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The Impact of Video Meeting Systems on Psychological User States: a State-of-the-Art Review

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ABSTRACT

In today's work and life, the use of video meeting systems is ubiquitous. As usage continues to rise, the negative effects of video meeting systems on users have become apparent. Consequently, scholars and public media have called for a better comprehension of the impact of video meeting systems on users with respect to psychological user states and ensuing outcomes. However, a synopsis of existing empirically grounded knowledge in this field is non-existent. To fill this gap, we review existing literature with a focus on psychological user states from a cognitive and affective perspective as well as downstream outcomes. Specifically, we review and conceptualize findings from 78 quantitative studies and describe the results in a morphological box. We identified a focus on examining the overall systems' impact on the user states of attention, awareness, and negative emotions. Moreover, there has been a rise in literature examining recently developed features that concentrate on supporting attention and emotion understanding. Besides, video meeting systems have been predominantly explored in the context of generic conversations in work settings. By providing future research directions, this overview offers scholars the potential to design their studies more effectively and informs designers to facilitate system improvements based on empirical findings.

1. Introduction

Video meeting systems (VMS) play a major role in communication in professional and personal communication. Remote work would be significantly more difficult without VMS, leading to substantial differences in the way we collaborate. To illustrate, Zoom's daily meeting participants notably skyrocketed from 10 million in 2019 to 350 million in 2020, due to the COVID-19 pandemic, social distancing requirements, and a shift towards remote work (Iqbal, 2022). Further, 54.0% of the United States workforce participates in video conferences on a regular basis and 78.0% of corporate businesses use VMS to facilitate team meetings (Skillscouter, 2022). CFOs invest in meeting software as surveys predict that using VMS can cut travel expenses in the business sector by up to 30.0%, and make a positive impact on time spent at work but also on environmental sustainability (Skillscouter, 2022). However, while VMS offer indisputable advantages since they connect communication partners and guarantee information flow and social exchange (Lowden and Hostetter, 2012) with their omnipresent adoption, public media and research have reported challenges for humans through their extensive use (see e.g., Fosslien and Duffy (2020), Karabasz (2020), Adam (2021), Murphy (2020)).

While VMS facilitate user connection regardless of location, the nature of their communication changes. For instance, virtual communication often involves reduced use of non-verbal cues such as gestures or eye contact due to the limitations of virtual environments (Kock, 2011). This not only impacts the meeting outcome by hindering communication processes such as turn-taking (Woolley et al., 2010) but also creates less engaging communication as these cues are important to obtain psychological safety within the meeting (cf. Choi et al. (2021) discuss non-verbal cues and their impact on meeting success and psychological safety). Further, the interaction takes place on a small two-dimensional screen which can detract from the communication and increase disturbance possibilities, ultimately reducing the focus on the meeting. Finally, users report phenomena like video meeting fatigue that arises when VMS are used heavily (Riedl, 2021; Kock, 2004; Meeren et al., 2005; Fauville et al., 2021). These challenges hinder not only productivity but also impact users' health and well-being negatively.

To mitigate these outlined negative consequences and promote a comprehensive understanding of the detailed impact of information systems on individuals, it is important to get a state-of-the-art overview of existing knowledge about the impact of VMS on users. So far,

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existing research frameworks and conceptualizations have typically concentrated either on the video meeting as a concept of social interaction (Hertel et al., 2005) or on the virtual team as a group and, thus, investigated the impact of virtual teams or meeting characteristics on various outcomes (e.g., Hertel et al. (2005), Hollingshead and McGrath (1995), Park et al. (2014)).

However, from technology adoption research we know that the success of adoption of a technology, in this case, the VMS technology, is also dependent on the user's attitude towards the system itself (Vogel, 1988; Johansen, 1988). Thereby, these attitudes can be influenced and altered by cognitive processes and affect, especially emotions (Petty and Cacioppo, 1986; Morris et al., 2005). In the context of our work, the VMS and its characteristics and design features have a strong impact on the user and trigger certain psychological user states and processes such as the cognitive processes and affective states mentioned above.

Thereby, cognition refers to the acquisition and use of knowledge (i.e., cognitive processes such as attention, or thought processes including problem-solving, and creative thinking to name a few) and the human brain and memory (e.g., working memory, long-term memory) as the underlying architecture (Davern et al., 2012). Affect encompasses a human's mood, feelings, and emotions, such as joy or anger (Zhang, 2013), and has varying degrees of pleasantness and intensity (Russell, 1980). As an example, the self-view feature to see oneself during meetings has been revealed to induce cognitive load due to additional information that has to be processed (Horn and Behrend, 2017) and virtual backgrounds of VMS have shown to impact creativity (Palanica and Fossat, 2022). Further, the video element helps not only to communicate with higher non-verbal communication compared to audio calls but also to be aware of the willingness to communicate with the other participant (Whittaker, 1995).

This highlights the relevance of the impact of these VMS design features. To understand the impact of VMS and its specific design features on the user, it is imperative to obtain a clear understanding and conceptualization of this relationship. So far, to the best of our knowledge, no state-of-the-art overview of research on the impact of VMS on psychological user states and subsequent outcomes exists. Existing reviews conducted within the last years mainly focused on the phenomenon of video meeting fatigue that has been investigated intensively during the intense use of VMS during the pandemic (see e.g., Li and Yee (2023), Döring et al. (2022), Riedl (2021), Fauville et al. (2023)). However, beyond fatigue, there is a lack of understanding regarding the impact of VMS on a wider range of psychological user states. For such states, no overarching review exists. Therefore, we articulate the following research questions (RQ):

RQ 1: "What do we know about the impact of video meeting systems on psychological user states and subsequent outcomes?"

RQ 1.1: "What research disciplines investigate the impact of video meeting systems on psychological user states and what data collection methods are applied?"

RQ 1.2: "Which contexts, tasks, and video meeting system characteristics do current studies on the impact of video meeting systems on psychological user states focus on?"

RQ 2: "What research streams investigating the interplay of video meeting systems and psychological user states exist?"

RQ 3: "What future research directions for investigating the interplay of video meeting systems and psychological user states can be identified?"

To answer these questions, we conducted a systematic literature review (SLR) following the methodology by Webster and Watson (2002). We analyzed our findings based on the conceptual framework for interactive systems by Zhang and Li (2005) that covers the dimensions of context, task, technology, and their interplay with the user, in our case the users' psychological states (i.e., cognitive states such as cognitive load and affective states such as emotions), and subsequent outcomes (i.e., individual well-being, performance, technological experience, interpersonal relationship, see Good et al. (2016)). We take the perspective of cognitive psychology to conceptualize cognition and focus on a conceptualization of affect provided by Zhang (2013). Based on the analysis of 78 quantitative studies, we integrate the results in a concept matrix which is represented by a morphological box. Further, by investigating accumulations of the coded publications in the underlying concept matrix, we will identify six main research trajectories on the impact of VMS on psychological user states. Building on these insights and the outlined research trajectories, we propose research directions to guide scholars.

Our study contributes to extant research by providing a state-of-the-art overview of existing quantitative studies that investigate the impact of VMS on psychological user states. Further, our six directions for future research provide guidance for advancing future research on VMS and may inform the future design of VMS. Through our work, we lay the foundation for a more human-centered understanding and design of VMS in the future.

2. Conceptual foundations

Subsequently, we provide an overview of the relevant foundations of this paper: VMS, psychological user states, and the conceptual framework of interactive systems. Based on these foundations, we conduct the SLR and shape our framework of analysis.

2.1. Video meeting systems

VMS, also called video conferencing systems, or web conferencing systems, have been studied for decades (Kock, 2004; Egido, 1988). VMS represent a communication technology that enable users to connect with each other in real-time despite being situated in different places (Johansen, 1988). In contrast to audio calls, VMS enable users to see each other, understand their willingness and availability to communicate, and share their screens so that remote users can follow their activities. Depending on the system used, additional basic features of VMS allow users to send files, chat messages, or make use of reactions (e.g., emojis, Krutka and Carano (2016), Al-Samarraie (2019), Whittaker (1995)).

According to media naturalness theory and synchronicity theory, video-based communication is richer than text-based communication, but still not fully capable of mimicking a face-to-face conversation due to additional but also lacking cues (Kock, 2011; Dennis et al., 2008; Whittaker, 1995). Additional cues are for example an additional mirrored image of oneself, a lacking cue is a lack of eye contact (Riedl, 2021). This has been widely acknowledged and its impact on social dimensions such as social presence has been researched in information systems. Existing work including VMS has thereby so far investigated the impact of the system on the user and on their productivity. It outlines the problems and benefits of using the system (e.g., Baltes et al. (2002), Hollingshead and McGrath (1995)). Due to the increase in remote work opportunities during the pandemic, however, the adoption of VMS has increased substantially throughout the last years and additional new insights have emerged (Iqbal, 2022; Döring et al., 2022). One very prominent new phenomenon intensively discussed but not yet fully understood in research and public media thus belongs to the fatiguing and exhausting effects of video meetings, especially when conducted extensively throughout the whole day (Fauville et al., 2021). To understand this phenomenon, a wide range of possible input factors, including environmental, technological to individual factors are discussed (see e.g., Döring et al. (2022) or Li and Yee (2023) for a review).

However, despite VMS and their acknowledged impact have been discussed in the literature intensively, a comprehensive overview of the current knowledge on how these VMS impact the users' psychological states and their subsequent outcomes is not available.

2.2. Psychological user states

Following the stimulus-organism-response paradigm, environmental cues as stimuli impact cognition and affect as the guiding psychological user states that are ultimately leading to a certain behavior as a response (Forgas, 2008; Mehrabian and Russell, 1974). The mechanisms involved in these processes and the human organism are complex. There is an ongoing discussion in research on how cognition and affect influence each other as well as what these concepts cover in detail. In this work, our main goal is to analyze and aggregate existing literature in the field of VMS and their impact on investigated cognitive and affective states. To do so, we will treat cognition and affect as two distinct concepts and in addition highlight studies that focus on both, cognitive and affective states.

2.2.1. Cognition

In our work, we take the perspective of cognitive psychology to describe the concept cognition. Cognitive psychology investigates the internal processes which are involved in sense-making of the environment and deciding which actions are appropriate (Eyseneck and Brysbaert, 2018). The aim of cognitive psychology is thereby to comprehend the processes that occur within cognition while individuals engage in tasks. Furthermore, the activity and structure of the brain are crucial to comprehending cognition (Eyseneck and Brysbaert, 2018).

Following the perspective of cognitive psychology, we define cognition as "[...] the activity of knowing: the acquisition, organization, and use of knowledge. It entails both knowledge structures (organization) and processes (acquisition and use) that occur within a given (human) cognitive architecture" (Davern et al., 2012, p.2). The organization of knowledge refers to the way the information is stored by the individual (Piaget and Inhelder, 1969; Turk and Salovey, 1985), i.e., the cognitive architecture itself (memory) as well as mental structures in which individuals categorize information in the form of concepts, such as schemata or mental models (Pinker and Feedle, 1990; Al-Diban, 2012). The cognitive architecture represents the constellation of the human brain and its memory systems, such as working, short-term, and long-term memory (Davern et al., 2012).

Besides the organization of the information, a wide range of cognitive processes are at the center of acquisition and use: attention, perception, learning and knowledge generation, memory, language understanding and generation, or thinking to name the prominent ones (Eyseneck and Brysbaert, 2018). Especially thought processes do encompass a variety of specific cognitive processes comprised in mental activities such as remembering, reasoning, judging, or problem-solving (American Psychological Association, 2021). In cognitive psychology, a very early model describing the way we access information from a stimulus is the procedure of bottom-up information processing. Information is managed by multiple internal cognitive processes and starts with awareness followed by attention to the stimulus (e.g., technology, sensory input), perception, and thought processes, and results in making a decision that triggers the response or action of an individual (Eyseneck and Brysbaert, 2018). It is important to note that this model of human information processing oversimplifies the actual processes that occur within the human brain. Information processing can also occur in a top-down manner. Moreover, recent research has revealed that information processing is not a serial process; instead, multiple processes occur simultaneously in parallel.

We want to highlight again that psychologists may use different models of cognition depending on the theoretical paradigms are theories they are following. Depending on the theory used, the conceptualization of cognition may differ from the information processing model mentioned earlier. In addition, various theories exist that focus on specific subcategories of cognitive processes, particularly attention and thought processes (see e.g., dual process theory differentiating between lower-order and higher-order thought processes (Evans and Stanovich, 2013)). To prevent confusion, our review avoids constructing a particular model that explains cognition. Instead, we utilize the described understanding of what cognition entails to observe which cognitive processes have been studied so far in research on the impact of VMS on user states.

2.2.2. Affect

Another central part that is known to impact human behavior is affective user states. From the lens of cognitive psychology, affective states influence the cognitive states mentioned above (Evans and Stanovich, 2013; Eyseneck and Brysbaert, 2018). However, as mentioned above, depending on the theoretical lens applied, the conceptualization and understanding of the interplay between affect and cognition may differ (see e.g., Forgas (2008)). In our model, we thus explicitly separate cognition and affect to avoid discussion on what influences what and outline studies that focus on both separately.

Research thereby depicts affect as an umbrella term for various sub-variables such as emotions, mood, or feeling (Zhang, 2013). While there are various conceptualizations of affect (e.g., circumplex model of affect (Russell, 1980) or the wheel of emotions (Plutchik, 1991)), affect can also be categorized based on how a selected stimulus impacts a human.

The affective response model proposed by Zhang (2013) therefore provides a comprehensive overview of how technology as a stimulus can influence the user. Following this conceptualization, temporally constrained free-floating affective states, such as mood, can arise. They are independent of a certain stimulus. Between the individual and stimulus, induced affective states, such as emotions or feelings, and temporally unconstrained affective evaluations exist. Thereby emotions "[...] typically arise as reactions to situational events and objects [...] [and] emphasize a person's subjective feeling" (Zhang, 2013, p.251). Ekman (1999) therefore introduced a model of six basic emotions, widely used in IS and HCI research (i.e., fear, anger, disgust to name a few). Based on the basic emotions, more advanced emotions then evolve. Thereby, a wide range of nuanced emotions can be experienced, as a study by Cowen and Keltner (2017) shows. The authors here report on 27 distinct emotion categories based on self-reported measures. Feelings are more conscious compared to emotions (Zhang, 2013). Besides, affective evaluations summarize according to Zhang (2013, p.254) "[...] a set of concepts that focus on evaluating or appraising the affective quality of a stimulus". They are directed at the stimulus and support the user in deciding how to behave. Thus, these evaluations can be framed as outcomes of affective user states.

