p.m.). Fatigue was also measured in the morning before work. Videoconference characteristics assessed using shortened 1-item measures of constructs to minimize work interruption, which is similar to other event-based survey designs (e.g., Hunter & Wu, 2016) and is reasonable for constructs with a single dimension (Gabriel et al., 2019). If participants had multiple meetings during the previous hour, they were asked to respond to the items considering their most recent meeting. [a] We computed Cronbach's alpha and ω at the within-day (α = .90, ω =.90), between-day (α = .94, ω =.95), and between-person (α = .97, ω =.97) levels using multilevel confirmatory factor analysis (e.g., Geldhof et al., 2014).

Table 2

Means, Standard Deviations, and Correlations among Study Variables at Meeting Level

	M	SD	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1 Fatigue (*t* – 1)	1.99	1.05							
2 Fatigue	2.04	1.07	.53**						
3 Attention	4.97	1.12	-.15*	-.08					
4 Microphone off (mute)	2.65	1.53	.14	-.01	-.49**				
5 Webcam off	2.13	1.67	.08	-.09	-.32**	.42**			
6 Watching oneself	1.96	.88	.05	.03	.18	-.18*	-.53**		
7 Group belongingness	5.04	1.00	-.15	-.26**	.50**	-.45**	-.30**	.19*	
8 Meeting duration	37.90	19.91	.09	.02	.06	.21	-.01	.05	-.08

Note. Correlations are at the between-meeting level (*N*= 279) hourly observations nested within 5 days within 55 employees). Fatigue (*t* – 1) is fatigue measured at the previous time point. * $p < .05$. ** $p < .01$.

Table 3

Test and Comparison of Latent Growth Trajectories of Fatigue

Model	χ^2	*df*	scr	CFI	RMSEA	[90% CI]	AIC	ΔAIC	ΔSB χ^2	Δscr	Δ*df*	*p*
Linear	171.89	40	1.68	0.91	0.11	[.09, .13]	4475.95					
Quadratic	89.42	36	1.25	0.96	0.07	[.06, .09]	4402.35	73.6	32.07	5.49	4	<.01

Note. AIC = Akaike information criteria; CFI = comparative fit index; χ^2 = chi-square value given by maximum likelihood robust estimator; 90% CI = 90% confidence interval associated with RMSEA; *df* =degrees of freedom; *p* = significance of the ΔSB χ^2; RMSEA = root mean square error of approximation; scr = scaling correction factor; ΔAIC = change in AIC; Δ*df* = difference in *df*; ΔSB χ^2= corrected differences in SB chi-square; Δscr = src for ΔSB χ^2.

Table 4

Parameter Estimates for Quadratic Latent Growth Model of Fatigue with Time-Varying Covariates

	Model 1				Model 2				Model 3			
	Coeff.	SE	*t*-value	Cum. Prob. (%)	Coeff.	SE	*t*-value	Cum. Prob. (%)	Coeff.	SE	*t*-value	Cum. Prob. (%)
Time 1 (9:30 a.m. survey)												
Videoconference meeting	.11	(.09)	1.22	22.31	.14	(.10)	1.40	28.01	.07	(.11)	.64	9.03
Other work					-.17	(.15)	-1.13	19.74	-.28	(.22)	-1.27	23.79
Time 2 (10:30 a.m. survey)												
Videoconference meeting (*t* – 1)	-.09	(.08)	-1.25	23.21					-.12	(.08)	-1.5	31.43
Videoconference meeting	-.13	(.08)	-1.63	35.99	-.14	(.08)	-1.75	40.75	-.08	(.08)	-1.00	16.31
Other work					-.05	(.10)	-.50	7.03	-.17	(.25)	.68	9.69
Time 3 (11:30 a.m. survey)												
Videoconference meeting (*t* – 1)	-.09	(.07)	-1.29	24.44					.08**	(.03)	2.67	75.30
Videoconference meeting	.14*	(.07)	2.00	50.62	.19**	(.07)	2.71	76.51	.21**	(.07)	3.00	84.44
Other work					-.05	(.08)	-.63	8.84	-.20	(.44)	-.45	6.34
Time 4 (12:30 p.m. survey)												
Videoconference meeting (*t* – 1)	.08	(.10)	.80	11.94					.12	(.16)	.75	10.94
Videoconference meeting	-.01	(.08)	-.13	3.32	.06	(.05)	1.20	21.72	-.10	(.20)	-.50	6.98
Other work					.10	(.09)	1.11	19.19	-.01	(.52)	-.02	2.55
Time 5 (1:30 p.m. survey)												
Videoconference meeting (*t* – 1)	-.03	(.05)	-.60	8.45					-.08	(.09)	-.89	13.76
Videoconference meeting	.01	(.09)	.11	3.18	-.15**	(.06)	-2.50	69.63	-.16	(.19)	-.84	12.70
Other work					.15*	(.07)	2.14	56.16	.06	(.63)	.10	3.06
Time 6 (2:30 p.m. survey)												
Videoconference meeting (*t* – 1)	-.19**	(.05)	-3.80	96.39					-.14	(.12)	-1.17	20.82
Videoconference meeting	.07	(.06)	1.17	20.86	.15*	(.07)	2.14	56.16	.16*	(.08)	2.00	50.62
Other work					.03	(.06)	.50	7.03	-.09	(.49)	-.18	3.65
Time 7 (3:30 p.m. survey)												
Videoconference meeting (*t* – 1)	.12**	(.05)	2.40	66.07					.14	(.20)	.70	10.03
Videoconference meeting	.18	(.13)	1.38	27.34	.14	(.12)	1.17	20.86	.14	(.11)	1.27	23.79

