Nonverbal Mechanisms Predict Zoom Fatigue and Explain Why Women Experience Higher Levels than Men

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Abstract

There is little data on Zoom Fatigue, the exhaustion that follows video conference meetings. This paper tests associations between Zoom Fatigue and five theoretical nonverbal mechanisms (mirror anxiety, being physically trapped, hyper gaze from a grid of staring faces, and the cognitive load from producing and interpreting nonverbal cues) with 10,591 participants from a convenience sample. We show that daily usage predicts the amount of fatigue, and that women have longer meetings and shorter breaks between meetings than men. Moreover, women report greater fatigue than men, and we replicate this effect with an online sample. The five nonverbal mechanisms predict Zoom fatigue, and we confirm that mirror anxiety, measured both by self-report and by linguistic analysis of open-ended responses, mediates the gender difference in fatigue. Exploratory research shows that race, age, and personality relate to fatigue. We discuss avenues for future research and strategies to decrease Zoom fatigue.

Introduction

Over the last year, billions of conversations that would otherwise have taken place face to face in work meetings, classrooms or social gatherings took place instead over video conferencing. Video conferencing platforms like Zoom have provided tremendous value during the pandemic, allowing us to connect with one another socially and maintain productivity at work. This massive transition from physical to digital interactions, however, has raised concerns about the psychological effects of 'Zoom fatigue,' which refers to the feeling of exhaustion associated with using video conferencing (we use Zoom as a generalized term for all video conferencing). Zoom fatigue may be caused by the complexity of the specific spatial dynamics taking place in video conferences or by the additional cognitive effort to interact with others in this context (1, 2).

Given that video conferencing is likely to remain an important part of the future of work (3), and as a way to stay connected with friends and family, it is important to understand the factors that may lead to Zoom fatigue. It is also important to examine whether Zoom fatigue is affecting different parts of the population more than others. For example, according to the Global Gender Gap Report 2021 (4), the COVID-19 pandemic has impacted women more severely than men, leading to the intensifying of pre-existing gender inequities in employment, productivity (5,6), childcare (7,8) and mental health. For example, researchers (8) found that women have struggled more with body image anxiety and regulating diet and exercise. Since the pandemic has impacted women more than men in many domains, does Zoom fatigue also have a gender component?

Nonverbal mechanisms of Zoom fatigue

Given that the concept of Zoom fatigue appeared only recently with the pandemic, the empirical research concerning its causes and consequences is still in the early stages. In a recent paper, Bailenson (9) theorized about five specific nonverbal mechanisms unique to current implementations of video conferences that may cause Zoom fatigue. The first mechanism is mirror anxiety, which can be triggered by the self-view in video conferences that acts as an omnipresent mirror during social interactions. Psychological research suggests that exposure to digital and physical mirrors can heighten self-focused attention (10, 11), which can lead to negative affect, including anxiety and depression (12). The second mechanism is a sense of being physically trapped because of the need to stay within the field of view of the camera frustrum to stay centered within the video stream. In face-to-face meetings people can pace, move and stretch, but on video conferences their mobility is reduced to within a narrow cone. Research shows that reduced mobility can undermine cognitive performance (13). The third mechanism, hyper gaze, refers to the perceptual experience of constantly having peoples' eyes in your field of view. During in-person meetings, the speaker tends to draw the gaze of others, but during video conferences all participants get the direct eye-gaze of one-another, regardless of who is speaking. Being stared at while speaking, even by digital faces, causes physiological arousal and anxiety (14).

The last two mechanisms are related to the increased cognitive load of managing nonverbal behavior in this novel communication environment. The availability and proximity of nonverbal cues contribute to interpersonal communication, social judgment and task performance (15). While nonverbal communication can be nonconscious and spontaneous during in person interactions (16, 17), video conferences require intentional effort and attention to both produce and interpret nonverbal communication. Attending to

the production of nonverbal behaviors that normally occur naturally, such as head nodding at appropriate times or exaggerating gestures so they can be seen on the screen, can increase cognitive load in video conferences (18). Interpreting other people's nonverbal cues can also be challenging given that cues, such as eye gaze, can be distorted by the placement of the camera or the location of the video on a person's screen. This leads to situations where audio only interactions can be more successful in terms of synchronicity and collaboration than video-based interactions (19).

Gender differences in nonverbal behavior

These nonverbal mechanisms may affect men and women differently. Nearly a century of research in psychology has examined how gender influences nonverbal communication (20, 21). One concern raised by Bailenson (9), for example, is that women may be more affected by mirror anxiety than men. A meta-analysis of two decades of psychological work examining how physical mirrors can trigger increased self-focused attention (12) indicated a small effect size linking mirror image viewing with negative affect, but this effect is larger for women than for men. Women are more likely than men to have greater self-focused attention during real-time views of the self, and women are more likely to experience negative affect as a consequence of that self-focus, especially in contexts that are stressful (11). If this is also the case with the self-view in video conferencing, then women may be more likely to suffer mirror anxiety during video conferencing, which in turn could lead to higher levels of Zoom fatigue for men than women.

More generally, there are many gender effects in nonverbal communication that may be related to the other nonverbal mechanisms in video conferencing. Women, for example tend to display more facial expressions than men (21, 22), such as smiling more (21,23), with evidence suggesting that this difference is associated with awareness of being observed and feeling self-consciousness (24). In terms of interpreting nonverbal behavior, women recall details about other people's appearance and nonverbal behaviors better than men (25, 26). These results have been corroborated by studies finding women more accurate at judging emotions based on the eyes (27), recognizing neutral facial expressions (28), and interpreting someone's personality or thoughts and feelings (29, 30). Video conferencing may increase the cognitive load associated with these nonverbal mechanisms more for women than for men.

