**Lights, Cameras (on), Action! Camera Usage During Zoom Classes Facilitates Student
Engagement Without Increasing Fatigue**

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Abstract. Video conferencing software such as Zoom has facilitated the recent explosion in online learning. In two field experiments, we explored how students having their cameras on versus off affected their engagement during, and their fatigue after, a large, lecture-based class. In an affective forecasting experiment (Study 1), we asked 81 students across two university classes to predict how they would feel if they had their cameras on versus off during a particular class session. Consistent with popular concerns about “Zoom fatigue,” students expected to feel both more engaged and more fatigued when their cameras were on than when they were off. A subsequent longitudinal, experience-based study (Study 2) with 319 observations across 65 students, however, only bore out one of these expectations. As anticipated, students felt more engaged during class when they were assigned to have their camera on, but they were no more fatigued afterward. Our findings suggest that at least in the context of large online lectures, asking students to have their cameras on can increase engagement without increasing fatigue.

Keywords: learning, engagement, fatigue, video conferencing, virtual meeting

At the inception of the COVID-19 pandemic, people quickly found themselves limited almost exclusively to virtual interactions in myriad contexts, including education. Online learning had already been on the rise (Institute of Education Sciences, 2017), but the pandemic catalyzed this trend, forcing many universities suddenly to transition either to a predominantly or fully online format. Only a few months into the pandemic, in June of 2020, more than 700 universities were holding classes online, using the video communication platform Zoom (Over 700 universities and colleges now use zoom, 2020). Even though quarantine restrictions are beginning to lift, there is a general consensus that classrooms will remain virtually accessible even after in-person learning resumes (George et al., 2021; Lockee, 2021; Martin, 2021; McMurtie, 2021; Pokhrel & Chhetri, 2021). Virtual learning platforms have thus become an indispensable educational tool.

At the same time, experts, educators, parents, and students agree that online classes are less engaging than in-person ones. In a recent poll of 350 college students, 80 percent of respondents found it harder to focus in newly online classes (Peper et al., 2021). Thus, the importance of exploring ways of improving virtual learning has never been greater. We seek to advance this aim through a set of studies showing how one easily manipulatable aspect of online education—students’ camera use during class—affects both engagement and fatigue.

Camera Use and “Zoom Fatigue”

As the COVID-19 pandemic forced people to learn and work remotely, the term “Zoom fatigue” quickly entered popular parlance; it described feeling exhausted as a result of extensive video conferencing (e.g., Degges-White, 2020; Jiang, 2020; Morris, 2020). But what causes Zoom fatigue? Recent evidence suggests that Zoom fatigue stems, in part, from camera usage

(Fauville et al., 2021; Shockley et al., 2021). For example, in a four-week field experiment, 101 healthcare company workers reported that they felt more fatigued at the end of the workday when assigned to have their cameras on during meetings than when assigned to have them off (Shockley et al., 2021). The researchers interpreted these findings using self-presentation theory (Baumeister, 1982; Goffman, 1959), which posits that people are motivated to be viewed favorably by others. The self-regulation required to present oneself favorably involves an inherently fatiguing cognitive demand (Klotz et al., 2018; Vohs et al., 2005). Similarly, Bailenson (2021) theorized that the perceived size of one's image on other people's screens is a key factor that feeds self-presentational concerns during video conferencing. Consistent with this theorizing, a recent correlational study with more than 10,000 respondents showed that Zoom fatigue was associated with mirror anxiety—the stress induced by seeing, in real time, one's own video feed as it may appear to others (Fauville et al., 2021).

Self-presentational concerns may be less likely to arise in the context of online classes than in the work context for a host of reasons. First, the number of participants in a typical online lecture class is larger than in a typical workplace meeting. One survey found that an average of nine people participate in work meetings (Russell, 2015), a more intimate grouping even than a small college class. Greater numbers of participants may decrease self-presentational concerns since the more participants there are, the smaller one's video appears on other participants' screens. Second, most college classes tend to have a primary speaker—the teacher—with students playing a less central role as listeners. In this context, a student's own video feed is likely to appear smaller on their own screen and on the screens of others. Finally, teachers often rely on sharing their screens, which makes visual aids (e.g., lecture slides) rather than participant

videos the main focus of attention. For these reasons, findings in the work context may not readily lend themselves to the educational context.