Other work					.10	(.07)	1.43	29.02	-.04	(.28)	-.14	3.34
Time 8 (4:30 p.m. survey)												
Videoconference meeting (*t* – 1)	.17	(.11)	1.54	32.88					.03	(.10)	.30	4.69
Videoconference meeting	.32**	(.09)	3.56	93.98	.17**	(.04)	4.25	98.73	.25	(.14)	1.79	42.30
Other work					.12**	(.04)	3.00	84.39	-.06	(.11)	-.55	7.66
Time 9 (5:30 p.m. survey)												
Videoconference meeting (*t* – 1)	.30**	(.11)	2.72	76.82					.35**	(.08)	4.38	99.12
Videoconference meeting	.03	(.27)	.11	3.18	.24	(.20)	1.20	21.72	.24	(.14)	1.71	39.20
Other work					.07	(.06)	1.17	20.86	-.15	(.44)	-.34	5.09

Note. N = 274 days. (55 employees for 5 days; 1 person was missing all data from 1 day). *Videoconference meeting* is dichotomous (0 = no videoconference, 1 = videoconference). *Videoconference meeting* (t – 1) is the lagged effect of a videoconference meeting at the previous time point. *Other work* is a dichotomous variable (0 = no work; 1 = any work in past hour). Model 1: Videoconference meetings and lagged videoconference meetings as time-varying covariates of fatigue. Model 2: Videoconference meetings, lagged videoconference meetings, and other work at time-varying covariates of fatigue. Unstandardized estimates shown. * $p < .05$. ** $p < .01$.

Table 5

Results of Multilevel Regression of Fatigue

	Fatigue	
Variable	γ	SE
Intercept	2.02 **	(.13)
Fatigue (*t* – 1)	.52 **	(.11)
Videoconference characteristics		
Attention	-.08	(.07)
Microphone off (mute)	-.09 *	(.04)
Webcam off	-.09	(.05)
Watching oneself	-.09	(.08)
Group belongingness	-.21 **	(.07)
Meeting Duration	.00	(.00)

Note. *N* = 279 hourly observations (nested within 55 individuals across 5 days). Using the formula by Bryk and Raudenbush (1992) as suggested by LaHuis et al. (2014), this model explains 16% of the variance in fatigue. Unstandardized estimates provided. Fatigue (*t* – 1) is fatigue measured at the previous time point and used as a control variable in this analysis. * $p < .05$. ** $p < .01$.

