Computers in Human Behavior Reports 4 (2021) 100119

Contents lists available at ScienceDirect

Computers in Human Behavior Reports

journal homepage: www.sciencedirect.com/journal/computers-in-human-behavior-reports

Zoom Exhaustion & Fatigue Scale

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ARTICLE INFO

Keywords:
Videoconference
Zoom fatigue
Nonverbal mechanisms
Communication
Scale

ABSTRACT

In 2020, video conferencing went from a novelty to a necessity, and usage skyrocketed due to shelter-in-place throughout the world. However, there is a scarcity of academic research on the psychological effects and mechanisms of video conferencing, and scholars need tools to understand this drastically scaled usage. The current paper presents the development and validation of the Zoom Exhaustion & Fatigue Scale (ZEF Scale). In one qualitative study, we developed a set of interview prompts based on previous work on media use. Those interviews resulted in the creation of 49 survey items that spanned several dimensions. We administered those items in a survey of 395 respondents and used factor analyses to reduce the number of items from 49 to 15, revealing five dimensions of fatigue: general, social, emotional, visual, and motivational fatigue. Finally, in a scale validation study based on 2724 respondents, we showed the reliability of the overall scale and the five factors and demonstrated scale validity in two ways. First, frequency, duration, and burstiness of Zoom meetings were associated with a higher level of fatigue. Second, fatigue was associated with negative attitudes towards the Zoom meetings. We discuss future directions for validation and expansion of the scale.

Introduction

In March 2020, the World Health Organization declared COVID-19 a pandemic, leading to the declaration of a public health emergency (WHO, 2020). Public health measures, such as social distancing, quarantine, and closing places of social contact (e.g., schools and businesses) were adopted by governments around the world to slow down the spread of the virus (Nussbaumer-Streit et al., 2020). As a consequence, regular activities individuals usually performed outside of their home had to be conducted at home. For example, Bick, Blandin, and Mertens (2020) showed a dramatic increase in the percentage of the US workforce that worked entirely from home, rising from 8.2% in February 2020 to 35.2% in May 2020.

With individuals sheltered at home and trying to remotely conduct their daily activities (Nguyen et al., 2021), video conferencing has become a crucial tool for education (Lowenthal, Borup, West, & Archambault, 2020), healthcare (Feijt et al., 2020), and business (Bloom, Davis, & Zhestkova, 2021). A prime example is the rapid rise in the use of Zoom, a video conferencing app, from approximately 10 million daily Zoom meeting participants in December 2019 to 200 million in March 2020 and 300 million in April 2020 (Chawla, 2020; Iqbal, 2020).

This thirty-fold increase in video conferences may be part of a growing concern about exhaustion, with the term "Zoom fatigue" catching on quickly in the popular media. The ubiquity of the Zoom platform in video conferences has resulted in genericization, with many people using the word "Zoom" as a verb to replace video conferencing. For this reason, we will use the term Zoom Fatigue throughout the manuscript.

As Zoom Fatigue emerged due to the COVID-19 pandemic, its research is still scarce. Nadler (2020) argued that Zoom fatigue is not caused solely by staring at a screen – a behavior we have been engaging in long before the pandemic – but rather by the complexity of the interpersonal interactions due to the specific spatial dynamics taking place in video conferences. While Wiederhold (2020) noted that the adoption of new communication technologies rarely come without bumps, Nadler theorized Zoom fatigue as emerging from the third skin concept where "participants are not engaged as human actors but 'flattened' into a totality of third skin comprising person, background, and technology." (2020, p. 1). This embodied transformation would then require additional cognitive effort to interact with others through video conferences.

While there is a lack of empirical studies examining the

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https://doi.org/10.1016/j.chbr.2021.100119
Received 10 June 2021; Accepted 5 July 2021
Available online 6 July 2021

psychological effects of this increase in video conference usage, three fields of research can help us theoretically ground the new construct of Zoom fatigue, namely the concept of fatigue, the research on social media fatigue and on interpersonal interaction and nonverbal communication.

Social media fatigue

Similarly, to how video conferences have recently infiltrated many aspects of our life and changed the way we interact with each other, social media have become a main source of communication as argued by Bright and Logan (2018, p. 1213) who stated that "driven by advances in technology and smart phone access, social media have infused themselves into our lives in an unprecedented manner."

This quick rise of social media consumption was followed by users showing signs of social media fatigue. Based on previous research (e.g., Bright, Kleiser, & Grau, 2015; Lee, Son, & Kim, 2016), Dhir, Yossatorn, Kaur, and Chen (2018, p. 141) defined social media fatigue as "a situation whereby social media users suffer from mental exhaustion after experiencing various technological, informative and communicative overloads through their participation and interactions on the different online social media platforms." Frequent and excessive use of social media has been shown to cause social media fatigue (Karapanos, Teixeira, & Gouveia, 2016; Yoa & Cao, 2017) and negatively impact psychological and mental health (Choi & Lim, 2016; Shin & Shin, 2016). Adding to the body of research on the negative impact of social media fatigue, Dhir et al. (2018) identified elevated depression and anxiety as consequences of social media fatigue.

In terms of antecedents to social media fatigue, Fear of Missing Out (i.e., the social anxiety associated with the feeling of missing known but unattended experiences; Bright & Logan, 2018; Dhir et al., 2018), compulsive media use (Dhir et al., 2018) and boredom proneness (Whelan, Najmul Islam, & Brooks, 2020) have been identified as potential triggers. Maier, Laumer, Eckhardt, and Weitzel (2014) also argued that the social overload resulting from social media usage leads to exhaustion and low levels of user satisfaction and a greater intention to decrease their use of social media. Moreover, Shensa and colleagues (2017) investigated the impact of social media users' behavior. They discovered that participants who visited social media platforms more frequently presented significantly more depressive symptoms while the time spent on social media did not seem to play a significant role.

Based on (Maier and colleagues' (2014)) findings concerning a correlation between social media fatigue and low level of satisfaction among the users, we argued that Zoom fatigue might be negatively correlated with the users' attitude toward video conference. Moreover, Shensa and colleagues (2017) argued that the more frequent the visits on social media, the more depressive symptoms were experienced by users although the duration didn't seem to play a role. Expanding their findings to video conferences, we argue that the intensity of video conference usage will positively correlate with the experienced Zoom fatigue. These two hypotheses will be tested in order to validate the ZEF Scale.

Different sets of questions have been used to measure social media fatigue with items such as "I am frequently overwhelmed by the amount of information available on FB" (Dhir et al., 2018), "When searching for information on social media sites, I frequently just give up because there is too much to deal with" (Bright et al., 2015) or "I deal too much with my friends' problems on Facebook" (Maier et al., 2014). While fatigue is defined by several scholars as a self-reported sense of exhaustion grounded both in physical and psychological causes (Potempa, Lopez, Reid, & Lawson, 1986; Yu, Lee, & Man, 2010), the items used to measure social media fatigue have focused on the psychological aspect. Since our goal is to develop a tool that would take into account both the distinct psychological and physical aspects of fatigue associated with video conferences, in particular the nonverbal dynamics unique to videoconferencing (Bailenson, 2021), we decided to theoretically ground our work in the literature on nonverbal behavior and fatigue instead of adapting the existing social media fatigue questionnaires to video conferences.