Present study

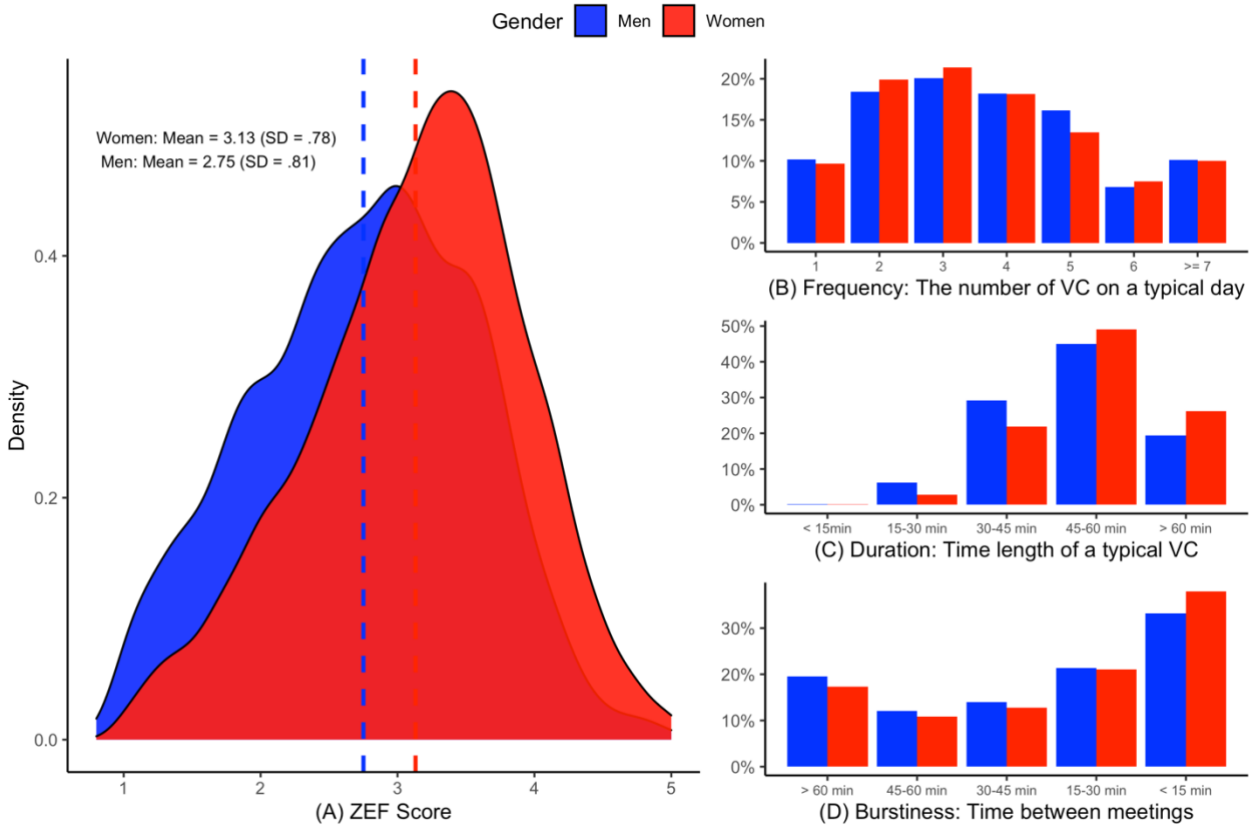
This study empirically tests four theoretical predictions (9) using the Zoom & Exhaustion Fatigue (ZEF) scale (31). We predict that (a) fatigue is associated with high amounts of video conference usage and (b) nonverbal mechanisms, that (c) women will have more fatigue than men, and that (d) the mirror anxiety mediates the gender difference. To triangulate the self-report data from the ZEF scale, we computationally analyzed the language of the responses to the open-ended question concerning participants' experience with video conferencing. First, we used the meaning extraction method (MEM; 32, 33) to conduct a topic modeling analysis to discover key themes in the open-ended responses. We then examined gender differences in how frequently the topics were discussed. Second, we analyzed the frequency of first-person singular pronouns (e.g., me, my, I), which have long been used as a measure of self-awareness (34, 35). Prior work has associated first person singular pronouns with both increased self-focused attention and negative affect (36, 37). We therefore examined the production of first person singular in

relation to mirror anxiety and its role in mediating fatigue gender effects. We examined other individual differences, including age, race and personality (38). Finally, given the increase of video conference use for social interactions - for example, as a recommendation from the World Health Organization (39) to overcome the social isolation imposed by the COVID-19 pandemic - we examined how fatigue differs between social and work context.

Results

Figure 1(A) shows the distribution of ZEF scores for women and men, and the distribution of usage measures for frequency of meetings (B), duration of meetings (C) and burstiness (i.e., time between video conference meetings) (D) by gender. All three measures of video conferencing usage were positively correlated with fatigue (frequency, r = .17, p <.001; duration, r = .11, p <.001; burstiness (i.e., less time between meetings), r = .18, p <.001; see Table S1), suggesting that more frequent meetings, longer meetings, and less time between meetings all corresponded to increased fatigue. A multiple regression with the three VC usage measures predicting ZEF score was significant [F(3, 10444) = 226, p <.001, Adj R^2 = .06], with the largest coefficient for meeting duration (B = .16, SE = .01, p <.001), followed by meeting frequency (B = .06, SE = .01, p <.001) and time between meetings (B = .06, SE = .01, p <.001). Unstandardized coefficients are reported throughout the regression analyses. This pattern suggests that meeting duration is more important than frequency and burstiness for fatigue. The variance inflation factor (VIF) for the predictors is below 2.00, which suggests the absence of multicollinearity.