Table 6

Recommendations for Reducing Videoconference Fatigue

Recommendations Supported by our Quantitative Study	Potential Explanation for Fatigue Reduction	Current State of Evidence	Future Research Directions
1. Hold meetings at a time that is least fatiguing for as many participants as possible based on work schedule, which may be earlier in the work period.	Human energy levels, including fatigue levels, can fluctuate over the course of a day, and past research suggests that certain experiences can alter an individual's fatigue trajectory (Hülsheger et al., 2016). Given that meetings are affect-generating events (Rogelberg et al., 2010), they may influence fatigue trajectories throughout the day.	Results of our quantitative study suggested that meetings at different times of day affected individuals' fatigue beyond their expected trajectories. Fatigue was higher than expected at more timepoints later in the day.	Although holding meetings at certain times may be less fatiguing, additional research is needed to determine the productivity-fatigue tradeoff that may exist.
2. Enhance perceptions of group belongingness.	Enhancing perceptions of group belonginess is expected to reduce fatigue by making attendees feel more connected with each other and more interested in participating in the meeting, thus reducing effortful attention and fatigue (Kaplan & Berman, 2010).	Theory suggests that when individuals are given the opportunity to interact socially with others, they are more likely to feel part of a group (e.g., Reichers, 1987). In our quantitative study, higher feelings of group belongingness were associated with less post-meeting fatigue.	There are several different ways for employees to interact socially, including allowing meeting attendees to chit-chat (Methot et al., 2020), organizing happy hours (Maurer, 2020), etc. More research is needed to determine the best way to build perceptions of group belongingness during videoconferences.
3. Unless you are speaking, mute your microphone.	ART (Kaplan, 1995) suggests that fatigue is caused by the mental effort required to sustain attention, but that individuals can reduce fatigue in a variety of ways, such as "detaching" from meeting characteristics that cause	Results of our quantitative study indicated that individuals who muted themselves during meetings experienced less	Future research should consider the influence of mute on attendees' willingness to speak up

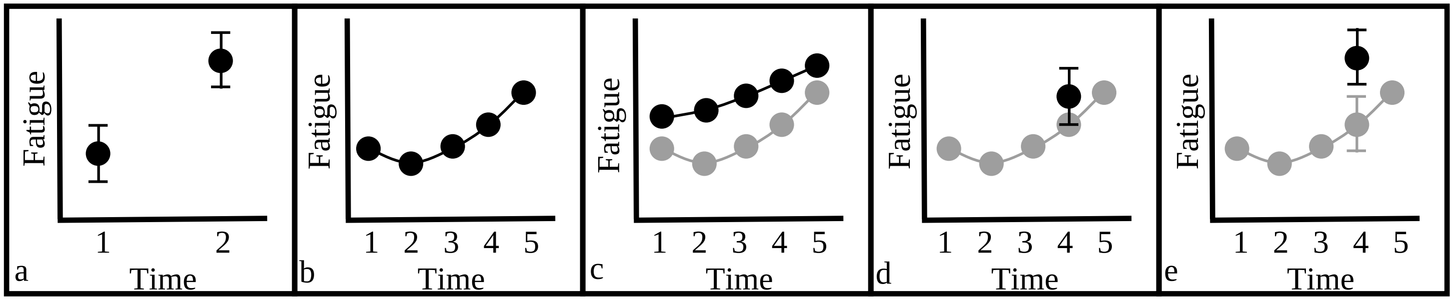
	distraction or require sustained attention. By using mute when not speaking, distractions such as background noise are avoided, making it easier for everyone in the meeting to pay attention with less effort. Furthermore, using mute may reduce the amount of time one spends worrying about maintaining a quiet atmosphere during meetings, which could also reduce fatigue levels.	fatigue. However, results of the interaction between group belongingness and mute found that at low levels of group belongingness, using mute more frequently was related to increased fatigue, whereas use of mute had no apparent relation with fatigue when group belongingness perceptions were high.	and whether this affects their perceptions of group belongingness.
Recommendations with Inconclusive Evidence from our Quantitative Study	**Potential Explanation for Fatigue Reduction**	**Current State of Evidence**	**Future Research Directions**
4. Decrease/increase webcam usage.	Turning off one's webcam is another way to "detach" that may reduce fatigue by reducing the number of stimuli on one's computer screen to be distracted by. Furthermore, having one's video off may also reduce the time one spends worrying about what their colleagues will think about how they look, their facial expressions, how clean their house is, etc., resulting in less fatigue. Indeed, several participants noted that one reason they felt videoconferences were fatiguing was because they felt pressure to be "on" and pay more attention to their "looks and attire." However, keeping one's webcam on may enhance the extent to which one feels connected and engaged with the other meeting attendees, thus increasing feelings of group belongingness. For instance, one participant stated that they use their webcam more often because, "For people not yet back to the office it helps them stay	Results of our quantitative study were inconclusive. Individuals who indicated that they did not use their webcam reported less fatigue; however, this effect was not statistically significant.	Additional research is needed to better understand the two competing perspectives on how webcam usage affects videoconference fatigue and whether there are specific circumstances in which one strategy might be more effective than the other.