Measuring fatigue

The concept of fatigue is complex, multifaceted and has been defined in various ways by scholars working in various fields. Piper and colleagues (1987, p. 19) argued that fatigue is a "subjective, unpleasant feeling of tiredness that has multiple dimensions". Smets, Garssen, Bonke, and de Haes (1995, p. 315) defined fatigue as "a normal, everyday experience that most individuals report after inadequate sleep or rest, or after exertion of physical power. People also report feelings of fatigue after mental effort or when they lack the motivation to initiate activities." Despite the lack of general consensus concerning the definition of fatigue, the North American Nursing Diagnosis Association (NANDA) settled on a working definition of fatigue as a sense of exhaustion associated with decreased capacity for physical and mental work (Voith, Frank, & Smith Pigg, 1989). In order to align our work on Zoom Fatigue with NANDA, we define Zoom fatigue as a feeling of exhaustion from participating in video conference calls. In order to account for the physical and mental aspects of fatigue, and based on previous work on fatigue, nine dimensions of fatigue could contribute to our theoretical understanding of Zoom fatigue.

The Multidimensional Fatigue Inventory (Smets et al., 1995) constitutes one of the more widely adopted scales for measuring fatigue and covers five constructs. The way in which people express themselves about their fatigue inspired the first three dimensions. First, a person can comment about their general functioning in relation to fatigue with an utterance such as "I feel tired". In this way, *general fatigue* refers to the general experience of being tired. Second, according to Smets et al. (1995) people relate their feeling of fatigue to a physical sensation and thus they see *physical fatigue* as another construct related to fatigue. Third, people can illustrate their fatigue through difficulty concentrating and thus the authors refer to *mental fatigue* as the cognitive symptoms related to fatigue. The fourth dimension of fatigue in the Multidimensional Fatigue Inventory, *reduced motivation*, implies a lack of motivation to engage in any task, linked to fatigue. Finally, Smets et al. (1995) identified *reduced activity* as the fifth dimension as a decreased level of activity occurs frequently, although not necessary as a consequence of fatigue.

As attending video conferences implies staring at the screen, the *visual fatigue* associated with it might constitute another important dimension of Zoom Fatigue. Visual fatigue is defined by the National Research Council Committee on Vision as "any subjective visual symptom or distress resulting from use of one's eyes" (1983, p.153) and is measured by Tyrrell and Leibowitz (1990) with items such as "my vision seems blurry".

Moreover, video conferences imply social interactions and speech. Scholars have investigated vocal fatigue as a self-perceived condition associated with voicing (Vilkman, 2004). In order to quantify *vocal fatigue*, Nanjundeswaran and colleagues (2015) have developed a self-reported questionnaire, the Vocal Fatigue Index, to identify individuals with vocal fatigue and study the underlying mechanisms. This questionnaire includes 21 statements for which the patients indicate how frequently they experience each of these symptoms such as "My voice feels tired when I talk more". Wright and Cropanzano (1998) argued that social interactions can also lead to *emotional fatigue* that Maslach (1982, p. 2) defined as "the state of feeling overwhelmed, drained and used up".

Finally, McCarthy and Saegert (1978) proposed the concept of social overload based on the negative impact of crowded places. They argued that individuals living in densely populated residences can experience mental and psychological stress as they were exposed to excessive social encounters. In other words, these excessive social contacts would exceed the capacity for social interaction, leading to social overload and potential social withdrawal. As video conferences can often feel like an

overcrowded environment, *social fatigue* can also be taken into account.

Potential causes of zoom fatigue

Previous research helps us understand which aspects of video conferences could lead to Zoom fatigue. As previously outlined by Bailenson (2021), at least four dimensions of interpersonal interaction are transformed by video conferencing and in this way might be responsible for triggering Zoom fatigue, a general experience of exhaustion that seems unique to this mode of communication (though that is a hypothesis which needs to be tested).

Early work by Argyle and Dean (1965) documented the important trade-off between eye gaze and interpersonal distance, suggesting that individuals tend to decrease one cue to compensate for a context-driven increase in another. For example, this trade-off is often experienced when riding an elevator with strangers. As the limited space forces proximity, people tend to compensate by looking down to avoid eye-contact. Video conferences challenge this trade-off with long stretches of direct eye gaze and faces that appear larger on the screen thus mimicking a proximity that would be avoided in a face-to-face situation. Moreover, research has shown that being stared at while speaking causes physiological arousal (Takac et al., 2019), a phenomenon amplified on video conferences because all other participants appear to be directly staring at you, regardless of whether you are speaking or not.

Second, nonverbal communication flows naturally in face-to-face interaction, as people rarely consciously attend to their own nonverbal behavior. As argued by Kendon (1970), nonverbal behavior is simultaneously effortless and incredibly complex. During video conferences, the complex nature of nonverbal behavior remains while extra effort is needed to send and receive signals. For example, Hinds (1999) found that attending a video conference increased cognitive load, measured by mistakes in a recognition task, in interpersonal interaction compared to an audio-only system. This may be because additional cognitive resources are used to manage technological aspects of a videoconference, such as image and audio latency (Hinds, 1999). Indeed, during video conferencing, people need to consciously monitor nonverbal behavior, and to intentionally send cues to other participants. For example, they nod in an exaggerated way for a few extra seconds to signal agreement, which would be executed automatically and effortlessly if they were interacting in person.

A third aspect that may be fatiguing is that video conferences participants often see a real time video feed that functions like a mirror. Duval and Wicklund (1972) argued that individuals are more likely to evaluate themselves when seeing a mirror image. While this can lead to more prosocial behavior, self-evaluation can be stressful. Fejfar and Hoyle (2000) reported a small effect size in their meta-analysis linking self-viewing to negative affect. While studies in the meta-analysis used real mirrors, some studies have examined the effect of seeing oneself via real-time video feed. Ingram, Cruet, Johnson, and Wisnicki (1988) demonstrated an interaction effect in which women become more self-conscious and experience greater social anxiety than men by seeing a video of themselves. Ingram et al. (1988) also investigated the consequences of self-consciousness in a study where participants from both genders received negative feedback after taking a test, priming a negative affect experience. Afterwards, participants either saw real-time video of themselves or not. Women who saw video of themselves responded with greater levels of self-focused attention and negative affect than when they did not view themselves on video. The authors argued that the tendency to self-focus might prime women to experience depression. It is important to note that these studies typically are short and show participants a mirror image for minutes rather than hours. Therefore, it is reasonable to argue that viewing oneself via video conference may trigger self-evaluation, which in turn increases negative affect and fatigue.

Finally, motion has been demonstrated to be an essential part of the learning and creative processes (Oppezo & Schwartz, 2014; Goldin-Meadow et al., 2003). For example, in one study, children who were required to gesture with their hands while learning math showed more learning retention compared to children who were asked to engage in limited gesture or no gesture at all (Goldin-Meadow, Wagner Cook, & Mitchell, 2009). While video conference does not prevent movement per se, being forced to sit in view of the camera likely hinders movement, increases the amount of effort it takes to communicate, and potentially impacts the quality of the work produced through video conference.

To test these hypothetical causes, it is important to create a rigorous scale to measure fatigue associated with video conferencing. Although objective outcomes such as behavioral and physiological measures are generally considered more reliable than self-report measures, a reliable and valid questionnaire is an obvious starting point, and has benefits in terms of scalability and ease of administering.

Overview of studies

In the present paper, we present the development and validation of the Zoom Exhaustion & Fatigue Scale (ZEF Scale) aimed to assess the fatigue associated with video conference use. The scale development process involves three phases, guided by the best practices for scale development proposed by Boateng, Neilands, Frongillo, Melgar-Quiñonez, and Young (2018): Item development, scale development and scale evaluation. Table 1 outlines five studies, and how they mapped onto this framework. This study was approved by the Stanford University Administrative Panel on Human Subjects in Research (IRB-57116).