Fig. 1. Density plot of ZEF score and histograms of video conference usage. Panel A presents the density plot of ZEF score by gender (N = 10,332). Panels B, C and D present by gender the three dimensions of video conference (VC) usage; frequency, duration and burstiness as a measure of the amount of time between meetings.



Gender differences in Zoom fatigue

Figure 1(A) shows the distribution of Zoom fatigue scores by gender of participants that completed the ZEF scale (N = 10,332). Our next hypothesis predicted that women will experience more Zoom fatigue than men. As predicted, women (M = 3.13, SD = .78) reported a significantly higher level of Zoom fatigue than men (M = 2.75, SD = .81) ($t(5506) = -21.9$, $p < .001$, $d = .48$). Compared to men, women reported 13.8% higher Zoom fatigue.

Given that video conferencing usage is a strong predictor of fatigue, we examined if patterns of video conference usage between men and women accounted for the gender effect. Women reported having the same number of meetings per day as men, but women's meetings were significantly longer ($p < .001$, d = .27) and were more bursty (i.e., had less time in between) ($p < .001$, d = .10). To examine if the longer duration with shorter breaks that characterized women's meetings accounted for the gender fatigue effect, we conducted a regression that included the usage measures and gender as predictors of fatigue. The model was significant [$F(4, 10190) = 281$, $p < .001$, Adj R^2 = .10] and was significantly improved compared to the use measure only regression model [Adj R^2 = .06; $F(1, 250) = 423$, $p < .001$]. Results revealed that the gender effect on fatigue persisted (B = .35, SE = .02, $p < .001$), suggesting that even when controlling for differences in meeting duration and time between meetings, women's fatigue is higher than men.

The text analysis of the language provided by participants in the open-ended question (N = 5359) revealed a gender effect consistent with women having longer meetings and experiencing greater fatigue than men. The Meaning Extraction Method (MEM, 33) identified three factors, or topics: (a) terms related to scheduling and fatigue, (b) video conferencing terms and (c) terms related to social connection (see Table 1). The scheduling and fatigue topic correlated significantly with participant ZEF scores (r = .13, $p < .001$), suggesting that people who wrote more about scheduling and fatigue also had higher ZEF scores. The other topics did not correlate with ZEF scores. Women more frequently used language related to scheduling and fatigue than men [$t(2520) = 5.96$, $p < .001$, $d = .18$)]. In contrast, women and men did not differ in how often they used terms related to video conferencing [$t(2288) = .93$, $p = .35$] or social connection [$t(2503) = .87$, $p = .39$].

Table 1. Meaning Extraction Method (MEM) Factors, Terms and Loadings. This table provides the eigenvalues (λ) for each factor (or topic), percent variance explained (%) by the topic, the loadings for each term on that topic. The last row describes the mean and (standard deviation) by gender of each participant's standardized composite score of the factor loadings (e.g., someone who has a 2.0 score on component 1 is 2 SD's above the mean on how frequently they used terms from that topic).

Topic 1		Topic 2		Topic 3	
Scheduling and Fatigue		Video Conferencing		Social Connection	
λ	%	λ	%	λ	%
1.87	4.2	1.76	3.9	1.64	3.7
Term	Loading	Term	Loading	Term	Loading
day	0.649	conference	0.882	friend	0.802
hour	0.648	video	0.877	family	0.793
break	0.469	Zoom	-0.341	social	0.390
exhaust	0.415			connect	0.224
time	0.400				
work	0.288				
long	0.271				
meeting	0.252				
Women	Men	Women	Men	Women	Men
.05 (1.02)	-.13 (.90)	.01 (1.00)	-.02 (1.00)	.01 (1.02)	-.02 (.92)