Camera Use and Engagement

Most research on video conferencing has focused on its effect on fatigue, but in the context of education, student engagement is, arguably, of even greater importance. Increased student engagement is associated with multiple improved learning outcomes (for a comprehensive review, see Fredricks et al., 2004). How, then, can we make online education more engaging? Media richness theory (Daft & Lengel, 1986) dictates that the richer the medium, the more effective it is at communicating information. Face-to-face communication is the richest medium, and communication media decrease in richness as they deviate further from this gold standard (Daft & Lengel, 1986). This may explain why students seem to find online classes less engaging than their in-person counterparts (Peper et al., 2021). Because during in-person classes students are visible to others, having one's camera on during an online class should approximate the in-person class experience more so than having one's camera off. Thus, students may have a richer experience in an online class when they have their camera on and can be seen by others, just like in their in-person classes. But this theorizing just begs the question of what it is about being seen by others that increases engagement during class.

We propose that being visible increases engagement by making students feel more accountable. When a person has their camera on, the norm is to remain in place, where one can both reach their keyboard and be visible through their camera (Bailenson, 2021). Just as in a physical classroom, a student on camera during a video class may feel sufficient accountability to refrain from simultaneously engaging in tasks, such as browsing the Internet, cooking lunch,

or folding laundry. Of course, just as in a physical classroom, being on camera is not a panacea, and students can—and likely do—browse the internet during class. Still, students whose cameras are on should, on average, be more motivated to stay on task, thus feeling more engaged than those with cameras off.

The Present Research

To explore how camera usage affects fatigue and engagement, we conducted two field experiments with undergraduate students across two university classes. Students in each study were recruited from the same two classes, during different semesters. In a within-subject affective forecasting study (Study 1), we investigated students' perceptions of how their camera usage affects engagement and fatigue. At the end of an in-person class, we asked students to imagine how fatigued and engaged they would have felt if the class had been online, and they had their camera on versus off. Due to the popularity of the Zoom fatigue concept, we expected that students would forecast greater fatigue when imagining themselves with their cameras on. We had no specific predictions about engagement. In Study 2, we investigated students' actual experience of fatigue and engagement while they attended class via video conferencing. Students were assigned at the outset of several classes to have their cameras on or off. At the end of class, students reported how engaged they felt during the session and how fatigued they felt at the end. We expected that camera usage during class would increase engagement. We had no specific predictions about the effect of camera usage on fatigue. The raw data used for both studies can be accessed through the Open Science Framework (OSF):

<https://doi.org/10.17605/OSF.IO/M63SG>.

Study 1

Method

Participants. During the 2021 fall semester, we recruited $N = 81$ undergraduate students at a U.S. university from two psychology courses: Health Psychology and Social Psychology. Both classes were large, with an enrollment of at least 30 students. We asked students to complete the survey at the end of an in-person class as part of an educational activity. Seven students did not consent to participate in this research—a decision that had no bearing on their grades. Of the 81 students who consented, 18 identified as male, 62 as female, and one student as nonbinary. Participants were largely White ($n = 57$) and Asian ($n = 19$). Their ages ranged from 18–23, with a mean age of 20.0. The sample size was entirely determined by practical constraints, but post-hoc sensitivity analysis with G*Power v3.1 indicated that our sample size allowed us to detect within-subjects effects as small as *Cohen's* $f = .16$ with 80% power, $\alpha = 0.05$, two-tailed.

Design and measures. We conducted the survey when classes returned to in-person instruction after two semesters of online instruction. At the end of an in-person class, we gave students a one-time survey asking them to imagine that they had taken that same class virtually, on Zoom. We then asked students to predict how they would have felt in two situations: if they had spent the duration of the imagined virtual class with their cameras on, and if they had spent it with their cameras off. The order of presentation for these two scenarios was randomized. For each situation, students were asked: “How engaged would you have felt during the class?” and “How fatigued would you have felt at the end of class?” Students responded to both questions using a five-point Likert-type scale, ranging from 1 (*not at all*) to 5 (*very much*). After predicting their engagement and fatigue in both situations, students filled out a demographic questionnaire.