Thereby, emotions, mood, and feelings can be further categorized. One prominent model, the aforementioned circumplex model, categorizes affect variables on a two-dimensional scale and aims to describe affect based on valence and arousal (Russell, 1980). Valence thereby refers to the pleasantness of the user states, arousal on their intensity. For example, joy is a pleasant, positively perceived emotion, anger is an unpleasant, negative one (Scherer, 2005).

2.3. Conceptual framework

VMS represent interactive systems consisting of multiple elements that interact with each other and thereby also have influences on each other. To conceptualize research on interactive systems, Zhang and Li (2005) proposed a framework that is structured according to the dimensions of technology, human, task, and context. Based on the interaction of those elements, the impact of technology differs, and different outcomes arise. The proposed framework has been applied in various review articles focusing on interactive technologies (see e.g., Diederich et al. (2022) for a review of conversational agents) and

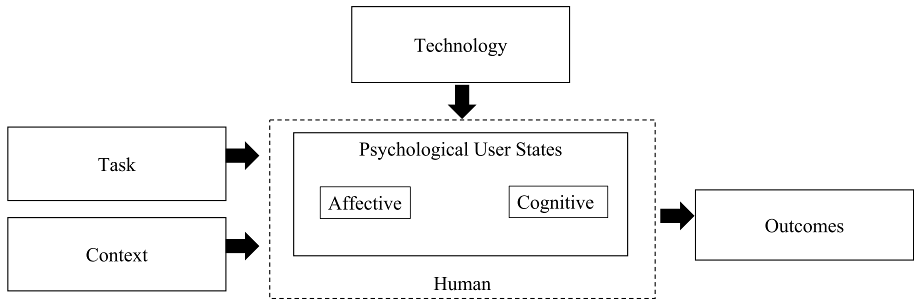

Fig. 1. Overview of adapted conceptual framework.

resembles the well-known People-Activity-Context-Task (PACT) model that has also often been used in systematic literature reviews (Benyon, 2019). Moreover, prominent models in team research, such as the input-process-output model and its further advancements make use of similar dimensions (Ilgen et al., 2005).

In the following, we briefly describe each of the framework's dimensions. The dimension *technology* describes the stimuli observed which is in the case of our study the VMS as a specific information and communication technology with corresponding characteristics (VMS characteristics). The second dimension describes the *human*. The framework differentiates between long-term characteristics such as personal traits, short-term user states as well as related outcomes. Thereby, this dimension can be narrowed down to the specific perspective of interest (see e.g., Diederich et al. (2022) who focused on user states and outcomes). The dimension *context* describes social and environmental factors that have an impact on the interaction. Different levels of context can be examined. For example, a differentiation between professional and private environments can be made. On a lower level, in collaboration technologies such as VMS, the context also encompasses social factors, especially team-related factors, such as team size and team constellation (Hackman, 1987; Ilgen et al., 2005). As the last dimension, the framework describes the dimension *task*. In the original version, the framework covers both the impact of technology on the human and the impact of the human on the technology. In our review, we focus on the first and thus present the adapted version of our framework in Fig. 1.

In summary, we have presented the fundamental conceptualization of interactive systems and introduced VMS as the interactive system under study. Additionally, we discussed two essential core components from a psychological standpoint, the user's cognition and affect. We will now employ the introduced framework to analyze and investigate the current state of the art in the literature on the impact of VMS on the user's cognition and affect. On this basis, we can classify current research paths and sketch out potential avenues for future research.

3. Research methodology

In this study, we follow a multi-step approach. First, we conduct a SLR and, second, we organize the results on the basis of our conceptual framework for interactive systems and a morphological box. Accordingly, we cluster the results to identify existing research trajectories. In the following sections, we describe each of the steps in more detail.

3.1. Literature review process

To answer the RQ, we conduct a SLR. Therefore we follow the recommendations from Webster and Watson (2002) and vom Brocke et al. (2009). We depict the process of our SLR in Fig. 2.

As a first step, we define the search strategy including the search string and the search criteria. In this step, we developed an initial search string covering (a) VMS and (b) the psychological user states. For this reason, we examined search strings used in comparable literature reviews (Benke et al., 2021; DeChurch and Mesmer-Magnus, 2010) and inserted the defining terms provided by our conceptualization of affect and cognition presented in the foundations. After reviewing the results of our initial search string, we refined the search string iteratively. To validate the search string, we manually checked that our final version of the search string included all findings relevant to our topic and published in selected outlets of our research disciplines of interest. Therefore, we manually validated the search string findings with the studies included in CHI, CSCW, IJHCS, and the international conference on information systems (ICIS) from the years 2021 and 2022. We present the final version of the search string in Table 1.

Table 1
Final search string.

Topic	Search string component
VMS	"video meeting" OR video-mediated OR "virtual meeting" OR webconferenc* OR videoconferenc* OR teleconferenc* OR "video conferenc*" OR "tele conferenc*" OR "web conferenc*"
Affect	Affect* OR emotion* OR Feel* OR "Mood"
Cognition	"memory" OR "mental" OR cognit* OR attent* OR think*

As a next step, to obtain a base set, we applied the finalized search string to relevant databases in computer science and information systems, namely ACM Digital Library, Scopus, IEEE, AIS eLibrary, Web of Science, and modified it based on database-specific recommendations (Bandara et al., 2015). The mentioned databases were selected since they have been deemed as the most prominent databases while conducting research on the concept matrix and due to their reputation in the corresponding fields (Bandara et al., 2015). To qualify as a result, the search string must apply to either title or abstract of the paper.

After applying the search string to the selected databases, we retrieved a total of 4.101 unique hits (search conducted in November 2022). In total, 3.970 hits were found in the database Scopus, 10 in AIS eLibrary, 161 in ACM Digital Library, 513 in IEEE, and 1.885 in Web of Science. Afterward, duplicates were removed, and incorrect results were deleted. In general, all elements of Web of Science have been included in Scopus as well. Overall, 4.101 papers remained.

To refine the initial set, we first scanned the title and abstract and afterward reviewed the full text of the remaining papers. For filtering, we applied the following inclusion criteria:

- Criteria 1: VMS as a core phenomenon (independent concept)
- Criteria 2: Psychological user state as a core dependent concept
- Criteria 3: Quantitative evaluation method (survey data, biosignal data, behavioral data)
- Criteria 4: Published in a peer-reviewed conference or journal paper with more than five pages
- Criteria 5: Written in the English language.

We decided to solely focus on quantitative evaluation methods (i.e., experimental studies and survey studies) as we aimed to find specific and evident effects.

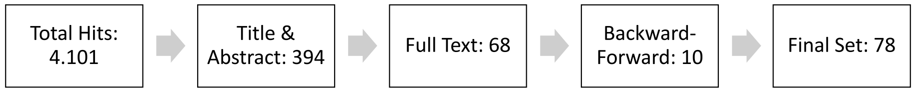

Fig. 2. Overview of systematic literature review.

This resulted in 394 entries which were reduced to 68 publications after a full-text analysis. We explain the high number of false hits with the fact that we did not filter for quantitative studies in the search string. Furthermore, a high number of studies especially during the last years made use of video-mediated communication in their research strategy but did not investigate the impact of VMS. Also, in this step, we removed studies that focus on the impact of affect or cognition on the use of the VMS instead of the VMS' impact on the user states.

Next, we conducted a backward–forward search and applied the same criteria. We identified ten additional papers. As a result, we retrieved a comprehensive set of 78 papers. In a final step, we coded this final set of papers based on our conceptual framework for interactive systems. We also summarized the literature on research methodology and data collection. Afterward, we performed a descriptive and conceptual analysis of the publication sample.

3.2. Framework development

To analyze and organize the identified literature, we developed a conceptual framework that we present in form of a morphological box. As such, we devised a high-level framework based on existing conceptualizations in the literature. We subsequently adapted it iteratively to the specific needs of our review following the conceptual-to-empirical and empirical-to-conceptual approach from Nickerson et al. (2013). In the first step, we draw on the conceptual framework for interactive systems by Zhang and Li (2005). As mentioned above the authors mention four major dimensions when it comes to work investigating human–computer interaction: human, technology, context, and task. These four dimensions interact with each other. In the framework's original version, the authors explain that the technology impacts the human user, and the human can influence the technology. As our review focuses on the impact of the system on the user, we will concentrate on this direction of influence and not focus on the human's influence on the system. In the second step, we adapted the subdimensions to our use case based on existing conceptualizations. Therefore, we developed and iteratively refined several categories for each dimension and subdimensions and categorized each publication accordingly (Kitchenham and Charters, 2007). In the third step, we coded the retrieved final set respectively. Finally, we used the conceptualization to derive existing research trajectories and future research directions. In order to allow interested researchers to further explore the conceptualization interactively, we developed an interactive version of the final morphological box, based on Knaeble et al. (2023).

4. Results

In this chapter, we describe the results of our SLR and analyze the identified papers based on the created conceptual framework.

4.1. Research disciplines and data collection methods (RQ 1.1)

Fig. 3 shows the descriptive results of our final set covering the distribution of articles per discipline and the date of publishing. On the left side, the distribution of articles per discipline is presented. Most literature has been published in the field of human–computer interaction. A strong focus is visible in HCI journals and conferences, such as CHI or CSCW (in total 41%). In addition, we identified a second focus in further computer science outlets, lecture notes on different topics (21%). In these outlets, a focus on more recent and advanced features is visible. However, we also found studies in further typical disciplines researching communication behavior (4%), human behavior (i.e., psychology, 12%), and the impact of information systems in general (i.e., information systems, 6%). Finally, we observe that more task-oriented research fields such as education (6%), management science (4%), or medicine (4%) are less represented. Taking a look at the cumulated distribution of papers over time depicted in the right part of Fig. 3, a peak is visible in the last years. This may be explained by the increase in the use of VMS during the pandemic and thereby increased interest from scholars and public media.

Fig. 4 presents the chosen evaluation method. Thereby, the data collection method is of interest as different strategies of data collection, especially additional sources of data complementing questionnaire data, can lead to interesting insights that help to better understand the way a system impacts the human. As an example, biosignal, as well as behavioral data, provide nuanced, continuous information on the impact the system has on the user and are considered to be more objective (Allanson and Fairclough, 2004). Thereby, biosignals are autonomous signals produced by an organism and measurable through sensors. Biosignals can be distinguished according to their physical properties in different categories: bioacoustic, biochemical, bioelectric, biomagnetic, biokinematic, biooptical, and biothermal signals (Schultz et al., 2013). Behavioral data refers to data collected based on interactions with the system or based on interactions between participants, e.g., by conducting a thorough analysis of interactions between participants when analyzing audio signals. An exemplary method applied is interaction process analysis (Bales, 1950). Keeping in mind that we only included studies following a quantitative research approach, we distinguish only between survey-based and experimental research and additional data collection methods. We identified that 21% of studies conducted surveys instead of experiments (e.g., Gabbiadini et al. (2020), Wu and Lee (2012)). All remaining papers used questionnaires in their experimental studies (e.g., Oren-Yagoda and Aderka (2021), Kizilcec et al. (2014)). Among experimental studies, 27% used biosignals as an additional data collection method, mainly based on eye-tracking data (e.g., Vrzakova et al. (2021), Vertegaal et al. (2003)). Thereby, these studies predominantly analyzed eye-tracking data to observe where users direct their attention to during the study. Physiological and neurological signals (e.g., ECG, EEG) were less used. These studies mostly target affective user states when observing these signals (see e.g., Murali et al. (2021)). 14% further investigated behavioral data from speech or conversations (e.g., Duan et al. (2019)). As an example, these studies focused on self-attributions when seeing or not seeing oneself in a video meeting (Miller et al., 2021). 14% additionally used interviews (e.g., Rojas et al. (2022)) to gain deeper insights in qualitative self-reported data. Thereby, interviews cover semi-structured, unstructured, and structured interviews. Most data has been collected in the laboratory or online, based on a single point of data collection (91%). As an example for a study collecting data over more than one point, a study conducted by Shockley et al. (2021) can be mentioned that investigated the effect of the camera turned on or off on awareness and resulting fatiguing user states over a period of two weeks.

4.2. Conceptual analysis (RQ 1.2)

Based on the 78 papers identified in our SLR, we created a conceptual framework as an overview. We derived our framework as a foundation for the conceptual analysis based on Zhang and Li (2005) and extended it with subdimensions for the context, VMS, the psychological user states of affect and cognition, and subsequent outcomes (Mc

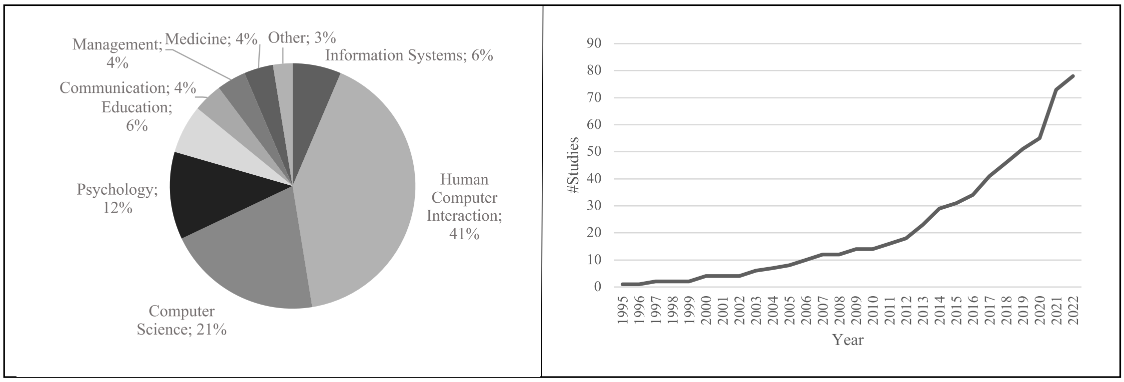

Fig. 3. Descriptive results: Distribution of sample per discipline (left), and accumulated studies over time (right).

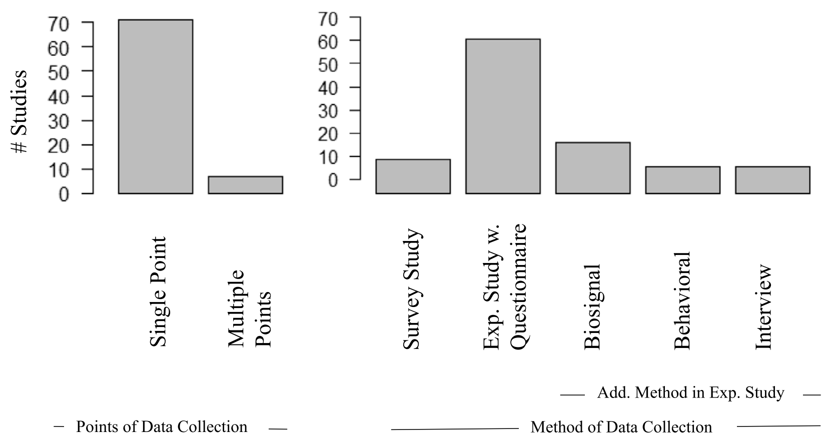

Fig. 4. Data collection method. In the left part, the number of data collection points is depicted. We differ between studies collecting data only once (single point) or collecting data multiple times (multiple points). In the right part, the frequency of the chosen data collection method (experimental vs. survey and additional biosignal, behavioral, or interview data) is shown.