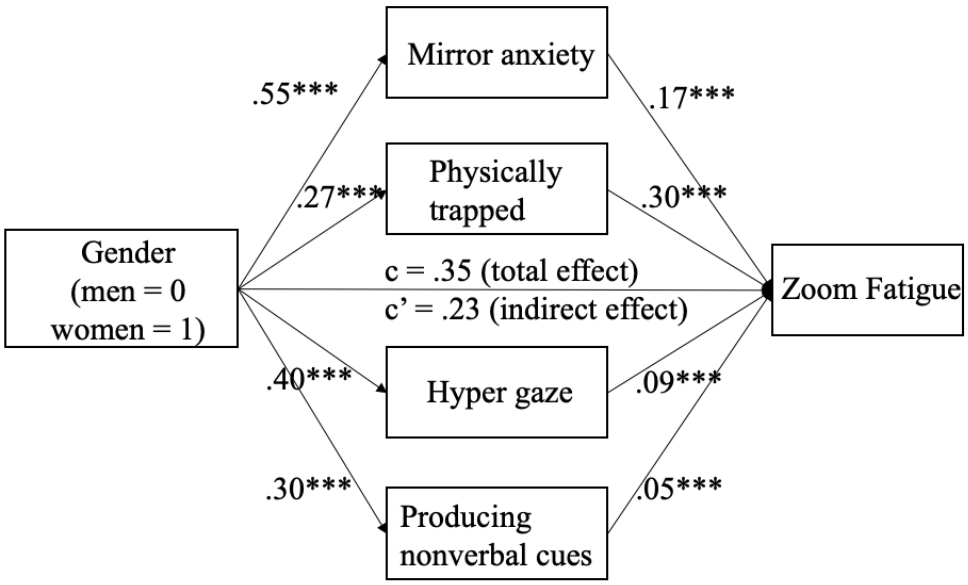
Mechanisms of Zoom fatigue

Our next hypothesis concerned the mechanisms that lead to Zoom fatigue. To test the degree to which the five nonverbal mechanisms predicted Zoom fatigue we fitted a multiple linear regression with mirror anxiety, physically trapped, hyper gaze, producing and interpreting nonverbal cues as predictors. We analyzed the subset of data for which we had the mechanisms questions (N = 7,846). The model was significant [F(5, 7841) = 641, p < .001] and accounted for 29% of the variance in fatigue scores. The largest predictor of fatigue was being physically trapped (B = .32, SE = .01, p <.001) followed by mirror anxiety (B = .17, SE = .06, p <.001), hyper gaze (B = .09, SE = .01, p <.001), producing nonverbal cues (B = .06, SE = .01, p <.001) and interpreting nonverbal cues (B = .06, SE = .01, p <.001). Gender influenced the degree to which participants reported concerns with each of the nonverbal mechanisms. Compared to men, women reported significantly higher levels of mirror anxiety (p < .001, d = .57), physically trapped (p < .001, d = .40), hyper gaze (p < .001, d = .33), and producing nonverbal cues (p < .001, d = .27).

To test our hypothesis that increased self-focused attention for women underlies the gender fatigue effect, we conducted a mediation analysis with mirror anxiety as the mediator, gender as the predictor and fatigue score as the dependent variable using the "mediation" package in R that also controlled for video conference usage. Using bootstrap estimation (1000 samples) the analysis revealed that, as predicted, the fatigue gender effect was significantly mediated by mirror anxiety (ACME = .19, 95% *CI* = [.16, .20]), suggesting that women's increased self-focused attention substantially mediated the gender effect, accounting for 53% of the effect. A computational analysis of the use of first-person singular pronouns (e.g., I, me, my) in the open-ended responses, which is a linguistic marker of self-focused attention (36), was consistent with the mediation pattern in the self-report data. Women used more first-person singular pronouns than men, and first person singular pronouns were correlated with both mirror anxiety (r = . 09, p < .001) and fatigue scores (r = .06, p < .001). The mediation analysis revealed that first person singular significantly mediated the gender difference in fatigue (ACME = .01, 95% *CI* = [0, .02], p < .01) (see Table S3).

Given the gender differences for the other nonverbal mechanisms, to understand how these gender differences played a role in the fatigue gender effect, we ran a mediation analysis with multiple mediators using the "lavaan" package in R. Using bootstrap estimation (1000 samples), the analysis revealed significant indirect effects of gender on Zoom fatigue through mirror anxiety, physically trapped, hyper gaze, and producing nonverbal cues (see Figure 2). The total indirect effect including all the mediators and covariates was significant (*B* = .23, *SE* = .01, 95% *CI* = [.20, .25]), and accounted for approximately 66% of the total effect (*B* = .35, *SE* = .02, 95% *CI* [.31, .39]). The multiple mediation analysis revealed that in addition to mirror anxiety, physically trapped (*B* = .08, *SE* = .01, 95% *CI* = [.07, .09]), hyper gaze (*B* = .04, *SE* = .004, 95% *CI* = [.03, .04]), and producing nonverbal cues (*B* = .01, *SE* = .01, 95% *CI* = [.01, .02]) were also significant mediators. The indirect effects of mirror anxiety and being physically trapped were significantly larger than hyper gaze or producing nonverbal cues ($X^2(1) > 44.4$, p's <.001).

Fig. 2. Multiple mediation model. The coefficients are unstandardized coefficients. ***p <.001



