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# Fatigued by yourself? Towards understanding the impact of self-view designs in virtual meeting software

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# Fatigued by Yourself? Towards Understanding the Impact of Self-View Designs in Virtual Meeting Software

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## ABSTRACT

Video meetings are essential for our life. Besides their relevance and advantages, users increasingly observe the negative phenomenon of virtual meeting fatigue (VMF). VMF is described as the feeling of exhaustion during virtual meetings when overusing virtual meeting software. Virtual meeting software presents additional technical stimuli that are not present in offline meetings and require additional cognitive resources. One of these stimuli is the self-view feature, a mirrored image of oneself shown during the meeting which allows controlling the personal appearance. However, research is scarce about the trade-off between the benefits of control and the disadvantages of the additional cognitive load of the self-view. In our pilot study with 17 participants, we want to understand the impact of three self-view designs (self-view on, off, initial) on users' cognitive load, self-awareness, perceived control, and VMF. Therefore, we propose a research model and report initial results.

## KEYWORDS

Self-view, Virtual meeting software, Virtual meeting fatigue, Cognitive load, Self-awareness

## INTRODUCTION

Motivated by the shift towards remote work, the amount of time spent in video meetings increased drastically in the last years. Video meeting systems have become a key element in our daily work (Chew & Azizi, 2022). However, despite enabling users to communicate remotely and facilitate working from separate places, video meetings can also have negative effects. The increased use of video meeting systems led to the phenomenon of virtual meeting fatigue (VMF) (Bailenson, 2021; Fosslien & Duffy, 2020). VMF is defined as "somatic and cognitive exhaustion" (Riedl, 2021, p. 5) and is accompanied by decreased performance and health (Bailenson, 2021; Fauville et al., 2021a).

Experimental research on VMF is still limited and knowledge on influencing factors of VMF is scarce. A recent review by Döring et al. (2022) suggests that increased fatigue can be caused by a myriad of influencing factors (organizational, user-specific, and technological) and that VMF consists of cognitive, emotional but also motivational facets (Fauville et al., 2021b). In contrast to physical meeting fatigue arising in offline meetings, the VMF has a strong technological component. Due to the use of virtual or video meeting software, some information cannot be sent or received. However, also additional information is present, which, based on cognitive load theory, leads to additional cognitive resource demands. An example of such additional information that has been highlighted in research and public media is the self-view feature (Arnu, 2022; Fosslien & Duffy, 2020).

The self-view is a mirrored image of oneself depicted in the interface of the virtual meeting software and thus can be categorized as a technological input factor. It has several functions and was initially designed to allow the user to check if the sent image of oneself looks as intended (del Valle, 2020). On the one side, this additional stimulus requires cognitive resources to process the information. On the other hand, the self-view allows oneself to see a mirrored image of the personal appearance and what information is sent to other meeting participants. Thus, the self-view tile appears to create higher self-awareness. Furthermore, as it functions as a control mechanism, we hypothesize that the self-view leads to an increased feeling of control for the users. Based on mental fatigue and VMF, research stated that an increased cognitive load and demands due to self-awareness over a certain period and a low feeling of control increase the level of fatigue (Döring et al. 2022). However, knowledge about the influencing factors of VMF and how self-view increases VMF is limited. Therefore, we aim to investigate two potential explanatory streams for the development of VMF based on the usage of the self-view feature over time: first, based on cognitive load theory and, second, based on self-awareness theory.

Supporting the self-view's suggested impact as a distractor but also as control mechanism, Balogová & Brumby (2022) show that mixed emotions exist regarding the self-view and some users feel disturbed, while some appreciate the feature. A study by Abramova et al. (2021) confirms this and shows that the current role in the meeting (i.e., talking, not talking) might have an impact on the perception. Also, de Vasconcelos Filho et al. (2009) identified that 55% of eye fixations on the self-view happen during the first minute of a video meeting. This suggests that the self-view serves as a control mechanism. Furthermore, literature examining the impact of the self-

view has mainly covered dyadic teams and explored the design options no self-view/self-view, mostly in a participant-only setting with no shared screen and no mixed-media interface. With our study we want to close this research gap and postulate the following research question:

*"What is the effect of self-view designs in virtual meeting software on self-awareness, feeling of control, cognitive load, and virtual meeting fatigue?"*

