Team Communication Actions: Beyond the Dichotomy of Face-to-Face versus Virtual Interactions in Teams

A thesis submitted to The University of Sheffield for the degree of Doctor of Philosophy

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LIST OF CONTENT

THESIS ABSTRACT

The usage of multiple communication media, including face-to-face interactions and information communication technologies (ICTs), is a relevant characteristic of modern teams. Yet, the examination of this phenomenon has presented several limitations in the literature. First, research has usually linked the use of ICTs to conditions of spatial and/or temporal dispersion between team members, studying them as part of virtual teams or team virtuality. Second, the capabilities offered by ICTs have been mostly ignored, considering them inferior means of communication compared to face-to-face interactions. Third, past research in teams has also adopted deterministic views of media in which their material attributes are assumed to be used by users without considering the role of human agency. Considering all the above, this thesis will present the new construct of team communication actions to address some of these limitations. This thesis follows a Thesis-by-publication format comprising three different articles. The first article will develop and present the idea of team communication actions. The second develops and validates a scale to measure team communication actions. The final article examines how different team communication actions can be relevant for team effectiveness by analysing their impacts on several teamwork processes and, ultimately, on team performance.

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THESIS INTRODUCTION

The development of information and communication technologies (ICTs, e.g., emails, phone and video calls, chats and online documents) has played an instrumental role in shaping how modern teams operate. These technologies have allowed team members to transcend the barriers of space and time to work together in conditions of geographical and temporal dispersion. This way, early research on the use of ICTs focused on virtual teams, reflecting instances in which team members cannot meet regularly face-to-face due to dispersion conditions and, therefore, rely and depend on ICTs to interact with each other (Hertel, Geister and Konradt, 2005; Kanse *et al.*, 2023). However, these technologies are not only used by teams with geographical and/or temporal dispersion. Researchers have proposed and shown that most modern teams rely highly on ICTs even when they work in the same location (Dixon and Panteli, 2010; Gibson *et al.*, 2014). This way, the term team virtuality was coined as a gradual construct to reflect that this phenomenon is a characteristic of all teams. Nevertheless, team virtuality research has not been without its own limitations because it has combined several dimensions that are relatively independent, such as geographical/temporal dispersion, technological reliance, structural dynamism, and cultural diversity, among others (Gibson and Gibbs, 2006; Foster *et al.*, 2015; Hosseini *et al.*, 2015). Considering this, researchers have argued the need to study these dimensions independently, which can help to have a more detailed understanding of them (Gibson and Gibbs, 2006).

One of the dimensions that could benefit from a more refined analysis is the technology reliance dimension. Even when using a gradual approach, the examination of this dimension still maintains a dichotomous view of face-to-face interactions versus ICTs when grouping all ICTs together and considering them equivalent. Moreover, this research has usually assumed that all ICTs represent more limited communication media when compared to face-to-face interactions and, therefore, are likely to harm team dynamics (Gibbs and

Navick, 2023). This assumption comes from classic media theories (e.g., Media Richness and Reduced Social and Contextual Cues; Daft and Lengel, 1984, 1986; Sproull and Kiesler, 1986) that analysed the communicational capabilities offered by face-to-face interactions and how other media are limited in offering them. However, some of these classic media theories were developed before the appearance of more sophisticated ICTs (e.g., video calls and instant messaging). Therefore, this research does not consider that some of the newer ICTs offer similar capabilities to face-to-face, such as video calls, which offer the possibility to listen and see other communication participants, all aspects deemed an important part of face-to-face interactions (Kock, 2004). Moreover, this research also neglects the fact that some ICTs can offer capabilities that are not offered by face-to-face communications, which can be instrumental for teams to be effective in their work, such as emails and online collaboration tools that offer the possibility to edit and access communications over time (Gibson *et al.*, 2022). This may be one of the reasons that co-located teams rely on them heavily even when they can still communicate face-to-face.

Considering the above, Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) is a relevant theoretical development that systematised the capabilities of different communication media, including face-to-face interactions and ICTs to address the lack of consideration of these technologies' unique advantages and features. Unfortunately, this theory has not received much attention in the team virtuality literature. Moreover, this theory could also be relevant for integrating the examination of communication media usage into the teams literature, which is an important aspect of team dynamics that has not received much attention yet. Past research has shown that team members can use complex repertoires of media, including multiple ICTs and face-to-face interactions, depending on the communicational goals they have (e.g., coordination or knowledge sharing; Bélanger and Watson-Manheim, 2006; Watson-Manheim and Bélanger,

2007). The capabilities that different media offer are instrumental to understanding and explaining how the combination of different media can impact team functioning and overall effectiveness.

Although capabilities are important to understand the possibilities and constraints for action that different media offer (Treem and Leonardi, 2013), it is important not to fall into deterministic views of media in which their impact is analysed only based on them without considering the role that people have. Several theories have questioned this deterministic view, proposing that the way in which people use technologies and media will depend not only on their material attributes but also on the agency of people (e.g., their goals and needs) and other relevant aspects, such as the context in which they are used (Orlikowski, 2000; Leonardi, 2011; Lane *et al.*, 2023). Considering this, in this thesis, I will develop and present a new construct called team communication actions, which aims to integrate all these different aspects into the examination of how team members use communication media to support their interactions. Before delving into the development of this new construct, in the following sections, I will present a summary of relevant past research: (1) the virtual teams and team virtuality main ideas and findings, (2) the classic media theories used to explain the differences between virtual teams and traditional teams, (3) Media Synchronicity Theory, one of the most recent theoretical developments analysing the capabilities of both, face-to-face interactions and ICTs, and (4) non-deterministic theories that have addressed how the situated use of technologies and media will depend only partially on their material attributes. Then, the literature gap will be explained in detail based on this summary. Lastly, an overview of the structure of the remaining chapters and the main goals of this thesis will be presented.

Summary of Past Research

ICT Usage in Teams: Virtual Teams and Team Virtuality

A large amount of early research about the use of ICTs in team contexts focused on understanding the differences between virtual teams, ("work arrangements where team members are geographically dispersed, have limited face-to-face contact, and work interdependently through the use of electronic communication media to achieve common goals" - Dulebohn and Hoch, 2017, p. 569) and co-located (or face-to-face) teams (Martins, Gilson and Maynard, 2004). However, this research has been criticised as, in practice, purely face-to-face and purely virtual teams are scarce (Hertel, Geister and Konradt, 2005; Gibson *et al.*, 2014). Most modern teams will combine the use of ICT-mediated and face-to-face interactions to some extent (Purvanova, 2013). This means that virtual teams research is limited in its ability to explain what happens in (1) collocated teams that make heavy use of ICTs to communicate and (2) geographically distributed teams that rely on ICTs but also sometimes meet face-to-face (Gibson *et al.*, 2014).

The notion of team virtuality as a continuum was used to address the above limitation of virtual teams' research (Gibson and Cohen, 2003; Griffith, Sawyer, and Neale, 2003; Kirkman, Gibson and Kim, 2012). Nevertheless, team virtuality research has not been without its limitations as researchers have struggled to agree on a definition and operationalisation of the construct (Hosseini *et al.*, 2015). Multiple dimensions have been proposed as part of team virtuality, such as geographical/temporal dispersion, technology reliance, cultural diversity, and structural dynamism (Chudoba *et al.*, 2005; Schweitzer and Duxbury, 2010). Therefore, several authors have treated virtuality as multidimensional, combining several dimensions and exponentially increasing the number of definitions/operationalisations (Foster *et al.*, 2015). However, the combination of these

dimensions in a single measure of team virtuality is problematic as there is evidence that they are weakly correlated at best (Gibson and Gibbs, 2006).

The above limitations of virtual teams and virtuality research might help explain some of the mixed results in the literature. There is evidence that team virtuality can positively impact teamwork processes. Some studies have found positive effects on transition processes (such as planning and goal setting) and action processes, such as intrateam coordination (Brown, Prewett and Grossenbacher, 2020). Contrarily, other studies have found that virtuality can impair action processes, such as coordination (Cummings, Espinosa and Pickering, 2009), communication (Espinosa, Nan and Carmel, 2015), and overall information and knowledge sharing (Mesmer-Magnus *et al.*, 2011; Ortiz de Guinea, Webster and Staples, 2012). Similar results have been found regarding interpersonal variables. Some studies have shown that virtual teams present issues in the development of positive interpersonal relationships (Rogers *et al.*, 2021), lower levels of trust (Peñarroja *et al.*, 2013; Morrison-Smith and Ruiz, 2020) and cohesion (Shin and Song, 2011), and higher levels of conflict (Hinds and Mortensen, 2005; Stark, Bierly and R. Harper, 2014). Brown et al. (2020) study found that technology reliance is positively related to interpersonal processes and negatively related to task and relationship conflict. On the other hand, a meta-analysis by Purvanova and Kenda (2022) found that virtuality is not related to teams' cohesion and trust. In terms of performance, there is evidence that virtual teams need more time to accomplish the same task as collocated teams (Driskell, Radtke and Salas, 2003) and present an overall worse performance (Ortiz de Guinea, Webster and Staples, 2012). However, Purvanova and Kenda's (2022) meta-analysis did not find a significant relationship between virtuality and teams' performance rated by others (e.g., clients, leaders) or by team members. Lastly, other studies have found that the use of ICTs can enhance creativity and the proposition of new ideas (e.g., Chamakiotis, Dekoninck and Panteli, 2013).

To address some of the limitations and mixed results, researchers have argued for the need to clarify our understanding of what is meant by the term "virtual". Some have proposed that the defining dimension of virtuality should be the technology reliance/usage (e.g., Kirkman and Mathieu, 2005; Dixon and Panteli, 2010), with geographical/temporal dispersion and cultural diversity being characteristics of globally distributed teams (Gibson *et al.*, 2014; Kramer, Shuffler and Feitosa, 2017). While these dimensions can concur (i.e., in globally distributed virtual teams), this distinction reflects that some teams can be highly virtual (i.e., rely heavily on ICTs) without being geographically or temporally distributed or having members from different cultures. Moreover, some authors have also proposed the need to go beyond the dichotomy of face-to-face versus ICT-mediated communications of the technology reliance dimension to include the characteristics of communications and media, such as the levels of synchronicity and media capabilities (Maruping and Agarwal, 2004; Kirkman and Mathieu, 2005). This is particularly relevant when considering that, as mentioned before, researchers have typically viewed ICTs as limited media following the ideas of classic communication media theories.

Classic Communication Media Theories

The negative results of team virtuality research have usually been explained using classic media theories that compared the capabilities of ICTs to face-to-face interactions. Media Richness Theory (MRT; Daft and Lengel, 1984, 1986) – one of the most influential media theories – argues that (1) information richness is important for organisations as it reduces uncertainty and equivocality, and (2) that media vary in their capacity to transmit richer information depending on four aspects (Daft, Lengel and Trevino, 1987): (a) immediate feedback, referring to the lack of time delays between the act of sending a message and the reception of it; (b) multiple cues and channels, i.e., the capacity of the medium to allow for multiple codifications of a specific message (e.g., face-to-face

interactions allow for verbal expression of 'happiness' together with non-verbal expressions, like a smile); (c) language variety, which is "the range of meaning that can be conveyed with language symbols" (p. 358) with numbers conveying greater precision, but natural language offering a deeper understanding of broader concepts and ideas; and (d) personal focus, which is the infusion of emotions and personal feelings into the message. Newer developments have reduced the four dimensions proposed by Daft and colleagues to two aspects (e.g., Kirkman and Mathieu, 2005): (1) immediacy of feedback and (2) informational bandwidth that combines the multiple cues and channels, together with the language variety that a specific medium offers. Personal focus has been mostly ignored as it reflects the sender's communication style rather than an objective characteristic of a specific medium. Based on this, several authors have proposed that ICTs, such as email or phone calls, present a lower level of media richness than face-to-face (FtF) interactions, as they usually lack some important features: phone calls lack the transmission of visual cues, while emails do not allow for real-time interactions. Moreover, the use of less rich media could be detrimental for teams as they do not allow for the clarification of ambiguous messages and the quick exchanges necessary to develop shared understandings, and therefore, are prone to incoherent messages, misunderstanding, and misattributions (Axtell, Fleck and Turner, 2004).

Other theories, such as Reduced Social and Contextual Cues (Sproull and Kiesler, 1986) and Social Presence (Short, Williams and Christie, 1976), have offered other important mechanisms by which 'richer' or 'poorer' media could impact interpersonal processes. Sproull and Kiesler (1986) argued that media conveying lesser social and contextual cues can create a situation of de-individuation in which people focus less on their interaction partners, feel less pressure to conform to social and group norms, and have more impersonal task-oriented communications. This, in turn, could lead to greater conflict and the presence of hostile behaviour, which has been labelled as "flaming" (Axtell, Fleck and Turner, 2004). In a

similar vein, Social Presence Theory (Short, Williams and Christie, 1976) focuses on the perception that people have of their partners when interacting.

Social presence is defined as "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships" (p. 65). In other words, it is the degree to which a medium conveys the presence – or 'realness' – of the communicating participants (Rice, 1993; Gunawardena, 1995). Short and colleagues argue that social presence is a capacity or quality of the medium itself, and it will vary depending on the media analysed. They proposed two determinants of social presence based on the work of previous authors: intimacy and immediacy. While Argyle and Dean (1965) did not propose a formal definition of intimacy during social interactions, they argued that it is a function of aspects such as the degree of eye contact, physical proximity, the intimacy of the topic, amount of smiling, and other personal expressions of closeness. Similarly, Wiener and Mehrabian (1968) used the term immediacy to refer to the "degree of directness and intensity of interaction between communicator and referent in a communicator linguistic message" (Mehrabian, 1966, p. 28). The concept of immediacy has been clarified, and nowadays, it is most commonly understood as the psychological distance that a communicator puts toward their partner, which can be reflected in physical proximity and verbal and non-verbal expressions of humour, among others (Gunawardena, 1995). Based on Social Presence, the use of leaner media can lead to interactions that are perceived as impersonal and distant, thus hindering the creation of positive links and relationships within teams.