Item generation

Study 1: literature review and interviews

The first step of the scale development is to define a domain of interest and generate items that measure different aspects of the defined domain. Study 1 aimed to generate a large and broad range of potential items for the ZEF Scale that tap into different dimensions of Zoom fatigue. To this end, we combined deductive and inductive methods by drawing on theoretical insights from a literature review and exploring people's experience of Zoom fatigue from semi-structured interviews.

Method

We created a large pool of potential Zoom fatigue items based on the nine theoretically grounded dimensions of fatigue and researchers' own experience. Next, we conducted interviews with 10 frequent video conference users to identify additional factors that have not been covered in the proposed scale.

Interviewees (5 women and 5 men) were between 20 and 59 years old (M = 37.4, SD = 13.8) and included the following racial/ethnic demographics: three African or African-American or Black, three White, one Hispanic or LatinX, and three participants identifying with more than one ethnic background. The lead author conducted 10 one-on-one interviews online, with an average duration of 43 min (min = 23, max = 70, SD = 13.3). Participants were compensated with $30 Amazon gift cards. Transcripts of the interviews were created using the software *Otter. ai* and then anonymized. In line with IRB guidelines, audio recordings were destroyed after the study.

At the beginning of each interview, the researcher reiterated the study goal and procedure. The researcher shared her screen and presented a series of slides. Each slide included four to five questions designed to capture a specific dimension of Zoom fatigue (e.g., mental fatigue, physical fatigue). For each slide, participants were asked to (1) think aloud how the questions worked together around a given aspect of Zoom fatigue, (2) suggest items that could be removed, (3) comment on the clarity of each item. Participants were also prompted to describe their own video conferencing experiences. We followed Willis (2005)'s strategy to conduct two rounds of interviews. We reviewed the

Table 1
Scale development overview: Five studies across the three phases.

Phase	Study	Description	Sample size (*N*)	Sample
Item generation	I	Literature review & interviews	10	Convenience sample
Scale development	II	Test run of items	52	University research pool
	III	Scale administration	395	Amazon Mechanical Turk
Scale evaluation	IV	Test of reliability	130	University research pool & Lucid
	V	Test of dimensionality & validity	2724	Convenience sample

transcripts of the first 5 interviews and revised the initial Zoom fatigue items based on the feedback. The second round of interviews followed the same procedure to test the revised set of questions with the other 5 participants. After ten interviews, researchers decided to stop as they started to observe similar feedback - an indicator of content saturation.

Results

The literature review and the interviews produced a pool of 49 items gathered around the nine aforementioned constructs related to Zoom fatigue; general fatigue, physical fatigue, mental fatigue, reduced motivation, reduced activity, visual fatigue, emotional fatigue and vocal fatigue and social fatigue. This large number was consistent with the recommended number of the initial pool of questions (i.e., two to five times as large as the items in the final scale; Kline, 1993; Schinka, Velicer, & Weiner, 2012).

Scale development

In this phase, our goal was to examine the 49 created items (see Appendix), reduce items and statistically test the measurement models of the ZEF Scale.

Study 2: test run of items

In order to prepare for a large data collection and make sure the output of the online survey was correct, we tested the survey with the 49 items created in Study 1, with a student sample from a large Western university ($N = 52$). The survey was administered through the Qualtrics platform. Participants (50% women, 50% men) were between 18 and 27 years old ($M = 20.35$, $SD = 1.81$). The distribution of ethnic backgrounds was: 40.4% of White ($n = 21$), 15.4% of Asian or Asian-American ($n = 8$), 13% of African or African-American or Black ($n = 7$), 3.9% of Hispanic or LatinX ($n = 2$), 9.6% Native Hawaiian or Pacific Islander ($n = 5$), 17.3% identifying with more than one ethnic background ($n = 9$). In addition to the 49 fatigue questions, participants were asked to indicate how frequently they used video conference. One student reported using video conferences about once a week (2%), 18 reported using video conferences about once a day (35%) and 33 participants reported using video conferences multiple times per day (63%).

The presence of only one participant using video conferences once a week triggered a reflection around the quality of participants' responses depending on their video conference usage. One of the goals of the scale development is to ensure that participants will lean toward unbiased answers rather than arbitrary ones. Krosnick (1991) argued that three factors trigger answering arbitrarily to a survey; task difficulty, respondents' ability and respondents' motivation. The task difficulty will depend on how remote in time the participants have to recall. Indeed, Krosnick (1991, p. 221) argued that:

> Reports of current states are presumably easier than retrospective recall questions because of the relative remoteness of the relevant information in memory, and questions that require recall of an attitude only a short time ago are presumably easier than questions that require long-term recall.

The respondents' ability can depend on how accustomed they are with the topic at stake as respondents may lack a pre-consolidated attitude or judgement about the topic at stake. The respondents' motivation also plays a crucial role as the motivation might be "influenced by the degree to which the topic of a question is personally important to the respondent" (Krosnick, 1991, p. 223). Based on these three factors influencing the quality of the respondents' answer, one can argue that someone who uses video conference once a week might have problems remembering how they felt after their last video conference. They might also not be accustomed with the topic to provide useful information. Moreover, we can expect that people who use video conferences at a low frequency might not care about the issue of Zoom fatigue. For these reasons, a screening question was added to the survey in subsequent studies to target frequent video conference users. Specifically, only participants who use video conferences at least once a day were considered in data analysis.

Study 3: scale administration

The purpose of this study was to reduce the number of items and test the fit of the measurement model through a series of Confirmatory Factor Analysis (CFA). A total of 395 participants were recruited online through Amazon's Mechanical Turk worker system. This sample size was consistent with the recommended size in prior literature (Comrey, 1988; Guadagnoli & Velicer, 1988). Each participant was compensated with $2.50 for completing the questionnaire. The sample included 37% of women ($n = 148$), 62% of men male ($n = 243$) and 1% of participants who identified neither as man nor woman ($n = 4$). The age ranged from 18 to 70 years old ($M = 30.05$, $SD = 9.13$). The distribution of ethnic backgrounds was: 56.7% of White ($n = 224$), 16% of Asian or Asian-American ($n = 63$), 10.4% of African or African-American or Black ($n = 41$), 8.1% of Hispanic or LatinX ($n = 32$), 4.5% identifying with more than one ethnic background ($n = 18$), 2% declined to answer ($n = 8$), 1.5% Middle Eastern ($n = 6$), 0.5% Native Hawaiian or Pacific Islander ($n = 2$), 0.25%, and one Indigenous or Native American participant ($n = 1$). Forty-five percent of the sample reported using video conferences once a day ($n = 176$) whereas 55% reported using video conferences multiple times a day ($n = 219$).

Results

All analyses were conducted in statistical language in R software (version March 1, 1093). First, item reduction analysis was performed to develop a parsimonious scale with internally consistent items (Thurstone, 1947; Boateng et al., 2018). We followed the Classical Test Theory (CTT) to exclude items based on their inter-item and item-total correlations. Out of the 49 items, eight were removed due to their low item-total correlation (r's < 0.3). Then, we calculated the mean inter-item correlation to test whether the remaining items were reasonably homogeneous while containing sufficient unique variance. The mean inter-item correlation ($r = 0.33$) was within the acceptable range from 0.2 to 0.4.