Grath, 1984; Davern et al., 2012; Zhang, 2013; Good et al., 2016). We, therefore, used iterative coding of the publications to derive our codes for promising subdimensions. As a result, we developed a morphological box that we present in Fig. 5. For each subdimension's categories, the relative frequency in our final set is shown. We included a color coding that visualizes the frequency. In the following, we present the results along the conceptual framework in detail.[1] We put our focus on the dimensions of VMS as the technology and psychological user states as the human.

4.2.1. Context dimension

For context, we identify two relevant subdimensions, the teams using the VMS as a social context and the place of use as an environmental context. An overview of all publications per category is depicted in Tables 2 and 3. The team is an important social context factor since virtual team research states, that among others, *team size*, can have an impact on how teams work together. We distinguish between dyads, small teams, and large teams. The context *environment* describes the place of use, i.e., whether the VMS is used in a professional or private setting.

Team size: For team size, we identified that more than half of the studies investigate the impact of VMS on psychological user states in dyadic settings (e.g., Rojas et al. (2022), Wegge et al. (2007)). Here, for instance, Rojas et al. (2022) investigated the impact of visual cues showing emotional feedback on the user's awareness of their own and others' emotions. Wegge et al. (2007) investigated the impact of the video feed on emotion and stress levels in dyadic call center work. The second category describes large teams (i.e., six or more users, 14% of all studies, e.g., Blau et al. (2016), Marlow et al. (2017), Sun et al. (2019)). These studies often include learning tasks or conversations and observe the impact on a presenting member. For instance, Marlow et al. (2017) investigate the impact that seeing the audience has on attendees and especially presenters in an educational setting. In a similar fashion, Sun et al. (2019) describe the effect that an additional feature predicting the audience's current state (e.g., boredom) has on the presenters. The rest of the participants only consume the content, e.g., by listening to the talk. Interestingly, this phenomenon is not focal in the research (e.g., Goethe et al. (2022)). So far, less attention has been paid to small teams (i.e., three to five users, in total 13%). Examples for this subclass are offered by Vrzakova et al. (2019), Namikawa et al. (2021). As an example, Vrzakova et al. (2019) investigate different forms of attention (i.e., attention on content, attention on others) in video meetings with a shared screen and the impact of attention distribution on meeting outcomes. In another study, Namikawa et al. (2021) explore the use of emojis instead of facial expressions to reduce the amount of information sent in video meetings.

Environment: This subdimension distinguishes between professional and private environments. The private environment encompasses the application of VMS for leisure activities such as connecting to friends. The professional environment describes the application for work-related activities such as brainstorming, counseling, and education. In our sample, we identify a strong focus on the professional environment (73%, e.g., Liu et al. (2016), Yao et al. (2013)). The

[1] Link for Concept Matrix: https://osf.io/ny67x/?view_only=90d86585c77e4b2590dce62b9ead64de, Interactive Morphological Box: https://vms-on-user-states.github.io/SLR_VMS/.

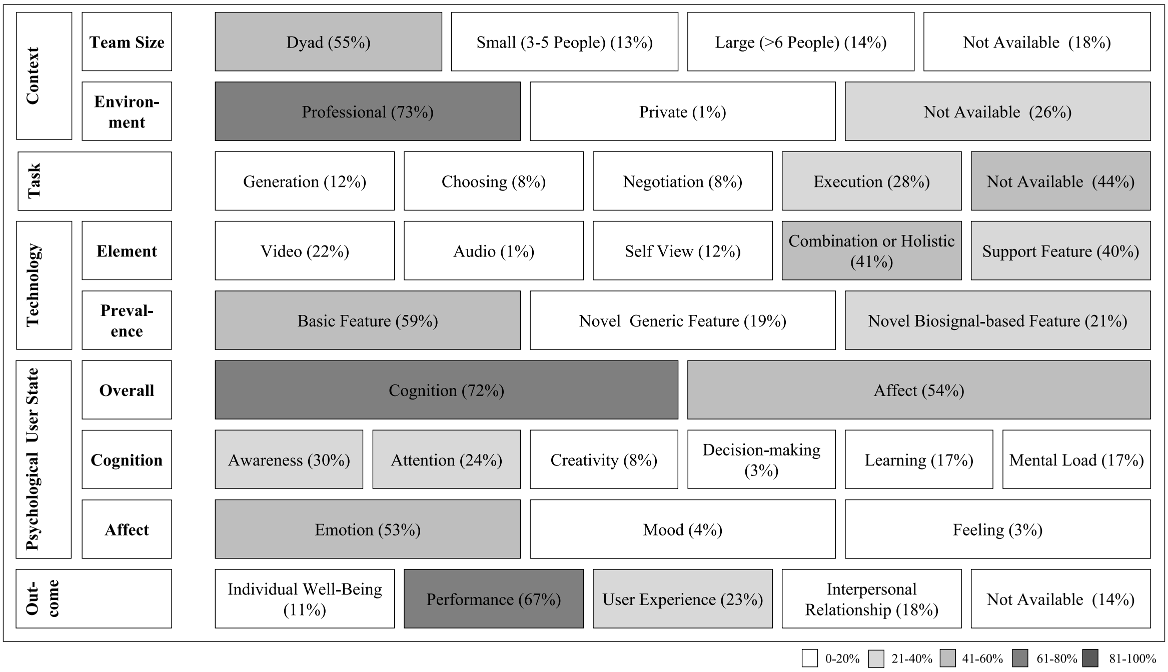

Fig. 5. Overview of morphological box. Percentages refer to the share of papers that address the related category. An interactive version can be found here: https://vms-on-user-states.github.io/SLR_VMS/.

Table 2
Overview on papers for context dimension — Team size.

Category	Short description	References	#Papers
Dyad	Two persons in call	Rojas et al. (2022), Sears et al. (2013), Melchers et al. (2021), Palanica et al. (2019), Taniuchi and Shibuya (2021), Capan (2013), Grayson and Monk (2003), Wegge (2006), Wegge et al. (2007), Otsuki et al. (2018), Pan et al. (2009), Hosseini et al. (2021), Liu et al. (2016), Langer et al. (2017), Schaarschmidt and Koehler (2021), Leong et al. (2021), Yao et al. (2013), Hron et al. (2007), Kim et al. (2020), Vertegaal et al. (2003), Tan et al. (2014b), Kim et al. (2014), Baker et al. (2020), Miller et al. (2021), Vrzakova et al. (2021), Forghani et al. (2014), Tam et al. (2016), Riby et al. (2012), Schneider and Pea (2013), Costa et al. (2018), Kim et al. (2019), Nakazato et al. (2014), Tomprou et al. (2021), Nitada et al. (2021), Tan et al. (2014a), Miller et al. (2017), Ferran-Urdaneta and Storck (1997), Jaklič et al. (2017), Alavi et al. (1995), Jung et al. (2015), Farooq et al. (2021), Horn and Behrend (2017), Brucks and Levav (2022)	43 (55%)
Small	Three to five persons in call	Sonderegger et al. (2013), Vrzakova et al. (2019), Taguchi et al. (2018), Namikawa et al. (2021), Boyle et al. (2000), Hu et al. (2022), Duan et al. (2019), Hassell and Limayem (2020), Andres (2011), Han et al. (2011)	10 (13%)
Large	More than 5 persons in call	Murali et al. (2021), Blau et al. (2017), Kashiwagi et al. (2006), Marlow et al. (2017), Blau et al. (2016), Sun et al. (2019), Chollet et al. (2018), Ouglov and Hjelsvold (2005), Kizilcec et al. (2014), Asai et al. (2009), Goethe et al. (2022)	11 (14%)
Not available	No #persons indicated	Abramova et al. (2021), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Wu and Lee (2012), Balogova and Brumby (2022), Butz et al. (2015), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Gabbiadini et al. (2020), Matulin et al. (2021), Okabe-Miyamoto et al. (2022), Bennett et al. (2021)	15 (19%)

studies thereby focus on broad range of tasks, technological elements and user states. Liu et al. (2016) for instance focus on the medical context and support medical staff in tele-consultation by providing feedback on their non-verbal behavior. In their study, they measure how the medical staff reacts to the feedback and whether the feedback alters their emotions. As an exemplary second study in this domain, Yao et al. (2013) investigate the effect of background blurring on attention and observe whether blurring supports focusing more on relevant parts of the meeting. Less focus is on the private environment (1% of studies, Costa et al. (2018)). Thereby, Costa et al. (2018) investigate the impact that voice alterations have on anxious feelings when having conflicts in personal relationships. Several studies in our sample do not mention an explicit environment (22%). Here, a strong focus is visible on existing, prevalent technological elements and cognitive user states. As an example, a study by Abramova et al. (2021) focuses on the impact of the self-view on self-awareness and meeting outcomes in different settings.

4.2.2. *Task dimension*

To better categorize the researched tasks, we decided to rely on the established conceptualization of Mc Grath (1984). We differentiate the task character into four quadrants. The first quadrant covers tasks that generate ideas or plans. The second quadrant covers choice tasks, including problem-solving and choosing between options with no correct answers. The third quadrant involves negotiation tasks and the final quadrant covers execution tasks. An overview of all publications per quadrant is depicted in Table 4. Regarding the conducted task, we perceive a focus on generic, non-specified tasks and execution tasks. With regards to the generic or non-specified tasks covering almost

Table 3
Overview on papers for context dimension — Environment.

Category	Short description	References	#Papers
Professional	Study conducted in work, school context	Rojas et al. (2022), Sears et al. (2013), Melchers et al. (2021), Murali et al. (2021), Capan (2013), Wegge (2006), Sonderegger et al. (2013), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Han et al. (2011), Otsuki et al. (2018), Pan et al. (2009), Kashiwagi et al. (2006), Namikawa et al. (2021), Wu and Lee (2012), Nitada et al. (2021), Liu et al. (2016), Langer et al. (2017), Schaarschmidt and Koehler (2021), Marlow et al. (2017), Blau et al. (2016), Yao et al. (2013), Blau et al. (2017), Sun et al. (2019), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Kim et al. (2014), Miller et al. (2021), Vrzakova et al. (2021), Hassell and Limayem (2020), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Tam et al. (2016), Riby et al. (2012), Schneider and Pea (2013), Andres (2011), Kim et al. (2019), Kizilcec et al. (2014), Tomprou et al. (2021), Butz et al. (2015), Goethe et al. (2022), Boyle et al. (2000), Ngien and Hogan (2022), Tan et al. (2014a), Miller et al. (2017), Ferran-Urdaneta and Storck (1997), Matulin et al. (2021), Jung et al. (2015), Okabe-Miyamoto et al. (2022), Farooq et al. (2021), Bennett et al. (2021), Alavi et al. (1995), Horn and Behrend (2017), Kim et al. (2020), Taguchi et al. (2018)	57 (73%)
Private	Study conducted in leisure time context	Costa et al. (2018)	1 (1%)
Not available	No dedicated environmental context given	Palanica et al. (2019), Taniuchi and Shibuya (2021), Abramova et al. (2021), Grayson and Monk (2003), Vrzakova et al. (2019), Hosseini et al. (2021), Leong et al. (2021), Hu et al. (2022), Vertegaal et al. (2003), Balogova and Brumby (2022), Baker et al. (2020), Nakazato et al. (2014), Asai et al. (2009), Shockley et al. (2021), Pikoos et al. (2021), Jaklič et al. (2017), Brucks and Levav (2022)	17 (22%)

Table 4
Overview on papers for task dimension.

Category	Short description	References	#Papers
Generation	Tasks requiring participants to generate new ideas/ content	Palanica et al. (2019), Han et al. (2011), Hosseini et al. (2021), Leong et al. (2021), Nakazato et al. (2014), Boyle et al. (2000), Brucks and Levav (2022), Sonderegger et al. (2013), Vrzakova et al. (2019)	9 (12%)
Choosing	Tasks requiring participants to make a selection, e.g., candidate selection	Sears et al. (2013), Otsuki et al. (2018), Baker et al. (2020), Hassell and Limayem (2020), Tomprou et al. (2021), Langer et al. (2017)	6 (8%)
Negotiation	Tasks requiring participants to find a common solution to agree on	Taguchi et al. (2018), Duan et al. (2019), Vrzakova et al. (2021), Tan et al. (2014b), Jung et al. (2015), Andres (2011)	6 (8%)
Execution	Tasks requiring participants to execute a giving task such as contests (interview as interviewee) or performance tasks, e.g., learning	Wegge (2006), Kashiwagi et al. (2006), Blau et al. (2016), Yao et al. (2013), Hron et al. (2007), Kim et al. (2020), Sun et al. (2019), Tan et al. (2014b), Miller et al. (2021), Ouglov and Hjelsvold (2005), Kizilcec et al. (2014), Asai et al. (2009), Ferran-Urdaneta and Storck (1997), Alavi et al. (1995), Goethe et al. (2022), Horn and Behrend (2017), Blau et al. (2017), Chollet et al. (2018), Liu et al. (2016), Melchers et al. (2021), Schaarschmidt and Koehler (2021), Schneider and Pea (2013), Sonderegger et al. (2013)	22 (28%)
Not available	Tasks that are generic, no further specification provided	Rojas et al. (2022), Murali et al. (2021), Taniuchi and Shibuya (2021), Capan (2013), Abramova et al. (2021), Grayson and Monk (2003), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Pan et al. (2009), Namikawa et al. (2021), Wu and Lee (2012), Nitada et al. (2021), Langer et al. (2017), Marlow et al. (2017), Hu et al. (2022), Vertegaal et al. (2003), Balogova and Brumby (2022), Kim et al. (2014), Forghani et al. (2014), Tam et al. (2016), Riby et al. (2012), Costa et al. (2018), Bennett et al. (2021), Andres (2011), Kim et al. (2019), Butz et al. (2015), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Miller et al. (2017), Gabbiadini et al. (2020), Jaklič et al. (2017), Matulin et al. (2021), Okabe-Miyamoto et al. (2022), Farooq et al. (2021)	36 (44%)

50% of all articles, we observe a high number of tasks that only involve talking (e.g., Taniuchi and Shibuya (2021), Kim et al. (2014), Costa et al. (2018)) with no prior specific task description. Thus, these studies were clustered having no available task. Often, these studies include the investigation of additional features or a holistic evaluation of the system. As an example for this category, the study conducted by Taniuchi and Shibuya (2021) investigates how avatarized displays of users influence the embarrassment of video meeting participants compared to normal displays in a generic conversation task. Furthermore, most studies covering only survey studies are categorized as having a generic task. For instance, Balogova and Brumby (2022), Abramova et al. (2021) investigate the influence of the self-view on comfort and distraction as well as on awareness in survey studies. In addition, Miller et al. (2021) use generic conversation tasks, such as ice-breaker questions, to investigate the impact of the self-view on anxiety. Execution tasks covering 28% of all articles, often involve contests, such as interviews from an interviewee perspective, or performance tasks, such as learning (11%, e.g., Blau et al. (2016), Melchers et al. (2021), Schneider and Pea (2013), Liu et al. (2016)). Thereby, learning processes are often researched, as done in a study by Blau et al. (2016). Besides, Melchers et al. (2021) investigate the perceived strain and anxiety of interviewees in job interviews conducted via VMS. Further, some papers do include choosing tasks, such as candidate selection (8%, e.g., Baker et al. (2020), Tomprou et al. (2021)), or negotiations tasks (8%, e.g., Miller et al. (2017)). As an example, a study by Vrzakova et al. (2019) investigates visual attention when performing a task

Table 5
Overview on technology dimension: VMS — Technological element under investigation.

