Are Videocalls Outdated? A Comparison with Virtual Reality Meetings as a Future Perspective

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Abstract **– The rise of remote collaboration tools is transforming team collaboration. Despite its current limitations, Virtual Reality (VR) technology has the potential to overcome the challenges of traditional video calls and enhance remote meetings in the future. This study compares the effectiveness of VR and video calls (MS Teams) on team collaboration. A total of $N = 90$ participants were performing a problem-solving task, and $N = 127$ were conducting a creative task in both conditions (VR and video call). Measures of meeting evaluation, engagement, performance, and fatigue were assessed. The results reveal that video call collaboration is superior to enhancing performance. In comparison, VR offers significant benefits regarding comfort, social interaction, and engagement, particularly with creativity tasks. However, at the current stage of technical development, using VR, regardless of the task, is exhausting and causes fatigue. This research highlights the potential of VR as an effective tool for remote collaboration, emphasizing the importance of selecting the right platform based on the specific needs of the collaborative context.**

Keywords – Virtual reality, digital collaboration, performance, fatigue

Nomenclature

M	Mean
HDMs	Head-Mounted Displays
VR	Virtual Reality
WFH	Working-From-Home

I. Introduction

The increase in remote collaboration tools has prompted a need to understand how different communication platforms impact team dynamics and task performance. While video call platforms like Microsoft Teams and Zoom have become predominant in enabling remote interactions, they also present distinct challenges that can influence the outcomes of team collaboration. For one, face-to-face communication has reduced social presence, partly due to the lack of spatial positioning [1]. Additionally, the ability to detect subtle changes in facial expressions and mood is significantly limited [2]. This results in both verbal and non-verbal communication being restricted [1].

While Virtual Reality (VR) technology still has technical limitations, it can potentially solve these challenges in the future and may overcome the usual issues found in video calls. This is because VR offers immersive experiences that more closely replicate face-to-face interactions, allowing for more natural communication and enhancing the sense of presence and engagement, which is often lacking in traditional video calls [3]. Therefore, also fewer distractions and stimuli lead to increased productivity [4]. Consequently, it makes sense to assess now whether there is potential for this technology in the future.

Although practical applications of VR have been explored in various sectors (e.g. such as retail experiences and tourism) so far [5], there have only been a few first studies investigating VR as a potential tool for team collaboration by directly comparing VR with video calls [3], [6], [7], [8]. However, the superiority or advantage of one communication tool (VR vs. video call) remains unclear and requires further research [3].

Focusing on further research, the type of task (task dependency) could be crucial in determining the effectiveness. Each task is unique, and comparing various tasks within each collaboration tool (VR vs. video call) may produce different and individual outcomes [9]. Due to the individuality of each task, they may impact fatigue differently. This calls for a better understanding of how different tasks influence outcomes such as fatigue but also engagement and performance [3], [8]. Also, understanding more about the mechanisms behind fatigue and exhaustion from using VR headsets, known in the literature as head-mounted displays (HDMs), is particularly important [3].

Therefore, this study aims to compare the efficacy of VR and video calls in supporting team collaboration across different types of tasks (problem-solving vs. creative) in a controlled lab setting. Problem-solving tasks require precise problem-solving and attention to detail, while creative tasks involve imagination, social stimulation, and brainstorming. Collaboration and interaction are essential in both tasks. By examining both subjective data (such as meeting evaluation and engagement) and objective data (including performance measures), we aim to explore how tasks differ between VR and video call settings.

This research contributes to the growing literature examining and comparing video and VR communication platforms [3]. Additionally, this initial study lays the foundation for further research that will delve into more detailed outcomes such as well-being, trust, and multitasking.

As teams increasingly rely on digital tools for complex tasks, leaders must identify each platform's strengths and limitations to optimize team synergy and productivity. Specifically, leaders must decide when to use each medium and be aware of potential challenges and risks.