Media Synchronicity Theory (MST)

As mentioned before, the classic media theories have been influential in explaining some of the negative results found in virtual teams and team virtuality research. However, because these theories focus mainly on the attributes offered by face-to-face interactions, they struggle to explain the instances in which teams that rely heavily on ICTs have positive

results. Moreover, they were developed before ICTs became an integral part of the workplace, as is reflected by the lack of consideration of e-mails in the original Media Richness Theory. This way, some efforts have been made to analyse newer ICTs developments, such as e-mail, instant messaging, and video calls, among others (e.g., Rice, 1992; Dennis and Kinney, 1998) using these classic theories. Unfortunately, these theories also had problems in predicting the use of these newer ICTs by people (Dennis and Kinney, 1998). This way, newer theories have emerged to consider the capabilities offered by ICTs and not only by face-to-face interactions as a way to address these limitations. One of the most significant contributions to the analysis of the capabilities of different interaction media, including FtF, older, and newer ICTs, has been the Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008).

Dennis and Valacich (1999) developed the Media Synchronicity Theory to address the lack of consideration of the capabilities offered by ICTs and to analyse in which instances different capabilities can be instrumental for effective communications. To achieve this, they built on the premise that the effectiveness of a specific medium will depend on the needs of the communication task being performed, and therefore, they built over previous task-technology fit theories (e.g., Zigurs and Buckland, 1998). However, they suggested that a problem with traditional definitions of communication tasks is that they are "too broad"; that is, they usually analyse tasks from a higher-level perspective based on task accomplishment, which does not allow the examination of how the use of a particular media could affect the micro communication processes (lower level) necessary to perform a "broad task". This way, they propose that the goal of every communication task is to develop a shared understanding – regardless of whether this is achieved or not – and to do so, they need to perform two primary processes: conveyance of information and convergence of meaning. Conveyance refers to the "transmission of new information – as much new, relevant information as needed

– to enable the receiver to create and revise a mental model of a situation" (Dennis, Fuller, and Valacich, 2008, p. 580). Convergence refers to the "discussion of pre-processed information about each individual's interpretation of a situation… The objective is to agree on the meaning of the information, which requires individuals to reach a common understanding…" (Dennis, Fuller, and Valacich, 2008, p. 580). In turn, they propose that to perform these two primary processes (which are situated at the interactional level), two individual-level processes are necessary (in different proportions depending on the primary process being performed): (1) transmission of information, that is, "preparing information for transmission, transmitting it through a medium, and receiving information from a medium" (p. 576), and (2) processing of information, "understanding the meaning of information and integrating it into a mental model" (p. 576).

Based on the previous analysis of task and communication processes, MST proposed that media offer different capabilities that allow them to be better suited for the transmission or the processing of information. They suggested five different capabilities (Dennis, Fuller and Valacich, 2009): (1) transmission velocity, namely, the speed by which a medium can deliver a message; (2) parallelism, that is, the number of simultaneous transmissions from multiple senders that a medium offers; (3) symbol sets, i.e., the number of ways in which a medium allows for information to be encoded (e.g., only verbal versus verbal, non-verbal and para-verbal); (4) rehearsability, namely, the degree that a medium allows for the refinement and fine-tuning of the definitive version of a message before sending it; and (5) reprocessability, that is, the extent that a medium allows for a message to be re-examined multiple times after being received. They proposed that transmission velocity and parallelism are transmission-oriented capabilities, while rehearsability and reprocessability are processing-oriented capabilities. Symbol sets is the only capability related to both processes as a more robust symbol set offers the possibility to transmit different types of information

(transmission) and also, facilitates the correct decoding or interpretation of the message by the receiver (processing).

An important consideration is that a specific interaction medium will usually present strong capabilities for the transmission or processing of information, but to date, there are no media with high levels on both aspects simultaneously (Robert and Dennis, 2005). Usually, transmission capabilities are at higher levels in media that rely on spoken words and facial and body expressions, such as face-to-face or video calls, while processing capabilities are usually present in text-based ones, such as emails or documents. This way, as some of the processing capabilities (reprocessing and rehearsability) are presented in lower levels by FtF interactions (Maruping and Agarwal, 2004), text-based ICTs could offer complementary features to collocated teams, explaining why some of them rely heavily on technologies even when having the possibility of interacting FtF. Furthermore, as almost every team must perform tasks comprising both processes, teams that use media with complementary features could be in a favourable position as they could use the media that better matches the task they are performing. For example, if a team member needs to convey large amounts of information to several other members for them to process it, they will be better off using a medium that offers a moderate level of symbol sets, and high levels of reprocessability, such as an email, but if the team then needs to discuss that information and make decisions based on it, they will be better suited using a medium with higher levels of transmission velocity, parallelism and symbol sets, such as an FtF or video call interaction.

Non-deterministic Theories of Technology

While there is consensus that media vary in their objective features and attributes, some authors have questioned the use of a deterministic view in which these characteristics are argued to shape human actions and interactions without considering the role of human agency (Orlikowski and Scott, 2008; Orlikowski, 2010). From a deterministic standpoint, it is

argued that developers are able to incorporate pre-existing social structures into technology; that is, they incorporate the rules and resources that will shape the actions that people can adopt while using the technology (Poole and DeSanctis, 1990; DeSanctis and Poole, 1994). From this perspective, using technology means that users must appropriate these pre-existing structures to some degree. When users cannot correctly appropriate these structures, that is, to use the technology for its intended purpose, the results will likely be negative. However, Orlikowski (2000) challenged this assumption based on Giddens' Structuration Theory (Giddens, 1979, 1984), which proposes that social structures should not be understood as external forces shaping human action. On the contrary, structures only exist 'in and through the activities of human agents' (Giddens, 1984, p. 256). Orlikowski's (2000) Technology-in-Practice perspective extends structuration theory to technology use, emphasising that technological structures emerge from their use, what the author called the enactment of structures, instead of them being embodied in the technology. The idea of enactment emphasises that people can use technologies as they were designed, but also, they can "circumvent inscribed ways of using the technologies — either ignoring certain properties of the technology, working around them, or inventing new ones that may go beyond or even contradict designers' expectations and inscriptions" (Orlikowski, 2000, p. 408).

The affordances perspective has been used to pose a similar criticism to deterministic views of technology. The notion of affordances was used by Gibson (1977) to explain how different species of animals perceive different opportunities for action from the same objects and their respective material attributes. From an affordance perspective, the physical properties of objects are independent of the animals (or humans) who use them, but what animals perceive an object allows (or affords) them to do will depend on the animals' unique attributes (e.g., height, weight, strength, posture) in relation to the object (Gibson, 1977). The idea of affordance has been applied to the analysis of how users perceive technologies and

actually use them (e.g., Hutchby, 2001; Zammuto *et al.*, 2007; Evans *et al.*, 2017). Markus

and Silver (2008) defined technological affordances as "the possibilities for goal-oriented

action afforded to specific user groups by technical objects (p. 622)". These possibilities

emerge from the relation between the user and its characteristics (e.g., goals, needs,

preferences, abilities, and knowledge) and the material attributes of the technology. This

means that different users can perceive different possibilities for action from the same

technology depending on their own attributes and the context of use. It is important to note

that these possibilities are not infinite, as their existence is enabled and, at the same time, is

constrained by the material attributes of the technology (Majchrzak, Markus and Wareham,

2016; Willems, 2021). For instance, while different users can perceive that video calls allow

them to afford different actions (e.g., contact relatives that live far away, discuss important

work documents), it is highly unlikely they will perceive that video calls afford them the

possibility to hug others as this medium lacks the capacity to support physical touch.

     Leonardi (2011) used the idea of imbrication to analyse how the material capabilities

of technology, which some authors have referred to as 'material agency' (Pickering, Engen

and Walland, 2017), and human agency became intertwined to produce a specific result. This

result can represent the creation or modification of a routine, namely a 'sequential pattern of

social action' (Leonardi, 2011, p. 148) or the creation/modification of technology. Building

on the affordances perspective, the author argues that when people perceive that a material

agency offers a possibility for action (affordance) to achieve a particular goal, the imbrication

will likely result in a routine, that is the enactment of the material agency of the technology

(or a Technology-in-Practice; Orlikowski, 2000). However, when the technology is perceived

as constraining people's actions, the imbrication is likely to result in the modification (or

creation of a new) technology in a way that satisfies the users' intentions (e.g., goals and/or

needs). Something that is relevant to the idea of imbrication is that neither material nor

human agency is enough to understand the structuring processes that occur in social dynamics. It is only through the continuous and multiple interweaving of material and human agencies that the infrastructure of social actions can be examined. This also emphasises the recurrent character of the imbrication between material and human agencies, in which past imbrications resulting in the creation or modification of a routine or technology will influence future imbrications but not determine them. In other words, the accumulation of past imbrications has a role in explaining future imbrications but cannot predict them.

Literature Gap

Whilst the study of virtual teams and team virtuality has been helpful in advancing our understanding of the impact of information and communication technologies (ICTs) in team contexts, it has presented some limitations that hinder its applicability. First, this research has usually assumed that ICTs are used in conditions of geographical and/or temporal dispersion, in which team members do not have constant access to face-to-face interactions and, therefore, must rely on technologies to interact with each other. While the gradual approach of team virtuality recognises that co-located teams can depend highly on ICTs, by combining several independent dimensions into one unique measure, it has been difficult to properly understand the differential effects of these subdimensions. Do some teams struggle due to their higher levels of geographical and/or temporal dispersion or because they rely heavily on ICTs? As mentioned before, this has also led to several researchers questioning which one of these subdimensions is the defining characteristic of team virtuality, but there has not been a definitive answer yet.

Second, team virtuality research has usually adopted a dichotomous view of ICTs versus face-to-face interactions, often assuming that technologies represent limited means of communication when compared to face-to-face interactions (Gibbs and Navick, 2023). This neglects the fact that ICTs can present vastly different attributes. For instance, video calls

offer access to voice and live video of communication participants, while emails offer asynchronous text-based communications. This also does not recognise that some ICTs, such as video or phone calls, offer similar capabilities to face-to-face interactions, such as access to verbal (voice) and non-verbal aspects of communication (voice intonation, facial and body language). This way, some authors started to propose the need to consider the capabilities offered by communication media, particularly of ICTs, which have been commonly neglected. The idea of technological affordances has been used to examine the users' perceptions regarding the possibilities for actions that ICTs (and their capabilities) offer to them (Faraj and Azad, 2012; Treem and Leonardi, 2013). Some of the technological affordances identified in the literature are visibility, editability, searchability, and persistence of information, among others (Rice *et al.*, 2017; Gibbs and Navick, 2023). Lane et al. (2023) used some of the most relevant technological affordances to analyse how they can be relevant for the effectiveness of teams, particularly for the performance of several teamwork processes. Unfortunately, the focus on technological affordances still represents a fragmented view because team members can use complex sets of media, combining both ICTs and face-to-face interactions at the same time or in a sequential manner (Bélanger and Watson-Manheim, 2006; Watson-Manheim and Bélanger, 2007). Therefore, while the focus on technological affordances addresses that ICTs can offer relevant features to teams, it still does not allow us to examine how team members can leverage both natural and artificial communication media to be effective in their work.

Media Synchronicity Theory (MST; Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) represents an important theoretical development as it systematised the capabilities offered by different types of communication media, including documents, ICTs and face-to-face interactions. Accordingly, it can help to address how the different types of communication media that team members use can help them perform their work.

Accordingly, Maruping and Argawal (2004) used MST to theoretically map how different capabilities can be relevant for the performance of interpersonal processes within virtual teams (e.g., affect and conflict management). Nonetheless, we are still lacking more comprehensive approaches that analyse how different media capabilities can be related to other teamwork processes, such as transition (e.g., planning, strategy formulation) and action (e.g., coordination, information sharing) (Marks, Mathieu and Zaccaro, 2001). Moreover, we are still lacking more complex and flexible frameworks that allow us to integrate the ideas of media usage and media capabilities into the general teams' literature and not only focus on virtual or hybrid teams.

Considering the above, newer theoretical developments are necessary, which aim to integrate all the different theories available to help explain the impact of using different communication media in teams. The capabilities systematised and identified by Media Synchronicity Theory represent a relevant initial development to achieve this. However, while the material attributes of media are relevant because they represent the materiality that enables and, at the same time, constrains people's actions, we also need to consider the role of human agency. As proposed by several non-deterministic theories, the characteristics of the users, such as their needs and goals (Leonardi, 2011), and the context in which media is used (Orlikowski, 2000), will be relevant in shaping the users' perceptions of the action possibilities that media offer (affordances; Rice *et al.*, 2017; Malhotra, Majchrzak and Lyytinen, 2021). In other words, as proposed by Leonardi (2011), the action of team members over media will result from the imbrication between material attributes and human agency.

Building on the above-mentioned theories, in this dissertation, I will develop and present the novel concept of *team communication actions* as a way to integrate these different theories into one construct that can help address the limitations of the literature.

Thesis Overview, Structure, and Goals

This thesis was written following a Thesis-by-publication format comprising three different articles. Below, the main goals of this thesis, together with an overview of each article and their specific objectives, are presented.