	connected on a personal level." Given that higher group belongingness is related to less fatigue, leaving one's webcam on may reduce fatigue if it increases a feeling of group belongingness.		
5. Consider using 'hide self' view.	When one's video is displayed on their own screen, there is a greater number of stimuli with which to be distracted. Indeed, one participant noted "I catch myself looking at my video, much more distracted." Therefore, to reduce the amount of stimuli onscreen, one can use 'hide self' view, which should ultimately result in less fatigue. Although others may still be looking at your video, being unable to see it yourself may reduce the amount of time that you spend worrying about how you or your background look while still enhancing group belongingness, resulting in less fatigue.	In our quantitative study, we asked participants to indicate how often they looked at themselves during the meeting. It is possible that participants may not have been consciously aware of how often they looked at themselves or felt uncomfortable indicating that they looked at themselves frequently. In fact, the mean for that item was comparatively low (1.95).	To better understand whether looking at oneself affects fatigue, future research should test whether using 'hide self' view mode results in less fatigue.
Recommendations Based on Qualitative Comments	**Potential Explanation for Fatigue Reduction**	**Current State of Evidence**	**Future Research Directions**
6. Take breaks during videoconferences (e.g., look away from the screen, stand up and walk around) and between videoconferences.	Breaks (either during meetings or between meetings) give participants an opportunity to detach, which is a key way that individuals can reduce fatigue according to ART (Kaplan, 1995). For instance, one participant noted "I sometimes turn off my webcam for brief periods if I need to get up and walk away from my computer or take a short break." Furthermore, it is particularly important to consider breaks when one is videoconferencing, if they are not naturally built in between meetings. As one participant noted, "there are nonstop zoom meetings back to back every hour or so all day. There's no time in between to take a break of walk or chat with others like it would be in real life/in person."	Evidence suggests that even short micro-breaks, can help reduce fatigue levels (Bennett et al., 2020).	Future research is needed to determine if breaks can affect videoconference fatigue specifically.

7. Establish group norms (e.g., usage of mute and webcam, acceptability of multitasking, when/how to speak up).	Establishing group norms may reduce fatigue in two ways. First, when strong norms exist, individuals will experience less ambiguity regarding what acceptable behavior is and when such behavior should occur (e.g., Hackman, 1992). Thus, when norms exist, individuals will not need to expend effort worrying about what they should do, which should reduce fatigue (Kaplan, 1995). Indeed, one participant noted, "I think some of this fatigue happens because we aren't sure what the expectations are of the meeting. Am I allowed to talk? Should I turn on my camera?" Second, when strong norms exist, individuals may feel more strongly connected to the group, which should enhance their level of interest and engagement in the meeting, and thus result in less fatigue (Kaplan, 1995).	There is extant evidence that group norms are associated with higher levels of cohesion and productivity (e.g., Chatman & Flynn, 2001; Gully et al., 1995).	More research is needed to determine if the existence of group norms related to videoconferences decreases videoconference fatigue.

Figure 1

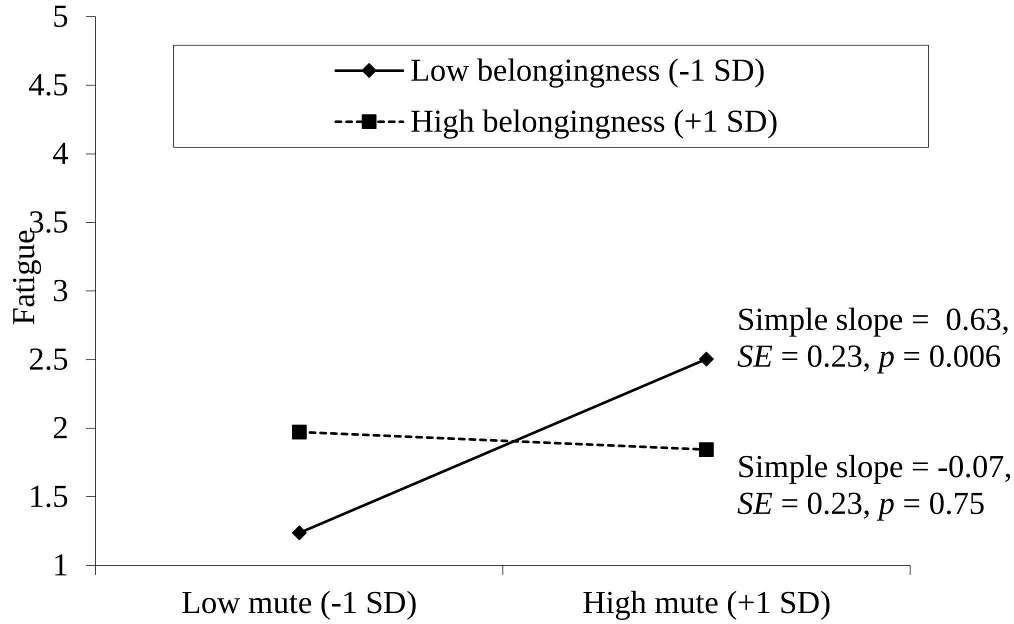
Illustrative Examples of How Time Impacts Fatigue