II. What do we know about Video calls and VR?

A. Common Challenges in Video Call Conferences

Video platforms like Microsoft Teams (MS Teams), Webex, and Zoom are the go-to solutions, allowing team members to connect via video calls. These calls enable real-time visual and audio communication, offering the convenience of meeting from any location with an internet connection, thus saving time and resources otherwise spent on travel [10]. However, video calls also come with challenges, such as potential connectivity issues, the difficulty of engaging participants in the same way as in-person interactions, and the now well-recognized phenomenon of Zoom or video fatigue [1]. Furthermore, video calls can often limit the richness of communication to what is captured by the camera, potentially missing non-verbal cues [2].

These disadvantages present significant challenges for leaders, making it difficult to build and maintain relationships in a purely digital environment. The absence of spontaneous and informal interactions, standard face-to-face meetings, and limited verbal and nonverbal communication options can complicate communication. The lack of direct eye contact and body language further leads to misunderstandings and makes it particularly challenging for leaders to gauge moods and reactions accurately [11, 12].

B. The Future Potential of Virtual Reality

The Metaverse, an innovative computer-mediated environment characterized by virtual, real-time interactions through avatars and interface technologies like VR headsets and glasses, represents a further evolution in digital communication [3]. VR provides an alternative to face-to-face communication by closely replicating the dynamics of in-person interactions. Compared to video calls, it offers high communication quality through avatars and other non-verbal cues [13].

Therefore, the 3D environment of VR allows for more natural and intuitive interactions, going beyond the flat screens of traditional video calls. Instead, VR creates a sense of presence, making users feel like they are indeed in the virtual environment and part of it. High-quality VR hardware allows users to perceive and translate their head movements, and sometimes body movements, into the virtual environment onto an avatar, enhancing this feeling of presence. The sense of social presence even exists when an avatar invades the personal space of another in the virtual world, prompting defensive reactions similar to those in the real world [6], [14], [15], [16].

Avatars enhance the sense of social presence, which can improve interaction despite challenges such as limited facial expressions and body movement inaccuracies. However, nonverbal cues in VR, including gestures, proximity, and haptic feedback, contribute to the realism of interactions, effectively mimicking real-life social dynamics. Therefore, facial expressions and lip-syncing of an avatar are crucial, significantly affecting user experiences by enhancing social presence and emotional perception. This has been found in the first study results showing that positive facial expressions in avatars can increase user comfort and encourage collaboration [13], [17].

While VR headsets (HDMs) offer an immersive experience, they also have their challenges. Non-verbal facial expressions are still largely absent in current VR technology. This limitation hinders the full range of human interactions in virtual environments, as facial cues play a crucial role in effective communication and emotional connection [18]. In the future, advancements in VR technology will likely address the challenge of incorporating non-verbal facial expressions. Innovations such as improved facial tracking sensors and more sophisticated avatar animation software are expected to enable more accurate and real-time rendering of facial expressions, enhancing the realism and emotional depth of virtual interactions [19].

VR glasses are often heavy and can cause discomfort during extended use, which is particularly problematic given the high cost of quality systems. Technical issues such as latency, insufficient frame rates, and resolution can also impair the user experience. Additionally, the range of VR content is still limited, restricting the technology's applications and making it less appealing to the broader market [20].

While Virtual Reality (VR) technology currently has technical limitations, it can potentially address and possibly overcome the common challenges associated with video calls via platforms like MS Teams or Zoom. Alongside Augmented Reality (AR), VR offers a promising future alternative that can circumvent many issues inherent in traditional video conferencing. Currently, VR technology utilizes avatars that are capable of detecting and representing both hand gestures and the orientation toward conversation partners, enhancing the interaction quality significantly [13]. By now, VR systems have been explored across multiple domains, including clinical treatment [21], [22], education [23], [24], training [25] and creative collaboration [26]. However, their use for digital team collaboration in the workplace is insufficiently researched.

C. Digital Team Collaboration in VR

Team members can use VR to extend their working-from-home (WFH) space into a virtual, three-dimensional office and collaborate on tasks. For instance, while traditional video calls are so far favoured for work tasks due to easier information exchange and note-taking, VR is preferred for team-building activities [6]. VR exhibits the most similarities to face-to-face interactions regarding spatial behaviour, actions, and facial expressions. Additionally, VR appears to have a positive effect on users' mood [13]. However, the high level of focus required in VR comes at a cost. Many people find spending time in VR demanding, mainly due to its newness and the pressure perception from the headset [14]. As users become more accustomed to VR, preferences may shift in the future [27]. In the context of workplace collaboration, a few types of tasks have been compared, but no definitive superior medium has been identified [3].