To answer this research question, based on the theory of cognitive load and the theory of self-awareness, we report a between-subjects group experimental design that explores the impact of three self-view feature designs (constant self-view, no self-view, initial self-view) on self-awareness, feeling of control, cognitive load, and VMF in this paper. Participants experienced three decision-making tasks in sequence in a triadic team with a mixed media screen including a shared document and the participants' images. Results from a pilot study with 18 participants suggest that the hypothesized self-awareness during constant self-view is higher compared to treatments with initial but then disappearing self-view and no-self-view. The cognitive load of the treatment group confronted with the self-view seems to slightly increase compared to the treatments with initial and then disappearing self-view and with no self-view. Further, a slight increase in VMF is visible over the rounds. In contrast to our hypotheses, the feeling of control is lower for the treatment group presented with a constant self-view.

With this study, we want to contribute to a study that explores an adapted self-view design in contrast to existing experimental designs in a mixed-media interface and a triadic group setting. We provide findings for the development of VMF over time and an in-depth examination of how the specific self-view design impacts the influencing factors of VMF. Thereby, we aim to provide insights on the contributing nature of the self-view to VMF as a negative outcome of virtual meetings.

## CONCEPTUAL FOUNDATIONS AND HYPOTHESES

To build our research model, we reviewed existing work and theories relevant to our research question. In general, our study aims to investigate two different theoretical streams for the effect of self-view designs on VMF highlighting the contradicting nature of the self-view: the cognitive load stream and the self-awareness-based stream. Based on these streams, hypotheses are developed. Our research model is presented in Figure 1.

**Cognitive Load Stream:** Cognitive load is defined as the amount of working memory used to perform a certain task (Sweller, 1988). It consists of mental effort due to a specific topic (*intrinsic*), the way information is presented (*extraneous*), and work put into creating a store of knowledge (*germane*) (Sweller, 1988). Based on cognitive load theory, additional elements lead to an increase in cognitive load due to attentional conflicts (Chaiken et al., 1989; Horn & Behrend, 2017). The self-view is an additional element compared to offline meetings (Riedl, 2021). A constantly available self-view requires constant processing of additional information. Therefore, it might increase the cognitive load of the user. When it is not visible, users have to process less information and cognitive load decreases. We hypothesize:

*H1: A constant self-view leads to a higher cognitive load than an alternating self-view and no self-view in video meetings.*

**Self-awareness Stream:** Early research in psychology investigating self-awareness is based on the self-awareness theory (Carver & Scheier, 1981; Duval & Wicklund, 1972). Accordingly, self-awareness can be described as the capacity to take oneself as the object of thought and think about what oneself is thinking, doing, and experiencing, and how oneself appears. It is strongly linked to self-focused attention since at a given moment, focus attention on the self or the external environment. When being self-aware, individuals compare the self with the environment and try harder to meet environmental standards (Carver & Scheier, 1981). Furthermore, self-awareness is said to impact performance, emotional reaction, communication, and recently VMF. This self-awareness therefore can be a result of either transient situational variables (conflicts), or individual differences (trait self-consciousness). In general, there is a public and a private component to self-awareness. Especially in the public one is related to knowing how one is perceived by others and thus hypothesized to be impacted by external representations of oneself, like the mirrored image of the self-view. Research from psychology and IS shows that mirrored images of oneself, via a mirror itself or a video image of oneself can increase self-awareness. So far mostly dyads and the impact on emotional intensity and cognitive load, as well as self-awareness, were researched (e.g., de Vasconcelos Filho et al., 2009; Hassell & Cotton, 2017; Horn & Behrend, 2017; Miller et al., 2017; Miller & Dechant, 2021; Potthoff & Schienle, 2021; Wegge, 2006). Studies lead to diverging results, especially regarding the impact on performance and productivity. Thus, we want to investigate the impact on meeting fatigue. Based on that, a constant self-view should increase self-awareness. No self-view thus should not increase self-awareness situationally. An adapted self-view, however, should increase self-awareness but not as much as a constant one. We hypothesize:

*H2: A constant self-view increases self-awareness more than an alternating self-view, and respectively more than no self-view in video meetings.*