Second, we conducted a series of iterative second-order CFAs to test our proposed model. The predicted nine-factor model with the remaining 41 items was tested. In the first CFA, 18 items with loadings lower than 0.7 were removed. Since all the items from vocal fatigue were removed, this construct was removed as well. A new model with 8 constructs and 24 items was tested. Nine additional items were removed

due to low factor loadings and the 15 remaining items focused on 5 constructs: general, visual, social, motivational, and emotional fatigue. The remaining two items from the general fatigue construct (gen_1 and gen_5, see Appendix for the wording of the items) were grouped with a remaining mental fatigue item (men_1), creating the construct general fatigue. The two remaining items from the reduced motivation construct (redmot_2 and redmot_4) were grouped with the only remaining item from the reduced activity construct (redac_5), creating the construct of motivational fatigue. This resulted in the following CFA model with good fit metrics: CFI = 0.942, TLI = 0.929, RMSEA = 0.086 and SRMR = 0.039, X^2 (85) = 332.1. Finally, Cronbach's alphas were calculated for each of the 5 remaining constructs, which indicated good reliability (all $\alpha > 0.8$; see Table 2).

While the original 49 items were presented in matrices in order to save participants' time, previous research has shown that completion rate to be lower for individual questions compared to matrices (Couper, Tourangeau, Conrad, & Zhang, 2013; Liu & Cernat, 2018). As the number of items decreased from 49 to 15, time saving became less of an issue. We decided to prioritise completion rate over time saving and edited the remaining 15 items into individual questions with construct-specific response options. These 15 items across 5 constructs constitute the final ZEF Scale and are presented in Table 3. All items are measured on a 5-point Likert-scale ranging from 1 = *"Not at all"*, 2 = *"Slightly"*, 3 = *"Moderately"*, 4 = *"Very"* to 5 = *"Extremely"* except for the two frequency questions (marked with asterisks) from 1 = *"Never"*, 2 = "*Rarely*", 3 = "*Sometimes*", 4 = "*Often*" to 5 = *"Always"*.

Scale evaluation

Study 4: test of reliability and validity

This study aims to assess the internal consistency of the revised version of the ZEF Scale using independent samples.

Table 2
Descriptive statistics, factor loadings and cronbach reliability of the 15 items in the ZEF Scale.

Constructs	Items	Std. loading	Construct loading	α	*Mean*	*SD*
General Fatigue	I feel tired	.81	.99	.87	2.77	1.06
	I feel exhausted	.85				
	I feel mentally drained	.81				
Visual Fatigue	my vision gets blurred	.80	.67	.88	2.30	1.09
	my eyes feel irritated	.87				
	I experience pain around my eyes	.86				
Social Fatigue	I avoid social situations	.72	.93	.81	2.58	1.66
	I just want to be alone	.81				
	I need time by myself	.76				
Motivational Fatigue	I dread having to do things	.78	.95	.86	2.50	1.10
	I don't feel like doing anything	.82				
	I often feel too tired to do other things	.84				
Emotional Fatigue	I feel emotionally drained	.81	1.00	.82	2.35	1.04
	I feel irritable	.75				
	I feel moody	.76				

Note. The prompt for the items was "After video conferencing …"

Table 3
Survey questions for the ZEF Scale.

Constructs	Questions
General Fatigue	How tired do you feel after video conferencing?
	How exhausted do you feel after video conferencing?
	How mentally drained do you feel after video conferencing?
Visual Fatigue	How blurred does your vision get after video conferencing?
	How irritated do your eyes feel after video conferencing?
	How much do your eyes hurt after video conferencing?
Social Fatigue	How much do you tend to avoid social situations after video conferencing?
	How much do you want to be alone after video conferencing?
	How much do you need time by yourself after video conferencing?
Motivational Fatigue	How much do you dread having to do things after video conferencing?
	How often do you feel like doing nothing after video conferencing? *
	How often do you feel too tired to do other things after video conferencing? *
Emotional Fatigue	How emotionally drained do you feel after video conferencing?
	How irritable do you feel after video conferencing?
	How moody do you feel after video conferencing?

Participants

Participants were recruited from Lucid - an aggregator of survey respondents from multiple sources – and a student research pool at a large Western university. Participants were qualified to answer the survey if they reported using video conferences at least "once a day" in a screening question. Participants who failed the attention check question were directly terminated and no data was recorded for them if they were from Lucid, and were removed from data analysis if they were university students (n = 4). A total of 130 participants took part in this study (73 students, 57 recruited from Lucid). Of these subjects, 57% identified as women and 42% identified as men. The mean age was 28.2 (SD = 12.5, min = 18, max = 62). The distribution of ethnic backgrounds was as follows: 43.8% of White (n = 57), 15.4% of African or African-American or Black (n = 20), 20.8% of Asian or Asian-American (n = 27), 6.9% of Hispanic or LatinX (n = 9), 9.2% of participants identifying with more than one ethnic background (n = 12), 1.5% of Middle Eastern (n = 2) and 2.3% of Native Hawaiian or Pacific Islander (n = 3).

Results

A second-order CFA was used to test the proposed model with 15 items and 5 constructs. Consistent with Study 3, the five-factor model fits the data well: CFI = 0.944, TLI = 0.930, RMSEA = 0.086 and SRMR = 0.060, X^2 (85) = 116.21.

Cronbach's alphas were above 0.8 for each of the five constructs (general fatigue: α = 0.89, visual fatigue: α = 0.88, social fatigue: α = 0.84, motivational fatigue: α = 0.83, emotional fatigue: α = 0.83), indicating a good reliability.

The ZEF Score is the averaged rating across the 15 fatigue items and showed high reliability (α = 0.95), which is significantly correlated with each of the five constructs of the scale (see Table 4 for the bivariate correlations).

Study 5: tests of validity

The final study aims to assess the convergent validity of the ZEF Scale. We examined the associations between the ZEF Score and two theoretically similar constructs – video conference use and attitude towards video conferencing. Prior literature suggested a positive association between fatigue and the use of the given technology, such as the duration of internet use (Dol, 2016) and social media overuse (Sanz-Blas, Buzova, & Miquel-Romero, 2019). Therefore, we predicted that

Table 4
Means, SDs, and bivariate correlations among the ZEF Score and 5 constructs of zoom fatigue.

Fatigue	1.	2.	3.	4.	5.	6.	*Mean*	*SD*
1. ZEF Score							2.98	.91
2. General	.91***						3.25	1.04
3. Emotional	.91***	.80***					2.83	1.05
4. Visual	.82***	.71***	.67***				2.85	1.17
5. Motivational	.88***	.84***	.76***	.65***			3.18	.99
6. Social	.78***	.59***	.71***	.50***	.58***		2.82	1.11

Note. $N = 130$, ZEF Score = average scoring of 15 items.
***$p < .001$ (two-tailed).

longer and more frequent use of video conference may be associated with higher levels of Zoom fatigue. We also predicted that individuals who feel more fatigued will have more negative attitudes towards the medium than those who feel less fatigued. Although feelings of fatigue may not necessarily correspond to negative affect (i.e., a rewarding day of work or a long walk can be tiring and positive at the same time), In the context of social media, Maier et al. (2014) indicated that social overload corresponds to a higher level of fatigue and a lower level of satisfaction with social media.

Participants

We recruited a convenience sample of individuals by posting our survey online from Feb 22nd to 26th, 2021. Substantial media coverage regarding related research examining the causes of Zoom fatigue (e.g., Bailenson, 2021) drew attention to the scale. Members of the current research team also distributed the online survey via email to their students and colleagues, who were in turn referred to their networks of video conferencing users. Upon seeing recruitment materials for our study on social media, individuals could elect to participate in our study after providing informed consent.