Exploratory individual factor analysis

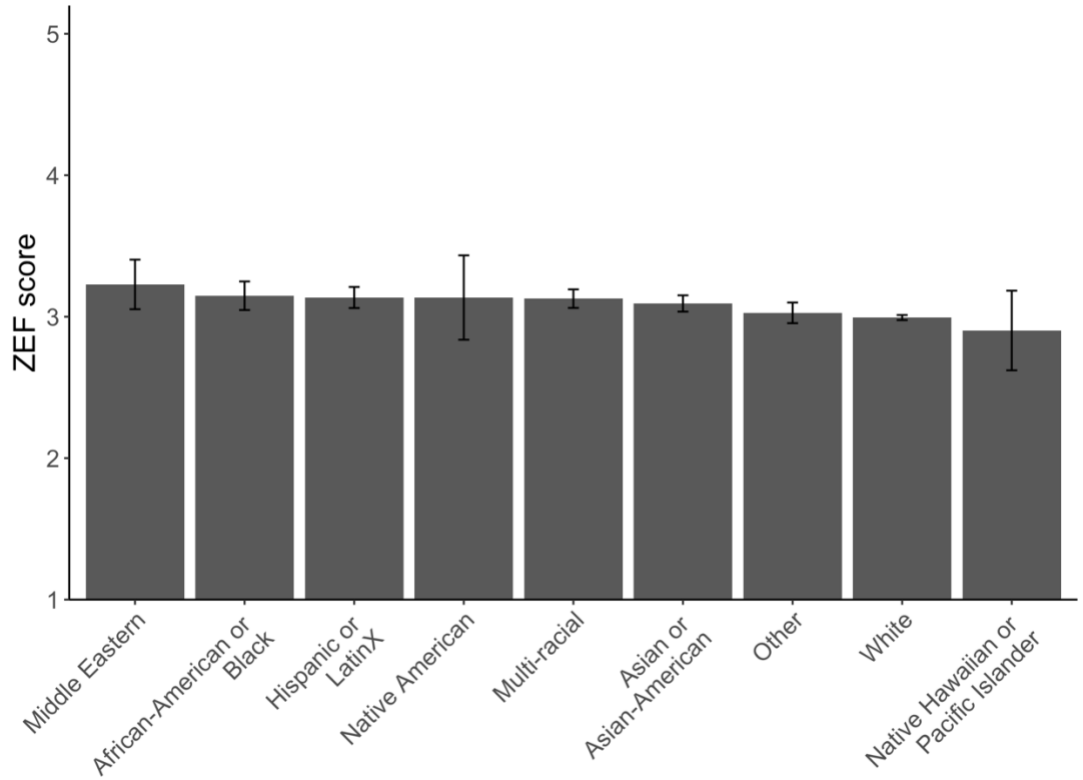
Table 2 describes the association of several other individual factors with Zoom fatigue. We found that age was negatively correlated with fatigue, suggesting that younger individuals reported higher levels of fatigue. Both extraversion and emotional stability were negatively correlated with fatigue, suggesting that more extroverted and emotionally stable individuals reported lower levels of fatigue compared to more introverted and less emotionally stable individuals.

Race was a significant predictor of ZEF scores, $F(8, 10554) = 5.82$, $p < .001$, though the effect size was very small, Adj $R^2 = .004$. Pairwise comparisons revealed that people identifying as White had significantly lower ZEF scores than other categories of race (p's <.05), except for those identifying as Native Hawaiian, Pacific Islander or other (p's = 1) (see Figure 3).

Table 2. Bivariate correlations between ZEF scores, personality traits and age.

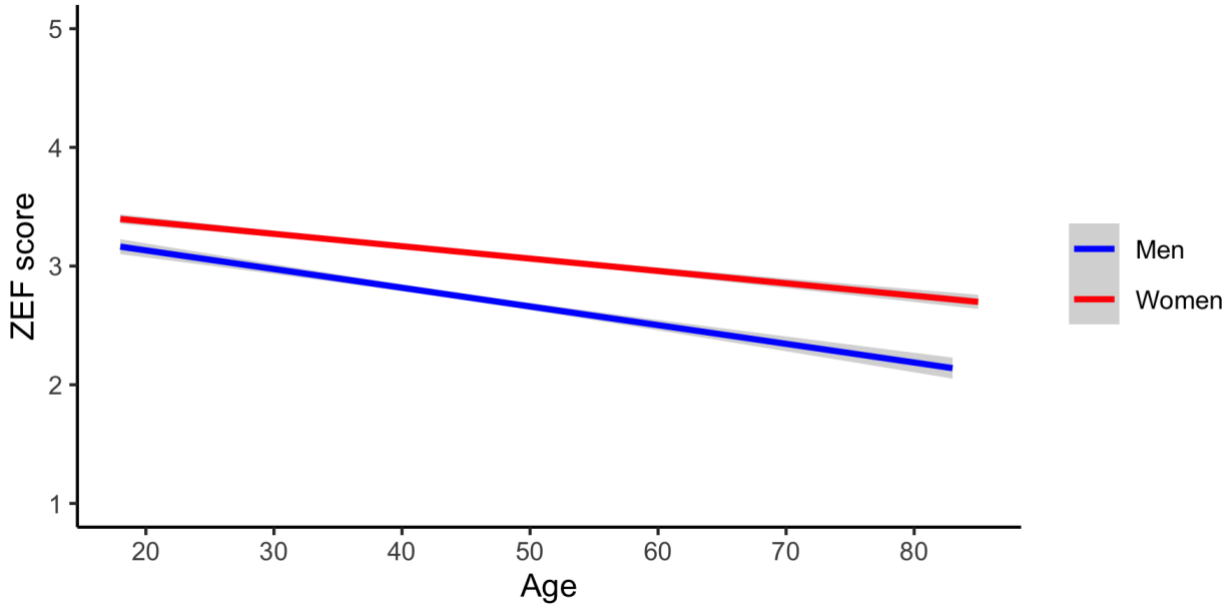
	1	2	3	4	5	6	7	Mean	SD
1. ZEF score	-							3.02	.81
2. Extraversion	-.06***	-						3.16	1.01
3. Agreeableness	.00	.12***	-					3.78	.71
4. Conscientiousness	-.03	.02	.17***	-				4.03	.75
5. Emotional stability	-.24***	-.09***	-.30***	-.30***	-			3.45	.86
6. Openness	0	.32***	.20***	.12***	-.18***	-		3.85	.71
7. Age	-.20***	.05***	.15***	.13***	.32***	.07***	-	43.68	12.99

Fig. 3. ZEF score by race. This figure illustrates the average ZEF score for the nine reported categories of race. The error bars denote 95% confidence intervals.