Main Goals

The first main objective of this thesis was to develop and describe the new construct of *team communication actions* as the result of the integration of several media usage relevant theories, such as Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) and non-deterministic theories (Orlikowski, 2000; Leonardi, 2011). The second main objective was to analyse the relationships between team communication actions and several relevant aspects of team effectiveness, such as teamwork processes and team performance. The third main goal was to compare team communication actions' predictive power to the most used subdimensions of team virtuality, such as geographical distance and technology reliance, to assess if this represents a more thorough way to examine media usage in teams. To fulfil these goals, this dissertation's articles followed a sequential development nature. The first article developed and described the new construct of team communication actions. The second article developed and validated a scale to measure this new construct, including the revision of incremental validity over other measures of team virtuality. The third and final article tested the relationship between team communication actions and relevant team variables, such as teamwork processes and team performance.

Article 1: Conceptual Article

The first article of this dissertation is a conceptual article titled *"Team Communication Actions: Beyond the Dichotomy of Face-to-Face versus Virtual Interactions in Teams"*. This paper presents the development of a new construct named team communication actions, which aims to address some of the gaps in the literature. To achieve

this, I build on and integrate the ideas of Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008), and non-deterministic theories regarding the use of technologies and media (Orlikowski, 2000; Leonardi, 2011). Additionally, in this article, I also analyse how different team communication actions can impact teams' effectiveness by formulating several propositions regarding how team communication actions relate to teamwork processes, such as transition, action, and interpersonal ones (Marks, Mathieu and Zaccaro, 2001).

This article contributes to the literature by offering a new construct that can help to better understand the impact of the use of different communication media in the functioning of all kinds of teams, including collocated, virtual and hybrid ones. This way, this construct can help to integrate the examination of communication media in the teams' literature, something that has not been thoroughly done before. Moreover, this construct also contributes to the team virtuality literature by offering a more nuanced understanding of the use of communication media beyond the dichotomous view of face-to-face interactions versus ICTs in the examination of technology reliance. Likewise, this construct also goes beyond deterministic views of media in which users are assumed to use the objective attributes of media without considering the role of human agency.

According to the Contributor Roles Taxonomy (CRediT; Brand *et al.*, 2015), I, the author of this dissertation, served as the first author because I contributed to the conceptualisation, writing of the original draft, review and editing, and visualisation of the article. Prof. Carolyn Axtell acted as the second author because she contributed to the review and editing, and supervision of the article. Prof. Jeremy Dawson acted as the third author by contributing to the review and editing, and supervision of the study. This article was submitted to the Human Resources Management Review Journal (Impact Factor: 11.4; SJR: Q1; ABS: 3) on 9 January 2024 and received a first Revision and Resubmission decision on

13 March 2024. Based on the reviewers' feedback, the article was reviewed and submitted again on 5 June 2024. This version is the one presented in this dissertation. This article received a second Revise and Resubmit decision on 31 July 2024 based on this version.

Article 2: Scale Development and Validation Article

The second article of this thesis is titled *"Developing and Validating a Scale to Measure Team Communication Actions"*. This article describes a scale's development and validation process to measure the construct of team communication actions in Spanish and English using five samples comprising 1738 individuals. Specifically, this article offers evidence of this new scale's validity by assessing its (a) content validity using samples of six experts in the team virtuality literature and of a total of 182 naïve judges who are representative of the population in which the scale will be used; (b) internal structure validity at the individual level using samples of a total of 605 workers, and at the team level using a sample of 951 team members in 268 teams; (c) incremental validity over measures of configurational distance and technology reliance using the same sample of 268 teams from the internal structure validation at the team level.

This study makes several contributions to the literature. First, it offers a validated 25-item Likert scale to measure the novel construct of team communication actions in Spanish and English. By using a Likert scale, this measure is a flexible tool that can be used by researchers and practitioners to obtain information about the use of communication media in team contexts. Moreover, because the scale is validated in multiple languages, it facilitates its use in various work contexts across the world, promoting further research. Second, this article offers support to the claims of the conceptual article by showing incremental validity of team communication actions when predicting teamwork processes over the technology reliance dimension of team virtuality. Third, this scale can help to promote future research on the impact of team communication actions on relevant team variables, such as team performance.

An example of this is the third study of this dissertation, in which I tested the conditional indirect effect of team communication actions on team performance through several teamwork processes, depending on team tenure.

According to the CRediT Taxonomy (Brand *et al.*, 2015), I served as the first author because I contributed to the conceptualisation, methodology design, formal analysis, data collection, writing of the original draft, review and editing, and visualisation of the article. Prof. Jeremy Dawson acted as the second author by contributing to the review and editing, and supervision of the study. Prof. Carolyn Axtell acted as the third author by contributing to the review and editing, and supervision of the study. This article will be submitted to the Journal of Business and Psychology (Impact Factor: 3.7; SJR: Q1; ABS: 3) in August/September 2024. If rejected, this article will be submitted to the Small Group Research Journal (Impact Factor: 3.7; SJR: Q1; ABS: 2). The former journal has published several scale development and validation articles, while the latter has an interest in topics related to virtual teams and team virtuality and has published scale development and validation articles in the past.

Article 3: Hypotheses Testing Article

The third and final article of this thesis is titled *"Team Communication Actions and Their Effects on Teamwork Processes and Team Performance"*. This article examines the relationships between team communication actions and team effectiveness variables, such as teamwork processes and team performance, using a sample of 517 team members in 143 teams. Specifically, this study examines the direct effects of team communication actions on transition, action, and interpersonal processes, 2) the moderating role of team tenure on these effects, and 3) the indirect and conditional indirect effects of team communication actions on team performance through transition, action, and interpersonal processes.

This article makes several contributions to the literature. It serves as the first study to empirically test the novel concept of team communication actions and their relationships with relevant team variables. Additionally, since some results diverge from the propositions of the conceptual article, this article offers theoretical explanations that further develop the concept of team communication actions and their connections to teamwork processes and performance. Finally, the findings reveal more complex interactions between team communication actions and teamwork processes, encouraging future empirical studies on the topic.

According to the CRediT Taxonomy (Brand et al., 2015), I served as the first author because I worked on the conceptualisation, methodology design, formal analysis, data collection, writing the original draft, review and editing, and visualisation of the article. Prof. Carolyn Axtell acted as the second author because she contributed to the review and editing, and supervision of the study. Prof. Jeremy Dawson acted as the third author by contributing to the review and editing, and supervision of the article. This article will be submitted to a special issue on "Team Dynamics in New Work and Organizational Contexts" in the Personnel Psychology Journal (Impact Factor: 5.5; SJR: Q1; ABS: 4*) in August 2024. If rejected, this article will be submitted to the Journal of Organizational Behaviour (Impact Factor: 6.8; SJR: Q1; ABS: 4) and subsequently to the Small Group Research Journal (Impact Factor: 3.7; SJR: Q1; ABS: 2).

Thesis Discussion and Conclusion

The final section presents the overall discussion and conclusion of this dissertation. The focus of this chapter is to reflect on how this body of work and its integration helps bridge the literature gap. Moreover, this chapter will reflect on some of the limitations and ideas that did not work out, how they were addressed, and how future research can help to continue building the idea of team communication actions.

Note. To facilitate the reviewers' revision of this thesis, citations to other articles within the dissertation are formatted as (Perez-Sepulveda et al., first article) instead of the conventional Harvard style (Perez-Sepulveda et al., no date) when the articles are unpublished. Additionally, when quoting, the indicated page number refers to this dissertation, not the original article. These are the only differences between the articles presented in this thesis and the versions that will be submitted to journals.

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ARTICLE 1: CONCEPTUAL ARTICLE

Team Communication Actions: Beyond the Dichotomy of Face-to-Face versus Virtual Interactions in Teams

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Abstract

Members of modern teams interact through multiple media, combining information and communication technologies (ICTs) and face-to-face interactions. Yet, the study of ICTs has usually been associated with teams that present some degree of virtuality, neglecting the fact that ICTs can be used extensively by all kinds of teams. Moreover, team virtuality research has usually adopted a dichotomous view of ICTs versus face-to-face interactions, grouping all ICTs together, ignoring that some of them present vastly different capabilities. To address these limitations, we build on research that has examined the capabilities that different types of media can offer and on non-deterministic theories that have addressed how media is used by people to present the new construct of *team communication actions*. This construct reflects the actions that team members can perform when using media that will shape the way they interact with each other, such as using written messages or involving multiple participants. Then, we analyse how different communication actions can impact team functioning. This new construct contributes to team research by offering a more nuanced understanding of media usage in all kinds of teams and by giving practitioners robust guidelines to manage the use of media in their teams.

Keywords: team communication actions, team virtuality, media capabilities, team functioning

Introduction

The development of information and communication technologies (ICTs) has significantly shaped the way modern work teams operate. They have allowed team members to work from remote locations by relying on these technologies to communicate and interact with each other (Gilson *et al.*, 2015). The COVID-19 pandemic propelled this even further as many workers were forced into isolation conditions to comply with their governments' health policies and, therefore, were only able to communicate with other members through ICTs (Feitosa and Salas, 2021; Garro-Abarca, Palos-Sanchez and Aguayo-Camacho, 2021). Even after the end of the pandemic, many people – and organisations – have continued to work this way, at least partially. The UK Office for National Statistics (2022) reported in May 2022 that 24% of workers were doing hybrid work, and 14% were working exclusively from home. Similarly, in April 2022, 58% of US workers reported being offered to work remotely at least part-time, with 35% having access to full-time remote work (McKinsey, 2022). Due to this, and because workers have become more proficient in working virtually and using ICTs during the pandemic, it is likely that all kinds of teams (i.e., co-located, hybrid, and virtual ones) are relying on ICTs more than ever before.

Because of modern teams increased reliance on ICTs, some attempts to examine and integrate the impact of the use of different communication media into the teams literature have been made (e.g., Hosseini *et al.*, 2015; Dulebohn and Hoch, 2017), but they have presented some limitations. This research has usually focused on team virtuality, which has been proposed as a multifaceted construct comprising different dimensions, such as technology reliance, geographical/temporal dispersion, and cultural diversity, among others (Gibson and Gibbs, 2006; Schweitzer and Duxbury, 2010; Weber and Kim, 2015). This way, the use of ICTs, captured by the technology reliance component of team virtuality, has been implicitly associated with teams that are fully or partly dispersed through space and/or time

and, therefore, are limited in their face-to-face communications. Moreover, this research has also viewed ICTs as an inferior means of communication when compared to face-to-face interactions (Gibbs and Navick, 2023), considering them a less optimal replacement. However, researchers have expressed concerns about this because there is evidence that co-located teams can depend highly on ICTs while maintaining regular face-to-face communications (Gibson *et al.*, 2014). One explanation for this is that ICTs can offer relevant attributes for the effectiveness of teams that are not necessarily offered by face-to-face communications. The idea of technological affordances has been used to examine the different possibilities for actions that ICTs can offer to users, such as editability or persistence of information (Rice *et al.*, 2017; Gibbs and Navick, 2023). Recently, Lane *et al.* (2023) examined how some of these technological affordances can be relevant for team dynamics, specifically teamwork processes that are essential for the effectiveness of teams. Nonetheless, the focus on technological affordances still represents a fragmented view because team members can use complex sets of media in parallel or in a complementary manner, combining both ICTs and face-to-face interactions (Bélanger and Watson-Manheim, 2006; Watson-Manheim and Bélanger, 2007). Therefore, while the focus on technological affordances addresses that ICTs can offer relevant features to teams, it has not considered how team members can leverage both natural and artificial communication media to be effective in their work.

To address the limitations mentioned above, we argue for the need for new theoretical constructs that address the relevant role of the use of different types of communication media within the teams' literature beyond the dichotomy of face-to-face versus ICTs. In this article, we build on the ideas of media capabilities from Media Synchronicity Theory (MST; Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) to achieve this. This was one of the first theories that considered the capabilities offered by both ICTs and face-to-face

interactions, but unfortunately, it has not been widely utilised in the teams literature (Raghuram *et al.*, 2019). However, when examining how team members make use of these capabilities, it is important to consider that, as several non-deterministic theories of technology have proposed, the actions that team members perform over media can vastly differ from their objective attributes (Leonardi, 2007; Orlikowski, 2000). For example, Leonardi (2011) proposed that the social actions that humans perform over technology, which the author called routines, result from (1) the imbrication between the material attributes of the technology and (2) human agency, such as people's goals and needs. Considering this, we propose a new construct called *team communication actions, which represent a set of actions that team members can perform when using communication media, which will shape how they interact with each other while performing their tasks*. Based on the capabilities systematised by Media Synchronicity Theory (Dennis, Fuller, and Valacich, 2008), we identified eight different communication actions, such as using verbal and non-verbal communications, using written communications, and involving multiple participants. It is important to note that while we use the media capabilities to identify the most basic communication actions that team members can perform, we do not associate the specific materiality of a medium with specific actions, following non-deterministic views of media.

The idea of team communication actions contributes to expanding the literature in several ways. First, it represents an attempt to understand the impact of the use of different communication media within teams beyond the dichotomous views used in past studies, particularly those examining technology reliance in team virtuality research. This new concept takes into consideration the wide range of possibilities for action that different types of media can offer to team members to achieve their goals. This is relevant because modern teams will have access to and combine complex sets of media regardless of conditions of geographical and/or temporal dispersion. This way, the idea of team communication actions

can contribute to the team virtuality literature by expanding the limited view of technology reliance. Moreover, this construct also offers more flexibility which can facilitate the analysis of the interactions that occur within all kinds of teams, that is, co-located, virtual, and hybrid ones. Second, by focusing on actions performed by team members instead of material attributes (i.e., capabilities), this approach also goes beyond deterministic views of media in which these attributes are assumed to be used by people. By relying on actions instead of specific media, this approach can also facilitate the inclusion and analysis of new media and theoretical developments in the future.