A total of 2724 participants completed the survey, with 66% female, 32% male, 0.7% identifying neither as female nor male, and 1.2% declining to answer. The age ranged between 18 and 75 years old (M = 38, SD = 10.9). The distribution of ethnic backgrounds was: 71.7% of White ($n = 1953$), 9.43% of Asian or Asian-American ($n = 257$), 4.6% of Hispanic or LatinX ($n = 127$), 0.8% of Middle Eastern ($n = 22$), 6.24% of participants identifying with more than one ethnic background (n = 170), 2.1% of African or African-American or Black (n = 57), 0.2% of Native Hawaiian or other Pacific Islander ($n = 6$), 1.1% identified as an unlisted ethnic background ($n = 29$), 0.4% of Native American ($n = 10$) and 3.4% declined to answer ($n = 93$). Participants who failed the two attention check questions were removed from the data analysis.

Measures

In addition to the 15-item multidimensional ZEF Scale (see Table 3 for all items), attitudes toward video conferences and three items of video conference use (frequency, duration and burstiness) were also included in the survey.

Attitudes. Attitude toward video conferences was measured on a three-item Likert-scale (i.e., "How much do you like participating in video conferences", "How much do you feel like video conferences are a burden?", and "How much do you enjoy video conferences") ranging from 1 = *"Not at all"* to 5 = *"Extremely"*.

Frequency. Participants were asked to indicate "On a typical day, how many video conferences do you participate in" on a 7-point Likert-scale ranging from 1 = "1" to 7 = "7 and more".

Duration. Participants were asked to indicate "on a typical day, how long does a typical video conference last" on a 5-point Likert-scale ranging from 1 = *"Less than 15 min"*, 2 = *"15 to 30 min"*, 3 = *"30 to 45 min"*, 4 = *"45 min to an hour"*, and 5 = *"More than an hour"*.

Burstiness. Participants were asked to indicate "on a typical day, how much time do you have between your video conferences?" As frequency, duration and burstiness are used to measure the level of intensity of the video conference experience, burstiness was reversed coded as less time between meetings indicating high burstiness. The response options range from 1 = *"More than an hour"*, 2 = *"45 min to an hour"*, 3 = *"30 to 45 min"*, 4 = *"15 to 30 min"*, and 5 = "*Less than 15 min*".

Results

Factor Analysis of the ZEF Scale. To test the dimensionality of the scale, a confirmatory factor analysis was firstly used to examine the model's goodness of fit. A second-order 5-factor (i.e., general, visual, social, motivational, and emotional fatigue) model was tested again using the current sample. The model revealed a good fit and supported the 5-factor structure in this diverse adult sample: CFI = 0.97, TLI = 0.96, RMSEA = 0.065 and SRMR = 0.032, X^2 (85) = 1058. See Table 5 for factor loadings, internal reliability, and descriptive statistics of each construct.

Analysis of Reliability. Two standard statistics were used to assess scale reliability. First, Cronbach's alpha assessed the internal consistency of the scale items. All the alpha coefficients for our latent constructs were above the threshold of 0.70 (see Table 5), indicating a good scale reliability. Second, composite reliability (CR) was also examined for internal consistency. As Table 5 shows, all CR values ranged from 0.83 to 0.90, which were above the acceptable threshold of 0.70 (Fornell & Larcker, 1981).

Scale Validity. To assess convergent and discriminant validity, we determined the average variance extracted (AVE) from the measurement model. The AVE ranged from 0.63 to 0.76 for 5 constructs, which exceeded the acceptable threshold of 0.50 (see Table 5). In addition, discriminant validity was assessed by showing the square root of the AVE for each latent construct is greater than the correlation between one latent construct and the other. Thus, discriminant validity was also acceptable (see Table 6).

To assess convergent validity, the correlations between the ZEF Score, which is the average rating of all items on the ZEF Scale, video conference attitude, and video conference use were examined. As shown in Table 7, attitude was significantly negatively correlated to the ZEF Score [r (2724) = −0.48, $p < .001$], suggesting that a higher level of Zoom fatigue corresponds to a lower positive attitude toward video conferences. Similarly, consistent with our hypotheses, the ZEF Score was positively correlated to the three measures of video conferencing use: a higher ZEF Score was associated with having more meetings (frequency, r (2724) = 0.27, $p < .001$), longer meetings [duration, r (2724) = 0.12, $p < .001$], and the tendency to cluster meetings together without breaks in between [burstiness; r (2724) = 0.22, $p < .001$], suggesting high convergent validity.

Finally, we used a linear regression to predict the ZEF score with the three measures of video conference use, frequency, duration and burstiness, as predictors. The omnibus model was significant, F (3,

Table 5
Descriptive statistics, factor loadings, cronbach alphas, composite reliability and average variance extracted of the ZEF Scale items.

Fatigue	Item	Std. loading	Construct loading	α	*Mean*	*SD*	*CR*	*AVE*
General	How tired do you feel after video conferencing?	.87	.95	.90	3.35	.93	.90	.76
	How exhausted do you feel after video conferencing?	.89						
	How mentally drained do you feel after video conferencing?	.85						
Visual	How blurred does your vision get after video conferencing?	.74	.55	.88	2.45	1.02	.89	.72
	How irritated do your eyes feel after video conferencing?	.90						
	How much do your eyes hurt after video conferencing?	.89						
Social	How much do you tend to avoid social situations after video conferencing?	.78	.82	.87	3.05	1.07	.87	.70
	How much do you want to be alone after video conferencing?	.87						
	How much do you need time by yourself after video conferencing?	.85						
Motivational	How much do you dread having to do things after video conferencing?	.75	.93	.82	3.27	.88	.83	.63
	How often do you feel like doing nothing after video conferencing?	.79						
	How often do you feel too tired to do other things after video conferencing?	.84						
Emotional	How emotionally drained do you feel after video conferencing?	.83	.93	.85	2.82	.94	.85	.66
	How irritable do you feel after video conferencing?	.879						
	How moody do you feel after video conferencing?	.79						

Note. $N = 2724$.

Table 6
Means, SDs, and bivariate correlations among the ZEF Score and each construct of zoom fatigue.

Fatigue	1.	2.	3.	4.	5.	6.	*Mean*	*SD*
1. ZEF Score							2.99	.79
2. General	.89***	**.87**					3.35	.93
3. Emotional	.87***	.77***	**.81**				2.82	.94
4. Visual	.67***	.49***	.47***	**.85**			2.45	1.02
5. Motivational	.86***	.79***	.71***	.43***	**.79**		3.27	.88
6. Social	.83***	.67***	.68***	.37***	.68***	**.84**	3.05	1.07

Note. $N = 2724$, $^{***}p < .001$. Diagonal elements (in bold) are square root of AVE.

Table 7
Means, SDs, and bivariate correlations among the ZEF Score and variables for validity tests.

	1.	2.	3.	4.	*Mean*	*SD*
1. ZEF score					2.99	.79
2. Attitude	-.48***				2.66	.79
3. Frequency	.27***	-.08***			3.62	1.75
4. Duration	.12***	-.04*	-.24***		3.92	.78
5. Burstiness	.22***	-.08***	.66***	-.12***	3.34	1.55

Note. $N = 2724$; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

2710) = 114, $p < .001$, 95% CI [1.49, 1.84], adjusted $R^2 = 0.111$. Controlling for the other two types of video conferences use, duration ($\beta = 0.19$, $SE = 0.019$, $p < .001$), frequency ($\beta = 0.13$, $SE = 0.011$, $p < .001$) and burstiness ($\beta = 0.03$, $SE = 0.012$, $p = .023$) were all significant predictors of the ZEF score. To examine the interaction effect of video conferencing use measures, a second linear regression was modelled with a three-way interaction to predict the ZEF score. A comparison between the full and reduced model was non-significant, $F(4, 2706) = 1.34$, $p = .25$, 95% CI [1.27, 2.67], suggesting that there was not an interaction effect.