Results

We ran two mixed-level ANOVAs predicting engagement and fatigue from camera usage scenario as a within-subjects factor and order of scenarios as the between-subjects factor.

Students forecasted that they would feel significantly more engaged during class with their cameras on ($M = 3.29$, $SE = 0.11$) versus off ($M = 2.05$, $SE = 0.10$), $F(1,79) = 93.34$, $p < .001$, $\eta_p^2 = .542$ (see Figure 1). This effect was not moderated by the order in which the scenarios were presented, $F(1,79) = 0.04$, $p = .840$, $\eta_p^2 = .001$. Scenario order did, however, have a small main effect on engagement: students who first imagined having their camera on reported lower engagement across both scenarios, $F(1,79) = 5.54$, $p = .022$, $\eta_p^2 = .064$.

Students also predicted that the camera-on scenario would leave them feeling significantly more fatigued at the end of class ($M = 4.03$, $SE = 0.11$) than would the camera-off scenario ($M = 2.99$, $SE = 0.12$), $F(1,79) = 64.88$, $p < .001$, $\eta_p^2 = .451$ (see Figure 2). This effect was not moderated by scenario order, $F(1,79) = 0.39$, $p = .536$, $\eta_p^2 = .005$, and there was no main effect of order, $F(1,79) = 0.01$, $p = .908$, $\eta_p^2 < .001$.

Overall, Study 1 showed that students expected to feel both more engaged and more fatigued when their cameras were on versus off during an online lecture. Because we conducted Study 1 after two semesters of remote learning, students' forecasts may have reflected their actual experiences. It is also possible, however, that the popularization of the concept of Zoom fatigue distorted students' judgments. In Study 2, we explored whether students' actual engagement and fatigue depend on their camera usage.

Study 2

Method

Participants. During the 2020 fall semester, we recruited $N = 65$ students from the same two undergraduate courses as in Study 1: Health Psychology and Social Psychology. We did not measure demographics in this field experiment, but the distribution was likely similar to the sample in Study 1. Though all students in those classes were required to complete the surveys as part of a class activity, sixteen additional students did not consent to have their data used in the study. Four students consented but did not complete any surveys. The students completed surveys during multiple class sessions between October 5, 2020, and November 11, 2020, yielding a total of $N = 319$ observations. The sample size was entirely determined by practical constraints, but post-hoc sensitivity analyses with G*Power 3 for the within factor in repeated-measures ANOVA indicated that, given our design, our sample size allowed us to detect within-subjects effects as small as *Cohen's* $f = .18$ with 80% power, $\alpha = 0.05$, two-tailed.

Design and measures. At the beginning of class over a 37-day period, students were assigned to either have their cameras on or off for the duration of a 75-minute lecture. We did not manipulate camera usage during examinations and during the class periods immediately preceding the 2020 U.S. presidential election. We assigned camera usage to the Social Psychology groups based on the first letters of the students' first names; students whose first names started with the letters A-J ($N = 28$) were in Group 1, and students whose first names started with the letters K-Z ($N = 21$) in Group 2. The Health Psychology students had already been randomly assigned into nine groups to complete collaborative assignments. We combined these nine groups into two larger groups, paralleling those formed in the Social Psychology course. Group 1 in Health Psychology consisted of nine students, while Group 2 consisted of

seven. Overall, our method of camera assignment resulted in slightly more observations in the camera-on condition ($N = 180$) than in the camera-off condition ($N = 139$).

At the end of each lecture, a three-question survey was distributed, using Zoom's in-meeting polling feature. The first two questions were: "How engaged did you feel during class today?" and "How fatigued do you feel right now?" Students responded using a five-point Likert-type scale ranging from 1 (*not at all*) to 5 (*very much*). The third question—"Was your camera on or off during this class?"—served as a manipulation check. Of the 54 instances in which students failed the manipulation check, 14 were in the camera-off condition, and 40 were in the camera-on condition. Thus, the number of actual observations with the camera on ($N = 140$) was similar to the observations with the camera off ($N = 125$).