Third, by offering a more fine-grained understanding of communication media when compared to the examination of technology reliance in team virtuality, team communication actions can facilitate the integration of communication media usage in the teams literature. Team communication actions can offer important explaining mechanisms for the effectiveness of teams that have not been considered before. These actions will shape the interactions that occur within the team, which are the building blocks that lead to team processes and, over time, to team performance. Thus, in this article's last section, we will integrate these actions into the traditional frameworks used in the team's research (i.e., Input-Mediator-Output-Input model; Ilgen *et al.*, 2005), and analyse how they can allow team members to perform different team processes, such as transition, action, and interpersonal processes (Marks, Mathieu and Zaccaro, 2001). Since different processes can have different communicational needs depending on the stage of the team (e.g., newly formed teams may require more synchronous exchanges than older teams; Maruping and Agarwal, 2004), we will take this into consideration when analysing the impact of communication actions on team processes.

Theoretical Background

Media Synchronicity Theory

Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) was developed as an effort to take into account the capabilities that both face-to-face and ICTs offer to users. Classic media theories, such as Media Richness Theory (Daft and Lengel, 1984, 1986) and Social Presence Theory (Short, Williams and Christie, 1976), mainly focused on the attributes that face-to-face interactions offer to participants of communications, such as the capacity to offer immediate feedback and high levels of social and contextual cues in communications. These theories have been used to explain the challenges faced by virtual teams using ICTs, particularly text-based ones like email or chat, which are considered 'leaner' media. These leaner media can lead to incoherent messages, misunderstandings and misattributions due to a lack of social and contextual cues in messages (Sproull and Kiesler, 1986; Axtell, Fleck and Turner, 2004). The reduced social and contextual cues can also result in a situation of de-individuation, where people focus less on their interaction partners and do not feel pressure to conform to social norms, potentially leading to conflict. However, these classic media theories were developed before the widespread use of ICTs in organisations and have struggled to explain the use and consequences of newer media like email, instant messaging, and video calls (e.g., Rice, 1992; Dennis and Kinney, 1998). Moreover, by focusing on the attributes offered only by face-to-face interactions, these theories struggle to explain situations in which teams that rely heavily on ICTs have positive outcomes.

Dennis and Valacich (1999) developed the Media Synchronicity Theory, building on the premise that the effectiveness of a specific medium depends on the communication needs of the task that is being performed. They proposed that the goal of every communication is to develop a shared understanding (regardless of whether this is achieved or not) between the

participants. To achieve this shared understanding, they will need to perform two primary processes: conveyance of information and convergence of meaning. Conveyance involves transmitting new information to help the receiver form a mental model of a subject. Convergence involves discussing each individual's interpretation of a subject to reach a common understanding (Dennis, Fuller, and Valacich, 2008, p. 580). Additionally, to perform these two primary processes (which are situated at the interactional level), two individual-level processes are necessary (in different proportions depending on the primary process being performed). These are (1) transmission of information, that is, "preparing information for transmission, transmitting it through a medium, and receiving information from a medium" (Dennis, Fuller, and Valacich, 2008, p. 576), and (2) processing of information, namely, "understanding the meaning of information and integrating it into a mental model" (Dennis, Fuller, and Valacich, 2008, p. 576).

Based on the previous analysis of task and communication processes, this theory argued that different media offer distinct capabilities, that is, *a set of physical characteristics or properties*, which allow them to be better suited for the transmission or the processing of information. This theory suggested five different capabilities (see Figure 1; Dennis, Fuller and Valacich, 2009, p. 582): (1) transmission velocity, the speed by which a medium can deliver a message; (2) parallelism, the number of simultaneous transmissions that a medium offers; (3) symbol sets, i.e., the number of ways in which a medium allows for information to be encoded (i.e., verbal, non-verbal and para-verbal components); (4) rehearsability, the degree that a medium allows for the refinement and fine-tuning of the definitive version of a message before sending it; and (5) reprocessability, the extent that a medium allows for a message to be re-examined multiple times after being received. Further, they proposed that transmission velocity and parallelism are transmission-oriented capabilities, while rehearsability and reprocessability are processing-oriented capabilities. Symbol sets is the

only capability related to both processes as a more robust symbol set, including natural (e.g., voice and gestures) and digital symbols (e.g., text and images), offers the possibility to transmit different types of information (transmission) and also facilitates the correct decoding or interpretation of the message by the receiver (processing).

Figure 1

Media capabilities proposed by Media Synchronicity Theory

Media Capabilities				
Transmission Capabilities				**Processing Capabilities**
Transmission velocity	Parallelism	Symbol sets	Rehearsability	Reprocessability
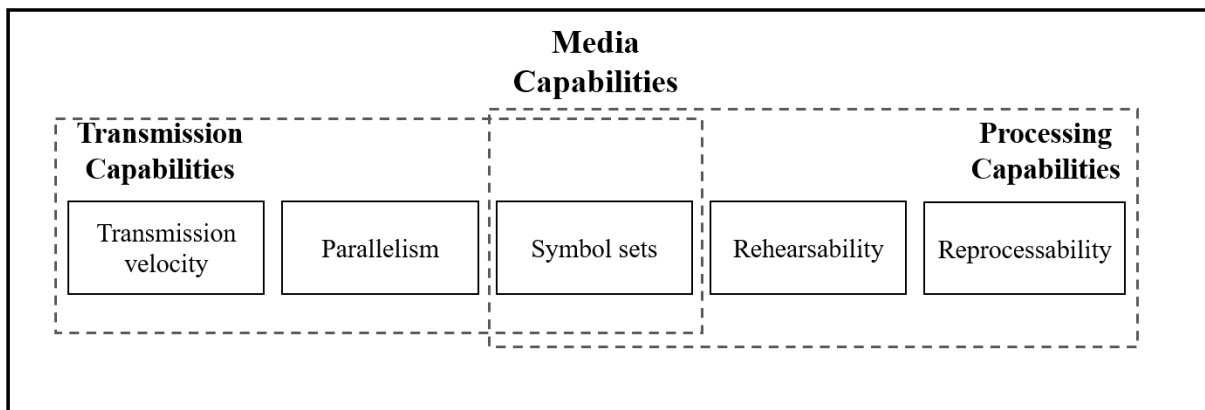
Note. From "Media, Tasks, and Communication Processes: A Theory of Media Synchronicity", by Dennis *et al.*, 2008, *MIS Quarterly*, *32*(3), p. 582.

The concepts of *synchronicity* and *media synchronicity* are important concepts to aid our understanding of how media and their capabilities can impact convergence and conveyance processes. Synchronicity between communication participants occurs when they exhibit coordinated behaviours with a common focus while having synchronous exchanges (Harrison *et al.*, 2003; Dennis, Fuller, and Valacich, 2008). Media synchronicity refers to the "extent to which the capabilities of a communication medium enable individuals to achieve synchronicity" (Dennis, Fuller, and Valacich, 2008, p. 581). Media that allows for higher levels of synchronicity will be better suited for convergence of meaning, as they allow for quick back-and-forth exchanges and clarifications, which, in turn, facilitate achieving a common understanding between participants. Usually, media with strong transmission capabilities (e.g., video calls or face-to-face interactions) will offer the high levels of

synchronicity required for convergence of meaning. However, in some instances, parallelism can hurt synchronicity if participants are involved in multiple simultaneous communications with different focuses, for example, when participants have multiple simultaneous discussions about different topics. On the other hand, media that support lower levels of synchronicity (e.g., emails or text messages) will be better suited for the conveyance of information. This type of media allows participants enough time to process and understand larger amounts of information and then to create or revise their mental models. Often, media with strong processing capabilities also have the low levels of synchronicity needed for conveyance processes.

Beyond Determinism: The Role of Human Agency

While there is consensus that media vary in their objective features and attributes, some authors have questioned the use of a deterministic view in which these characteristics are argued to shape human actions and interactions without considering the role of people's agency (W. Orlikowski and Scott, 2008; Orlikowski, 2010). From a deterministic standpoint, it is argued that during development stages, developers are able to incorporate social structures into technology; that is, they incorporate the rules and resources that will shape the actions that people can adopt while using the technology (Poole and DeSanctis, 1990; DeSanctis and Poole, 1994). Thus, the actual use of technology results from the users appropriating these structures. From this view, when users cannot correctly appropriate these structures, that is, to use the technology for its intended purpose, the results will likely be negative. However, Orlikowski (2000) challenged this assumption based on Giddens' Structuration Theory (1979, 1984), which proposes that social structures should not be understood as external forces shaping human action. On the contrary, structures only exist 'in and through the activities of human agents' (Giddens, 1984, p. 256). Orlikowski's (2000) Technology-in-Practice perspective extends structuration theory to technology use,

emphasising that technological structures emerge from their use (what the author called the enactment of structures) instead of them being embodied in the technology. The idea of enactment emphasises that people can use technologies as they were designed, but also, they can "circumvent inscribed ways of using the technologies — either ignoring certain properties of the technology, working around them, or inventing new ones that may go beyond or even contradict designers' expectations and inscriptions" (Orlikowski, 2000, p. 408).

The affordances perspective has been used to pose a similar criticism to deterministic views of technology. Gibson used the notion of affordances (1977) to explain how different species of animals perceive different opportunities for action from the same objects and their respective material attributes. From an affordance perspective, the physical properties of objects are independent of the animals (or humans) who use them, but what animals perceive an object allows (afford) them to do will depend on the animals' unique attributes (e.g., height, weight, strength, posture) in relation to the object (Gibson, 1977). The idea of affordance has been applied to the analysis of how users perceive technologies and actually use them (e.g., Norman, 1999; Hutchby, 2001; Zammuto *et al.*, 2007). Markus and Silver (2008) defined technological affordances as "the possibilities for goal-oriented action afforded to specific users group by technical objects (p. 622)". These possibilities emerge from the relation between the user and its characteristics (e.g., goals, needs, preferences, abilities, and knowledge) and the material attributes of the technology. This means that different users can perceive different possibilities for action from the same technology depending on their own attributes and the context of use. It is important to note that these possibilities are not infinite, as their existence is enabled and, at the same time, is constrained by the material attributes of the technology (Majchrzak, Markus and Wareham, 2016; Willems, 2021). For instance, while different users can perceive that video calls allow them

to afford different actions (e.g., contact relatives that live far away, discuss important work documents), it is highly unlikely they will perceive that video calls afford them the possibility to hug others as this medium lacks the capacity to support physical touch. Several attempts have been made to identify and systematise technological affordances, such as visibility, editability, and persistence, among others ((Rice *et al.*, 2017; Malhotra, Majchrzak and Lyytinen, 2021; Lane *et al.*, 2023).

Leonardi (2011) used the idea of imbrication to analyse how the material capabilities of technology, which some authors have referred to as 'material agency' (Pickering, Engen and Walland, 2017), and human agency became intertwined to produce a specific result. This result can represent the creation or modification of a routine, namely a 'sequential pattern of social action' (Leonardi, 2011, p. 148), or the creation/modification of technology. Building on the affordances perspective, the author argues that when people perceive that a material agency offers a possibility for action (affordance) to achieve a particular goal, the imbrication will likely result in a routine, that is, the enactment of the material agency of the technology (or a Technology-in-Practice; Orlikowski, 2000). However, when the technology is perceived as constraining people's actions, the imbrication is likely to result in the modification (or creation of a new) technology in a way that satisfies the users' intentions (e.g., goals and/or needs). Something that is relevant from the idea of imbrication is that neither material nor human agency are enough by themselves to understand the structuring processes that occur in social dynamics. It is only through the continuous and repeated interweaving of material and human agencies that the infrastructure of social actions can be examined. This also emphasises the recurrent character of the imbrication between material and human agencies, in which past imbrications resulting in the creation or modification of a routine or technology will influence future imbrications but not determine them. In other words, the accumulation of past imbrications has a role in explaining future imbrications but cannot predict them.

Team Communication Actions

Up to this point, we have stated that modern teams use different communication media to support their interactions, including face-to-face interactions and ICTs, which will offer unique capabilities (Dennis and Valacich, 1999). Some capabilities allow for higher levels of synchronicity in communications, while others allow for lower levels. Furthermore, some communicational processes will be better suited by higher levels of synchronicity (convergence of meaning) and others by lower levels (conveyance of information). Finally, based on non-deterministic theories, we have stated that there is a gap between the capabilities of media and the actions that people perform over the media. The actions performed over media will emerge from the interplay between the materiality of media and the human agency (Leonardi, 2011; Orlikowski, 2000). In this section, we will present and define the idea of team communication actions as a way to apply these insights to the examination of how team members can use different media to interact with each other and be effective in their work.

Definition of Team Communication Actions

Because modern teams rely on multiple media, team members have access to a wide range of capabilities to support their interactions and communications. However, as stated in previous sections, the way in which team members will interact by utilising these capabilities depends not only on the material attributes of media but also on human agency (Markus and Silver, 2008; Leonardi, 2011). While non-deterministic theories have usually analysed the use of technology, we argue that these ideas also apply to face-to-face interactions. Our capacity to communicate face-to-face is built over several biological systems developed through evolutionary mechanisms offering certain physical properties or a 'biological materiality' (i.e., collocation, synchronicity, facial expressions, body expressions, speech, and spoken words; Kock, 2004). From a deterministic perspective, it is easy to assume that people will

use these capabilities in a similar way during face-to-face interactions as they are ingrained in a shared biological materiality. However, we argue that, like with technologies, the way in which different people use their biological materiality can be vastly different depending on their perceptions of what it affords them to do in a particular context.