A multiple regression examining the gender effect on fatigue while controlling for age, race, and personality was significant [$F(8, 3158) = 54.3$, $p < .001$], accounting for 12.1% of the variance in fatigue scores, and revealed that the gender effect on fatigue ($B = .27$, $SE = .03$, $p < .001$) persisted. Adding an interaction between age (mean-centered) and gender to the multiple regression significantly improved the model ($F(1, 7.1) = 11.1$, $p < .001$). While women exhibit higher fatigue than men ($B = .26$, $SE = .03$) and age is negatively associated with fatigue ($B = -.02$, $SE = 0$), the slope for age regressed on fatigue for women is significantly smaller than the slope for men ($B = .01$, $SE = 0$), suggesting that women report higher fatigue than men across the age span, but the difference becomes larger as age increases (see Figure 4).

Fig. 4. ZEF score across age and gender.



A subset of 2704 participants were randomly assigned to consider their experience with either social or work video conferencing contexts (see Supplementary Materials). A two-way ANOVA comparing the two groups revealed lower levels of fatigue after social video conferences (M = 2.59, SE = .03) than work ones (M = 3.01, SE = .02) [F(1, 2690) = 46.75, p <.001, d = .48]. The gender effect, however, persisted across both contexts [F(1, 2690) = 42.67, p <.001, d = .40], with women reporting higher levels of fatigue than men after both social and work video conferences, and gender did not interact with context.

Out of sample replication

To replicate the gender effect observed in our large convenience sample, we ran an out-of-sample replication. A power analysis suggested a new sample of 788 participants to detect a small effect size (d = .20) with 80% power, using a two-sample t-test with alpha at .05. A total of 1,203 participants (located in the US) were recruited online through Amazon's Mechanical Turk worker system with a minimum HIT approval rate of 97%.

After data exclusion using the same criteria as the main study, 778 responses (464 men and 314 women; Mage = 35.59, SD = 9.89) were included in the statistical analysis. The distribution of races was: 10.5% of African or African-American or Black (n =82), 9.1% of Asian or Asian-American (n = 71), 4.8% of Hispanic or LatinX (n = 37), .5% of Indigenous or Native American (n = 4), .4% of Middle Eastern (n = 3), .4% of Native Hawaiian or Pacific Islander (n = 3), 68.8% of White (n = 535), 5% of participants identifying with more than one ethnic background (n = 39), .5% identified as an ethnic background not listed or decline to answer (n = 4).

To minimize selection bias, participants were recruited to answer a survey on their usage of video conferencing tools rather than on Zoom fatigue. The online survey included questions about demographics and video conference usage along with the ZEF scale. Women (M = 2.64, SD = .98) reported a significantly higher level of Zoom fatigue than

men (M = 2.49, SD = .98) ($t(776) = -2.24$, $p = .02$, $d = .16$), which replicated the gender effect found in the convenience sample.

Discussion

In this study, using a large-scale, convenience sample of over ten thousand people, we confirmed a number of hypotheses. First, Zoom fatigue increased with frequency, duration of meetings, and burstiness (i.e., shorter time between meetings). Nonverbal mechanisms were related to fatigue, and explained almost a third of the variance in the ZEF Score. Women experienced more fatigue than men, even after controlling for differences in usage, demographics and personality. In support of this gender fatigue effect from the ZEF Scale, the text analysis revealed that women also were more likely than men to use terms related to scheduling and fatigue when describing their video conference experience in their open-ended responses.

Consistent with psychological research on self-focused attention and negative affect (11), women experienced more mirror anxiety associated with the self-view in video conferencing than men, and mirror anxiety was a primary mediator for the gender effect on fatigue. Importantly, this mediation pattern was observed in both the self-report and linguistic data, with women using more first-person singular pronouns than men, and this pronoun difference mediated the gender fatigue effect. Given that production of first-person singular has been used extensively as a measure of self-focused attention (34, 35, 43), these are compelling behavioral data that women were more self-focused when describing their video conference experience than men. In addition to mirror anxiety, the nonverbal mechanisms of hyper gaze and feeling physically trapped also mediated the gender effect of fatigue, as did producing nonverbal behavior, although to a lesser degree.

Finally, exploratory analyses showed less fatigue for extraverts than for introverts, for older people than for younger people, for social contexts than for work contexts, and for white people compared to other races. The greater fatigue for women compared to men, however, remained even when controlling for these additional variables.

Limitations

The current research has several limitations. First, participants were recruited through word of mouth, social media, and news media outlets publishing about Zoom fatigue. In this way, the sample is not representative of the population and likely resulted in a sample already holding an interest in the topic, which may have biased ZEF scores to be higher than the average population. In this study, the mean ZEF scores for women and men are respectively 3.13 and 2.75. This gender effect was observed again in the out of sample replication although the scores were slightly lower than in our main study. This difference might be expected because participants in the convenience sample were drawn to the topic and may be particularly high in virtual meeting fatigue.

Another limitation is our reliance on self-report measures of Zoom fatigue and video conference usage as opposed to behavioral measures given that several studies have found people tend to overestimate media use when self-reporting (44, 45). Although in some cases our linguistic measures correlated with their self-report counterparts. For example, the frequency of first-person singular pronouns in the open-ended responses were not only correlated with self-reported mirror anxiety, they also mediated the gender effect on fatigue in the same way that mirror anxiety did.

Finally, the mechanisms accounting for the cognitive load associated with interpreting and producing nonverbal cues were each measured with a single item, as opposed to a scale consisting of multiple items. Moreover, the mechanism around being physically trapped had a low reliability for the three items (alpha = .56). It will be important in future studies to strengthen the measurement tools used to quantify the different mechanisms.