Results. We used REML multilevel models clustered within-person to estimate the fixed effect of camera condition while also estimating the random intercept and random effect of condition. The covariance between the random effects was also estimated (see Table 1 for model details). Confidence intervals were calculated using the Wald method and degrees of freedom were computed by the Satterthwaite method. We computed partial eta-squared based on the omnibus F-test for the fixed effect of camera condition (Lakens, 2013). These analyses were conducted using Jamovi, version 1.6 for Mac (The jamovi project, 2021).

We first used intention-to-treat analyses with all 319 observations, regardless of whether participants passed the manipulation check. Consistent with students' forecasts in Study 1, we found that when students were assigned to have their cameras on, they were more engaged during class ($M = 3.63$, $SE = 0.09$) than when they were assigned to have their cameras off ($M = 3.35$, $SE = 0.10$), $b = 0.28$, 95% $CI[0.10; 0.47]$, $t(56.7) = 2.97$, $p = .004$, $F(1, 56.7) = 8.84$, $\eta_p^2 = .135$ (see Table 1, Figure 1). Contrary to student forecasts in Study 1, however, we found no

significant difference in fatigue between classes when students were assigned to have their cameras on ($M = 3.32$, $SE = 0.10$) versus off ($M = 3.26$, $SE = 0.11$), $b = 0.06$, 95% $CI[-0.17; 0.29]$, $t(50.2) = 0.52$, $p = .608$, $F(1, 50.2) = 0.27$, $\eta^2_p = .005$ (see Table 1, Figure 2). In separate models, we added the class from which participants were recruited as a fixed effect factor; we found that the effect of camera use was not moderated by class for either engagement, $b = 0.18$, $t(51.0) = .84$, $p = .407$, or fatigue, $b = 0.09$, $t(45.8) = .34$, $p = .739$.

Next, we ran the same REML multilevel models, this time excluding participants who failed the manipulation check. This reduced our original number of observations ($N_{\text{obs.}} = 319$) to $N_{\text{obs.}} = 265$. Comparing times when students actually had their cameras on versus off during class yielded the same pattern of results as the intention-to-treat analysis. Students felt more engaged when their cameras were on ($M = 3.67$, $SE = 0.09$) versus off ($M = 3.32$, $SE = 0.11$), $b = 0.36$, 95% $CI[0.14; 0.56]$, $t(54.5) = 3.26$, $p < 0.05$, $F(1, 54.6) = 10.60$, $\eta^2_p = .163$, but there was no effect of camera use on fatigue (cameras on: $M = 3.34$, $SE = 0.10$, cameras off: $M = 3.23$, $SE = 0.11$), $b = 0.11$, 95% $CI[-0.15; 0.36]$, $t(48.6) = 0.83$, $p = .413$, $F(1, 48.6) = 0.68$, $\eta^2_p = .014$.

Figure 1. Camera usage during online lectures predicts greater engagement both in student forecasts (Study 1) and experiences (Study 2). Marginal means are displayed and the error bars denote standard error.

Figure 2. *Camera usage during online lectures predicts greater fatigue in student forecasts (Study 1) but not in their experiences (Study 2). Here, marginal means are displayed, and the error bars represent standard error.*

Table 1. Multilevel models showing the effect of condition (camera-on vs. camera-off) on engagement and fatigue that students experienced while attending classes via video conferencing (Zoom).

		Engagement		Fatigue	
Fixed Components		Model E0	Model E1	Model F0	Model F1
	Intercept [95%CI]	3.51 [3.35; 3.67]	3.35 [3.14; 3.55]	3.30 [3.12; 3.47]	3.26 [3.05; 3.47]
	Condition [95% CI]		0.28 [0.10, 0.47]		0.06 [-0.17, 0.29]
Random Components					
Random intercept		0.29	0.41	0.31	0.31
Random slope (condition)			0.08		0.09
Intercept-slope correlation			-0.64		-0.19
Residual (σ^2)		0.62	0.57	0.87	0.85
ICC _{person}		0.32	0.42	0.26	0.27
Model Statistics					
Marginal R ²		0.000	0.022	0.000	0.001
AIC		831.165	825.473	930.617	936.004

Note: Condition was coded using “1” for camera on and “0” for camera off.