Following Leonardi's (2011) ideas of imbrication and routines, we propose the construct of team communication actions as a way to examine the communicational routines that emerge from the situated use of communication media, specifically in team contexts. We define team communication actions as *a set of actions that team members can perform using communication media that will shape the way in which they interact with each other while performing their tasks*. These actions will result from the imbrication of the media capabilities (material agency) to which team members have access but also from their perceptions of what these capabilities afford them to do to achieve their goals and satisfy their needs (human agency). Based on past research, some of the aspects that can be relevant in shaping the goals and needs of team members are (a) team members' characteristics, such as the geographical/temporal distance between them (O'Leary and Cummings, 2007; Espinosa, Nan and Carmel, 2015; Chattopadhyay *et al.*, 2020), their cultural background (Eisenberg, Glikson and Lisak, 2021), their knowledge and skills using media, personal preferences, and past experiences with media (Carlson and Zmud, 1994, 1999), (b) the team design and tasks characteristics (e.g., autonomy, interdependence, complexity; (Dulebohn and Hoch, 2017; Costa, Handke and O'Neill, 2021) which will demand a specific set of communicational needs, and (c) the team context, that is, the external environment which can impulse certain forms of communication and inhibit others, such as organisational policies and training (Dulebohn and Hoch, 2017; Nordbäck and Nurmi, 2023).

By focusing on the actions resulting from the imbrication process of media capabilities and team members' goals and needs, researchers can go beyond deterministic

views and put emphasis on the actual way in which communication media is enacted in team contexts. We argue that these actions are more helpful in understanding the dynamics that occur within a team than focusing on the media being used, which has been the common approach used in team virtuality research. By going beyond deterministic views, examining communication actions can also help to understand the changes that occur over time in the way that team members interact with each other. The imbrication of material and human agency is recurring over time, and while a previous imbrication will influence the way in which media is used in the future, its impact is non-deterministic (Leonardi, 2011). Depending on changes in their communicational needs and goals, team members can alter the way they have been using media to better satisfy those requirements. Additionally, it is important to note that while these actions represent a phenomenon emerging at the team level, this does not mean that all team members will perform the same communication actions within a team. There will be instances where team members are able to develop shared patterns of communication actions, but also cases in which team members present vast differences in the way they use communication media within a team. This is similar to the distinction made over other team-level constructs in which researchers have argued the need to consider not only the mean level but also the level of dispersion they present within the team (e.g., team affective divergence and team climate strength; Schneider, Salvaggio and Subirats, 2002; Barsade and Knight, 2015).

Types of Team Communication Actions

We used the media capabilities systematised by Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) to identify eight distinct basic communication actions that team members can perform using media (see Table 1). We build on this theory because it is the only comprehensive systematisation that has focused on the capabilities offered by both face-to-face and ICTs. Other systematisations have had a partial

focus on face-to-face interactions (e.g., psychobiological model; Kock, 2004) or on technologies (e.g., technological affordances; Treem and Leonardi, 2013; Lane *et al.*, 2023). It is important to mention that this typology represents an initial attempt to systematise the actions that team members can perform to shape their interactions based on the capabilities of the media they use. However, it does not represent a comprehensive list, as newer theoretical and/or media developments can allow the expansion of this list in the future.

To develop this list of actions, we analysed how each media capability from MST can be used within team contexts to shape the interactions that occur between members. To facilitate the analysis, we separated the symbol set capability into two, digital symbol sets and natural symbol sets, recognising that most media will offer one or the other (e.g., email encodes messages using digital symbols, while face-to-face interactions use natural symbol sets). Moreover, even when media can offer the possibility to use both sets, users have to make an effort to craft two different messages, and, therefore, it is not the same message that is encoded through both natural and digital symbols at the same time. For instance, WhatsApp users have the possibility to send written messages (digital symbols) and voice or video messages (natural symbols). However, if users want to use both, they will have to actively write a message and then record a voice or video message trying to replicate it, thus representing two communicational events.

Some capabilities and actions have a clear connection, such as natural symbols set and using verbal and non-verbal expressions; digital symbols set and using written and graphical expressions; transmission velocity and the speed of exchanges that occur within the team; reprocessability and the degree to which team members review messages multiple times within the team; rehearsability and the degree to which team members refine their messages before sending them. However, others required a more nuanced analysis. Specifically, parallelism is concerned with how many signals a medium allows to transmit simultaneously.

This way, at the team level, using a medium with high levels of parallelism can allow multiple team members to participate in one interaction, sending and receiving messages. However, the analysis of parallelism is more complicated if we consider that team members can communicate through multiple media simultaneously, for example, when some members communicate through chat, others via email, and others face-to-face. This way, team members can maintain multiple simultaneous communications regardless of the parallelism capabilities of the media involved. Considering this, we propose two different communication actions derived from parallelism: (1) multiple participants, reflecting that typically several team members participate in the communications and interactions within the team, and (2) simultaneous communications, representing that team members maintain several communications at the same time through one or multiple media.

Table 1

Team Communication Actions derived from the media capabilities of Media Synchronicity Theory (Dennis et al., 2008)

Media capabilities	Communication actions	Communication process	Definition
Natural symbols	Verbal and non-verbal communications	Convergence of meaning	Team members use the team's media to interact using their voice, facial and body expressions (e.g., smiles and gestures).
Digital symbols	Written communications	Conveyance of information	Team members use the team's media to send written messages and information (e.g., documents, tables, and numerical reports).
	Graphical communications		Team members use the team's media to send images, pictures, and graphs.
Transmission velocity	Speed of exchanges	Convergence of meaning	Team members use the team's media to reply quickly, or slowly, to other members' messages.
Parallelism	Multiple participants	Convergence of meaning	Team members use the team's media to involve multiple members in their interactions. Lower levels in this subdimension indicate that team members communicate often in dyads rather than involving the whole team.
	Simultaneous communications	Conveyance of information	Team members use the team's media to have multiple simultaneous communications through one or more media. Lower levels of this subdimension indicate that team members usually focus on just one communication at a time.
Rehearsability	Refine messages	Conveyance of information	Team members use the team's media to edit and refine their messages before communicating them.
Reprocessability	Review messages	Conveyance of information	Team members use the team's media to access other members' communications multiple times after receiving them.

Note. As argued in this article, media capabilities are just one of the factors that will influence the emergence of team communication actions, and thus, these actions are not directly determined by the capabilities of media.

Following the two communicational processes proposed by Media Synchronicity Theory, we argue that using verbal and non-verbal communications, high levels of speed of exchanges, and involving multiple team members are actions that should facilitate convergence of meaning between team members (see Table 1) (Dennis, Fuller, and Valacich, 2008). The use of verbal (voice) and non-verbal (facial and body movements, voice intonation) expressions can facilitate the transmission of more social and contextual cues in messages, which should enable them to be understood more easily. Likewise, higher levels of speed of exchanges can allow team members to clarify any misunderstandings through quick back-and-forth communications. Because convergence of meaning represents the development and achievement of a shared understanding between communication partners, we argue that in team contexts, how many members are involved in communications will be relevant for this to occur. If most of the communications and interactions within the team typically exclude some members or only happen between dyads, some team members may not have access to relevant information to guide their work, and this can also facilitate the formation of subgroups within the team (O'Leary and Mortensen, 2010). This way, involving more team members can help ensure that the whole team has a common idea about the messages and communications.

On the other hand, using written and graphical communications, having simultaneous communications, refining messages, and reviewing messages are actions that should facilitate the conveyance of information (Table 1). Sending messages through text, graphics, images, and pictures allows team members to send large amounts of information for other members to develop or change their understanding of the topic being discussed (develop or revise a mental model; Dennis, Fuller, and Valacich, 2008). Likewise, refining communications is a way in which team members can make sure that the content of their messages is clear and, therefore, ensure that others are able to process and understand them. In contrast, reviewing

messages multiple times is a way in which the receivers of communication can make sure that they understand the content of a message. Lastly, as the number of simultaneous communications increases within a team, the amount of information available within the team gets higher, which can promote the development and revision of team members' mental models. However, it is important to note that as past research has shown, when the number of simultaneous communications is too high, this could lead to conditions of information overload in which people do not have the cognitive resources to process the information available, leading to stress and impaired processing capacity (Edmunds and Morris, 2000; Ellwart *et al.*, 2015). Therefore, while a moderate number of simultaneous communications can facilitate team members' development and revise mental models by increasing the available information, excessive amounts can hinder the conveyance of information.

A relevant caveat is that while the previous analysis focuses on the most optimal fit between communication actions and communication processes, this does not mean that some actions cannot be used to perform the other communication process. Team members can, and usually do, use verbal and non-verbal expressions to send messages to other members that can make them modify their mental models about a topic (conveyance of information). For example, when one team member in a face-to-face or a video call meeting explains, using spoken words to other members, relevant information that only he knows. However, following the propositions of MST, we argue that verbal and non-verbal expressions are better for team members to develop a shared understanding of a topic. In our example of the face-to-face or video call meeting, it is likely that the team members who are receiving the message are going to actively engage in the conversation and try to ask questions regarding the topic. These questions, in turn, can make the original emitter of the message revise their own understanding of the topic, thus delving into convergence of meaning dynamics between the participants. This example also shows the need to consider the classification of

communication processes as only a theoretical analysis of communications because, in

practice, team members can rapidly fluctuate from one process to the other.

Integrating Team Communication Actions in the Teams Literature

In this section, we analyse how team communication actions are related to other

relevant team variables and how they can be instrumental in the effectiveness of teams. In

Figure 2, we position team communication actions within Ilgen *et al.*'s (2005) Inputs-

Mediators-Outcomes-Inputs (IMOI), one of the most influential in the teams literature. Inputs

usually involve the conformational aspects that constitute a team, comprising aspects such as

team composition (e.g., individuals' knowledge and demographic characteristics),

organisational factors (e.g., team design, technologies, training) and leadership (Dulebohn

and Hoch, 2017). As we argued before, inputs will be relevant in shaping the way in which

team communication actions emerge within a team.

The IMOI model also proposes mediators as the explaining mechanisms by which

team members are able to transform inputs into outcomes. These mediators usually involve

the actions of team members, which have been commonly referred to as processes, and

emergent states, which are collective phenomena that result or 'emerge' from these actions.

For instance, researchers have studied affective and conflict states within teams (Rapp *et al.*,

2021), as well as the processes that can influence these states, such as affect and conflict

management actions performed by team members (e.g., Mathieu *et al.*, 2020). In this context,

we placed team communication actions as a mediator that will influence the development of

other mediators (i.e., processes and emergent states). This is relevant because, to date, the

teams literature has not thoroughly considered how the communication media and how team

members use them will be relevant in shaping team dynamics. The communication actions

performed by team members will shape the way in which interactions occur within the team

by, for instance, impacting how many members are involved in communications or how

clearly messages are communicated. These interactions, in turn, are the building blocks that, over time, allow the occurrence of more complex mediators within the team, that is, team processes and emergent states.

Lastly, the IMOI model proposes outcomes as the results originating from the mediating mechanisms that are valued by the organisation, such as individual and team performance, turnover, and well-being (Ilgen *et al.*, 2005; Dulebohn and Hoch, 2017). It is important to note that, as proposed by the IMOI model and shown in Figure 2 by the dashed arrows, the workflow of teams is not static but usually recurrent. This way, a team's performance at one point in time can impact the next cycle's inputs and mediators. The same applies to the other components of the model; for instance, team processes in one cycle can impact the team communication actions performed by members in future ones. Due to this, the developmental stage of a team will be relevant in shaping the communicational needs that the team has in a particular work cycle (Maruping and Agarwal, 2004). At the same time, the developmental stage can also be understood as a moderator of the relationship between team communication actions and other components of the IMOI model, such as teamwork processes, emergent stages, and team performance. For example, one communication action can have a positive impact on coordination for teams in an earlier stage as it matches the communicational requirement to perform this process in that stage but not in later ones. This will be relevant for the next section, in which we examine how team communication actions can impact team functioning.

Impact of Team Communication Actions on Team Functioning

To analyse how team communication actions can impact team functioning, we will focus mainly on their effects on team processes based on Marks *et al.* (2001) Team Processes Framework, which distinguishes between transition, action, and interpersonal processes. We focus specifically on this taxonomy of team processes as it offers clear and specific actions

that team members must perform to be effective in executing their tasks. While emergent states are certainly relevant for team functioning, their study has been more scattered, lacking a common framework that joins them all (although some attempts are starting to emerge, e.g., Rapp *et al.*, 2021). As mentioned before, previous research has shown that team members' communication needs depend on the developmental stage of their team, so this will be taken into consideration when analysing the impact of the different communication actions (Maruping and Agarwal, 2004; Mathieu *et al.*, 2017). Based on this, several propositions regarding the relationships between these actions and team processes during different teams' developmental stages will be made.

Teamwork Taxonomy: Transition, Action, and Interpersonal Processes

Marks *et al.* (2001) framework argues that team members perform three different types of processes when executing each of their tasks: transition, action, and interpersonal processes (Salas, Rico and Passmore, 2017). Transition processes refer to a reflexive phase in which team members assess and/or determine their common goals and the activities they must perform (Mathieu *et al.*, 2017). Examples of transition processes are mission analysis, goal specification, strategy formulation and planning. Action processes involve the activities that team members perform during the phase of active execution of their tasks to ensure that they are carried out correctly (Marks, Mathieu and Zaccaro, 2001). Several action processes have received attention in the literature, such as coordination, communication, monitoring progress and resources, backup behaviours and cooperation, among others. This model argues that teams will usually cycle between transition and action processes for each of the tasks they must accomplish, performing one or the other for longer or shorter times, depending on the task (Mathieu *et al.*, 2020).