In addition with a few exceptions, there is a scarcity of experimental studies that analyse various dimensions of collaboration, such as performance, engagement, and fatigue, under controlled conditions [6], [7], [8], [9], [12], [28].

A comprehensive review of past research by Wei and colleagues [13] provides an overview of previous findings. They call for a deeper examination of communication processes, e.g. display of emotions and non-verbal cues. Although initial studies have explored the use of VR compared to video conferencing, the findings are inconsistent and often limited to specific use cases or short durations. Previous research has mainly focused on both general usage aspects and subjective perceptions of VR [3], [13]. For example, Hennig-Thurau and colleagues [3] focused on various tasks including brainstorming, product rating, presentation, and customer feedback. They found greater social presence and more exhaustion in VR in most tasks, but no overall superiority of VR with regard to performance. They emphasize that future studies should pay more attention to individual differences and control individual variables.

To further investigate the difference between VR and video calls, we build upon the work of Hennig-Thurau and colleagues [3] by using different tasks and a modified research design: 1) To better control for potential confounding third variables, such as individual differences, motivation, or mental state, we used a within-subjects design. This procedure not only increases the statistical power but also controls the variability between the participants. 2) The serial processing of multiple tasks could have blurred the effects of individual tasks and the overall effect of collaboration tools. To address this, we focus on one task per study. 3) Generally, the type of task may cause different communication requirements. We assume that more complex communication requirements can be better managed with VR. Therefore, we used a more complex problem-solving task with distributed information to enhance interdependency and provoke more interaction and discussion among group members.

To sum up, we aim to directly compare VR and video call tools within the same individuals using a within-subjects design. Additionally, we conduct two separate studies with independent samples for each task. We will measure both subjective and objective outcomes to provide a comprehensive understanding of how these communication platforms influence collaboration.

Due to its advantages, VR might lead meeting participants to perceive meetings held in the VR environment as more favourable compared to video conference calls [29]. So far, few studies have fundamentally examined the direct comparison of media for collaboration (focusing on performance), so no superior tool has yet been identified. The lack of differences observed in previous studies could also be due to the lack of suitable tasks for comparison [30]. Therefore, other researchers call for further research to understand the barriers to adapting VR as one support for future remote work and to consider the impact of task types in VR [31].

In our studies, we aim to compare the conditions (VR vs. video call) and additionally examine how these differ depending on the task type (a problem-solving task in Study 1, a creative task in Study 2), as this could also be relevant and be a reason for inconsistent findings. Objective outcomes should be considered in addition to participants' subjective evaluations. Specifically, engagement, performance, and fatigue are key factors relevant to assessing the overall effectiveness of the interaction methods.

D. What happens to Engagement and Performance?

While VR might improve the "fun", "presence", and "naturalness" of interactions in collaborative meetings [29], it does not necessarily boost team effectiveness in terms of engagement and performance.

VR environments can minimize external distractions common in a home or office setting, potentially leading to more focused meetings. At the same time, VR might reduce the multitasking often observed during digital meetings via videoconferencing. This focused environment might help participants concentrate more on the meeting content as in traditional face-to-face settings, minimizing the distractions typically associated with other digital platforms [12], [32].

Furthermore, in previous experiments, participants experienced higher enjoyment, immersion, and temporal dissociation in VR, suggesting that VR can induce a more pronounced sense of flow [26], [33]. VR can have a positive impact on the flow experience and can demonstrate a mediating effect explained through motivation, curiosity, and cognitive benefits [34], it might also be positive for engagement in meetings [35].

VR might enhance their performance if participants feel more engaged in VR meetings. One advantage is that it works across multiple virtual synchronized screens and applications. This integration of software and VR headsets offers significant benefits for academic and work-related tasks [4]. Moreover, the first experimental results show that VR enhances team performance in logical tasks [36] but also for the creative process, though its impact on variety and novelty remains unclear [37]. Therefore, we believe VR could enhance participants' engagement and performance.