General discussion

Summary of the findings

The current research outlines the process and results of the development and validation of the ZEF Scale (freely available for use). Across five studies, which included over 3000 participants, we created a scale examining Zoom fatigue and provided initial evidence for the scale validity. The final scale includes 15 items measuring 5 aspects of fatigue experienced in video conferences, which were found reliable across multiple studies. Moreover, the ZEF Scale has been validated by both video conference use and attitudes towards video conferences. People who have more and longer meetings tend to feel more fatigued than those with fewer and shorter meetings. Moreover, people who feel more fatigued after a video conference tend to have a more negative attitude towards it.

Implications

Video conference platforms have been a crucial communication technology to maintain social connections during the COVID-19 pandemic. It is possible that video conferencing will keep playing an important role in interpersonal communication in the post-pandemic age. The rise of any new communication tool comes with challenges that need to be understood and mitigated in order to maximize the benefit drawn from its use. Similarly to other media, video conferencing can trigger fatigue that may be experienced by many but whose causes and antecedents are yet to be uncovered. This study provides a first step in this direction by providing a short questionnaire that can now be used widely by researchers to measure Zoom fatigue. The ZEF Scale will be useful in testing theoretical predictors of why Zoom Fatigue may take place (e.g., Bailenson, 2021; Riva, Wiederhold, & Mantovani, 2021). Understanding the antecedents and consequences of Zoom fatigue will then become an important resource for video conference platform designers who could then challenge and rethink some of the paradigm video conferences have been built on (e.g., self-view by default). As the COVID-19 pandemic has forced us to rethink our work practices, new ways of collaborating across geographical locations might challenge the pre-pandemic commuting and face-to-face practices and might lead to increasingly hybrid work environments (Almeida et al., 2020) in which video conferences will remain an essential component. Therefore, understanding the benefits and downfalls of video conferencing such as Zoom fatigue will still be a current and relevant issue that will require tools such as the ZEF Scale to explore it further.

Limitations and future directions

The current research has limitations. First, while we employed a

number of strategies to ensure a diverse population of respondents (e.g., university research pool, online panels), our convenience sample underrepresented some ethnic groups. Second, the five dimensions of the scale highly correlate with one another, and thus are likely to be dependent. In this way, future work should include the creation and validation of a short ZEF Scale similar to how, for example, Gosling and colleagues (2003) developed a brief measure of the Big-Five personality domains. Third, the different versions of the survey did not include questions concerning education or occupation of the participants which would have been valuable information. This will be added in future studies. Finally, the current research did not assess all types of validity or reliability, such as test-retest reliability (Boateng et al., 2018), which will be addressed in future work.

In addition to a systematic assessment of scale validity, future work could focus on the antecedents and outcomes of Zoom fatigue. For example, our initial qualitative interview suggested potential predictors of Zoom fatigue, such as perceived gaze, self-presentation concerns, and immobility. The antecedents and outcomes identified for similar constructs such as social media fatigue (Choi & Lim, 2016; Dhir et al., 2018; Shin & Shin, 2016) could also apply for Zoom fatigue and need to be examined. Future work could also explore how contexts of video conferencing (e.g., work vs. socializing, size of the video conferencing) and how individual differences (e.g., gender, personalities, culture) may impact the experience of Zoom fatigue.

It will also be important to empirically investigate the cost-benefit ratio of video conferencing, especially given how important video conferencing has been for social connection during the COVID-19 pandemic and social distancing requirements. For example, as an important avenue for online interactions, can video conferencing foster a sense of connection and satisfy other basic psychological needs that tie to psychological well-being (Deci & Ryan, 2000; Bavel et al., 2020)? How would video conferencing affect well-being compared to other technologies such as social media? Does specific use of video conferencing trigger Zoom fatigue, which in turn undermine connectedness or offset benefits? Understanding the well-being implications of video conferencing can be a fruitful direction for future research.

Video conferences have allowed us to keep engaging in important tasks such as working, learning, and socializing during an extended period of social distancing. According to self-determination theory, individuals will feel motivated to pursue activities if they satisfy some basic psychological needs (Deci & Ryan, 2000). Researchers have identified three of these psychological needs, namely autonomy as an eagerness to engage in the activity at stake, competence as a need for challenge and relatedness as a need for interpersonal connection (Deci & Ryan, 2000; Ryan & Deci, 2000). Tamborini and colleagues (2010) used the field of video game research to test the appropriateness of the three constructs. Their results supported the idea of enjoyment as need satisfaction. The way Tamborini and colleagues (2010) argued that enjoyment can emerge from need satisfaction can be applied to video conferences as this technology has been a cornerstone in satisfying many people's need for relatedness during the COVID-19 pandemic. It is essential to investigate the potential tradeoff between the negative and positive impacts of Zoom fatigue. For example, it will be important to examine how zoom fatigue is related to the connectedness benefits associated with video conferencing. The framework of Uses and Gratifications has been widely used to assess the socio-psychological motivations that drive the media use of individuals. Traditional research on uses and gratifications has focused on traditional media such as film, newspaper, television and radio. New media bring new kinds of gratifications and give rise to needs not identified with more traditional media (Sundar & Limperos, 2013). For example, traditional media did not take into account interactivity as this is an affordance typical of emergent media. Consequently, Sundar and Limperos (2013) argued for research that does not just include survey methods based on existing uses and gratification typologies. They call for exploratory research, such as focus groups, that would identify the unique gratifications and needs arising from emergent media. This call for action could be applied to video conferences where listening to what users have to say about their benefits could help researchers identify new uses and gratifications provided by this new media.

Conclusion

In sum, the present research provides a valid and reliable measure for Zoom Fatigue. In the emerging media era, the fact that increasing numbers of people have seamlessly integrated Zoom and other video conferencing technologies into their work and social lives has posed important questions such as when, how, and why Zoom fatigue occurs, as well as how to mitigate the fatigue effectively. We encourage future work on this topic to advance our understanding of how video conferences influence interpersonal communication and how interface design and social norms can be developed to reduce fatigue associated with video conferencing.

Declaration of competing interest

I attest that my coauthors and myself hve no conflict of interest to disclose.

Acknowledgments

This work was supported by the National Science Foundation under Grants IIS-1800922 and CMMI-1840131; Knut och Alice Wallenberg under Grant 20170440 . Moreover, we are thankful for assistance in this research from Jet Toner, [redacted], Tobin AsherSunny Liu and Carlyn Strang.

Appendix

Original Forty-Nine Items Tested.

Dimensions of fatigue	After participating in a video conference: (not at all - Slightly - Moderately - Very - Extremely)	
General fatigue	gen_1	I feel tired
	gen_2	I feel rested (Reversed)
	gen_3	I feel energized (Reversed)
	gen_4	I feel refreshed (Reversed)
	gen_5	I feel exhausted
	gen_6	I need to take a nap
Physical fatigue	phy_1	I can take on only a little physically
	phy_2	I can take on a lot physically (Reversed)
	phy_3	I feel restless

(continued on next page)

(*continued*)