Future directions

Zoom allows us to stay socially connected with family and friends and to work remotely with colleagues, and provides an incredibly useful service. As the world transitions to the post-pandemic era, in which the future of work is likely to be hybrid (3), it will be important to maximize the benefits of video conferencing while reducing the psychological costs, especially given that these costs are born unequally across society. As the research on Zoom fatigue is in its infancy, more research is needed to understand the causes and consequences of Zoom fatigue. First, video conferences are one of many types of meetings and as the population returns to increasingly hybrid workspaces it is important to study video conferences in comparison to face-to-face or phone meetings to uncover the benefits and drawbacks of each of these meeting types. The longitudinal aspects of Zoom fatigue have not been explored yet and following individuals' Zoom fatigue during a working week would provide insight into how Zoom fatigue accumulates and dissipates over time, which would provide important information for organizing video conferencing schedules. The findings on race, in which non-white respondents reported higher levels of fatigue than white participants, were not predicted in this study and deserve urgent research attention. The effect size was small--race accounted for less than one half one percent of the variance in the ZEF Score--but nonetheless our research group is currently working with scholars who specialize in race and media to explore this finding further. Finally, given that these effects were observed with adults, it is imperative that future research examine Zoom fatigue with children given that many children have been required to use video conferencing for school and to maintain family and friend relationships.

Implications

Several researchers have already pointed at the disproportionate negative impact of COVID on women such as greater economic hardships (46) heavier childcare load than men (8), and also increased struggles with body image (47). In this way, our findings add to the body of knowledge showing the disproportionate negative impact of the COVID pandemic on women. While Zoom fatigue is an emerging concept that appeared during the COVID pandemic due to the sudden increased reliance on video conferences to engage in daily tasks, very little is known about its causes and consequences, leading to limited knowledge concerning how to mitigate this new form of fatigue. Confirming the role played by the nonverbal mechanisms such as mirror anxiety, feeling physically trapped, hyper gaze and cognitive load associated with producing and interpreting nonverbal cues, offers an opportunity to address these challenges.

Communication systems can be designed to allow for natural nonverbal behavior (48). Individually, video conference users can take some time to assess their working station and adapt their environment to alleviate mechanisms, such as feeling physically trapped by, for example, using a standing desk or increasing the space between them and the camera. The burden of reducing Zoom fatigue, however, should not be placed solely on individuals as this can intensify inequities (e.g., not everyone can afford a standing desk). Instead, these findings can help companies become aware of the extra Zoom fatigue experienced by women and adapt their policies and culture at the institutional level. For example, companies could prohibit the use of video in a subset of meetings, and provide

guidelines on how frequent and long meetings should be, along with recommendations for intervals between meetings. Companies could also support the use of asynchronous nonverbal communication tools that have been argued to be beneficial for interpersonal interaction (49). Finally, these findings can contribute to the design process of video conference platforms companies, for example the default should be that the self-view is hidden. Given that mirror anxiety accounted for a substantial amount of the gender effect, changing the default self-view could help reduce the increased fatigue women report relative to men.

Materials and Methods

Between February 22nd and March 12th, we recruited participants through word of mouth with friends and colleagues, through social media, and also through news media outlets who published a link to the ZEF Scale in their stories. A convenience sample of 14,760 individuals completed an online survey. Informed consent was obtained after the nature and possible consequences of the studies were explained. Data analyses included only responses from participants who (a) reported using video conferences on a daily basis, (b) passed the attention check question (see Supplementary Materials), (c) were between 18 and 85 years old, and (d) had a minimum completion rate of 90% of the items for the survey. These criteria resulted in a dataset of 10,591 responses with a completion rate over 91%.

During the month-long data collection, additional items were included at two time points to the survey, leading to three subsets of data. For all three subsets, the survey included (a) demographic questions: gender, age, and race, (b) the Zoom & Fatigue (ZEF) scale, (c) video conference usage items and (d) open-ended responses about their video conference experience. The second and third subsets also included items related to the five nonverbal mechanisms. The third subset also included the Ten Item Personality Inventory personality questionnaire.

Participants

The data analyses included responses from 10,591 participants, with 68.8% of women (n = 7284), 28.8% of men (n = 3048), .85% identifying as neither women nor men (n = 90), and 1.6% declining to answer (n = 167). The age ranged between 18 and 85 years old (M = 43.6, SD = 12.99). The distribution of races was: 2.3% of African or African-American or Black (n =246), 7.2% of Asian or Asian-American (n = 764), 4.2% of Hispanic or LatinX (n = 443), .3% of Indigenous or Native American (n = 30), .8% of Middle Eastern (n = 80), .3% of Native Hawaiian or Pacific Islander (n = 26), 74.5% of White (n = 7892), 5.7% of participants identifying with more than one ethnic background (n = 602), 4.8% identified as an ethnic background not listed or decline to answer (n = 508). ¨

Scales and items

Zoom Fatigue. The Zoom Exhaustion & Fatigue (ZEF) Scale is a 15-item scale (Fauville et al., 2021) addressing five dimensions of fatigue (three items each): general, visual, emotional, social and motivational. The items are answered on a 5-point Likert scale ranging from 1 = “not at all” to 5 = “extremely” or from 1 = “never” to 5 = “always”. The items inquire how respondents feel after video conferencing with sample items for the respective five aspects of fatigue being “I feel tired”, “my eyes feel irritated”, “I feel irritable”, “I avoid social situations”, and “I dread having to do things”. The ZEF score is measured by computing the mean of the 15 items (M = 3.02, SD = .81, alpha = .94).