E. Which collaboration tool is more exhausting?

Zoom or video fatigue is the phenomenon of exhaustion known from the increased number of online meetings during the COVID-19 pandemic.

It describes the fatigue resulting from extensive use of virtual communication platforms, where symptoms can range from physical tiredness to psychological effects such as reduced concentration and heightened feelings of social disconnect [1], [38], [39]. This type of fatigue has also been observed in three-dimensional spaces, as evidenced by initial experiments [3].

Next to general fatigue, there is also visual fatigue, which often appears in digital contexts. Visual fatigue, usually called eyestrain, is discomfort or impairment arising from extended eye use. It is characterized by symptoms such as tiredness, burning eyes, blurred vision, and headaches. These symptoms are exacerbated by prolonged visual tasks such as staring at computer screens, reading, or driving [40], [41]. Thus, immersive interactions can also result in increased exhaustion.

Additionally, "Cybersickness" can occur in VR. This refers to a condition when exposure to virtual environments causes symptoms like motion sickness. These can include dizziness, nausea, and disorientation. Cybersickness is often triggered by a disconnect between what the user sees and what their body feels, especially in immersive VR settings [40], [42].

Other studies suggest that VR can enhance well-being in the workplace and serve as a tool for stress prevention and management [5], [43], [44]. However, given the multitude of findings and first results from prior studies [3], we expect that VR, due to or precisely because of its immersive nature, leads to greater fatigue in collaboration.

In summary, few comparative studies to date indicate a research gap for a small, controlled, artificial experimental setting. This setting is needed to compare collaboration across both mediums and tasks regarding outcomes.

III. METHODS

To evaluate how collaboration in VR and video conferences differ in terms of subjective meeting assessments, engagement, performance, and fatigue, we compare these aspects in both conditions (VR vs. video call) and also in different types of tasks. Specifically, we planned to compare problem-solving tasks (Study 1) and creative tasks (Study 2) to see how each medium supports or hinders these distinct activities.

A. Design

The experimental setup of both studies is structured as a 2x2 within design, aiming to directly compare two different mediums: virtual reality (VR) and video conference calls. These studies involve two distinct types of team-based tasks - one problem-solving (Study 1) and the other a creative (Study 2) task. Each session involves assembled teams of three participants.

B. Procedure and Materials

Both studies have the same procedure. Participants were randomly assigned to groups for one task on MS Teams or VR (via MetaQuest in WorkRooms Horizons). After performing their first task, they switched platforms for the other task.

C. Samples

The first sample for the problem-solving task (Study 1) consisted of $N = 90$ participants, and the second sample for the creative task (Study 2) contained $N = 127$ participants.

D. Outcome Measures

We examined how participants subjectively rated their collaborative experience after each meeting. We assessed six facets of the subjective collaboration evaluation regarding simplicity, productivity, enjoyment, comfort, sociability, and better-liked medium. Furthermore, we employed the scale developed by Schaufeli et al. to measure engagement during each meeting [45]. Performance evaluation was based on objective criteria. We matched the number of correctly and incorrectly placed seatings for the problem-solving task. For creative performance, we examined the relative frequency of each solution and calculated a score reflecting an overall performance. Lastly, to assess general and visual fatigue, we used the scale from Fauville et al. [46].

IV. Results

A. Evaluation of Meeting in Video Calls vs. VR

In evaluating meetings for the problem-solving task (Study 1), differences emerged across all dimensions between video calls and VR platforms. Participants were asked which medium they preferred, referring to different aspects of the medium. Video calls were rated higher in terms of ‘simplicity’ (video calls: 62.22%, VR: 37.78%) and 'productivity' (video calls: 64.44%, VR: 35.56%). Conversely, VR outperformed video calls in being 'more enjoyable' (video calls: 13.33%, VR: 86.67%), making participants feel 'more comfortable' (video calls: 33.33%, VR: 66.67%), being 'more sociable' (video calls: 24.44%, VR: 75.56%) and providing a 'the more liked medium' (video calls: 25.55%, VR: 74.45%).