Discussion

We set out to investigate how students' camera use during online classes affects both their engagement and fatigue. In a field experiment employing a within-subjects design, students in two online university classes felt more engaged but no more fatigued during classes when they were randomly assigned to have their cameras on versus off. In a separate experiment, a different sample of students (forecasters) taking the same two classes in person predicted they would feel more engaged if they had taken the class online with their cameras on versus off. However, these student forecasters also predicted that they would also feel more fatigued if they had their cameras on. Contrary to both students' own expectations and popular accounts of "Zoom fatigue," we found that when students had their cameras on during online classes, they experienced increased engagement *without* increased fatigue.

Implications

The present research is the first to explore the effect of camera usage on fatigue in an educational context. Several previous studies have documented the effect of camera usage in the work domain (Fauville et al., 2021; Shockley et al., 2021). The existing evidence suggests that a person's camera usage during a work meeting does increase fatigue (Shockley et al., 2021). Correlational findings further suggest that this effect may be due to the increased cognitive demand associated with elevated self-presentation concerns that arise when people are on camera (Fauville et al., 2021). The differences between those findings and ours may be due to myriad factors, such as the age of participants; university students, on average, are younger than employees. We propose, however, that the absence of an effect of camera usage on fatigue may be due, at least in part, to lower self-presentation concerns in the context of online lecture

classes, which tend to include more participants than a typical work meeting. If this is the case, then the number of participants in a video conference session may affect the existence of Zoom fatigue across contexts. In smaller, discussion-driven classes, for example, students' camera usage may lead to greater fatigue, just as it does for employees in a typical work meeting (Shockley et al., 2021). Conversely, in larger work meetings, especially those that focus on a presentation rather than participant video feeds, camera usage may increase engagement without leading to greater fatigue, just as it does for students in larger lecture-based classes.

If camera usage leads to fatigue by increasing self-presentation concerns, it may be possible to mitigate this effect directly by changing the prominence of one's own video feed (c.f., Bailenson, 2021). For example, software like Zoom allows participants to alter their settings so that they do not see their own video feed. Future research should explore whether people who know they are on camera but do not see their own video feed are more or less preoccupied with how they appear to others, and thus more or less fatigued. In addition, self-presentation concerns may be driven by the perception of how one's video feed appears on other people's screens. In Zoom's "grid view," for example, participants' video feeds appear the same size, regardless of who is speaking. If a company makes grid view the default for meetings, participants may be less concerned with how they appear to others, and thus less fatigued.

Limitations

One of the key strengths of the present research is that we were able to test the effect of camera usage in the real world, increasing the ecological validity of our findings. To make the studies possible in a field setting, however, we were not able to assess the proposed mechanisms behind the effects of camera usage on fatigue and engagement. Future research should thus

examine how camera usage affects cognitive load, self-presentation concerns, and accountability. Future research should also explore the downstream consequences that class engagement due to camera usage during online classes may have for learning outcomes. In addition, our sample size was determined by practical factors, such as the number of students in the two classes, rather than based on a priori power analyses. Thus, we cannot claim that our study was powered to provide evidence of the absence of an effect (Altman & Bland, 1995). Still, we note that the effect size we observed of camera usage on fatigue was extremely small, and thus unlikely to be of any practical significance (Funder & Ozer, 2019).

Several factors limit the generalizability of the present research. First, our study focused on a limited population: college students enrolled in two psychology classes at a selective private university located in a large metropolitan area of the United States. Thus, despite their high ecological validity, our findings may not generalize to other populations: students who attend different educational institutions, or who are taking classes in different subject areas may have different experiences. Second, we conducted our studies amid a once-in-a-lifetime pandemic that limited face-to-face interactions of any kind (World Health Organization, 2020). In the unique context of social isolation necessitated by the Covid-19 pandemic, camera usage may have been more energizing than it would be under normal circumstances. Finally, this research focused on a classroom that was newly online. Future studies could assess whether the effects of camera usage on fatigue and engagement depend on how long students have already been participating in online learning.

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