Category	Short description	References	#Papers
Combination	More than one element researched	Sears et al. (2013), Melchers et al. (2021), Capan (2013), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Han et al. (2011), Vrzakova et al. (2019), Kashiwagi et al. (2006), Wu and Lee (2012), Langer et al. (2017), Schaarschmidt and Koehler (2021), Blau et al. (2016), Hron et al. (2007), Blau et al. (2017), Kim et al. (2014), Baker et al. (2020), Vrzakova et al. (2021), Hassell and Limayem (2020), Ouglov and Hjelsvold (2005), Riby et al. (2012), Andres (2011), Tomprou et al. (2021), Butz et al. (2015), Oren-Yagoda and Aderka (2021), Gabbiadini et al. (2020), Ferran-Urdaneta and Storck (1997), Matulin et al. (2021), Alavi et al. (1995), Okabe-Miyamoto et al. (2022), Bennett et al. (2021), Brucks and Levav (2022), Miller et al. (2021)	32 (41%)
Video	Video element of user	Melchers et al. (2021), Taniuchi and Shibuya (2021), Wegge et al. (2007), Han et al. (2011), Taguchi et al. (2018), Marlow et al. (2017), Forghani et al. (2014), Tam et al. (2016), Kizilcec et al. (2014), Tomprou et al. (2021), Boyle et al. (2000), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Hron et al. (2007), Miller et al. (2021), Vrzakova et al. (2021)	17 (22%)
Background	Virtual background of video element of user	Palanica et al. (2019), Leong et al. (2021), Yao et al. (2013), Goethe et al. (2022)	4 (5%)
Self-view	Video element of user only displayed for oneself	Abramova et al. (2021), Wegge (2006), Balogova and Brumby (2022), Shockley et al. (2021), Pikoos et al. (2021), Miller et al. (2021, 2017), Horn and Behrend (2017), Bennett et al. (2021)	9 (12%)
Audio	Audio element of user	Oren-Yagoda and Aderka (2021)	1 (1%)
Support Feature	Additional newly introduced feature	Rojas et al. (2022), Murali et al. (2021), Grayson and Monk (2003), Sonderegger et al. (2013), Otsuki et al. (2018), Taguchi et al. (2018), Pan et al. (2009), Namikawa et al. (2021), Hosseini et al. (2021), Nitada et al. (2021), Liu et al. (2016), Leong et al. (2021), Hu et al. (2022), Yao et al. (2013), Kim et al. (2020), Vertegaal et al. (2003), Sun et al. (2019), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Schneider and Pea (2013), Costa et al. (2018), Kim et al. (2019), Nakazato et al. (2014), Asai et al. (2009), Tan et al. (2014a), Jaklič et al. (2017), Jung et al. (2015), Farooq et al. (2021)	31 (40%)
	Thereby: Emotional Support	Rojas et al. (2022), Murali et al. (2021), Sonderegger et al. (2013), Namikawa et al. (2021), Chollet et al. (2018), Costa et al. (2018), Tan et al. (2014b), Kim et al. (2019), Tan et al. (2014a), Jung et al. (2015), Farooq et al. (2021)	11 (14%)
	Thereby: Attention Support	Grayson and Monk (2003), Otsuki et al. (2018), Nitada et al. (2021), Kim et al. (2020), Vertegaal et al. (2003), Miller et al. (2021), Schneider and Pea (2013), Jaklič et al. (2017)	8 (10%)
	Thereby: Other Support	Taguchi et al. (2018), Pan et al. (2009), Hosseini et al. (2021), Liu et al. (2016), Leong et al. (2021), Hu et al. (2022), Yao et al. (2013), Sun et al. (2019), Duan et al. (2019), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Nakazato et al. (2014), Asai et al. (2009)	13 (17%)

that involves the creation of a deal between several participants. Besides, Baker et al. (2020) investigate how attentive interview observers are when conducting video-based job interviews. In 12%, generation tasks, mostly creative tasks, are investigated (e.g., Nakazato et al. (2014), Palanica et al. (2019)). As an example, Palanica et al. (2019) investigate the impact of natural versus urban backgrounds on creative thinking.

4.2.3. Technology dimension: Video meeting system

This dimension describes VMS from a technology perspective. As VMS is a core component of our review, we look at two subdimensions. First, we focus on the design features. We name this subdimension *technological elements under investigation*. For example, such design elements may be video or audio functionalities, self-view, or screen-sharing features. Since there is no holistic conceptualization of VMS design elements, we derived the categories for the subdimensions bottom-up based on the researched elements. An overview of the subdimension is provided in Table 5. Second, we focus on the *prevalence* of the design element researched. In this context, we distinguish between basic and established features versus innovative and novel technology features that are not yet a standard in contemporary VMS. An overview of this second subdimension is provided in Table 6.

Technological element under investigation: We can distinguish the design elements between studies that investigate a combination of multiple elements of the system, such as the holistic system (41%, e.g., Andres (2011), Han et al. (2011)) and specific elements. Thereby, we identify that especially survey-based studies largely focus on a holistic system evaluation and not on specific features (e.g., Okabe-Miyamoto et al. (2021), Ebardo et al. (2021)). Further, studies that compare to face-to-face communication belong to this category (e.g., Melchers et al. (2021), Sears et al. (2013)). Here, for example, Sears et al. (2013) investigate the holistic impact of VMS in job interviews. Ebardo et al. (2021) for instance observe the impact of VMS as a whole on mental load and fatigue amongst others. In terms of specific design elements, we identified that 22% of the studies investigate the specific effect of the video stream as a major design element of interest. Thereby, studies focused on individual user's videos but also on shared screen videos (e.g., Hron et al. (2007), Forghani et al. (2014)). As an example, Forghani et al. (2014) observe the impact of screen-sharing on emotions. As a sub-element of the video feed, the background was investigated in 5% of all studies (e.g., Palanica et al. (2019), Yao et al. (2013)). Here, for instance, Palanica et al. (2019) investigate the impact of the background on creativity. Further, the self-view as the user's own video feed mirrored to oneself has been investigated frequently (12%). Studies in this category often focus on attention, awareness, or anxiety related to this feature (e.g., Shockley et al. (2021), Vrzakova et al. (2021)). Another element of interest is audio (1%, e.g., Oren-Yagoda and Aderka (2021)). The remaining papers (41%) focus on novel design elements and aim to support the users in the observed situation, for example, via gaze-based attention support (10% e.g., Vertegaal et al. (2003), Otsuki et al. (2018)), emotional support (12% e.g., Sonderegger et al. (2013), Murali et al.

Table 6
Overview on technology dimension: VMS — Prevalence.

Category	Short description	References	#Papers
Basic Feature	All elements commonly available in a VMS	Sears et al. (2013), Melchers et al. (2021), Palanica et al. (2019), Taniuchi and Shibuya (2021), Capan (2013), Abramova et al. (2021), Wegge (2006), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Han et al. (2011), Vrzakova et al. (2019), Kashiwagi et al. (2006), Wu and Lee (2012), Langer et al. (2017), Schaarschmidt and Koehler (2021), Marlow et al. (2017), Blau et al. (2016), Hron et al. (2007), Blau et al. (2017), Balogova and Brumby (2022), Kim et al. (2014), Baker et al. (2020), Vrzakova et al. (2021), Hassell and Limayem (2020), Tam et al. (2016), Riby et al. (2012), Andres (2011), Kizilcec et al. (2014), Tomprou et al. (2021), Butz et al. (2015), Goethe et al. (2022), Boyle et al. (2000), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Miller et al. (2021), Gabbiadini et al. (2020), Ferran-Urdaneta and Storck (1997), Matulin et al. (2021), Alavi et al. (1995), Okabe-Miyamoto et al. (2022), Horn and Behrend (2017), Bennett et al. (2021), Brucks and Levav (2022)	46 (59%)
Novel Generic Feature	Generic, newly introduced feature not based on biosignal	Taguchi et al. (2018), Pan et al. (2009), Sonderegger et al. (2013), Hosseini et al. (2021), Liu et al. (2016), Leong et al. (2021), Hu et al. (2022), Yao et al. (2013), Nitada et al. (2021), Vertegaal et al. (2003), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Asai et al. (2009), Jung et al. (2015), Jaklič et al. (2017)	15 (19%)
Biosignal-based Feature	Additional, newly introduced feature based on biosignal	Rojas et al. (2022), Murali et al. (2021), Grayson and Monk (2003), Otsuki et al. (2018), Kim et al. (2020), Namikawa et al. (2021), Sun et al. (2019), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Miller et al. (2021), Schneider and Pea (2013), Costa et al. (2018), Kim et al. (2019), Nakazato et al. (2014), Tan et al. (2014a), Farooq et al. (2021)	16 (21%)

(2021)) or modifications to enhance creativity (e.g., Leong et al. (2021), Nakazato et al. (2014)).

Prevalence: We realize a strong focus on basic features of VMS, such as video stream or self-view (59%, e.g., Shockley et al. (2021), Boyle et al. (2000), Pikoos et al. (2021), Melchers et al. (2021)) which are common in VMS. Further, also newly created and tested features are investigated. These features are less prevalent and called novel in our work. They can be differentiated in two parts: First, novel generic features (19%, e.g., Shockley et al. (2021), Boyle et al. (2000)) and second novel biosignal-based features (21%, e.g., Pan et al. (2009), Hosseini et al. (2021)). Novel common features do not rely on biosignals as input and exemplarily cover face or voice deformation, real-time transcription, or viewport changes (Taguchi et al., 2018; Pan et al., 2009). Biosignal features thereby mostly cover features that provide awareness or attention support based on gaze data (e.g., Jaklič et al. (2017), Kim et al. (2019), Ouglov and Hjelsvold (2005), Schneider and Pea (2013)). As an example Jaklič et al. (2017), Schneider and Pea (2013) investigate the impact of eye contact on awareness. In contrast, Kim et al. (2019) investigate how sharing information close to where people are looking at impacts the video meeting participants. Besides, heart rate, skin conductance, or facial expressions are deployed as input sources (e.g., Rojas et al. (2022), Riby et al. (2012), Farooq et al. (2021)). These less prevalent features cover elements for emotional support or assistance in analyzing facial expressions or physiological cues (e.g., Murali et al. (2021), Tan et al. (2014b)). As an example, Farooq et al. (2021) investigates haptic cues and facial expression recognition on mental load. Tan et al. (2014b) investigate biofeedback's effect on mental load and emotions.

4.2.4. User dimension: Psychological user states

The subdimension of psychological user states covers the conditions of cognition and affect. In our review, these psychological states are the core interest when it comes to the human user. To better categorize cognitive and affective states we draw on the work by Zhang (2013) for affect and on the work by Davern et al. (2012) for cognition. We categorize our findings based on the three subdimensions *overall*, *cognition* and *affect*. The subdimension overall captures cognition and affect holistically. The subdimension of cognition divides cognitive constructs into specific cognitive processes and organization. The subdimension affect contrasts affect into emotions, feelings, and mood. A depiction of all studies present in the first subdimension *overall* is depicted in Table 7. An overview of the second and third subdimension is visible in Table 8.

Overall level of analysis: In total, we are able to report a rather balanced focus on constructs for cognition and affect in our sample. Further, we realize a slightly stronger focus on cognitive states (72% of studies, e.g., Horn and Behrend (2017), Leong et al. (2021), Hron et al. (2007)) compared to affective states (54%, e.g., Abramova et al. (2021), Blau et al. (2017)). In the following, we describe detailed results for cognition first and for affect second.

Cognition: For cognitive states we differentiate into cognitive organization and cognitive processes. We further differentiate the processes into awareness, attention, and the thought processes of creativity, decision-making, and learning. For cognitive organization, only a few constructs have been researched. Specifically, with respect to the memory of individuals, the cognitive or mental load has been reviewed in 17% of the studies (e.g., Ferran-Urdaneta and Storck (1997), Horn and Behrend (2017), Ebardo et al. (2021)). Thereby, studies either investigated the increase in cognitive load through traditional, existing video meeting system elements such as the self-view (Horn and Behrend, 2017; Shockley et al., 2021) or aimed to investigate the impact of newly created, less prevalent features on the user's cognitive load (e.g., biofeedback (Tan et al., 2014b), real-time transcription (Pan et al., 2009)). Few studies investigated the overall system's impact on mental load (Ebardo et al., 2021; Ferran-Urdaneta and Storck, 1997). Regarding mental models and schemata, only shared mental models have been investigated (e.g., Andres (2011), Hron et al. (2007)). As an example, Andres (2011) investigate how mental models evolve when collaborating together via video meetings. We further perceive a focus on the cognitive processes of awareness (30%, e.g., Grayson and Monk (2003), Asai et al. (2009)) and attention (24%, e.g., Vertegaal et al. (2003), Miller et al. (2017)). Regarding awareness, studies mostly focused on self-awareness and situational awareness. Thereby, some studies compared the impact of different video meeting system configurations (e.g., camera image on/off, self-view on/off, new feature added/not) on the users' self-awareness and related user states such as attention or cognitive load (Asai et al., 2009; Horn and Behrend, 2017) or emotions (Ngien and Hogan, 2022; Costa et al., 2018; Abramova et al., 2021). Results however are partly diverging. In detail, joint attention as well as visual attention on others versus the content of a presentation have been investigated (e.g., Miller et al. (2017), Vrzakova et al. (2019)). These studies thereby predominantly aim to solve the problem of paying and getting attention (Rae et al., 2015). Therefore, the authors have mostly examined either attention (Vrzakova et al., 2021) or provided attention support tools that helped to increase attention on relevant parts of the meeting (Nitada et al., 2021; Yao

Table 7
Overview on user state dimension — Overall level.