Similar results can be found for the creative task (Study 2). The meeting evaluation showed differences across all dimensions. Video calls were rated significantly higher for ‘simplicity’ (video calls: 52.38%, VR: 47.62%) and ‘productivity’ (video calls: 53.96%, VR: 46.04%). On the other hand, VR received higher ratings for making participants feel more ‘enjoyment’ (video calls: 4.72%, VR: N = 95.28%), ‘more comfortable’ (video calls: 27.55%, VR: 72.45%) and for being ‘more sociable’ (video calls: 19.68%, VR: 80.32%) and providing a ‘better liked medium’ (video calls: 22.41%, VR: 77.59%).

B. Engagement and Performance in Video Calls vs. VR

For the problem-solving task (Study 1), when looking at meeting engagement, the difference between video calls (M = 3.25) and VR (M = 3.31) was not significant. On the other hand, for the creative task (Study 2), there was a significant difference in meeting engagement between the two platforms. VR saw higher engagement (M = 3.55) compared to video calls (M = 3.13), $t(126) = 4.537$, $p < 0.001$; indicating that the immersive qualities of VR may enhance participant involvement and engagement during creative, collaborative tasks.

The data for performance in Study 1 shows significant differences between video calls and VR in problem-solving tasks. Teams using video calls scored significantly higher on average (M = 23) compared to those using VR (M = 19.23), suggesting slightly better performance via video calls ($t(82) = 4.273$, $p <$ .001). The number of errors was similar between the two platforms (video call: M = 2.07; VR: M = 2.23). Furthermore, in Study 2, for the creative task, the overall performance was significantly higher in video calls (M = 42.65) compared to VR (M = 37.33), $t(114) = 2.251$, $p = .026$.

C. Fatigue in Video Calls vs. VR

In the problem-solving task (Study 1), comparing fatigue levels between video calls and VR revealed significant differences. General fatigue was significantly higher when meeting in VR (M = 2.45) compared to video calls (M = 1.97); $t(88) = 2.536$, $p = .021$. For the creative task (Study 2), the only significant difference was noted in the subscale visual exhaustion, where VR yielded a higher mean value (M = 1.94) compared to video calls (M = 1.63); $t(125) = -2.465$, $p = .028$. The general scale also showed slightly higher means for VR but without significant differences from video calls.

V. Discussion

The first conclusions emerge from this comparative experiment of VR and video calls as communication platforms for digital collaboration.

Independent of the task type (problem-solving vs. creative task), participants' subjective evaluations of collaboration revealed significant differences between the platforms (VR vs. video call). They favoured video calls for their simplicity and productivity, likely because they integrate more seamlessly into prior tool experience, established workflows, and mimic the structure of traditional work environments [6]. However, VR as a collaboration tool was preferred for comfort and social interaction, suggesting that its enveloping nature can foster a stronger sense of comfort and social connectedness, enhancing collaborative experiences in a digital working context [6].

This positive evaluation of VR meetings is also reflected in participants' engagement. Engagement was notably higher in VR, especially during creative tasks, likely due to its interactive and immersive nature [6], [47]. This distinction was not as pronounced as in problem-solving tasks, where engagement levels were comparable in both platforms (VR and video call). This suggests that task nature may influence how platform choice impacts user engagement.

Conversely, while VR enhances engagement, it does not have the same positive results in performance outcomes. Video calls facilitated higher achievement, which could be attributed to users’ greater familiarity with the user-friendly interface designed for direct, goal-oriented tasks [47]. However, it could also simply be due to the technology, which still needs further improvement. Upgrades like the Meta Quest 3 could potentially yield different results [6].

Furthermore, both tasks linked VR to greater general and visual fatigue. This may be attributed to participants' limited prior experience with the technology, exposing them to various novel stimuli [48], [49]. The immersive nature of VR demands more cognitive and visual effort, which can contribute to fatigue and current technical limitations [42], [50]. Additionally, the physical discomfort from wearing VR headsets for extended periods can further exacerbate fatigue [51]. These factors collectively might contribute to fatigue and, consequently, negatively influence performance outcomes.