As a result of the increasing self-awareness, we hypothesize that the display of the self-view serves as a control mechanism. Survey and interview studies suggest that feeling of control and comfort is highly increased with a permanent self-view (Balogová & Brumby, 2022). Moreover, other control-focused concepts such as self-

control are strongly linked to high self-awareness (e.g., Alberts et al. (2011), Vohs et al. (2005)). Thus, a constant self-view should increase the feeling of control. Having no self-view available should decrease the feeling of control. Having an adapted self-view should support the feeling of control during the first minutes. Since this is the time users seem to focus the most on their appearance, the feeling of control should be equal to or slightly lower than a constant self-view. We hypothesize:

*H3: An increase in self-awareness increases the feeling of control when having a constant self-view in video meetings.*

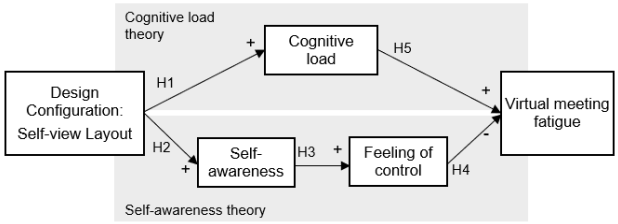


**Figure 1. Research Model**

**Virtual Meeting Fatigue:** The increased use of virtual meeting systems leads users to experience a phenomenon referred to as VMF (Bailenson, 2021; Fosslien & Duffy, 2020). VMF is defined as the "somatic and cognitive exhaustion that is caused by the intensive and/or inappropriate use of videoconferencing tools" (Riedl, 2021, p. 5). The increasing fatigue is accompanied by decreased well-being (e.g., digital burnout, appearance dissatisfaction, headache, discomfort) and productivity (e.g., poor participation, task performance) (Bailenson, 2021; Fauville et al., 2022; Kuhn, 2022; Pikoos et al., 2021; Rogelberg, 2020; Shockley et al., 2021; Yilmaz et al., 2020). Thereby, VMF has several facets such as physical, mental, emotional, motivational, and social components (Bailenson, 2021; Fauville et al., 2021b). VMF differs from mental fatigue and physical meeting fatigue and consists of several layers according to the current knowledge. Compared to pure mental fatigue on the lowest level, VMF does require participants to perform social interactions whereas pure mental fatigue can also occur in individual tasks. As Bafna & Hansen (2021) show, mental fatigue arises over time under high cognitive demands. Thus, in the context of collaborative tasks a second layer of physical meeting fatigue, defined as exhaustion caused by extensive amounts of meetings, has been stated (Bafna & Hansen 2021). In contrast to mental fatigue, on this level, the additional social interaction consists of influencing factors on mental fatigue. However, meeting fatigue also exists when participants meet physically. The virtuality of VMF as the third layer covers the fatiguing feeling when meeting virtually, thus compared to mental fatigue and meeting fatigue it requires the technological component of video-mediated communication. A review by Döring et al. (2022) suggests that increased VMF can originate in a myriad of factors which are either user-specific (personal characteristics), organization-specific (degree of interactivity, group belongingness), or technology-specific (nonverbal overload due to sending and receiving cues, constant self-view). However, existing research does not cover an in-depth examination of increased VMF and how specific technological factors contribute to the development of VMF in experimental settings. To analyze these factors and account for the described dual perception of self-view as control mechanism and source of distraction, we propose two streams on how the effect of the self-view may contribute to VMF. First, based on the presented influence on self-awareness and feeling of control, we hypothesize:

*H4: A higher feeling of control reduces virtual meeting fatigue in comparison to a lower feeling of control when experiencing the self-view in video meetings.*

Second, based on the cognitive load stream and findings from mental fatigue being part of VMF, we hypothesize:

*H5: A higher cognitive load increases virtual meeting fatigue in comparison to a lower cognitive load when experiencing the self-view in video meetings.*

## EXPERIMENTAL DESIGN

We developed an experimental design that allows us to discover the impact of the self-view feature's design on VMF over time. Therefore, it includes different meetings that follow successively.

**Procedure:** The experimental procedure consists of three phases: (1) Onboarding phase, (2) Execution phase, and (3) Perception phase. We present the experimental procedure in Figure 2. During the onboarding phase, users are asked for their consent and fill out a baseline survey to collect their current state of cognitive load and fatigue. Afterward, they are introduced to a test meeting to check that all functionalities are working properly. Then, participants navigate to the execution phase. This phase consists of three rounds, each including a decision-making task. The tasks are the NASA survival on the moon task, and its comparable versions, the Lost in the desert, and the Lost at sea task (Hall & Watson, 1970; Lafferty, 1974; Thompson et al, 2004). The chosen tasks are intelligent tasks based on the task classification by Mc Grath (1984).