Category	Short description	References	#Papers
Affect	Covers all papers which include affective constructs	Murali et al. (2021), Taniuchi and Shibuya (2021), Rojas et al. (2022), Sears et al. (2013), Melchers et al. (2021), Capan (2013), Abramova et al. (2021), Wegge (2006), Sonderegger et al. (2013), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Taguchi et al. (2018), Kashiwagi et al. (2006), Namikawa et al. (2021), Hosseini et al. (2021), Liu et al. (2016), Langer et al. (2017) Schaarschmidt and Koehler (2021), Leong et al. (2021), Hu et al. (2022), Kim et al. (2020), Balogova and Brumby (2022), Chollet et al. (2018), Tan et al. (2014b), Kim et al. (2014), Forghani et al. (2014), Riby et al. (2012), Costa et al. (2018), Kim et al. (2019), Kizilcec et al. (2014), Butz et al. (2015), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Tan et al. (2014a), Pikoos et al. (2021), Gabbiadini et al. (2020), Matulin et al. (2021), Alavi et al. (1995) Jung et al. (2015), Okabe-Miyamoto et al. (2022), Bennett et al. (2021)	42 (54%)
Cognition	Covers all papers which include cognitive constructs	Palanica et al. (2019), Murali et al. (2021), Abramova et al. (2021), Grayson and Monk (2003), Wegge (2006), Sonderegger et al. (2013), Ebardo et al. (2021), Han et al. (2011), Vrzakova et al. (2019), Otsuki et al. (2018), Pan et al. (2009), Kashiwagi et al. (2006), Hosseini et al. (2021), Wu and Lee (2012), Nitada et al. (2021), Marlow et al. (2017), Leong et al. (2021), Blau et al. (2016), Hu et al. (2022), Yao et al. (2013), Hron et al. (2007), Kim et al. (2020), Vertegaal et al. (2003), Blau et al. (2017), Balogova and Brumby (2022), Sun et al. (2019), Duan et al. (2019), Tan et al. (2014b), Baker et al. (2020), Miller et al. (2021), Vrzakova et al. (2021), Hassell and Limayem (2020), Ouglov and Hjelsvold (2005), Tam et al. (2016), Schneider and Pea (2013), Costa et al. (2018), Andres (2011), Kizilcec et al. (2014), Nakazato et al. (2014), Tomprou et al. (2021), Asai et al. (2009), Goethe et al. (2022), Boyle et al. (2000), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Miller et al. (2017), Ferran-Urdaneta and Storck (1997), Jaklič et al. (2017), Alavi et al. (1995), Jung et al. (2015), Okabe-Miyamoto et al. (2022), Farooq et al. (2021), Horn and Behrend (2017), Brucks and Levav (2022)	56 (72%)

et al., 2013). Vrzakova et al. (2019) for instance thereby investigate different types of social attention and joint attention and their impact on collaboration and performance. Attention support tools to increase attention exemplary cover blurring mechanisms to focus on relevant parts (Nitada et al., 2021). Regarding further cognitive processes, particularly learning and knowledge generation processes (17%, e.g., Blau et al. (2016), Alavi et al. (1995), Tomprou et al. (2021)) and creative thinking (8%, e.g., Leong et al. (2021), Hosseini et al. (2021)) have been investigated. These studies have often analyzed the overall system's impact on cognitive process and related performance outcomes compared to traditional face-to-face settings (Blau et al., 2016, 2017; Okabe-Miyamoto et al., 2022). The remaining studies investigated the impact of newly created collaboration or attention support features on these processes (Hron et al., 2007; Yao et al., 2013). For instance, Hron et al. (2007) investigate the impact of shared workspaces on knowledge construction. As another example, a study conducted by Nakazato et al. (2014) investigates whether face deformations enhance creative thinking. In contrast, decision-making was less researched (3%, e.g., Hassell and Limayem (2020)). An exemplary study was conducted by Hassell and Limayem (2020) which investigate whether the media of video meeting does impact the decision process and quality.

Affect: For affect, we follow the distinction by Zhang (2013) into emotion, feeling and mood. We report a clear focus on emotions as the construct of interest (53%, e.g., Gabbiadini et al. (2020), Oren-Yagoda and Aderka (2021), Kizilcec et al. (2014)). In contrast, feeling or mood are less often investigated (3% and 4% respectively, e.g., Bennett et al. (2021), Langer et al. (2017)). This is in line with Zhang (2013)'s conceptualization of mood as an affective construct which is conceptualized as a long-term and less stimuli-specific construct. Moreover, when categorizing the affective states, especially emotions, based on pleasantness (e.g., Russell (1980)), we identify a focus on negative-connoted constructs such as nervousness, anxiety, or stress (e.g., Wegge et al. (2007), Murali et al. (2021), Costa et al. (2018)). These studies often compared the overall system's impact or the self-view's impact on the negative emotional user states, especially during the increased use period in the pandemic (Ngien and Hogan, 2022; Melchers et al., 2021), or made use of newly created features to inform users about their or other's current level of such negative states (Tan et al., 2014b; Murali et al., 2021). In general, these studies often focused on the video image and appearance-related concerns of users in various settings (e.g., interviews, get-to-know tasks). Positive states such as enjoyment are less often researched (Balogova and Brumby, 2022; Schaarschmidt and Koehler, 2021). Methodwise, a slight focus is noticeable on survey-based studies related to emotional constructs (e.g., Gabbiadini et al. (2020), Pikoos et al. (2021)).

4.2.5. Outcome dimension

The impact of VMS on psychological user states results in different outcomes. Observed outcomes can be categorized into *performance* outcomes, *individual well-being* outcomes, technology-related *user-experience* outcomes, and *interpersonal relationship* outcomes. An overview of all publications is visible in Table 9. In our publication sample, we identified a focus on performance-related outcomes such as productivity or quality (67% of studies, e.g., Okabe-Miyamoto et al. (2021), Hosseini et al. (2021)). For example, for thought processes, the number of ideas or decision-making outcomes have been investigated (e.g., Hosseini et al. (2021)). Hosseini et al. (2021) investigate how real-time feedback to encourage turn-taking impacts creative processes and ultimately the creative outcome of the meeting. Further, 23% of studies investigated user experience as an important VMS outcome (Chollet et al., 2018; Taguchi et al., 2018). Thereby, the authors mostly investigated the user experience of newly developed features (Sun et al., 2019; Murali et al., 2021) or performed a comparison study of several existing video meeting systems (Okabe-Miyamoto et al., 2021). As an example, Murali et al. (2021) investigate the user experience of a feedback feature showing affective reactions of the audience on the presenter. Besides, studies also focused on privacy as a user experience-related construct (Hatscher et al., 2012; Boyle et al., 2000). Here, Boyle et al. (2000) exemplarily investigate how filtered video impacts awareness and privacy. In contrast, 10% of the studies focused on individual well-being outcomes. We set the scope of individual well-being outcomes broadly and cover all individual, non-work-related individual outcomes respectively (see e.g., Good et al. (2016) for a similar approach). For example, individual well-being covers stress (Wegge et al., 2007). As a part of this category, 5% of all studies focused on video meeting fatigue as a recent well-being-related phenomenon (e.g., Bennett et al. (2021), Shockley et al. (2021), Ebardo et al. (2021)) and investigate whether video meeting fatigue accrues in different settings, how it evolved over time or how different elements, such as the self-view, impact the perceived level of video meeting fatigue. Moreover, we

Table 8
Overview on user state dimension — Fine-grained view.

Subdimension	Category	Short Description	References	#Papers
Cognition	Cognitive processes	Thereof: Awareness	Murali et al. (2021), Abramova et al. (2021), Grayson and Monk (2003), Wegge (2006), Nitada et al. (2021), Marlow et al. (2017), Vertegaal et al. (2003), Balogova and Brumby (2022), Sun et al. (2019), Duan et al. (2019), Miller et al. (2021), Schneider and Pea (2013), Costa et al. (2018), Asai et al. (2009), Boyle et al. (2000), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Miller et al. (2017), Ferran-Urdaneta and Storck (1997), Jaklič et al. (2017), Jung et al. (2015), Horn and Behrend (2017)	23 (30%)
		Thereof: Attention	Vrzakova et al. (2019), Otsuki et al. (2018), Nitada et al. (2021), Bennett et al. (2021), Hu et al. (2022), Yao et al. (2013), Kim et al. (2020), Vertegaal et al. (2003), Baker et al. (2020), Miller et al. (2021), Vrzakova et al. (2021), Ouglov and Hjelsvold (2005), Tam et al. (2016), Schneider and Pea (2013), Kizilcec et al. (2014), Asai et al. (2009), Goethe et al. (2022), Pikoos et al. (2021), Miller et al. (2017)	19 (24%)
		Thereof: Creativity	Palanica et al. (2019), Han et al. (2011), Hosseini et al. (2021), Leong et al. (2021), Nakazato et al. (2014), Brucks and Levav (2022)	6 (8%)
		Thereof: Decision-making	Hassell and Limayem (2020), Andres (2011)	2 (3%)
		Thereof: Learning and knowledge construction	Kashiwagi et al. (2006), Wu and Lee (2012), Blau et al. (2016), Yao et al. (2013), Hron et al. (2007), Blau et al. (2017), Hassell and Limayem (2020), Schneider and Pea (2013), Andres (2011), Kizilcec et al. (2014), Tomprou et al. (2021), Alavi et al. (1995), Okabe-Miyamoto et al. (2022)	13 (17%)
	Cognitive Structures: Mental load	Amount of resources used of cognitive structures (working memory)	Sonderegger et al. (2013), Ebardo et al. (2021), Pan et al. (2009), Hron et al. (2007), Duan et al. (2019), Tan et al. (2014b), Kizilcec et al. (2014), Shockley et al. (2021), Ferran-Urdaneta and Storck (1997), Farooq et al. (2021), Horn and Behrend (2017), Hu et al. (2022), Sun et al. (2019)	13 (17%)
Affect	Emotion	Affective reactions to situational events and objects	Rojas et al. (2022), Sears et al. (2013), Melchers et al. (2021), Murali et al. (2021), Taniuchi and Shibuya (2021), Capan (2013), Abramova et al. (2021), Wegge (2006), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Kashiwagi et al. (2006), Namikawa et al. (2021), Hosseini et al. (2021), Liu et al. (2016), Schaarschmidt and Koehler (2021), Miller et al. (2021), Leong et al. (2021), Kim et al. (2020), Balogova and Brumby (2022), Chollet et al. (2018), Tan et al. (2014b), Kim et al. (2014), Forghani et al. (2014), Riby et al. (2012), Costa et al. (2018), Kim et al. (2019), Kizilcec et al. (2014), Nakazato et al. (2014), Butz et al. (2015), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Tan et al. (2014a), Pikoos et al. (2021), Gabbiadini et al. (2020), Matulin et al. (2021), Miller et al. (2021), Alavi et al. (1995), Jung et al. (2015), Okabe-Miyamoto et al. (2022), Horn and Behrend (2017), Sun et al. (2019)	41 (53%)
		Thereof: Negative emotions	Melchers et al. (2021), Murali et al. (2021), Taniuchi and Shibuya (2021), Capan (2013), Wegge (2006), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Kashiwagi et al. (2006), Langer et al. (2017), Schaarschmidt and Koehler (2021), Horn and Behrend (2017), Kim et al. (2020), Chollet et al. (2018), Tan et al. (2014b), Sun et al. (2019), Costa et al. (2018), Oren-Yagoda and Aderka (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Gabbiadini et al. (2020), Okabe-Miyamoto et al. (2022), Jung et al. (2015), Matulin et al. (2021)	23 (30%)
	Feeling	More consciously evaluated emotions	Taguchi et al. (2018), Langer et al. (2017)	2 (3%)
	Mood	Free-floating affective states, undirected of stimuli, longer-lasting than emotions/feelings	Sonderegger et al. (2013), Hosseini et al. (2021), Bennett et al. (2021)	3 (4%)

identified that 18% of all studies investigated interpersonal relationship outcomes, such as trust or cohesion or team satisfaction (Hassell and Limayem, 2020; Sears et al., 2013). The studies mostly focus on the overall system's impact (Gabbiadini et al., 2020) and partly performed comparison studies to physical meeting forms, as exemplarily done by Brucks and Levav (2022) who investigated creativity in physical versus video-based meetings.

4.3. Research trajectories (RQ 2)

Based on the outlined data collection method and the conceptual results from our SLR, we investigated which topics have been covered most in our literature sample. We aimed to identify existing accumulations of studies. More importantly, in a next step, we took into account the different dimensions used in our conceptual framework and explored highly investigated areas (i.e., dark-colored areas) in the conceptual framework depicted in the morphological box. We further build on the sub-categories of several subdimensions, specifically emotions and support features mentioned in the results chapter as well as outlined in the referenced concept matrix.

To generate more in-depth insights on VMS specific impact on user states, in the following, we particularly focused on highly investigated areas targeting the interplay of our core dimensions of interest, technology type, and psychological user state researched. This interplay is depicted in Fig. 7 and highly researched areas are highlighted in blue. On this basis, we are able to identify and present five research trajectories presented below. In a final step, we briefly outline the interactions between the applied data collection method and technological element investigated.

Table 9
Overview on papers for outcome dimension.