Comparing our findings with the previous research of Hennig-Thurau and colleagues [3], our results confirm that participants experience more fatigue after meetings in VR. In line with Hennig-Thurau and colleagues [3], who found higher levels of social presence and positive emotions with VR, our studies also showed that participants experienced more sociability, enjoyment, and comfort in VR in both tasks.

However, our findings differed regarding the performance. In contrast to Hennig-Thurau and colleagues [3], in our studies performance was better in video calls in both tasks. Nonetheless, this could be due to different measures of performance. Whereas Hennig-Thurau and colleagues [3] used the amount of interactions in some tasks we used an objective indicator.

In our two studies, we also measured engagement, which had previously only been indirectly assessed through social presence and emotional connection, suggesting higher engagement [3]. Our findings showed that engagement was higher in the creativity task with VR but not in the problem-solving task. However, differences in engagement in the problem-solving task point in the expected direction.

Although we did not find a clear superiority of one tool over the other in terms of collaboration, the subjective evaluation of meetings in VR was more positive. Consequently, the results slightly favour VR, at least for tasks that require a high degree of interaction, such as creative tasks.

A. Strengths and Limitations, and Future Directions

It is important to consider this study's strengths and limitations. First, previous findings suggest that straightforward gameplay is especially attractive to first-time VR users [52]. The main issue is that it is unclear whether these positive results are due to a short-term effect or if they persist over a more extended period [53]. Currently, no studies examine the use of VR across multiple measurement points and over an extended period. Longitudinal studies would be critical in ruling out potential habituation effects.

Second, the mean age of the sample in this study was notably low. Considering that the employment rate is between the ages of 30 and 55, an older sample might exhibit a lower degree of familiarity with new technologies such as VR. This factor could potentially influence the outcomes of studies involving digital tools, as older participants may require more time to adapt to these technologies [54]. Future studies should consider extending the sample and allocating time for each task to give participants more opportunities to get accustomed to the medium.

Third, future studies should utilize the newer VR technology (e.g. Meta 3). This could resolve technical issues such as the pixelated recognition of keyboards through the VR headset (HDMs). Additionally, the improved hardware and software capabilities of Meta 3 might enhance overall user experience and interaction quality, providing more reliable data on the effectiveness of VR in collaborative settings. These initial insights into problem-solving and creative tasks should be expanded with further studies involving different types of collaborative work in the workplace context [55]. Therefore, it would also be interesting to explore how these tasks impact not only engagement and performance but also social involvement and team cohesion.

Lastly, the intersection of VR and leadership has been scarcely explored. While there are preliminary first approaches to using VR for leadership assessment [56], [57] and development [58], there is no research on VR's effectiveness as a leadership tool. Future research should focus on digital interactions, examining aspects such as communication quality, social proximity, and familiarity to determine VR's potential as a leadership instrument.

B. Practical Implications

VR could enhance flexible work models and simplify digital collaboration across physical distances. These initial findings illustrate how different collaboration platforms can positively impact participants' engagement, potentially increasing social involvement and team cohesion. Using VR for collaborative tasks might simulate real-life interactions more effectively than traditional video calls.

The introduction of VR could offer employees the opportunity to be part of a modern and motivated workplace. However, it is crucial that they receive adequate training and support to adapt to the new technology. An open dialogue between employees and leaders is essential to ensure that VR technology is used in a way that promotes their well-being, productivity, and long-term engagement.

For companies, investing in VR technologies could be a strategic decision. Beyond enhancing digital meetings for collaboration, VR could also serve as a tool for professional development and team-building initiatives.

VI. Conclusion

Our studies reveal that video calls are currently superior in digital collaboration when focusing solely on performance. However, VR offers significant benefits in comfort, social interaction, and engagement, particularly for creative tasks. At this stage of technical development, VR use remains exhausting and causes fatigue due to technical limitations, which may change in the coming years. Therefore, this research highlights the potential of VR as an effective tool for digital team collaboration.

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