Figure 2

Adaptation of Ilgen et al.'s (2005) IMOI model including the concept of Team Communication Actions

This framework also proposes that team members must perform interpersonal processes in parallel to action/transition cycles (Marks, Mathieu and Zaccaro, 2001). They represent all the actions that members perform to manage and develop their interpersonal relationships. This involves, for example, the management of conflict and/or affective experiences and the confidence building within the team. Usually, team literature has treated interpersonal emergent states and interpersonal processes somewhat interchangeably. The former represents the shared perceptions of the degree to which interpersonal variables are expressed within the team, such as the levels of trust, conflict and emotional states of team members (Mathieu *et al.*, 2017), while the latter represents the actions that allow the emergence and/or management of the states. In general, team virtuality has put a larger emphasis on interpersonal emergent states, such as trust and conflict, than on processes (e.g., Benda et al., 2023; Mortensen & Hinds, 2001; Stark et al., 2014). Therefore, to be precise, in the next sections, we will use the term "interpersonal states" to refer to these emergent states.

Team Communication Actions and Transition Processes

Marks *et al.* (2001) framework proposes that team members will cycle between performing transition and action processes to accomplish their different tasks. During the transition phase of a task, team members will perform processes focused on assessing the activities they have to do, such as planning, goal specification, and strategy formulation (Mathieu *et al.*, 2019). By performing these processes, they can formulate (or clarify) the goals of the team and the most adequate strategy to achieve them, including identifying critical resources and delineating specific goals (Salas, Rico and Passmore, 2017).

Transition processes are of relevance for teams in early developmental stages, especially for those who will perform their tasks for the first time. Team members in this situation will likely have to share and review large amounts of new information regarding the task (conveyance of information) but also discuss and agree on the goals and the strategies to achieve them (convergence of meaning). Considering this, team members can benefit by

using actions that allow the conveyance of information and the convergence of meaning in a complementary manner. For example, they can work on crafting and refining clear and precise text- and graphics-based messages to share information with each other, and they can also review them multiple times to understand the contents of those messages. Then, team members can meet through synchronous media (e.g., face-to-face or video calls) to discuss their goals and the strategy to effectively perform their tasks. In this instance, team members will likely benefit from communicating using verbal and non-verbal expressions that allow them to notice when someone has doubts or has misunderstood and by having rapid exchanges that allow them to quickly clarify points. Additionally, the participation of multiple members in the discussion and having simultaneous communications can facilitate that all team members achieve a shared understanding of the most important aspects of the task they have to perform. Considering this, the following proposition is made:

Proposition 1: Teams in early developmental stages that perform communication actions that facilitate both the conveyance of information, and the convergence of meaning will be more effective in performing transition processes than teams with low levels of these actions.

Transition processes are also relevant for teams in late developmental stages, as such processes allow them to make the necessary adjustments to their plans and strategies depending on the challenges they faced when performing tasks on previous occasions (Mathieu *et al.*, 2020). In this context, as team members already have previous experience with the task, the need to share large amounts of new information between team members is reduced. However, they will likely still benefit from performing communication actions that facilitate the convergence of meaning, that is, using verbal and non-verbal messages, having high-speed exchanges, and involving multiple participants to discuss how to deal with the challenges they previously faced and quickly agree on better ways to achieve their goals. Based on this, the following proposition is made:

Proposition 2: Teams in late developmental stages that perform communication actions related to the convergence of meaning will be more effective in performing transition processes than teams that use other communication actions.

Team Communication Actions and Action Processes

Marks *et al.* (2001) framework proposes that after teams have formulated and clarified their goals and strategy, they will perform several action processes, which involve the execution of their tasks and other activities that facilitate achieving their goals. Some examples of relevant action processes are monitoring resources, monitoring progress toward goals, coordination, and knowledge and information sharing (Mathieu *et al.*, 2017). Coordination and knowledge sharing have received the most attention in virtual teams and virtuality literature (Gilson *et al.*, 2015). Past research has shown that the development of shared mental models is fundamental for teams to be effective in performing action processes (e.g., Gorman, Amazeen and Cooke, 2010). Shared mental models are organised knowledge structures within team members' cognition that allow them to describe, explain and predict each other's behaviours (Mathieu *et al.*, 2000). By having similar and accurate mental models, team members are able to interpret information similarly and predict how others will interpret and use that information (Mohammed, Ferzandi and Hamilton, 2010). They also allow team members to arrive at similar explanations of why a situation occurred in a particular way. All these aspects are relevant for the adequate performance of action processes, as they facilitate the anticipation of what other members are doing (and will do in the future) and an understanding of whether other members need a particular resource and/or information in a specific situation.

Teams in early developmental stages that have yet to develop shared mental models will likely benefit from performing communication actions that facilitate the convergence of meaning. In an experiment that compared face-to-face and ICT-mediated teams, Andres (2013) showed that having face-to-face exchanges facilitated team members requesting

information from one another, confirming their mutual understanding of things, and assessing the correctness of the solution to the task they were performing. In turn, this resulted in these teams exhibiting higher levels of shared mental models at the end of the experiment. This can be explained because face-to-face interactions allow for the quick back-and-forth exchanges necessary to develop a shared understanding between team members. Also, by having access to non-verbal expressions (e.g., voice intonation, body movements and gestures), team members can notice when others are confused about something and clarify it. Finally, the participation of multiple team members is also relevant in this context, as team members can only develop shared mental models if all of them are involved in the teams' interactions and communications. Considering all this, the following proposition is derived:

Proposition 3: Teams in early developmental stages that perform communication actions that facilitate the convergence of meaning will be more effective in performing action processes than teams that use other communication actions.

For teams in late developmental stages that have already developed shared mental models, we argue that the conveyance of information likely has a predominant role. Performing communication actions related to the conveyance of information will allow for lower levels of synchronicity, which can facilitate team members coordinating their work, monitoring each other's progress, and sharing knowledge/information without interfering with the execution of their tasks. For example, one team member can share information regarding their progress with a task using a written message on an online board, and then the rest of the team can access to that information when this does not interfere with their progress on their own tasks. In this context, team members will likely benefit from clearly formulating their communications (i.e., refining messages) and that they can be accessed any time that another member requires them (reviewing messages). Nevertheless, we argue that the involvement of multiple team members in communications will still play a large role during this stage, as it will allow all team members to have access to these resources or

information without having to ask for them. Considering this, the following proposition is formulated:

Proposition 4: Teams in late developmental stages that perform communication actions that facilitate the conveyance of information, together with involving multiple team members in communications, will be more effective in performing action processes than teams that use other communication actions.

Team Communication Actions and Interpersonal Processes

Marks *et al.*'s (2001) framework proposes that throughout the action and transition phases, team members will have to perform several interpersonal processes that focus on managing the interpersonal relationships between team members. Team virtuality and virtual teams research has placed great emphasis on the interpersonal aspects of teamwork (Gilson *et al.*, 2015). However, they have mostly focused on interpersonal emergent states rather than processes. Although similar, emergent states refer to the levels at which interpersonal aspects are experienced at the team level, such as the levels of conflict and affective experiences of team members (Mathieu *et al.*, 2017). On the other hand, interpersonal processes refer specifically to the actions that team members perform to manage the level of those states, such as affect and conflict management (Mathieu *et al.*, 2020).

We argue that the communication actions team members use will be relevant for the effectiveness of teams' interpersonal processes as well. For instance, research has shown that actions related to the convergence of meaning can facilitate team members' development of positive and shared emotions (Cheshin, Rafaeli and Bos, 2011) and the management of interpersonal conflicts within teams (Hinds and Mortensen, 2005). Having quick real-time exchanges and using verbal and non-verbal communication facilitate the expression of humour and friendliness, aspects that have been found relevant for the development and management of positive affect within teams (Hareli and Rafaeli, 2008; Van Kleef, Homan and Cheshin, 2012). Moreover, the use of non-verbal communication and involving multiple

participants can help spread the emotions of members, creating a shared affective tone within the team through emotional contagion processes (e.g., through mimicry; Elfenbein, 2014).

Regarding conflict, the use of verbal and non-verbal expressions helps to transmit more social and contextual cues during communications, reducing the possibility of misunderstandings and misattributions. Additionally, using quick back-and-forth exchanges allows team members to clarify and deal with conflicts more easily when they do occur. As Maruping and Agarwal (2004) argued, involving multiple team members is the only action whose impact will depend on the situation. In general, communications that involve multiple team members will help to reduce – and clarify – task and process conflict. The same applies to interpersonal conflict that involves several or all members of the team. However, the interpersonal conflict that occurs at the dyadic level will be better resolved by only including the team members involved in the issue, as the involvement of other members can lead to further noise and misunderstandings of the situation. Having said that, performing communication actions that facilitate the convergence of meaning seems to be a crucial aspect of the management of interpersonal relationships within teams regardless of the developmental stage of the team. Considering this, the following proposition is derived:

Proposition 5: Teams in early and late developmental stages that perform communication actions that facilitate the convergence of meaning, specifically using verbal and non-verbal communications and having high levels of speed of exchanges, will be more effective in their interpersonal processes than teams that use other communication actions.

Discussion and Conclusion

In our analysis, we have proposed that members of modern teams often use multiple communication media, including both ICTs and face-to-face, which can offer different levels of capabilities. Additionally, team members can use media in ways that follow the material attributes of media, but they can also use them in ways that challenge these attributes,

depending on factors such as personal preferences, the task they are trying to perform, and the team context, among others. Considering this, we presented the idea of team communication actions as a way to examine how team members can actually use communication media to support their interactions while they work together. Then, we presented propositions for relationships between these different communication actions and transition, action, and interpersonal processes.

Theoretical Contributions

The idea of team communication actions represents an attempt to integrate and expand the ideas from complementary research streams, such as the examination of technology reliance and computer-mediated communications, into the teams literature. By doing so, this new construct offers important theoretical contributions to the literature that are worth noting. First, this construct allows us to expand the dichotomous view used in past research, particularly of technology reliance in team virtuality, by considering the different possibilities for action that different types of media can offer to team members. Past research examining technology reliance in team virtuality has used a dichotomous approach of face-to-face versus ICT-mediated interactions (e.g., Rapp *et al.*, 2010; Maynard *et al.*, 2012) which glosses over the unique communicational capabilities that different media offer. Past research has usually viewed ICTs as more limited media when compared to face-to-face interactions (Handke *et al.*, 2019; Gibbs and Navick, 2023) due to their reduced media richness and capacity to transmit social and contextual cues (Daft and Lengel, 1984; Sproull and Kiesler, 1986). However, as Media Synchronicity Theory (Dennis, Fuller, and Valacich, 2008) has shown, some ICTs can offer relevant capabilities that are not necessarily offered by face-to-face interactions, such as text-based ICTs that allow communications to persist over time (reprocessability). Moreover, by grouping all ICTs together, this research has ignored (1) that ICTs can offer largely different capabilities, such as text-based emails, which offer lower levels of media synchronicity in comparison to video calls, and (2) that some ICTs offer

similar communicational features than face-to-face interactions, such as video calls which allow to hear and see other communication partners. Because teams have to perform a wide array of tasks with different communicational requirements, taking into account the different capabilities of media is relevant to understanding how team members can use and combine various communication media to be effective in performing their tasks.

Second, the idea of team communication actions also goes beyond deterministic views of media by exploring team members' actual use of media. As several authors have noted, people are not passive users of technology (Markus and Silver, 2008; Orlikowski and Scott, 2008; Leonardi, 2011). They can, and most times will use media in unintended ways, either mistakenly (e.g., by lack of knowledge) or intentionally (e.g., innovation or sabotage; Orlikowski, 2000). The way in which team members will use communication media will be the result of the imbrication between the material capabilities offered by media and the human agency of members, including their goals and needs (Leonardi, 2011). Therefore, identifying how team members actively use their teams' communication media to perform specific communication actions could offer a better understanding of the dynamics that occur within a team than focusing on just the media that they are using. Additionally, by considering how team members use communication media to shape the way they interact with each other, we were able to examine how team members can be effective in performing several teamwork processes that are necessary for the adequate performance of teams.

Examining the actual use of media will also allow researchers to better comprehend the temporal dynamics of team members' interactions. Following the idea of imbrication of Leonardi (2011), the communication actions performed at one point in time will influence the way in which communication media is used in the future. Because of this, teams can develop rigid rules and norms regarding the communication actions they must perform over time (Orlikowski, 2000). However, team members can also decide to use different media or use the same media in different ways for a myriad of reasons. Changes in their communicational

goals and/or needs can change the team communication actions that team members perform. For example, based on results in previous work cycles, previous experiences using the media, or changes in the context, tasks, and team composition can cause them to stop using one or more media, start using new media, or use the same media in new ways. If research assumes a deterministic view of media based on their objective set of capabilities, researchers can fail to capture the adjustments that team members make when using the same set of media but in different ways. These changes in the situated use of media, that is, the communication actions that team members perform over time, could be instrumental in understanding the functioning of teams. Likewise, as this approach is less reliant on specific media, it can also help to quickly include and analyse the newer media developments that occur in the future by examining the actions that team members can perform when using them.

Third, due to the above-mentioned contributions, the idea of team communication actions also contributes to expanding the teams literature by incorporating the examination of communication media usage as an integral part of team dynamics. Up to this point, most research addressing the use of ICTs has focused on teams with some degree of virtuality, that is, in which team members are sometimes or always geographically or temporarily dispersed and, therefore, have to rely on ICTs to communicate with each other. However, there is research showing that most modern teams combine the use of ICTs with face-to-face interactions, even in contexts of no geographical or temporal dispersion (Watson-Manheim and Bélanger, 2007; Gibson *et al.*, 2014; Handke, Klonek, *et al.*, 2020). This way, the idea of team communication actions addresses an important aspect of team functioning and dynamics that is often overlooked in the teams literature. In this article, we integrated team communication actions into the IMOI model (Ilgen *et al.*, 2005), one of the most used in this literature. Additionally, we also presented several propositions regarding how different team communication actions can impact teamwork processes (Marks, Mathieu and Zaccaro, 2001) depending on the developmental stage of the team. To develop these propositions, we build

on the distinction between convergence of meaning and conveyance of information communicational processes from Media Synchronicity Theory.