Category	Short Description	References	#Papers
Performance	Outcomes related to work e.g., productivity, number of ideas	Sears et al. (2013), Melchers et al. (2021), Palanica et al. (2019), Murali et al. (2021), Abramova et al. (2021), Wegge (2006), Sonderegger et al. (2013), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Han et al. (2011), Vrzakova et al. (2019), Otsuki et al. (2018), Kashiwagi et al. (2006), Namikawa et al. (2021), Hosseini et al. (2021), Wu and Lee (2012), Liu et al. (2016), Langer et al. (2017), Leong et al. (2021), Tomprou et al. (2021), Blau et al. (2016), Hu et al. (2022), Yao et al. (2013), Hron et al. (2007), Blau et al. (2017), Balogova and Brumby (2022), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Baker et al. (2020), Vrzakova et al. (2021), Hassell and Limayem (2020), Ouglov and Hjelsvold (2005), Schneider and Pea (2013), Andres (2011), Kizilcec et al. (2014), Nakazato et al. (2014), Butz et al. (2015), Asai et al. (2009), Shockley et al. (2021), Ngien and Hogan (2022), Ferran-Urdaneta and Storck (1997), Alavi et al. (1995), Jung et al. (2015), Sun et al. (2019), Farooq et al. (2021), Horn and Behrend (2017), Brucks and Levav (2022), Forghani et al. (2014), Marlow et al. (2017), Pan et al. (2009), Miller et al. (2021)	52 (67%)
Individual well-being	Outcomes not related to work, focusing on the individual (e.g., fatigue)	Rojas et al. (2022), Sonderegger et al. (2013), Langer et al. (2017), Shockley et al. (2021), Bennett et al. (2021), Ngien and Hogan (2022), Pikoos et al. (2021), Ebardo et al. (2021)	8 (11%)
Interpersonal Relationship	Outcomes not related to work focusing on the team (e.g., trust)	Brucks and Levav (2022), Costa et al. (2018), Wegge (2006), Langer et al. (2017), Miller et al. (2021, 2017), Hassell and Limayem (2020), Tan et al. (2014b), Gabbiadini et al. (2020), Hu et al. (2022), Ferran-Urdaneta and Storck (1997), Sears et al. (2013), Jung et al. (2015), Oren-Yagoda and Aderka (2021)	14 (18%)
User experience	Outcomes related to technology	Rojas et al. (2022), Murali et al. (2021), Taniuchi and Shibuya (2021), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Otsuki et al. (2018), Taguchi et al. (2018), Liu et al. (2016), Langer et al. (2017), Yao et al. (2013), Kim et al. (2020), Sun et al. (2019), Chollet et al. (2018), Boyle et al. (2000), Matulin et al. (2021), Forghani et al. (2014), Hu et al. (2022), Nitada et al. (2021)	18 (23%)
Not available	No outcomes mentioned	Capan (2013), Goethe et al. (2022), Grayson and Monk (2003), Jaklič et al. (2017), Kim et al. (2014, 2019), Okabe-Miyamoto et al. (2022), Riby et al. (2012), Schaarschmidt and Koehler (2021), Tam et al. (2016), Vertegaal et al. (2003)	11 (14%)

Research Trajectory 1 — VMS role in unspecified conversational tasks:. This research trajectory describes 24 papers that focus on the impact of VMS in unspecified conversation tasks (e.g., Kim et al. (2014, 2019), Pan et al. (2009)). We further analyzed the interplay of technology under investigation and task, as well as user state and task in Fig. 6.

As visible, a focus is also set on the holistic evaluation of VMS and its impact (e.g., Capan (2013)). Besides, Pan et al. (2009) focused on the impact of transcriptions. Hu et al. (2022) explored the impact of frictionless transitions between meeting rooms in conversations. A potential reason for this trajectory might be that using a conversation only is easy to implement and task-depending influences can be avoided. On the one hand, this generic conversation is interesting, as a lot of meetings include casual or generic conversational topics. Exemplarily, informative talks or ice-breaking scenarios are researched (Miller et al., 2021; Wegge et al., 2007). However, as we are able to illustrate in our conceptualization, the task is one dimension that influences how VMS impact the human. Depending on the task, different affordances for affective or cognitive resources exist which may alter the VMS impact (see e.g., Norman (1999), Zhang and Patel (2006), Chemero (2010), Waizenegger et al. (2020) for literature on affordances).

Research Trajectory 2 — VMS and negative emotions:. When looking at Fig. 7 showing the frequencies of interactions between technology under investigation and analyzed user state, a focus is visible on the investigation of negative emotions. This trajectory consists of 17 studies that focus on VMS' impact on emotions such as anxiety, stress, or nervousness, which can be perceived as negative emotions. This notable focus on negative emotions could be a result of the tasks and related negative user state constructs (e.g., nervousness in job interviews, impact of VMS on state anxiety). For example, Wegge (2006) observed the impact of the self-view on heightened anxiety, or Jung et al. (2015) investigated the impact of conflict support tools. Thereby, we observe two focal aspects: First, we realize an enlarged focus on evaluative settings and user teams that tend to struggle with such settings, e.g., socially anxious people (Oren-Yagoda and Aderka, 2021; Capan, 2013). These studies aim to understand how vulnerable user teams are impacted by VMS compared to other user teams. They attempt to shed light on user recommendations and recommendations for evaluators in such settings to avoid biases made due to technology use. This seems to be particularly relevant, as anxiety as an individual characteristic or user state seems to also impact technology acceptance and use of video meeting systems (Park et al., 2014). Second, we perceive a focus on studies investigating the impact of VMS in general or specific new features on negative user states, such as frustration (Wheeler, 2000; Farooq et al., 2021; Gabbiadini et al., 2020; Schaarschmidt and Koehler, 2021). This second focus may be triggered by the authors' intentions to derive design knowledge for system improvements, i.e., reducing negative emotions and preventing negative evaluations. By better understanding how such negative states arise, it becomes feasible to mitigate them and propose VMS improvements.

Research Trajectory 3 — VMS' holistic impact on cognition and affect:. Besides, we observe a prevalent focus on investigating the impact of VMS holistically, capturing 32 studies. As visible in Fig. 7, the impact of the holistic system or a combination of several elements is mostly observed with respect to its impact on negative emotional states, and the cognitive processes of attention as well as learning and knowledge generation. Especially investigating the impact on such thought processes hereby differs from the investigations of the specific design element. A potential reason might be that these studies often make use of survey-based methods or were conducted in the early years of 2000. As an example, Andres (2011), Wu and Lee (2012) observed the holistic impact of VMS on learning and knowledge generation via survey studies, also in large group settings. Furthermore, Alavi et al. (1995), Kashiwagi et al. (2006), Ouglov and Hjelsvold (2005) conducted studies when VMS was not broadly used by everyone and the features were limited. In contrast, we also see an increase in studies conducted during the pandemic. Such studies often focus on the impact of negative emotional states via surveys and experiments. Specifically, Okabe-Miyamoto et al. (2021, 2022), Gabbiadini et al. (2020) observed the holistic impact of VMS on negative emotions in survey studies. One potential reason might be the increased adoption of VMS in diverse use contexts and the rise of claims for negative outcomes of VMS, such as virtual meeting fatigue (Fauville et al., 2021).

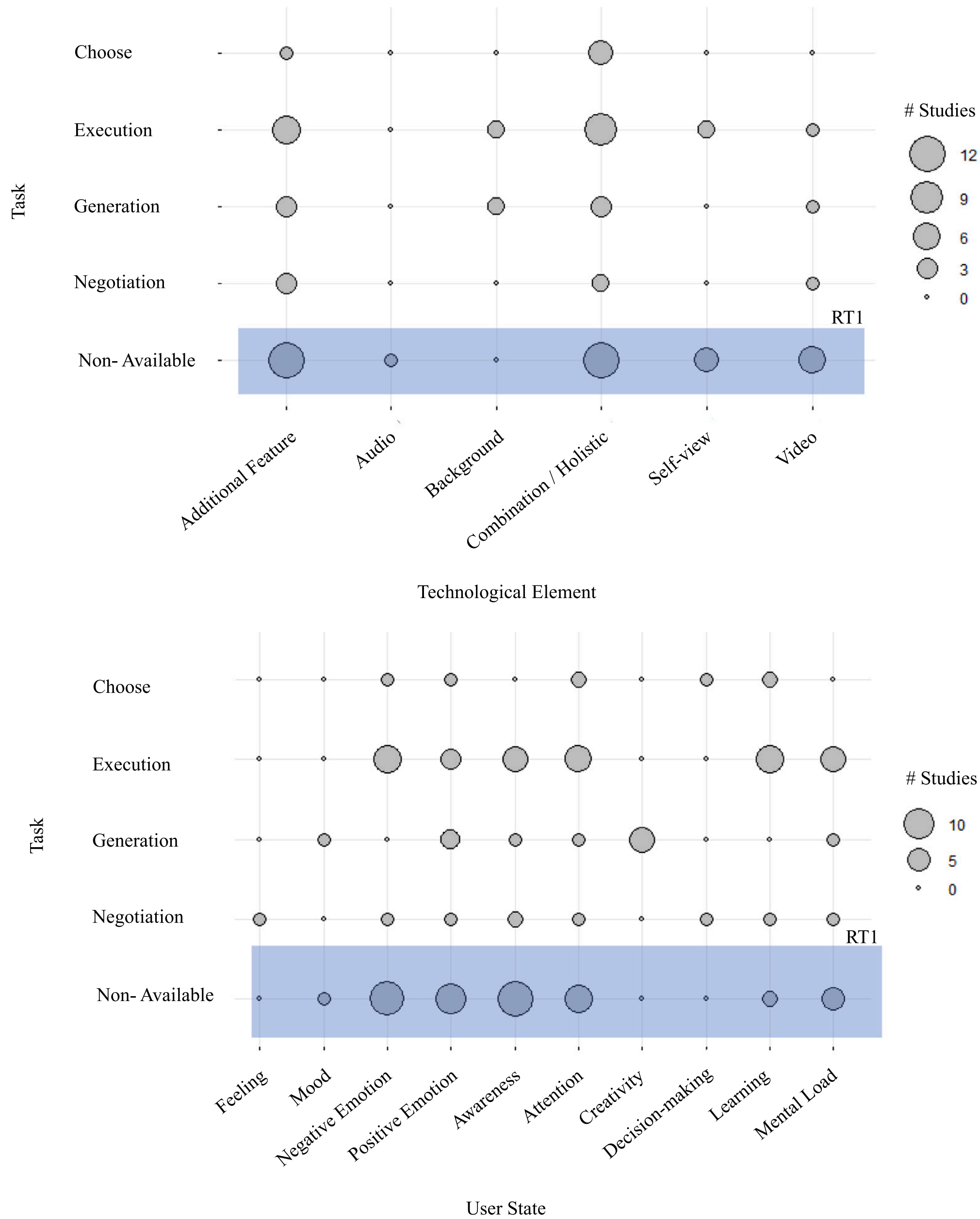

Fig. 6. Frequencies of interactions over publication sample between technology under investigation and given task type (upper graph) as well as analyzed user state and given task type (lower graph) with identified research trajectory 1 (RT1).

In contrast, Langer et al. (2017), Kashiwagi et al. (2006) conducted experimental studies also already focusing on negative emotional states. By understanding the holistic impact, we believe that researchers were able to get a profound overview of the overall perceptions of users and thereby lay the foundation to identify system improvements and ideas for novel specific support features, such as Emodash (Ez-zaouia et al., 2020).

Research Trajectory 4 — Impact of Video and Self-view on attention and awareness:. As a fourth accumulation of existing studies, we highlight studies that focus on observing the impact of the self-view and video feature on attention and awareness, presented as RT4 in Fig. 7. Compared to the previous research trajectory, this stream covers 24 publications that focus on a specific integral design feature of VMS: the video feed of oneself (i.e., self-view) and others. For instance, these studies investigate whether an existing self-view impacts the user's awareness and alters attention in a meeting (Miller et al., 2021; Horn and Behrend, 2017). Often, this investigation is complemented by observing performance-related outcomes or emotional states such as anxiety. This focus on self-view can be explained by the fact, that the self-view is one of the most striking differences between video-mediated and face-to-face communication. Already early findings from psychology thereby suggest that adding self-depictions may alter behavior and attention (Duval and Wicklund, 1972). In recent years, these elements have also been of high interest in public media (Arnu, 0000). Besides the self-view's impact, also the impact of the video element is investigated frequently. Thereby, we distinguish between studies investigating the impact of the video stream per se (i.e., investigating the video being on/off) and studies investigating modifications of the video feed. For the first category, the impact is observed on cognitive processes and mental load (e.g., Han et al. (2011), Hron et al. (2007), Shockley et al. (2021) for instance. For the second category, modifications include showing a shared screen or not (e.g., Miller et al. (2021)) or showing face deformations and their impact on emotions (e.g., Taguchi et al. (2018)). As self-view and video are the most basic

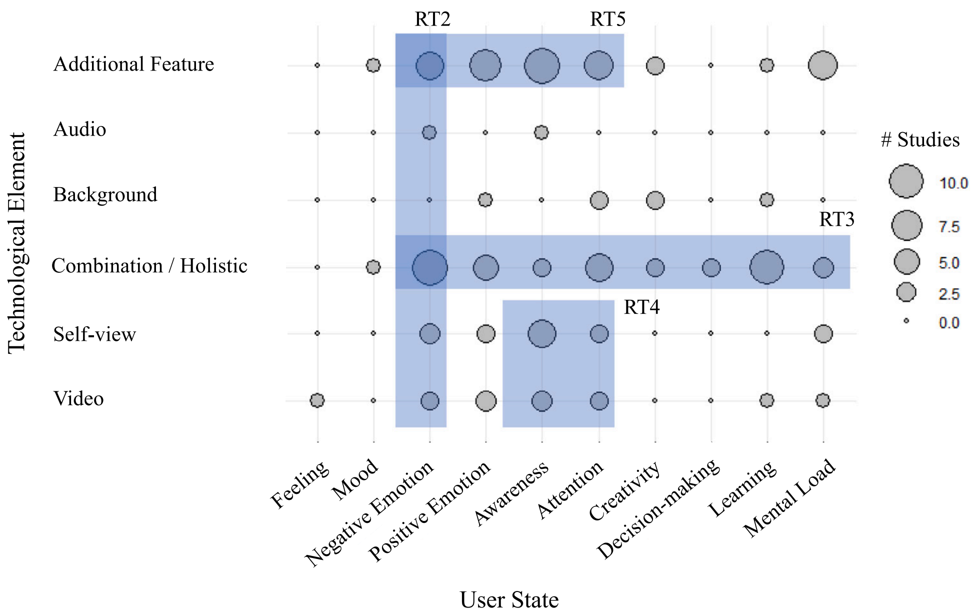

Fig. 7. Frequencies of interactions over publication sample between technology under investigation and analyzed user state with four research trajectories RT2, RT3, RT4, and RT5.

differences between face-to-face and video-mediated communication, we believe that researchers so far often focused on these elements. Again, understanding their core impact is important to identify required novel support features and to understand these features' additional impact irrelevant to the core impact, the video mediation has on communication.

Research Trajectory 5 — Biosignal-based support features:. Our fifth trajectory covers publications that use biosignals as input for support features of VMS. This focus is visible in Fig. 7. Thereby, when taking a closer look on the type of support, we identify two sub trajectories covering a) gaze-based attention support and (b) support in understanding affective user states. Details on both sub trajectories are outlined below as well as in the respective results chapter and supplementary material.

Research Trajectory 5a — Gaze-based features for awareness and attention support:. This sub trajectory covers seven publications that use biosignals as input for support features of VMS for the retention of attention and awareness. Thereby, these papers aim to address the existing lack of gaze cues in mediated communication by making use of gaze data collected via eye-tracking, modifying the VMS interface to achieve better eye contact, or enriching the communication with information on joint attention (e.g., Kim et al. (2020), Grayson and Monk (2003)). One reason for this trajectory may be that the recognition of these user states is a widely acknowledged problem in video-mediated communication. Early work on VMS described that a lack of eye contact or awareness of where collaborators are looking distinguishes video meetings from physical meetings (Kock, 2004). However, to date, this problem is not yet sufficiently solved and users still struggle with it (Döring et al., 2022). Thereby, all identified papers focus on dyadic communication and on activities in professional contexts.