Note. Panel (a) illustrates how fatigue can change from one time point to another. Panel (b) illustrates how fatigue changes over time throughout the day with a typical trajectory. Panel (c) illustrates how fatigue trajectories may differ between days or between individuals. The grey trajectories in Panels (c), (d), and (e) are the same as in Panel b, black dots or trajectories illustrates a possible change. Panels (d) and (e) illustrate how an experience at a certain time may create deviations from one's expected trajectory, and that deviation may be minimal (d) or a statistically significant different level from one's expected trajectory (e).

Figure 2

Figure of Interaction between Mute and Group Belongingness on Fatigue



Appendix

Empirical Analytic Approach

Analyses were completed using Mplus 8.4 (Muthén & Muthén, 1998-2017). To explore how videoconference meetings impacted fatigue throughout the day (Research Question 1), we utilized latent growth analysis with videoconference meetings included as time-varying covariates of fatigue[10]. Time-varying effect models are useful in studying the temporal change of a construct (i.e., fatigue) and how a covariate (i.e., videoconference) influences the construct at each specific time point accounting for the temporal patterns (Tan et al., 2012). The effects of videoconference characteristics on fatigue (Research Question 2) were tested using multilevel modeling in which videoconferences were nested within days, which were nested within individuals. We within-person centered Level 1 predictors, which removed variance that could be attributed to between-day factors (e.g., Monday compared to Tuesday variations) and between-person factors like individual differences in fatigue or survey response tendencies (Enders & Tofighi, 2007). We controlled for each person's previous level of fatigue because this measure captures the negative effects of any previous work (e.g., feeling fatigued from videoconferences earlier in the day)[11].

[10] We used the sandwich estimator to take into account the clustered nature of our data (i.e., observations nested within days). This estimator has been shown to provide unbiased and robust estimation of standard errors for clustered data (Rogers, 1993; White, 1980). We specified this estimator in Mplus by using the syntax TYPE=COMPLEX.

[11] We did not control for the previous amount of videoconferences during the day because the previous fatigue level captures the fatigue that could be caused by videoconferences earlier in the workday or any other reason for fatigue. For the first hourly survey sent at 9:30 a.m., the previous level of fatigue was measured in the before-work survey.

Appendix Table 1

Results of Multilevel Regression of Fatigue with Interaction

Variable	Fatigue γ	SE
Intercept	1.89 **	(.10)
Fatigue (*t* – 1)	.35 **	(.07)
Meeting characteristics		
Attention	-.07	(.06)
Microphone off (mute)	.28	(.17)
Webcam off	-.01	(.06)
Watching oneself	-.03	(.05)
Group belongingness	.02	(.09)
Meeting Duration	-.01	(.05)
Mute X Group belongingness	-.35 *	(.15)

Note. $N = 279$ hourly observations (nested within 55 individuals across 5 days). Using the formula by Bryk and Raudenbush (1992) as suggested by LaHuis et al. (2014), this model explains 17% of the variance in fatigue. Standardized estimates provided to more easily interpret the interaction with variables on different scales (Mute was measured on a 5-point scale and Group Belongingness was measured on a 6-point scale). Fatigue (*t* – 1) is fatigue measured at the previous time point and used as a control variable in this analysis. $^{*}\ p < .05$. $^{**}\ p < .01$.