Future Research

The idea of team communication actions offers several opportunities for future research. First, to use this new construct for empirical research, it is necessary to develop and validate scales to measure the communication actions identified in this article. Second, after the development and validation of new scales, this new construct offers several opportunities for future empirical research in team contexts. New research needs to be done to test the propositions presented in this article, that is, the relationships between the communication actions and team processes in different developmental stages of teams (Marks, Mathieu and Zaccaro, 2001; Maruping and Agarwal, 2004). Another possibility for future research is the examination of the existence of different combinations of communication actions in teams. For example, teams can usually combine high levels of speed of exchanges and verbal and non-verbal communications with low levels of written information in the early stages. To do this, researchers can use empirically-driven statistical analyses such as Latent Class Analysis (LCA) and Latent Profile Analysis (LPA) and their multilevel extensions (i.e., Multilevel LPA and LCA; Oberski, 2016; Mäkikangas *et al.*, 2018) to identify teams with specific patterns of communication actions.

Third, the construct of team communication actions can also promote the development of future theories. In this article, we integrated this new construct into the IMOI model (Ilgen *et al.*, 2005) and also examined how different communication actions can have an impact on transition, action and interpersonal processes (Marks, Mathieu and Zaccaro, 2001). However, future developments can connect this idea with other team-relevant variables, such as team emergent states (Rapp *et al.*, 2021). Future research can also link the idea of team communication actions with other aspects of team virtuality, such as geographical/temporal dispersion or cultural diversity (Gibson *et al.*, 2014; Leonardi, Parker

and Shen, 2024). All these aspects can be relevant in shaping the communicational needs of teams and, therefore, have moderating roles on the effects of team communication action on other variables. Moreover, team communication actions can also be linked to newer conceptualisations of team virtuality, such as those of Handke *et al.* (2020), which argued it as an emergent state based on information deficits and perceived distance between team members. The communication actions of members could be relevant to understanding how the different communication actions can create low or high levels of information deficits and perceptions of distance in teams.

Future theories can also expand the list of communication actions identified in this article. For instance, based on empirically driven work and due to the development of new technologies and capabilities, researchers can identify other team communication actions that have not been considered in this article. The developments in the technological affordances literature can be relevant for this as they have covered a wide range of possibilities for actions that ICTs offer to users (Gibbs and Navick, 2023; Lane *et al.*, 2023). Lastly, this construct might inspire future developments that aim to integrate theories and empirical research from different streams into the teams literature.

Practical Contributions

This new theoretical development presents relevant practical contributions for managers and team leaders. After the ease of the restrictions to fight the COVID-19 pandemic, team members are combining the use of face-to-face interactions and ICTs more than ever before. Many organisations have decided to implement hybrid work settings in which team members work some days from their homes and others from a common location (e.g., their office) (McKinsey, 2022; Office for National Statistics, 2022). However, it is likely that even teams from organisations that decided to go back to pre-pandemic office work are still using some of the ICTs they relied heavily on during the pandemic. The ideas of team communication actions can be helpful in offering guidelines and support to managers

and team leaders in this context. The differentiation between communication actions that facilitate the convergence of meaning or the conveyance of information can help team leaders promote specific communication actions that help their teams be effective with the process they are performing (e.g., planning, coordination, information sharing, or managing conflict) at a particular stage of their teams.

The above is particularly relevant for virtual teams that may have sporadic access, or no access at all, to face-to-face interactions. Based on the propositions formulated in this article, virtual team leaders can plan certain instances where having access to specific communication actions is relevant. For example, transition processes benefit from the convergence of meaning actions, such as using verbal and non-verbal expressions, having high-speed exchanges, and involving multiple participants. Considering that virtual teams usually involve a high degree of geographical and/or temporal distance between team members, they can have issues in performing these actions that require some degree of co-presence (Lampinen, Tamminen and Oulasvirta, 2009). This way, team leaders can facilitate that meetings where transition processes will be performed (e.g., planning, goal specification, and strategy formulation) occur through alternative media that facilitate convergence of meaning actions, such as video calls. Similarly, as past research has shown, virtual teams can present issues in their interpersonal dynamics, such as presenting more conflict and more difficulties managing conflict (Gilson *et al.*, 2015). Based on our propositions, team leaders can promote that when conflicts arise within the team, they are managed using media that allows for convergence of meaning actions, too. Lastly, these ideas can also help to inform upper and human resources managers' decisions in organisations. They can support workers by offering training regarding the different actions they can perform using media and how they can match their specific communicational needs.

Conclusion

The construct of team communication actions developed in this article addresses the fact that modern teams will use and combine different types of communication media. Unfortunately, the teams literature has been slow in incorporating and examining the influence that the use of different communication media has on team dynamics and, ultimately, on their effectiveness. This construct represents an important step in addressing this limitation by offering a more nuanced view of face-to-face and ICT-mediated interactions based on the capabilities that they can offer to team members. However, this construct also challenges deterministic views of technology and media by taking into consideration the actual way in which team members use media in their teams, which depends not only on the material attributes of media (capabilities) but also on their communicational goals and needs. Based on this, we were able to identify eight different communication actions that team members can perform using media to shape the way they interact with each other. Then, several propositions were formulated examining how these eight different communications can be instrumental in performing different teamwork processes (i.e., transition, action, and interpersonal ones) that are necessary for teams to be successful in their work. In conclusion, the study of team communication actions represents a promising avenue for researchers to understand how communication media and the way it is used by team members can impact team dynamics and the effectiveness of teams.

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ARTICLE 2: SCALE DEVELOPMENT AND VALIDATION

Developing and Validating a Scale to Measure Team Communication Actions

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Abstract

This article describes the development and validation process of a scale to measure the construct of team communication actions and its eight dimensions. Five different samples containing a total of 1738 individuals were collected to validate this scale. Two samples of 93 and 89 team members were used to validate the content of the scale in Spanish and English, respectively. Additionally, two samples of 303 and 302 team members were used to validate the scale's internal structure at the individual level in Spanish and English, respectively, by performing reliability, confirmatory factor analyses, and measurement invariance tests. Lastly, a sample of 951 team members in 268 teams from two organisations in Latin America was gathered to test the scale's internal structure, discriminant, and predictive validity at the team level. To test the discriminant and predictive validity, we used measures of team virtuality's subdimensions (i.e., technological reliance and configurational dispersion) and teamwork variables (i.e., transition, action, and interpersonal processes) and performed correlational and hierarchical regression analyses. This new scale offers researchers an easy-to-use and flexible tool to study team communication actions, which can help further our understanding of how media use impacts team functioning.

Keywords: team communication actions, content validity, internal structure validity, discriminant validity, predictive validity

Introduction

After the end of the COVID-19 pandemic, team members are using multiple communication media more than ever before, including face-to-face interactions and information and communication technologies (ICTs, e.g., video calls, chat, emails, and online platforms). In this context, studying the impact of the use and combination of different types of communication media could be instrumental in understanding how modern teams are effective in performing their tasks. However, one challenge researchers face is that most theories and scales in the literature have been developed by adopting reductionist and deterministic views of communication media, particularly of technology (Gibson *et al.*, 2022). One example is team virtuality research, which has tried to understand how technological reliance, the degree to which team members interact through ICTs, can impact several teamwork processes. To do this, researchers have usually measured virtuality by aggregating the proportion of time that team members spend communicating through any type of ICT versus face-to-face interactions. Often, this approach assumes that ICTs represent less favourable means of communication by offering less social and contextual cues than face-to-face exchanges (Gibbs and Navick, 2023). By doing so, this approach has glossed over the different functions and capabilities that different types of ICTs can offer to team members (Maruping and Agarwal, 2004; Dennis, Fuller, and Valacich, 2008). For instance, emails can offer important documentation features to team members which are not necessarily offered by face-to-face communications.

By focusing on media and its objective attributes, past approaches have also fallen into deterministic views of communication media. As non-deterministic theories have argued, it is relevant to pay attention to how team members use media and technologies, which can vastly differ from their material attributes (Orlikowski, 2000; Markus and Silver, 2008; Leonardi, 2011). Thus, team members can use communication media by following their objective capabilities, but they can also ignore some or all its capabilities, use media in

creative or innovative ways, or modify the material capabilities of media. One of the most recent theoretical developments that have tried to bridge the gap between deterministic and non-deterministic views of communication media is the construct of team communication actions (Perez-Sepulveda, Axtell and Dawson, article 1 in this thesis). This construct identifies eight different actions that team members can perform using the media they have at their disposal in their teams. These actions emerge from the imbrication of different aspects, with just one of them being the objective attributes of media.

Considering the above, this article has two main objectives. First, to describe the development process of a scale to measure the team communication actions identified by Perez-Sepulveda *et al.* (article 1) in English and Spanish. Second, to analyse the validity of this scale by presenting evidence of content, internal structure, discriminant, and predictive validity.

Team Communication Actions

Team communication actions represent "a set of actions that team members can perform using communication media that will shape the way in which they interact with each other while performing their tasks" (Perez-Sepulveda, Axtell and Dawson, article 1, p. 48). According to the authors, the actual actions that team members perform over the available media set will emerge from the combination of multiple factors. These factors involve (1) the objective capabilities that the media offers, (2) the team design (e.g., autonomy, interdependency) and characteristics of the tasks they must perform (e.g., complexity), (3) team members characteristics, such as their personal preferences, knowledge, and skills with the media, and geographical dispersion between members; and (4) the team context such as organisational policies. While the objective attributes of media are relevant because they constrain and, at the same time, enable the actions of team members (Malhotra, Majchrzak and Lyytinen, 2021; Willems, 2021), they represent just one of the contributing factors to the emergence of team communication actions.

Dimensions of Team Communication Actions

Building on Media Synchronicity Theory (Dennis, Fuller, and Valacich, 2008), Perez-Sepulveda and colleagues (article 1) identified eight different communication actions that team members can perform over media and their capabilities. Media capabilities represent the objective material attributes that media offer to users. For example, video calls offer high levels of natural symbols (Maruping and Agarwal, 2004; Dennis, Fuller and Valacich, 2009) as they allow users to communicate using verbal and non-verbal aspects of communication (e.g., voice intonation and body language). In contrast, team communication actions represent the behaviours that team members perform over these capabilities. Following the previous example, video calls offer the possibility to perform an action to users, but the focus on team communication actions is on whether team members actuate that potential and, indeed, communicate using verbal and non-verbal expressions (e.g., if they use body gestures when they communicate with each other). Accordingly, the media capabilities identified in Media Synchronicity Theory are static if the materiality of media does not change, while team members' communication actions can vary over time. The authors identified the following eight different actions (Perez-Sepulveda, Axtell and Dawson, article 1, p. 52):

1) Verbal and non-verbal communications: Team members use the team's media to interact using their voice, facial and body expressions (e.g., smiles and gestures).

2) Written communications: Team members use the team's media to send written messages and information (e.g., documents, tables, and numerical reports).

3) Graphical communications: Team members use the team's media to send images, pictures, and graphs.

4) Speed of exchanges: Team members use the team's media to reply quickly, or slowly, to other members' messages.

5) Multiple participants: Team members use the team's media to involve multiple members in their interactions. Lower levels in this subdimension indicate that team members communicate often in dyads rather than involving the whole team.

6) Simultaneous communications: Team members use the team's media to have multiple simultaneous communications through one or more media. Lower levels of this subdimension indicate that team members usually focus on just one communication at a time.

7) Refining communications: Team members use the team's media to edit and refine their messages before communicating them.

8) Reviewing communications: Team members use the team's media to access other members' communications multiple times after receiving them.

Based on the two communicational processes identified by Media Synchronicity Theory, the authors argued that some of these actions would facilitate the convergence of meaning, that is, developing a shared understanding between team members (Dennis, Fuller, and Valacich, 2008): verbal and non-verbal communications, speed of exchanges, and multiple participants. In contrast, simultaneous communications, written communications, graphical communications, refining messages, and reviewing messages will facilitate the conveyance of information, that is, sending new information to help other team members to form or revise a mental model of a subject.

Scale Development and Validation

Following recommendations from past research, we used a multi-step approach to the scale development process (see Figure 1) (American Educational Research Association *et al.*, 2014; DeVellis and Thorpe, 2021). Specifically, the process consisted of (a) the development of an initial pool of items in English and translation to the Spanish language, (b) collecting evidence of their content validity based on an expert revision in English, and naïve judges' revision in English and Spanish, (c) collecting evidence of its internal structure validity at the

individual in English and Spanish, and (d) collecting evidence of its internal structure, discriminant, and predictive validity at the team level.