Dimensions of fatigue	After participating in a video conference: (not at all - Slightly - Moderately - Very - Extremely)	
	phy_4	my back hurts
	phy_5	my neck hurts
	phy_6	my body feels tired
Mental fatigue	men_1	I feel mentally drained
	men_2	I can concentrate well (Reversed)
	men_3	it takes a lot of effort to concentrate on my next tasks
	men_4	my thoughts easily wander
	men_5	I am able to think clearly (Reversed)
Visual fatigue	vis_1	I often get a headache
	vis_2	my vision gets blurred
	vis_3	my eyes feel fine (Reversed)
	vis_4	my eyes feel irritated
	vis_5	I experience pain around my eyes
	vis_6	I experience a burning or pricking sensation in the eyes
Vocal fatigue	voc_1	I feel like talking (Reversed)
	voc_2	my voice feels tired
	voc_3	I tend to generally limit my talking
	voc_4	my throat aches with voice use
	voc_5	my voice feels strong (Reversed)
	voc_6	my voice gets hoarse
	voc_7	it feels like work to use my voice
Social fatigue	soc_1	I avoid social situations
	soc_2	I just want to be alone
	soc_3	I crave seeing other people (Reversed)
	soc_4	I feel like engaging with other people is effortless (Reversed)
	soc_5	I need time by myself
Reduced activity	redac_1	I feel very active (Reversed)
	redac_2	I feel like I can do a lot (Reversed)
	redac_3	I get little done
	redac_4	I need to take a break
	redac_5	I often feel too tired to do other things
Reduced motivation	redmot_1	I feel like doing all sorts of things (Reversed)
	redmot_2	I dread having to do things
	redmot_3	I feel like making plans (Reversed)
	redmot_4	I don't feel like doing anything
Emotional fatigue	emo_1	I feel emotionally drained
	emo_2	I feel irritable
	emo_3	I feel moody
	emo_4	I feel excited (Reversed)
	emo_5	I feel happy (Reversed)

References

Almeida, F., Duarte Santo, J., & Augusto Monteiro, J. (2020). The challenges and opportunities in the digitalization of companies in a post-COVID-19 world. *IEEE Engineering Management Review, 48*(3), 97–103. https://doi.org/10.1109/EMR.2020.3013206.

Argyle, M., & Dean, J. (1965). Eye-contact, distance and affiliation. *Sociometry, 28*(3), 289–304. https://doi.org/10.2307/2786027.

Bailenson, J. N. (2021). Nonverbal overload: A theoretical argument for the causes of zoom fatigue. *Technology Mind and Behavior, 2*(1). https://doi.org/10.1037/tmb0000030.

Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., et al. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*. https://doi.org/10.1038/s41562-020-0884-z.

Bick, A., Blandin, A., & Mertens, K. (2020). Work from home after the COVID-19 outbreak. CEPR Discussion Paper No. DP15000, Available at: SSRN https://ssrn.com/abstract=3650114.

Bloom, N., Davis, S. J., & Zhestkova, Y. (2021). *COVID-19 shifted patent applications toward technologies that support working from home*. University of Chicago, Becker Friedman Institute for Economics Working. https://doi.org/10.2139/ssrn.3695191. Paper No. 2020-133.

Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quiñonez, H. R., & Young, S. L. (2018). Best practices for developing and validating scales for health, social, and behavioral research: A primer. *Frontiers in Public Health, 6*(June), 1–18. https://doi.org/10.3389/fpubh.2018.00149.

Bright, L. F., Kleiser, S. B., & Grau, S. L. (2015). Too much Facebook? An exploratory examination of social media fatigue. *Computers in Human Behavior, 44*, 148–155. https://doi.org/10.1016/j.chb.2014.11.048.

Bright, L. F., & Logan, K. (2018). Is my fear of missing out (FOMO) causing fatigue? Advertising, social media fatigue, and the implications for consumers and brands. *Internet Research, 28*(5), 1213–1227. https://doi.org/10.1108/IntR-03-2017-0112.

Chawla, A. (2020). Coronavirus (COVID-19) – 'Zoom' application boon or bane. Available at: SSRN https://doi.org/10.2139/ssrn.3606716.

Choi, S. B., & Lim, M. S. (2016). Effects of social and technology overload on psychological well-being in young South Korean adults: The mediatory role of social network service addiction. *Computers in Human Behavior, 61*, 245–254. https://doi.org/10.1016/j.chb.2016.03.032.

Comrey, A. L. (1988). Factor-analytic methods of scale development in personality and clinical psychology. *American Psychological Association, 56*, 754–61.

Couper, M. P., Tourangeau, R., Conrad, F. G., & Zhang, C. (2013). The Design of Grids in Web Surveys. *Social Science Computer Review, 31*(3), 322–345. https://doi.org/10.1177/0894439312469865.

Deci, E. L., & Ryan, R. M. (2000). The "what'' and "why'' of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01.

Dhir, A., Yossatorn, Y., Kaur, P., & Chen, S. (2018). Online social media fatigue and psychological wellbeing—a study of compulsive use, fear of missing out, fatigue, anxiety and depression. *International Journal of Information Management, 40* (January), 141–152. https://doi.org/10.1016/j.ijinfomgt.2018.01.012.

Dol, K. S. (2016). Fatigue and pain related to internet usage among university students. *Journal of Physical Therapy Science, 28*(4), 1233–1237. https://doi.org/10.1589/jpts.28.1233.

Duval, S., & Wicklund, R. A. (1972). *A theory of objective self awareness*. Academic Press.

Feijt, M., De Kort, Y., Bongers, I., Bierbooms, J., Westerink, J., & Ijsselsteijn, W. (2020). Mental health care goes online: Practitioners' experiences of providing mental health care during the COVID-19 pandemic. *Cyberpsychology, Behavior, and Social Networking, 23*(12), 860–864. https://doi.org/10.1089/cyber.2020.0370.

Fejfar, M., & Hoyle, R. (2000). Effect of private self-awareness on negative affect and self-referent attribution: A quantitative review. *Personality and Social Psychology Review, 4*, 132–142. https://doi.org/10.1207/S15327957PSPR0402_02.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39–50.

Goldin-Meadow, S. (2003). *Hearing gesture: How our hands help us think*. Belknap Press of Harvard University Press.

Goldin-Meadow, S., Cook, S. W., & Mitchell, Z. A. (2009). Gesturing gives children new ideas about math. *Psychological Science, 20*(3), 267–272. https://doi.org/10.1111/j.1467-9280.2009.02297.x.

Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37*(6), 504–528. https://doi.org/10.1016/S0092-6566(03)00046-1.

Guadagnoli, E., & Velicer, W. F. (1988). Relation of sample size to the stability of component patterns. *American Psychological Association, 103*, 265–75.

Hinds, P. J. (1999). The cognitive and interpersonal costs of video. *Media Psychology, 1*(4), 283–311. https://doi.org/10.1207/s1532785xmep0104_1.

Ingram, R. E., Cruet, D., Johnson, B. R., & Wisnicki, K. S. (1988). Self- focused attention, gender, gender role, and vulnerability to negative affect. *Journal of Personality and Social Psychology, 55*(6), 967–978. https://doi.org/10.1037/0022-3514.55.6.967.

Iqbal, M. (2020). *Zoom revenue and usage statistics*. Business of apps. Retrieved February 12, 2021 from https://www.businessofapps.com/data/zoom-statistics/.

Karapanos, E., Teixeira, P., & Gouveia, R. (2016). Need fulfillment and experiences on social media: A case on Facebook and WhatsApp. *Computers in Human Behavior, 55*, 888–897. https://doi.org/10.1016/j.chb.2015.10.015.

Kendon, A. (1970). Movement coordination in social interaction: Some examples described. *Acta Psychologica, 32*, 101–125. https://doi.org/10.1016/0001-6918(70)90094-6.

Kline, P. A. (1993). In *Handbook of psychological testing.* London: Routledge (Taylor & Francis Group).

Krosnick, J. A. (1991). Response strategies for coping with the cognitive demands of attitude measures in surveys. *Applied Cognitive Psychology, 5*, 213–236.

Lee, A. R., Son, S. M., & Kim, K. K. (2016). Information and communication technology overload and social networking service fatigue: A stress perspective. *Computers in Human Behavior, 55*, 51–61. https://doi.org/10.1016/j.chb.2015.08.011.