Research Trajectory 5b — Support features for understanding affective states:. Besides a focus on the impact of VMS on negative affect, we observe a subtrajectory that aims to support reducing negative affective states in VMS. This trajectory covers 11 papers and aims to increase the communication partners' knowledge of one's own emotional state or introduce new support features to facilitate emotional understanding within a team. For example, Sonderegger et al. (2013) investigated the impact of mood feedback on teams and Namikawa et al. (2021) examined the impact of emojis to improve facial expression recognition. Thereby, among others, the continuous data streams of facial expressions or physiological data were used as input. The included articles focus on the challenge of lacking nonverbal cues and poorer transmission of emotional cues in video-mediated settings (Jung et al., 2015; Nakazato et al., 2014; Namikawa et al., 2021; Rojas et al., 2022). In contrast to the features for gaze-based support for attention and awareness, support features to transport more emotions have been examined in dyadic, small, and larger teams.

Research Trajectory 6 — Different data collection approaches with a focus on quantitative survey data:. Our last research trajectory targets the chosen data collection method when examining the VMS element. A visualization of the chosen data collection method per VMS technological element is visible in Fig. 8. Here, we can see that mainly experimental studies including questionnaires have been conducted. This pattern is consistent for all types of investigated technological elements. In terms of other data collection methods, we see an accumulation of survey studies that conduct a holistic evaluation of the system, as for example Okabe-Miyamoto et al. (2021). In addition, several survey studies investigate the impact of the self-view feature, e.g., Abramova et al. (2021), Balogova and Brumby (2022). When it comes to studies collecting and analyzing biosignals or behavioral data from users, in total 13 papers investigated enhancement features with biosignals. The focus on these features may here be explained by the fact that several enhancement features do rely on gaze data or understanding affect via biosignals, as we see in research trajectory 5 (see e.g., Grayson and Monk (2003), Rojas et al. (2022)). Thus, these studies require the collection of such data. However, several studies also focus on prevalent features or the system as a whole when investigating biosignals. For example, five studies focused on the evaluation of the holistic systems including biosignals (see e.g., Vrzakova et al. (2019) who investigated the impact on different types of social attention, or Riby et al. (2012) who observed reactions to faces for individuals with or without neurodiverse backgrounds). Looking at a prevalent investigated feature, the self-view, behavioral data was for example gathered by Miller et al. (2021) who investigated self-attributions in relation to self-viewing and self-awareness. Looking at the timing of data collection, in 91% of the cases, data was only collected at a single point. Studies focusing on multiple points of data collection are rare and have predominantly been conducted for holistic evaluations (see e.g., Han et al. (2011)) or evaluation of the self-view (see e.g., Shockley et al. (2021)).

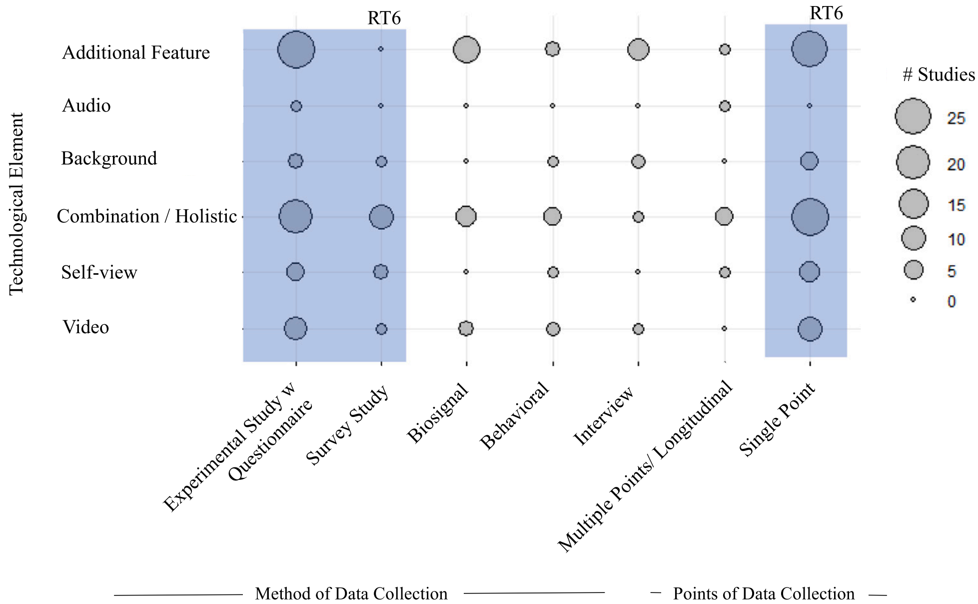

Fig. 8. Frequencies of interactions in publication sample between technology element and data collection method. In the left part, the frequency of the chosen data collection method (experimental vs. survey and additional biosignal, behavioral, or interview data) is shown. In the right part, the number of data collection points is depicted. We differ between studies collecting data only once (single point) or collecting data multiple times (multiple points).

Table 10
Summary of proposed existing research trajectories and future research directions.

Target	Existing research trajectories	Future research directions
Conceptual Framework: VMS and user state observed in a specific context and task	RT1: VMS role in unspecified tasks	RD1: VMS beyond professional use-cases RD3: VMS impact on thought processes and related specific conversational tasks
Conceptual Framework: VMS and user state observed in general	RT2: VMS and negative emotions RT3: VMS holistic impact RT4: Impact of self-view and video feed on attention and awareness RT5: Biosignal-based support features for attention support and affective state understanding	RD2: VMS design elements beyond video and self-view RD4: Impact of VMS on positive emotions and feelings
Data collection Method	RT6: Different data collection approaches with a focus on quantitative survey data	RD6: Biosignals and behavioral data as enablers for deep user state understanding

5. Discussion

This paper synthesizes quantitative work investigating the impact of VMS on psychological user states. Therefore, we conducted a SLR and identified 78 relevant papers. We conceptualized the findings and illustrated them in a morphological box to structure the state-of-the-art. Afterward, we identified six research trajectories that revolve around understanding the impact of VMS on negative affect, a focus on specific VMS features, such as video and self-view as well as an investigation of VMS as a whole. Further, we identified research trajectories targeting VMS' use for generic conversations, highlighting advanced features for gaze and attention support as well as emotional support, and covering studies using only subjective measures at a single point of data collection. In addition to reviewing existing studies on specific topics (i.e., the research trajectories), we aimed to identify gaps in the current research. Based on this, we propose several future research directions to cover areas that have been underinvestigated. We can divide these research directions into two parts: First, research directions focusing exclusively on elements of our conceptual framework, and second, research directions targeting the specific data collection method and related experimental design. Table 10 provides an overview of all existing research trajectories, as well as future research directions.

5.1. Research directions targeting the conceptual framework dimensions (RQ3)

In a first step, we focus on research directions derived from the conceptual dimensions of our technology-human-task-context framework. Based on this, we propose four research directions:

Research Direction 1 — Extending VMS research beyond professional use-cases:. Context-wise, we identified that 93% of all investigated articles focused mostly on the professional environment, not the private one. Despite this being reasonable as VMS have their roots in observing business environments, the impact on user states might differ in a private context. Drawing on findings from teams' research on the impact of team configuration and impression management, we argue that perception of VMS and accordingly proposed system improvements may differ when considering the private context (Ames et al., 2010; Kozlowski and Ilgen, 2006). This is especially relevant since the recent pandemic led to a shift towards more video-mediated communication in the private context where individuals have more experience in private use compared to previous years (Business Insider Intelligence, 2020). Even though private life may mostly shift back to normal and physical encounters, long-distance friendships and relationships may benefit from such improvements (Ames et al., 2010; Brubaker et al., 2012).

Research Direction 2 — Focusing on specific VMS design elements beyond video and self-view:. Zooming in on VMS, we identified that a high number of studies focus on a combination of multiple design elements (e.g., the overall system). For example, Sears et al. (2013) investigated the holistic impact of VMS on emotions in job interview settings and Brucks and Levav (2022) investigated the impact of the entire system on creativity. However, our knowledge of the impact of particular elements of VMS is rather limited. Moreover, there is no clear definition of what a VMS actually consists of. Contemporary system implementations like Zoom have multiple elements such as the video feed, a chat function, reaction buttons, or live transcription but also elements that allow to apply virtual backgrounds and video filters. Moreover, Zoom and MS Teams, two prominent VMS applications, recently launched platforms that introduce further add-ons and innovative features, such as emotion analysis or dashboards, and open source VMS provide even more opportunities for personalized adaptations (see Zoom (2022), Microsoft (2022)). To propose more nuanced system improvements, we need to understand VMS on a more fine-grained level. Therefore, we suggest in-depth studies of specific design elements of VMS, other than the ones already researched, such as video or self-view. To ensure that none of these elements are left out, we argue that a taxonomy of such VMS design elements existing in the literature and real world would be helpful. Similar taxonomies have been created for other interactive systems such as conversational agents, or guidance systems (Morana et al., 2017; Feine et al., 2019).

Research Direction 3 — Understand the impact on thought processes and related specific conversational tasks:. We observe a currently under-investigated area on thought processes, especially decision-making, creativity, problem-solving, to name a few. As VMS are increasingly used in remote work scenarios and new contexts, also meetings involving more complex tasks that require a vast amount of creative thinking, decision-making, or problem-solving, the so-called thought processes, emerge. In parallel, the adoption of VMS in related fields of application (i.e. remote work, medicine, education) raises. Examples, therefore, include but are not limited to strategic meetings from executives in charge of decision making sometimes under high-risk, human resource recruitment tasks, including candidate selection via video meetings, brainstorming meetings for upcoming projects, or medical appointments including therapeutic diagnoses (De Weger et al., 2012; Karimi et al., 2022; Fennell, 2022). Despite the growing interest in the practical applications of VMS in these fields, still, extant quantitative research targeting the impact of VMS on the required thought processes is still underrepresented in our literature sample. Additionally, there is a shortage of research that focuses on tasks specifically requiring these processes. We see an increasing focus on such more complex and specific tasks observed in experiments. However, still, the impact of VMS on these complex cognitive processes is not yet fully understood. We argue that by gaining a better understanding of the detailed impact of VMS in such specific tasks on the relevant thought processes involved, additional VMS features can be created that support users in such situations in overcoming existing burdens introduced by existing VMS instantiations.

Research Direction 4 — Understanding VMS impact on positive emotions and feelings:. So far, we observe a slight focus on negative emotions and feelings in our literature sample. As an example, anxiety or nervousness are emotions often studied in papers in our sample (Wegge et al., 2007; Murali et al., 2021). Besides, existing studies covering positive emotions mostly focus on prevalent basic features. We argue that in particular novel features could benefit from understanding their positive emotional impacts, as they help to reach adoption (Beaudry and Pinsonneault, 2010). Here, we encourage scholars to not only focus on user experience and satisfaction-related emotional constructs (e.g., enjoyment, excitement (Laugwitz et al., 2008)) but also include further positive emotions such as astonishment or happiness that also seem to have an impact on IT use (Russell, 1980). In addition, we encourage scholars to complement the focus on positive emotions with investigating the long-term impact of VMS on emotional user states. Specifically, since affective responses towards the stimuli may change over time and can thereby alter the intention to use VMS, similar to other systems (Beaudry and Pinsonneault, 2010). For instance, positive emotions evoked by the technology could over time be outweighed by more negative emotions, resulting in decreased usage or lowered user satisfaction as well as severe well-being-related problems, as seen in various studies investigating mental health problems due to excessive internet or social media use (Longstreet et al., 2019; Montag et al., 2019). Thereby, this effect can partly be explained by specific design elements of these systems. Whether such changes in the technology's impact also hold true for VMS is, according to our knowledge, underexplored so far.

5.2. Research directions targeting data collection methods and experimental design (RQ3)

The outlined research directions based on underexplored areas in our conceptual framework suggest a need for better understanding of the impact of VMS on the outlined cognitive processes beyond awareness and attention but also in detail on the exact processes that happen within the human while interacting with the VMS. To achieve this better understanding we propose to methodologically expand research in terms of data collection methods and longitudinal experimental design. Based on this, we identify two research directions: First, making use of longitudinal studies, and second, making use of continuously collected data from humans.

Research Direction 5 — Longitudinal study design to understand time-dependent VMS impact:. In our sample, 91% of all studies have collected data on a single point in time and longitudinal studies are scarce. From a user state perspective, in our sample, a first study that aimed to investigate attention traces over time is De Vasconcelos Filho et al. (2009). Besides, changes in behavior, such as turn-takings or self-attributions are observed with repeated measurements (e.g., Chatwin and McEvoy (2019)). Self-attributions are thereby interesting to observe how aware individuals are of themselves and of the group as a whole (Chatwin and McEvoy, 2019). Turn-taking is interesting as it is a suitable means to measure how teams work together and identify team dynamics. As an example, one can state the influence of turn-takings on collective intelligence within a meeting (Woolley et al., 2010). By repeatedly measuring these metrics, one can see how dynamics within a team change over time, or even intervene when asymmetric dynamics are observable (see e.g., Samrose et al. (2020) who studied the impact of a continuous feedback tool and observed changes within one meeting). Related to this, some work has been conducted in virtual team literature focusing on knowing each other and exploring the impact on the development of trust and team cohesion (Kozlowski and Ilgen, 2006). Still, according to our review, extant literature that applies such longitudinal study designs or repeated measurements in VMS is scarce. However, observation of changes in cognitive and emotional processes during the use and adoption of VMS can best be achieved through the use of longitudinal studies in the field or continuous data with repeated points of measurement in a laboratory setting. Moreover, we suggest that such data can also increase the understanding of VMS' impact on time-dependent constructs such as fatigue or longer-lasting user states such as mood. We argue that by complementing existing research with insights from such studies, scholars can explain changes in perception over time more precisely. By providing a more grounded rationale for the observed effects that VMS has on users, we posit that this research can offer insight into why certain features, or VMS as a whole, gain long-term adoption.

Research Direction 6 — Biosignals and behavioral data as enablers for deep user state understanding:. Upon closer examination of the identified continuous data collection methods, it is evident that there is a primary focus on the collection of gaze data and facial expression analysis. Nevertheless, there are other types of continuous user data that can offer valuable insights into user behavior and experiences (for an overview on biosignals, see Riedl et al. (2020), Schultz et al. (2013)). For instance, behavioral data from interaction logs, as well as voice and microphone data, are already being collected during video meetings and can provide additional useful information. Moreover, already collected video data from webcams can be used for collecting gaze data (Papoutsaki, 2015) or identifying affect based on skin tone changes (Nithyaa et al., 2021). In addition, an emerging stream in ubiquitous computing does investigate so-called earables, which can be compared to in-ear headphones (Röddiger et al., 2022; Kawsar et al., 2018). These devices can measure cardiovascular functions and are able to monitor emotions or stress. When integrating these sensors in commodity in-ear headphones, an additional source of continuous information can be accessed easily and unobtrusively in meetings. Such signals can be gathered without additional hardware costs and putting an increased (physical) burden on the user compared to wearable devices used for measuring brain activity, heart data, or gaze data.