The procedure during each round is as follows: The participants are first instructed to provide their solution within three minutes. Afterward, they are directed to a meeting with three participants which lasts for 12 minutes. In this meeting, they are asked to discuss their individual solution and find a common solution. After the meeting, the participants are navigated back to the survey and are asked to answer questions related to our constructs of interest (cognitive load, VMF, feeling of control, self-awareness, focused attention) as well as performance and perception of how often they look at themselves is asked for. The second and third task follow an equal procedure. In each meeting, one of the participants is sharing their screen. The role of the screen sharer changes so that every

participant is sharing the screen in one meeting only. The current role is logged so that possible influences due to screen sharing can be tracked and examined. Finally, participants answer a final survey including demographics and personality-related factors and get debriefed. The setting of three meetings in a row and an alternating screen sharing role is chosen to best replicate a normal virtual meeting behavior throughout a workday.

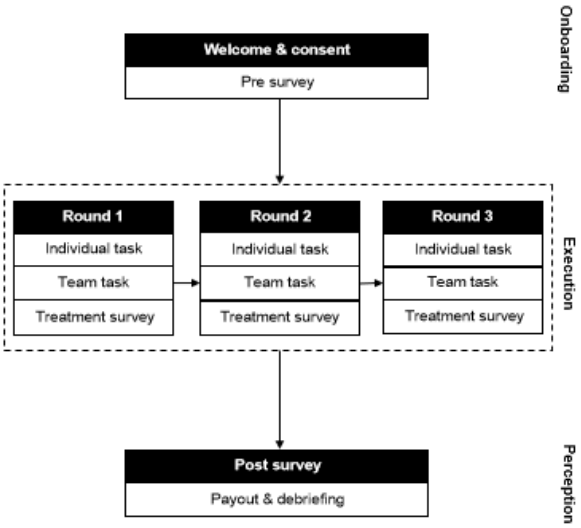


**Figure 2.** Experimental study procedure.

**Experimental Treatments:** During our study, participants are having a virtual meeting and experience an experimental stimulus. Therefore, we hosted an open-source virtual meeting software JITSI (see https://jitsi.org/) which allows the manipulation of front-end features. We further implemented the questionnaires and instructions in a survey that navigates users through the experimental procedure and allows them to join the virtual meetings. We chose three different treatments based on the described findings in related work. In treatment T1 users are constantly faced with their mirrored image. In treatment T2 there is no self-view tile. Treatment T3 is designed based on the findings from de Vasconcelos Filho et al. (2009) and only shows the self-view during the first minute of the meeting. We call this initial self-view. We decided on a between-subjects design to monitor the time-dependent effects of the self-view and see changes in the behavior.

**Data and Measurement Variables:** For data collection, we used survey-based measures. In our experiment, we have three surveys, baseline, treatment, and final survey. The baseline survey consists of adapted versions of established scales for the cognitive load (modified Nasa TLX questionnaire (Hart & Staveland, 1988)) and VMF (modified Zoom Exhaustion & Fatigue Scale (ZEFS) (Fauville et al., 2021b)). The treatment survey consists of the constructs for the cognitive load (as above), VMF (as above), feeling of control, situational self-awareness (Fenigstein et al., 1975) and focused attention on the self (Hong et al., 2004). As an outcome construct, we ask for perceived satisfaction (participation, solution, and process satisfaction) (Green & Taber 1980). We, further, asked them for looks at themselves. We chose multiple surveys to be able to monitor temporal changes over time by using a repeated measures approach. The treatment survey was similar in each round. In the final survey we ask for demographics (age, gender), previous experiences on task topics and virtual meetings, and personality-related factors such as self-satisfaction with face/body appearance, self-consciousness (Fenigstein et al., 1975), and Big-5 short scale (Rammstedt et al., 2014).