Liu, M., & Cernat, A. (2018). Item-by-item Versus Matrix Questions: A Web Survey Experiment. *Social Science Computer Review, 36*(6), 690–706. https://doi.org/10.1177/0894439316674459.

Lowenthal, P., Borup, J., West, R., & Archambault, L. (2020). Thinking beyond Zoom: Using asynchronous video to maintain connection and engagement during the COVID-19 pandemic. *Journal of Technology and Teacher Education, 28*(2), 383–391.

Maier, C., Laumer, S., Eckhardt, A., & Weitzel, T. (2014). Giving too much social support: Social overload on social networking sites. *European Journal of Information Systems, 24*(5), 1–18. https://doi.org/10.1057/ejis.2014.3.

Maslach, C. (1982). *Burnout: The cost of caring.* Englewood Cliffs, NJ: Prentice-Hall.

McCarthy, D., & Saegert, S. (1978). Residential density, social overload, and social withdrawal. *Human Ecology, 6*(3), 253–272. https://doi.org/10.1007/BF00889026.

Nadler, R. (2020). Understanding "Zoom fatigue": Theorizing spatial dynamics as third skins in computer-mediated communication. *Computers and Composition, 58*(102613). https://doi.org/10.1016/j.compcom.2020.102613.

Nanjundeswaran, C., Jacobson, B. H., Gartner-Schmidt, J., & Verdolini Abbott, K. (2015). Vocal fatigue Index (VFI): Development and validation. *Journal of Voice, 29*(4), 433–440. https://doi.org/10.1016/j.jvoice.2014.09.012.

National Research Council Committee on Vision. (1983). *Video displays, work and vision.* Washington, DC: National Academy Press.

Nguyen, M. H., Gruber, J., Marler, W., Hunsaker, A., Fuchs, J., & Hargittai, E. (2021). Staying connected while physically apart: Digital communication when face-to-face interactions are limited. *New Media & Society*, 1461444820985442.

Nussbaumer-Streit, B., Mayr, V., Dobrescu, A. I., Chapman, A., Persad, E., Klerings, I., et al. (2020). Quarantine alone or in combination with other public health measures to control COVID-19: A rapid review. *Cochrane Database of Systematic Reviews, 4*, CD013574. https://doi.org/10.1002/14651858.CD013574.pub2.

Oppezzo, M., & Schwartz, D. L. (2014). Give your ideas some legs: The positive effect of walking on creative thinking. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*(4), 1142–1152. https://doi.org/10.1037/a0036577.

Piper, B. F., Lindsey, A. M., & Dodd, M. J. (1987). Fatigue mechanisms in cancer patients: Developing nursing theory. *Oncology Nursing Forum, 14*, 17–23.

Potempa, K., Lopez, M., Reid, C., & Lawson, L. (1986). Chronic fatigue. *Image - the Journal of Nursing Scholarship, 18*(4), 165e169.

Riva, G., Wiederhold, B. K., & Mantovani, F. (2021). Surviving COVID-19: The neuroscience of smart working and distance learning. *Cyberpsychology, Behavior, and Social Networking, 24*(2), 79–85.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78, 10.1037110003-066X.55.1.68.

Sanz-Blas, S., Buzova, D., & Miquel-Romero, M. J. (2019). From instagram overuse to instastress and emotional fatigue: The mediation of addiction. *Spanish Journal of Marketing - ESIC, 23*(2), 143–161. https://doi.org/10.1108/SJME-12-2018-0059.

Schinka, J. A., Velicer, W. F., & Weiner, I. R. (2012). Research methods in psychology, *Vol. 2. Handbook of psychology*. Hoboken, NJ: John Wiley & Sons, Inc.

Shensa, A., Escobar-Viera, C. G., Sidani, J. E., Bowman, N. D., Marshal, M. P., & Primack, B. A. (2017). Problematic social media use and depressive symptoms among U.S. Young adults: A nationally-representative study. *Social Science & Medicine, 182*, 150–157. https://doi.org/10.1016/j.socscimed.2017.03.061.

Shin, J., & Shin, M. (2016). To be connected or not to Be connected? Mobile messenger overload, fatigue, and mobile shunning. *Cyberpsychology, Behavior, and Social Networking, 19*(10), 579–586. https://doi.org/10.1089/cyber.2016.0236.

Smets, E. M. A., Garssen, B., Bonke, B., & de Haes, J. (1995). The multidimensional fatigue inventory (MFI) psychometric qualities of an instrument to assess fatigue. *Journal of Psychosomatic Research, 39*(5), 315–325. https://doi.org/10.1016/0022-3999(94)00125-O.

Sundar, S. S., & Limperos, A. M. (2013). Uses and grats 2.0: New gratifications for new media. *Journal of Broadcasting & Electronic Media, 57*(4), 504–525. https://doi.org/10.1080/08838151.2013.845827.

Takac, M., Collett, J., Blom, K. J., Conduit, R., Rehm, I., & Foe, A. D. (2019). Public speaking anxiety decreases within repeated virtual reality training sessions. *PloS One, 14*(5). https://doi.org/10.1371/journal.pone.0216288. Article e0216288.

Tamborini, R., Bowman, N. D., Eden, A., Grizzard, M., & Organ, A. (2010). Defining media enjoyment as the satisfaction of intrinsic needs. *Journal of Communication, 60*(4), 758–777. https://doi.org/10.1111/j.1460-2466.2010.01513.x.

Thurstone, L. (1947). *Multiple-Factor Analysis*. Chicago, IL: University of Chicago Press.

Tyrrell, R. A., & Leibowitz, H. W. (1990). The relation of vergence effort to reports of visual fatigue following prolonged near work. *Human Factors, 32*(3), 341–357. https://doi.org/10.1177/001872089003200307.

Vilkman, E. (2004). Occupational safety and health aspects of voice and speech professions. *Folia Phoniatrica et Logopaedica, 56*(4), 220–253. https://doi.org/10.1159/000078344.

Voith, A. M., Frank, A. M., & Smith Pigg, J. (1989). Nursing diagnosis: Fatigue. *Proceedings of 8th Conference NANDA*, 453–458.

Whelan, E., Najmul Islam, A. K. M., & Brooks, S. (2020). Is boredom proneness related to social media overload and fatigue? A stress–strain–outcome approach. *Internet Research, 30*(3), 869–887. https://doi.org/10.1108/INTR-03-2019-0112.

Wiederhold, B. K. (2020). Connecting through technology during the coronavirus disease 2019 pandemic: Avoiding "zoom fatigue." cyberpsychology, behavior, and social networking, 23(7), 437–438. https://doi.org/10.1089/cyber.2020.29188.bkw.

Willis, G. B. (2005). *Cognitive interviewing: A tool for improving questionnaire design.* Thousand Oaks, CA: Sage Publications.

World Health Organisation. (2020). Joint ICAO- WHO Statement on COVID-19. World Health Organisation. Retrieved on February 12, 2021 from: https://www.icao.int/Security/COVID-19/Pages/Statements.aspx.

Wright, T. A., & Cropanzano, R. (1998). Emotional exhaustion as a predictor of job performance and voluntary turnover. *Journal of Applied Psychology, 83*(3), 486–493. https://doi.org/10.1037/0021-9010.83.3.486.

Yoa, J., & Cao, X. (2017). The balancing mechanism of social networking overuse and rational usage. *Computers in Human Behavior, 75*, 415–422.

Yu, D. S., Lee, D. T., & Man, N. W. (2010). Fatigue among older people: A review of the research literature. *International Journal of Nursing Studies, 47*(2), 216e228.