However, despite being less accurate than established laboratory devices, these signals are likely to be beneficial help to obtain a nuanced understanding of what happens in a human's cognition and affect during the use of VMS. Comparable work has been conducted in the field of ubiquitous computing, affective computing, or NeuroIS, for instance (e.g., Weiser (1991), Picard (2003)). We argue that by complementing survey-based data with biosignals or behavioral data as well as drawing on existing research insights, scholars can enrich their findings and explain ongoing mechanisms within the human more precisely and get a fine-grained understanding of individual user states. Thereby, more nuanced forms of user states, such as different forms of cognitive load (i.e., intrinsic, extrinsic, germane) or attention (i.e., functional vs. non-functional attention, attention as action vs. as a state), may be investigated (Kuzminykh and Rintel, 2020; Sweller, 1988). Besides, underinvestigated cognitive constructs such as the mentioned thought processes would be easier to investigate by making use of in-depth information generated using neurological signals from EEG. When considering the implementation of such continuous data collection methods, especially in field studies or when transferring insights from research into practice and towards the workplace, however, we strongly suggest researchers and practitioners to critically reflect on the negative downsides evolving around data privacy and ethical implications, particularly within the confines of workplace environments. As an example, we motivate researchers to think of misuse by bad intentions, e.g., for evaluating work performance or mistracking of physical movements in general, including duration and number of breaks (see e.g., Anaya et al. (2018), Constantinides and Quercia (2023), Midha et al. (2022), Martinez et al. (2022) for studies focusing on ethical implications of wearables and continuous user data collection on the workplace in general as well as a change in perception related to remote vs. on-site work setting).

We argue that considering these research directions in the experimental design and following corresponding ethical guidelines that address participants' concerns related to such data sources (Behnke et al., 2022), supports researchers in getting a more fine-grained understanding of VMS' impact on the specific user state. Thereby, scholars can better explain the rationale behind the observed impact of VMS on the user. This leads to new ideas for system improvements, feedback, and even adaptations (for more information, see Pope et al. (1995)).

5.3. Limitations and future research

Despite conducting the SLR in a rigorous fashion, several limitations apply. First, we acknowledge the risk of overlooking relevant work that is not covered by our search strategy. Second, with introducing our selection criteria, especially limiting the search results to studies reporting quantitative results, we exclude a range of studies that investigate the system's impact on the user based on in-depth interviews. Future literature reviews could supplement our findings by exploring these aspects and comparing results gathered from different data collection methods. Besides, we explicitly aimed to provide an overview of existing research and did not perform a meta-analysis. We encourage future research to conduct such meta-analyses by focusing on one specific construct, mirroring the approach taken in a previous review of computer-mediated communications impact on emotions (Derks et al., 2008). Furthermore, we set the scope of our review on studies explicitly focusing on the impact of the system on user states. This excludes a wide range of studies that implicitly report on the system's impact by investigating video meetings without explicitly focusing on the virtual aspect and by excluding studies that report on the impact of the system on the outcomes without investigating the user states in between (e.g., directly and only focusing on trust or fatigue as two defined individual wellbeing outcome variables in our conceptualization (Peñarroja et al., 2013; Li et al., 2022; Hassell and Cotton, 2017)). Besides, studies published after applying our search strategy are not reflected in our work (e.g., Fauville et al. (2023)). To extend this rather technology-centric view, we want to point out reviews that put their lens on virtual team characteristics and their impact on the effectiveness of work in virtual teams, such as Ebrahim et al. (2009), Morrison-Smith and Ruiz (2020). We encourage researchers to also observe interpersonal user states that are of interest when thinking of team interactions. As an example, factors affecting engagement, such as psychological availability, meaningfulness, and psychological safety may be mentioned Edmondson (1999), Kahn (1990), Allen and Rogelberg (2013). Our work followed the objective of complementing these reviews with a more technology-focused review. These decisions may induce a bias in the extracted results, however, were important to manage the number of findings. To counteract these potential biases, we followed a structured and established process and transparently reported the search strategy and selection criteria. Finally, the created conceptualization is based on a conceptual foundation established in the literature but uses subdimensions at the same time that were created in an empirical-to-conceptual approach. Thus, the subdimensions that rely solely on empirical-to-conceptual evidence may be vulnerable to biases associated with our literature set. To ensure a rigorous process, we used iterative coding and a bilateral approach to categorize the findings. We specifically want to clarify that the derived research trajectories and directions are subject to our created conceptualization. Making use of other conceptualizations, especially also applying other perspectives on the conceptualization of cognition and affect than the view of cognitive psychology and the affective model by Zhang (2013) that we applied, may lead to diverging results.

Based on the described limitations, we recommend future research to not only focus on our outlined research directions but also engage in reviewing qualitative findings. Furthermore, researchers are encouraged to conduct meta-analyses in each outlined research trajectory to investigate whether findings are consistent or inconsistent within selected research trajectories, such as attention support or team emotions.

6. Conclusion

Video meetings have become an essential part of our life. In consequence, VMS have a large impact on users, their psychological states, the subsequent performance as well as the well-being of participating individuals. However, there exists no up-to-date conceptual overview of the impact of VMS on psychological user states. Based on the conceptualization of cognition and affect and the framework for interactive systems, we conducted a SLR and analyzed the impact of VMS

Table 11
Overview on study information.

Subdimension	Category	Short description	References	#Papers
Place	Laboratory	Data collected in artificial, controllable lab or online setting	Sears et al. (2013), Melchers et al. (2021), Palanica et al. (2019), Taniuchi and Shibuya (2021), Capan (2013), Wegge (2006), Sonderegger et al. (2013), Wegge et al. (2007), Han et al. (2011), Otsuki et al. (2018), Pan et al. (2009), Namikawa et al. (2021), Hosseini et al. (2021), Nitada et al. (2021), Langer et al. (2017), Schaarschmidt and Koehler (2021), Marlow et al. (2017), Leong et al. (2021), Blau et al. (2016), Hu et al. (2022), Yao et al. (2013), Hron et al. (2007), Kim et al. (2020), Vertegaal et al. (2003), Blau et al. (2017), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Kim et al. (2014), Baker et al. (2020), Miller et al. (2021), Vrzakova et al. (2021), Hassell and Limayem (2020), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Tam et al. (2016), Riby et al. (2012), Schneider and Pea (2013), Costa et al. (2018), Kim et al. (2019), Kizilcec et al. (2014), Nakazato et al. (2014), Tomprou et al. (2021), Asai et al. (2009), Boyle et al. (2000), Tan et al. (2014b), Miller et al. (2017), Ferran-Urdaneta and Storck (1997), Jaklič et al. (2017), Grayson and Monk (2003), Jung et al. (2015), Farooq et al. (2021), Horn and Behrend (2017), Brucks and Levav (2022), Murali et al. (2021), Rojas et al. (2022), Taguchi et al. (2018)	57 (73%)
	Field	Data collected in less controllable field, real-world setting	Alavi et al. (1995), Kashiwagi et al. (2006), Liu et al. (2016), Sun et al. (2019), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Brucks and Levav (2022)	7 (9%)
Data Collection Points	Single Point	Only one point of data collection used	Rojas et al. (2022), Sears et al. (2013), Melchers et al. (2021), Palanica et al. (2019), Murali et al. (2021), Taniuchi and Shibuya (2021), Sun et al. (2019), Abramova et al. (2021), Grayson and Monk (2003), Wegge (2006), Sonderegger et al. (2013), Wegge et al. (2007), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Vrzakova et al. (2019), Otsuki et al. (2018), Taguchi et al. (2018), Pan et al. (2009), Namikawa et al. (2021), Hosseini et al. (2021), Wu and Lee (2012), Nitada et al. (2021), Langer et al. (2017), Schaarschmidt and Koehler (2021), Marlow et al. (2017), Leong et al. (2021), Blau et al. (2016), Hu et al. (2022), Yao et al. (2013), Hron et al. (2007), Kim et al. (2020), Vertegaal et al. (2003), Blau et al. (2017), Balogova and Brumby (2022), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Kim et al. (2014), Baker et al. (2020), Miller et al. (2021), Vrzakova et al. (2021), Hassell and Limayem (2020), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Tam et al. (2016), Riby et al. (2012), Schneider and Pea (2013), Costa et al. (2018), Andres (2011), Kim et al. (2019), Kizilcec et al. (2014), Nakazato et al. (2014), Tomprou et al. (2021), Butz et al. (2015), Asai et al. (2009), Goethe et al. (2022), Boyle et al. (2000), Ngien and Hogan (2022), Tan et al. (2014b), Pikoos et al. (2021), Miller et al. (2017), Gabbiadini et al. (2020), Ferran-Urdaneta and Storck (1997), Jaklič et al. (2017), Matulin et al. (2021), Alavi et al. (1995), Jung et al. (2015), Okabe-Miyamoto et al. (2022), Farooq et al. (2021), Horn and Behrend (2017), Bennett et al. (2021), Brucks and Levav (2022)	71 (91%)
	Multiple Points	More than one point of data collection used	Han et al. (2011), Kashiwagi et al. (2006), Liu et al. (2016), Bennett et al. (2021), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Capan (2013)	7 (9%)
Method	Survey	Survey conducted in study, no laboratory or field experiment	Abramova et al. (2021), Andres (2011), Okabe-Miyamoto et al. (2021), Ebardo et al. (2021), Wu and Lee (2012), Balogova and Brumby (2022), Butz et al. (2015), Goethe et al. (2022), Ngien and Hogan (2022), Pikoos et al. (2021), Gabbiadini et al. (2020), Matulin et al. (2021), Okabe-Miyamoto et al. (2022), Bennett et al. (2021)	14 (21%)
	Questionnaire	Questionnaire/Survey data collected during an experiment	Rojas et al. (2022), Sears et al. (2013), Melchers et al. (2021), Palanica et al. (2019), Taniuchi and Shibuya (2021), Capan (2013), Wegge (2006), Sonderegger et al. (2013), Wegge et al. (2007), Han et al. (2011), Murali et al. (2021), Vrzakova et al. (2019), Otsuki et al. (2018), Taguchi et al. (2018), Pan et al. (2009), Kashiwagi et al. (2006), Namikawa et al. (2021), Hosseini et al. (2021), Nitada et al. (2021), Liu et al. (2016), Langer et al. (2017), Schaarschmidt and Koehler (2021), Marlow et al. (2017), Leong et al. (2021), Blau et al. (2016), Hu et al. (2022), Grayson and Monk (2003), Horn and Behrend (2017), Yao et al. (2013), Hron et al. (2007), Kim et al. (2020), Vertegaal et al. (2003), Blau et al. (2017), Sun et al. (2019), Duan et al. (2019), Chollet et al. (2018), Tan et al. (2014b), Kim et al. (2014), Baker et al. (2020), Miller et al. (2021), Vrzakova et al. (2021), Hassell and Limayem (2020), Forghani et al. (2014), Ouglov and Hjelsvold (2005), Riby et al. (2012), Schneider and Pea (2013), Costa et al. (2018), Kim et al. (2019), Kizilcec et al. (2014), Nakazato et al. (2014), Tomprou et al. (2021), Asai et al. (2009), Tam et al. (2016), Boyle et al. (2000), Shockley et al. (2021), Oren-Yagoda and Aderka (2021), Tan et al. (2014b), Miller et al. (2017), Ferran-Urdaneta and Storck (1997), Jaklič et al. (2017), Alavi et al. (1995), Jung et al. (2015), Farooq et al. (2021)	63 (81%)

(continued on next page)

Table 11 (*continued*).

Subdimension	Category	Short description	References	#Papers
	Biosignal	Additional autonomous signals collected from human user (e.g., EEG, eye-tracking, heart rate)	Rojas et al. (2022), Murali et al. (2021), Grayson and Monk (2003), Brucks and Levav (2022), Wegge et al. (2007), Vrzakova et al. (2019), Taguchi et al. (2018), Namikawa et al. (2021), Liu et al. (2016), Tomprou et al. (2021), Kim et al. (2020), Vertegaal et al. (2003), Sun et al. (2019), Tan et al. (2014b), Miller et al. (2021), Vrzakova et al. (2021), Riby et al. (2012), Schneider and Pea (2013), Costa et al. (2018), Kizilcec et al. (2014), Tan et al. (2014b), Melchers et al. (2021)	21 (27%)
	Behavioral	Additional behavioral signal collected from user (e.g., Gestures)	Taguchi et al. (2018), Hosseini et al. (2021), Yao et al. (2013), Duan et al. (2019), Hassell and Limayem (2020), Tomprou et al. (2021), Miller et al. (2017), Brucks and Levav (2022), Hron et al. (2007), Rojas et al. (2022), Wegge et al. (2007)	11 (14%)
	Interview	Additional qualitative data collected via interviews	Rojas et al. (2022), Murali et al. (2021), Okabe-Miyamoto et al. (2021), Namikawa et al. (2021), Hu et al. (2022), Duan et al. (2019), Forghani et al. (2014), Kim et al. (2019), Leong et al. (2021), Sun et al. (2019), Yao et al. (2013)	11 (14%)

on psychological user states and subsequent performance and well-being outcomes. Our results outline six existing research trajectories with a focus VMS' impact on negative affect, VMS use in generic conversations, the impact of gaze-based support features or team emotion support, examining the influences of the video and self-view on awareness and attention, as well as an assessment of the VMS's holistic impact in recent years. In addition, we see a focus on data collection using discrete, questionnaire, or survey-only evaluation techniques that only include a single point of data collection. On this basis, we shaped four future research directions targeting the dimensions of our conceptual framework. These include a focus on VMS research beyond professional use cases, an in-depth investigation of specific VMS design elements, a focus on thought processes and related conversational tasks as well as understanding the impact of VMS on positive emotions and feelings. Besides, data collection methods-wise, we encourage scholars to investigate cognition and affect comprehensively beyond one-time observations, utilizing biosignals to enrich VMS and understand its impact on cognitive and affective user states. These research directions should motivate researchers to further investigate the growing and rich field of VMS. With our work, we aim to provide a foundation for the future development of VMS by researchers and practitioners and, in consequence, better support video meeting communication in different settings.

CRediT authorship contribution statement

Julia Seitz: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Ivo Benke:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing. **Armin Heinzl:** Conceptualization, Methodology, Writing – original draft. **Alexander Maedche:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Appendix

See Table 11.

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