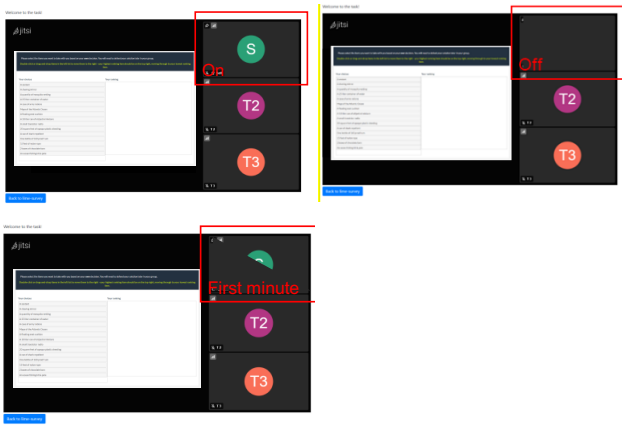


**Figure 3.** Experimental treatments with T1 (constant self-view, top left), T2 (self-view off, top right), and T3 (initial self-view, bottom)

**Participants:** To conduct our study, we aim to recruit participants from a local student participant pool. We aim to have mixed-gender teams to simulate a normal as possible team environment. Most participants likely have experience in virtual meetings due to online lectures and should be in general experienced with interaction in a virtual context. For our pilot study, we recruited 18 participants (33.33% female, 66.67% male) which were between 20 and 30 years old. We excluded one participant due to a failed attention check.

## PILOT STUDY RESULTS

So far, we conducted a preliminary pilot study to test the effect of the three treatments (T1, T2, T3). Each treatment group contained two teams with three participants each. Each team was mixed-gendered. Participants were participating from remote in their natural environment. They used their own devices to join the meeting. Further, we asked them to avoid multitasking and using multiple screens. Average total duration of the experiment was 1:15 h. Subsequently, we present a descriptive analysis of the results for 17 participants with boxplots over the three treatment conditions and three time periods in Figure 3.

**Cognitive Load:** The cognitive load was perceived as moderate in all conditions. A slight increase seems to be visible between the rounds. The treatment with no self-view seems to perceive a slightly higher cognitive load throughout the first and second tasks compared to the groups presented with no self-view. This is in line with our

hypothesized increased cognitive load due to the additional stimuli. However, for the third task, the level of cognitive load is almost similar in all conditions.

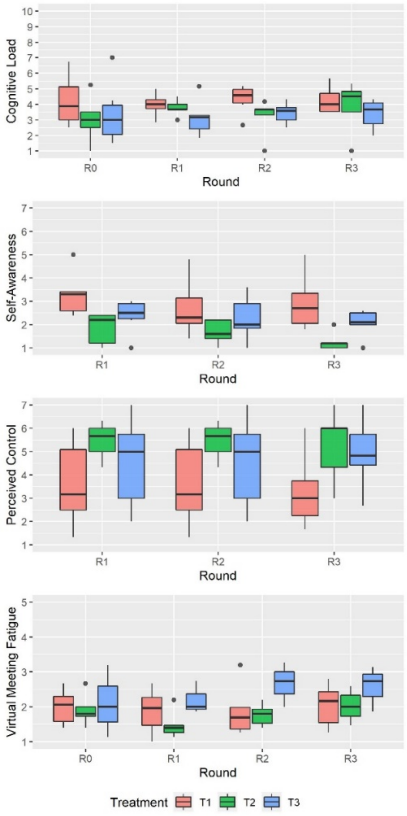


**Figure 3.** Boxplots of cognitive load, self-awareness, feeling of control, and VMF over the three treatment conditions (T1: constant self-view, T2: no self-view, T3: initial self-view)

**Self-awareness and Feeling of Control:** The results indicate that self-awareness seems to be reduced when users were not confronted with their image. This is in line with existing findings and the self-awareness theory. Especially for the treatment condition in which participants were not able to see themselves at all, a decrease in self-awareness is visible throughout the rounds. A similar, however smaller decrease in self-awareness is visible for the treatment group confronted with an initial self-view that only enabled seeing self during the first minute of the meeting (T3). However, in the condition of a constant self-view the level of self-awareness is constantly moderate. Interestingly, the hypothesized increased feeling of control was lowest for the condition that was confronted with the self-view. This contrasts with our suggested hypothesis.

**Virtual Meeting Fatigue:** For all conditions, differences in the reported levels of VMF are visible however remain at a low level. Interestingly, VMF after the first meeting seemed to be lower than one of the pre-task surveys. Afterward, a slight increase is visible in each round.