Video conference usage. The video conference usage was measured through three items, namely frequency, duration and burstiness. To measure 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” (*M* = 3.69, *SD* = 1.77). To measure 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 minutes”, 2 = “15 to 30 minutes”, 3 = “30 to 45 minutes”, 4 = “45 minutes to an hour”, and 5 = “More than an hour” (*M* = 3.93, *SD* = .80). To measure 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 conferences 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 minutes to an hour”, 3 = “30 to 45 minutes”, 4 = “15 to 30 minutes”, and 5 = “Less than 15 minutes” (M = 3.47, *SD* = 1.51).

Open-ended question. The participants were invited to write down anything they wanted to share about their experience with video conferences. A total of 5,359 participants completed the open-ended question (word count: *M* = 54.5, *SD* = 51.06).

Mirror anxiety. This measure aimed to investigate how self-viewing while video conferencing would associate with Zoom fatigue. This mechanism was measured by three items on a 5-point Likert-scale from 1 = “not at all” to 5 = “extremely”. These items were “During a video conference, how concerned do you feel about seeing yourself?”, “During a video conference, how concerned do you feel about what people think of your appearance?” and “During a video conference, how distracting is it to see yourself?” (*M* = 3.16, *SD* = .99, alpha= .79).

Physically trapped. To investigate how the restricted movements imposed by the need to be in front of the camera while video conferencing would associate with Zoom fatigue, the following three items were asked: “During a video conference, how often do you need to stay seated?”, “During a video conference, how often do you feel you need to stay within the camera’s frame?” and “During a video conference, how physically constrained do you feel?” on a 5-point Likert scale from 1 = “never” to 5 = “not at all” and from 1 = “not at all” to 5 = “extremely” (*M* = 4.12, *SD* = .69, alpha= .56).

Hyper gaze. A single-item scale was used to measure the perceived gaze of other participants. Participants were asked to indicate “During a video conference, how often do you feel like people are staring at you?” on a 5-point Likert from 1 = “never” to 5 = “always” (*M* = 3.10, *SD* = 1.21).

Cognitive load linked to producing nonverbal cues. To account for the additional cognitive load required to produce nonverbal cues, we asked “During a video conference, how much do you need to think about your body language?” (*M* = 3.36, *SD* = 1.09), answered through a 5-point Likert scale from 1 = “not at all” to 5 = “extremely”.

Cognitive load associated with interpreting nonverbal cues. To measure the cognitive load associated with decoding other participants’ nonverbal cues, participants were asked to indicate “During a video conference, how easy is it to interpret other people’s body language?” (*M* = 3.62, *SD* = .90), on a 5-point Likert scale from 1 = “not at all” to 5 = “extremely”.

Personality traits. The Ten Item Personality Inventory (TIPI, 38) measures the following five personality domains: extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience. Each domain was measured by two couples of adjectives (e.g., for the extraversion dimension: “extraverted and enthusiastic” and “reserved and quiet”). The participants were asked to indicate how much they saw

themselves in 10 couples of adjectives on a 5-point Likert scale ranging from 1 = "not at all" to 5 = "extremely". Moreover, for participants completing the TIPI, participants were randomly assigned to one of the two conditions: (a) in the Work condition, participants were asked to answer the survey from the perspective of their work-related video conference calls (e.g., having a work meeting or taking/giving a class); (a) in the Social condition, the participants were prompted to answer the survey from their experience with video conference calls for social purposes (e.g., virtual parties with friends).

Statistical analysis

All the data analyses were conducted in R (version 4.0.2). Bivariate correlations were conducted in Pearson correlation, and Spearman rank correlation when necessary (in Supplementary Materials). Multiple linear regressions used the standard regression R package. Single-mediator analysis of mirror anxiety was non-parametrically estimated using the R package mediation. The multiple-mediation model was estimated using a path analysis in the R package lavaan.

For the computational text analysis, we used a standard analytic tool Linguistic Inquiry and Word Count (LIWC; 40) to quantify the use of first-person singular pronouns (e.g., me, my, I) as a percentage of total word count, which we used as a measure of self-focused attention (34). We also employed the *Meaning Extraction Method* (MEM, 33) that uses a factor analytic approach to identify meaningful word clusters within a corpus of text (41). A basic assumption of MEM is that different words that reflect a common topic will cluster together to form a relevant topic category amenable for subsequent analysis (42). The MEM is a two-step process: In step one, the text of each participant's open-ended response was entered into the Meaning Extraction Helper, Version 2 (32) for basic data preparation procedures, including segmentation, lemmatization, and frequency counts. We excluded any participant responses that were less than five words long, and following Chung and Pennebaker's criteria (33), only root words that were used in at least 5.0% of the responses were retained. In step two, we conducted a principal components analysis with varimax rotation, and we retained terms that loaded at .20 or higher.
The results of the MEM analysis (Kaiser-Meyer-Olkin (KMO) = . 659, Bartlett's test = 16322.03, $p < .001$) revealed three factors that accounted for 11.7% of the variance (see Table 1). The first factor, *scheduling and fatigue*, detailed words related to meeting schedules "long" "meeting" "break" and feeling tired "exhausted". The second factor, *video conferencing*, included terms that related to video conferencing generally versus the platform "Zoom" specifically. The third factor, *social connection*, identified relationships "friend" "family" and the terms "social" and "connect."

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