## DISCUSSION AND OUTLOOK

The results on self-awareness seem to confirm our hypothesis. For self-awareness, one must bear in mind that the presented study includes a mixed-media interface in the design. This implies that the self-view tile is not as prominent as the self-view tile in the participants-only view. Our initial insights derived from the limited pilot study are in line with other findings, such as a study by Miller & Dechant (2021). Keeping in mind that the tasks required to be performed are classified as intelligent consensus tasks, the moderate level of cognitive load for all treatments is reasonable. Nevertheless, a slight increase in cognitive load and VMF seems to be visible in the treatment group with the self-view present. The decrease of VMF after being presented with the first task may be explained by positive emotions due to a stimulating task. Therefore, we aim to collect information on the perceived enjoyability of the task in a future study. For further analysis, making use of performance data, especially regarding participation and influence of own opinion on the outcome may help to identify if the increase in cognitive load and fatigue throughout the experiment is reflected in the performance. Here, the influence of self-awareness on opinion shifts might be of interest (Siegel et al., 1986).

An interesting finding is the level of perceived feeling of control during the experiment. Here, the group presented with no self-view seems to feel more in control than the control group with the self-view present. This is not in line with our hypothesis and the suggested function of the self-view as a control mechanism. One explanation for this finding could be that participants did not only connect the feeling of control to their control over themselves but on the overall meetings. Here, diverse influences can exist based on confounding variables. Especially the experience with the task or the trust in the person currently asked to share the screen can have a high influence. Again, as the task involved finding a consensus for a solution, the necessity to make opinion shifts during the meeting could also impact the felt control. In the upcoming study, a more fine-grained analysis of the feeling of control is therefore crucial and, again, performance indicators may provide interesting information.

The presented research comes with limitations. First, due to the duration of the study (i.e., more than one hour but less than two hours), fatiguing effects are only partially depictable. In this case, complementing the current data collection with a diary-based field study could bring additional insights into the level of fatigue throughout the day in a real-world setting. Second, as the experimental procedure consists of three subsequent tasks performed in a group, short waiting times exist and cannot be avoided. To best avoid influencing factors on the overall results, we only allowed participants to enter the meeting room after all three participants were ready to join. In our opinion, this approach resembles meetings in a real-world scenario in the best way possible. Third, the changing number of participants presented on the screen might influence cognitive load. We decided to not test against a static image of one-self, as this image may again induce self-awareness and by our design, we can best simulate a missing self-view in a real-world scenario. Finally, for the pilot study,

multiple limitations exist. The pilot study data is preliminary and must be interpreted with caution. Due to the small sample size, no statistical conclusions can be drawn, only initial indications.

In the next step, we plan to run a full research study to statistically analyze our hypotheses. We plan to refine and develop an adaptive self-view treatment, which alternates the self-view when the speaker is speaking. We aim to analyze this adaptive self-view design as it exists in real-world virtual meetings and pre-study participants mentioned the impression of not being confronted with their self-view during treatment T3. Therefore, the impact of such a design seems to be similar to a design with no self-view present at all. Besides, we plan to complement the current methods of data collection with behavioral and biosignal-based data streams. Specifically, we want to collect eye-tracking data and audio and video recording. By this, the users' current role in the meeting can be understood in a more fine-grained manner. As additional survey items, the enjoyability of the tasks may lead to interesting insights as our pilot study showed a drop in VMF which might be a result of stimulating activity, such as an exciting task. Further, more information on influences regarding the feeling of control need to be gathered. Besides, performance as an outcome variable has been collected but not yet analyzed. With the collected data, we can compare the overall performance of the group and to calculate the influence of the users' initial response on the group response. By that, we can objectively measure opinion shifts as an interesting confounding variable (Siegel et al., 1986). Still, team factors such as equality of participation and hierarchies may have an impact as well.

Besides understanding the impact of the self-view feature on the user in detail and over time, our study can help to improve the design of advanced virtual meeting systems. Therefore, an interesting approach to reducing the negative effects of virtual meetings, such as VMF, the system itself can be designed intelligently. This system-centric adaptation can be realized by recognizing corresponding user states via biosignals by following the principles of physio-adaptive systems (Fairclough, 2009). With this, we hope in the future to provide a better foundation of virtual communication and a better experience for the users.

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