Figure 1

Diagram of the Scale Development and Validation Process
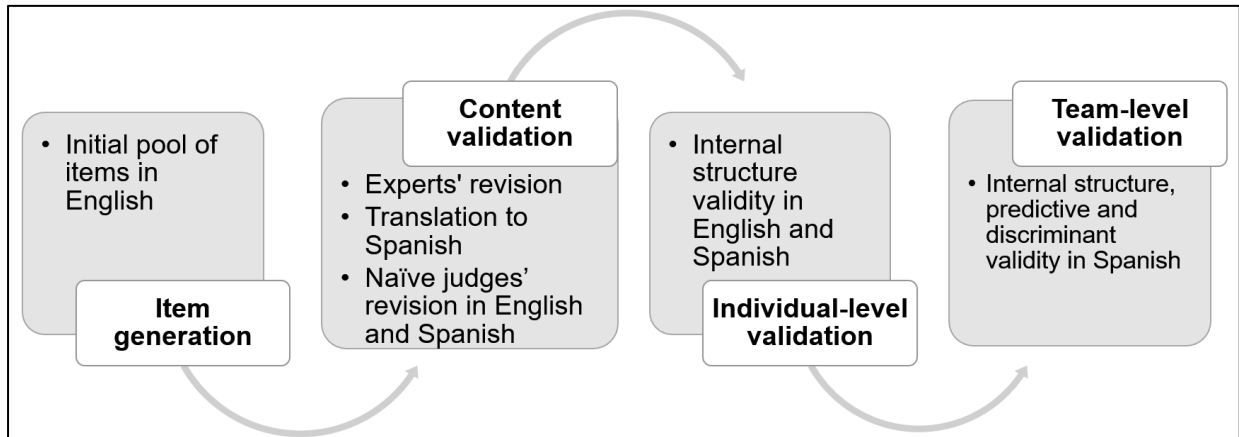
Item Generation and Translation

An initial pool of 50 items, approximately seven items per subdimension, was developed in English (e.g., speed of exchanges, "Usually, we reply quickly to communications within the team"). Following the Chan (1998) typology, we used a referent-shift model in which every item was developed to refer to the team level of analysis using the stem "When members of my team communicate using the team's communication media…". This was done to make sure that team members think about all the communications that occur within the team rather than only think about the communication actions that they perform individually. Each item used a 5-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. We checked every item to ensure that its formulation avoids typical issues in the item development process, such as double barrel (capturing two contents), excessive length, and biased phrasing (e.g., negatively or positively worded items) (Dillman, 2011; DeVellis and Thorpe, 2021). An initial priming task was also developed with the purpose of reminding team members of all the different communication media they use in their team. To achieve this, the task asks team members how frequently (1: never to 5: always) they

communicate using different communication media: face-to-face interactions, video calls, phone calls, emails, chat, and sharing documents platforms, among others.

Content Validation – Experts

We contacted eight scholars who have recently published in the computer-mediated communication and/or team virtuality literature to assess the content validity of the initial pool of items. Content validity refers to whether the content of a scale and its items reflect the definition of the construct they attempt to measure (DeVellis and Thorpe, 2021). Six of the scholars agreed to participate based on their expertise on the topic. We shared with them the definitions of the eight team's communication actions, together with the pool of 50 items. Each expert was asked to assess the items in terms of their relevance towards the construct they intend to measure and their clarity of formulation using a three-point scale (low, moderate, and high). Also, experts had the opportunity to leave comments on the priming task and the overall scale in case we were missing relevant content in the set of items. Based on their feedback, we selected 34 items that had average scores above the 2.0 cutoff point on both relevance and clarity of formulation to continue with the validation process. Additionally, four additional items were created to address missing content based on the experts' suggestions.

After this revision, the scale, consisting of 38 items, and the priming task were translated into Spanish using a blind back translation procedure (Brislin, 1970). First, the scale was translated from English to Spanish by the first author, and then, a professional translator translated the items back from Spanish to English using only the Spanish version of the items as a reference. After this, the first author matched the original and the back-translated English versions of the items to correct any mistakes in their formulation. After the blind back translation process, the English and Spanish versions of items were reviewed by two academics fluent in both languages to assess the fidelity and clarity of the translation. All

items received strong scores in terms of the fidelity of the translation, and minor comments regarding the clarity of the Spanish version were addressed at this point.

Content Validation – Naïve Judges

Analysis Strategy

Anderson and Gerbing (1991) argued the relevance of assessing the content validity of scales by judges that are representative of the population of interest where the scales will be used. Commonly, researchers have relied on subject experts to assess the content validity of scales, but this approach has its limitations. Subject experts can detect subtle distinctions between items that are relevant to correctly determining the construct the item is trying to measure. However, when non-experts read the items, those differences can go unnoticed and, therefore, the item can evoke something different from the intended construct. Considering this, Anderson and Gerbing (1991) proposed a procedure for assessing the substantive content validity of items using naïve judges. Their approach consists of presenting a set of multiple construct definitions and a set of items to the reviewers. Then, reviewers must read each item and then select the construct's definition that they think the item is trying to measure.

Based on the reviewers' responses, Anderson and Gerbing (1991) proposed the calculation of two statistical indicators: the proportion of substantive agreement (*Psa*) and the substantive validity coefficient (*Csv*). The proportion of substantive agreement is a measure of the definitional correspondence of the item, that is, the degree to which the item corresponds to the construct definition (Colquitt *et al.*, 2019). This proportion is calculated by dividing the number of reviewers that assigned the item to its intended dimension by the total number of reviewers. This index ranges from 0 to 1, with higher values indicating higher levels of definitional correspondence. The substantive content validity (*Csv*) is a measure of the definitional distinctiveness of the item, that is, the degree to which the item 'corresponds more to the definition of the focal construct than to the definition of other orbiting constructs' (Colquitt *et al.*, 2019, p. 1243). This index is calculated by subtracting the number of

reviewers that assigned the item to its most frequent orbiting (incorrect) construct from the number of reviewers that assigned the item to its focal (correct) construct and then dividing this by the total number of reviewers. This index can range from -1 to 1, with higher negative values indicating that the item corresponds more to an orbiting construct than the focal construct and higher positive values indicating that the item corresponds more to the focal construct than an orbiting one. This is a more stringent test because it compares how consistently reviewers assigned the item to its intended category against their next most frequent category instead of a 'random' baseline (Mathieu *et al.*, 2020).

To test the content validity of our scales in both Spanish and English languages, we collected two different samples. Based on the results of the content validation and also the individual-level internal structure validation (which will be reported in the following section), we arrived at a final version of the scale consisting of 25 items (see Appendix A). However, it is important to mention that when performing the analyses on the Spanish samples (which were collected before in time), we noted the need to split the writing and graphical communications subdimensions that originally were considered together as one dimension called 'digital communications' consisting of five items. This way, as shown in Table 1, one additional item was developed and added to the graphical communications subdimension to have three items to measure this subdimension in the English sample.

Table 1

Definitional Correspondence and Distinctiveness Indices, Means, Standard Deviations and

Factor Loadings at the Individual in the Spanish and English-speaking Samples

Items	*Psa*	*Csv*	M	SD	Loadings	*Psa*	*Csv*	M	SD	Loadings
		Spanish-speaking sample					English-speaking sample			
VNC1	.90	.86	4.15	.88	.69	.93	.90	4.20	.87	.78
VNC2	.88	.82	3.80	.97	.82	.85	.74	4.00	1.05	.88
VNC3	.76	.65	4.17	.90	.77	.87	.80	4.26	.85	.72
VNC4	.98	.97	3.54	1.15	.65	.96	.93	3.56	1.10	.69
WC1	.90	.84	3.66	1.02	.76	.88	.80	3.33	1.08	.91
WC2	.85	.78	4.07	.79	.72	.87	.76	3.34	1.11	.94
WC3	.82	.73	4.04	.87	.60	.72	.61	3.93	.94	.69
GC1	.95	.89	2.82	1.07	.82	.99	.98	2.36	1.07	.89
GC2	.90	.82	2.67	1.07	.84	.89	.80	2.34	1.06	.92
GC3*						.72	.46	2.40	1.08	.85
SE1	.98	.96	3.74	.84	.83	1.00	1.00	4.10	.70	.84
SE2	.98	.97	3.91	.82	.93	.99	.98	4.14	.71	.95
SE3	.96	.95	3.91	.85	.82	.98	.97	3.92	.87	.69
MP1	.99	.98	3.76	.90	.86	.98	.97	3.87	.82	.80
MP2	.98	.96	3.55	.98	.89	.96	.93	3.80	.83	.88
MP3	.96	.94	3.60	.95	.66	.96	.93	3.80	.85	.82
SC1	.99	.98	3.06	1.15	.88	.98	.97	3.49	.95	.91
SC2	.97	.94	2.97	1.16	.95	.99	.98	3.48	1.02	.94
SC3	.97	.95	2.97	1.18	.84	.96	.93	3.41	1.06	.95
RFM1	.84	.72	3.70	.96	.96	.85	.81	3.90	.87	.94
RFM2	.85	.72	3.79	.92	.89	.90	.72	3.89	.84	.86
RFM3	.88	.77	3.40	1.17	.71	.92	.85	3.75	.89	.78
RVM1	.84	.69	2.87	1.07	.88	.90	.84	3.34	.96	.90
RVM2	.90	.83	2.98	1.08	.82	.88	.76	3.49	.93	.79
RVM3	.71	.59	2.98	1.04	.72	.67	.48	3.32	.96	.85

Note. VNC = Verbal and non-verbal communications. WC = Written communications. GC =

Graphical communications. SE = Speed of exchanges. MP = Multiple participants. SC =

*Simultaneous communications. RFM = Refining messages. RVM = Reviewing messages. * Item 3*

of graphical communications was developed after reviewing the content and individual-level

internal structure validity in the Spanish-speaking sample.

Spanish Language Sample

Using an online snowball sampling strategy (Baltar and Brunet, 2012), we distributed a survey through social media platforms such as Instagram, LinkedIn, Facebook, and Twitter. We invited people over 18 years old who were working as part of work teams and for whom Spanish was their first language to answer the survey. We received 93 full responses to the survey after deleting participants who responded without paying close attention to the instructions, which were checked using Instructional Manipulation Checks (IMC; Gosling and Mason, 2015). Participants were 54% females, their average age was 35.2 years old (SD = 9.9), 97% have undergraduate studies or above, their average organisational tenure was 6.5 (SD = 9.7), team tenure was 4.9 (SD = 7.2), and 63% stated that their organisation was in the service sector (e.g., transportation, finances, and health).

English Language Sample

We distributed a survey through the Prolific platform in which participants are paid a fee for answering surveys. The survey was distributed to individuals who were over 18 years old, who were working as part of work teams, and which English was their first language. 89 full responses were received after deleting participants who responded carelessly, which again was checked using IMC (Gosling and Mason, 2015). Participants were 48% females, their average age was 41.8 years old (SD = 11.9), 71% have undergraduate studies or above, their average organisational tenure was 8.3 (SD = 7.4), team tenure was 5.2 (SD = 5.4), and 54% stated that their organisation was in the service sector.

Results

First, we tested for differences in the proportion of correct/incorrect classifications of each item between the Spanish and English-speaking samples using two-sample Z-tests of proportions. There were no significant differences between the two samples in any of the items ($p \geq .05$).

Regarding the Spanish-speaking sample, on average, 87% (SD = 11%) of the non-experts assigned items to their intended subdimension (*Psa*). Items percentages ranged from 71% to 99% (see Table 1). Specifically, (1) the verbal and non-verbal communications subscale mean was 88%, with items ranging from 76% to 98%, (2) the written communications subscale mean was 86%, range from 82% to 90%, (3) the graphical communications subscale was 92%, range from 90% to 95%, (4) the speed of exchanges subscale mean was 97%, range from 96% to 98%, (5) the multiple participants subscale was 97%, range from 96% to 99%, (6) the simultaneous communications subscale was 97%, range from 97% to 99%, (7) refining messages subscale was 86%, range from 84% to 88%, and (8) the reviewing messages subscale was 82%, range from 71% to 90%. Using Colquitt et al. (2019) guidelines to assess content validity, one item presented evidence of weak content validity (72%, item 3 of reviewing messages, "Usually, we see or listen to the communications from other members many times") and one item presented evidence of moderate agreement (76%, item 3 of verbal and non-verbal communications, "Usually, we can hear each other when we communicate"). All remaining items presented evidence of strong or very strong content validity (>= .81).

On average, 90% (SD = 10%) of the English sample non-experts assigned items to their intended subdimension. Items percentages ranged from 67% to 100%. Specifically, (1) the verbal and non-verbal communications subscale mean was 90%, range from 85% to 96%, (2) the written communications subscale mean was 82%, range from 72% to 88%, (3) the graphical communications subscale was 87%, range from 72% to 99%, (4) the speed of exchanges subscale was 99%, range from 98% to 100%, (5) the multiple participants subscale was 95%, range from 96% to 98%, (6) the simultaneous communications subscale was 97%, range from 96% to 99%, (7) the refining messages subscale was 89%, range from 85% to 92%, and (8) the reviewing messages subscale was 82%, range from 67% to 90%. Just one item presented evidence of weak content validity (item 3 of reviewing messages, 67%). Two

items presented evidence of moderate content validity (72% and 72%, respectively, item 3 of written communications, "We often share written information with each other", and item 3 of graphical communications, "Usually, we communicate with each other using visual representations"). The remaining items presented evidence of strong or very strong content validity (≥ 81%).

Regarding the substantive content validity index, items ranged from .59 to .98 on the Spanish sample. Using the Colquitt *et al.* (2019) guidelines, one item presented evidence of moderate content validity (.59, item 3 of reviewing messages), and its second most frequent category was simultaneous communications. The remaining items presented evidence of strong or very strong content validity (≥ .61). On the English sample, items ranged from .46 to 1.00. Two items presented evidence of weak content validity: item 3 of graphical communications (.46), whose second most frequent category was verbal and non-verbal communications, and item 3 of reviewing messages (.48), whose second most frequent category was simultaneous communications. The remaining items presented evidence of strong or very strong content validity (≥ .61).

Individual level - Internal Structure Validation

Analysis Strategy

After reviewing the content validity of the items, two separate samples were collected to assess the internal structure validity of the scale at the individual level in English and Spanish, respectively. Internal structure validity refers to the evidence that each item and component of the scale conform to the construct they are trying to measure (American Educational Research Association *et al.*, 2014). As this scale contains several dimensions, the internal structure validity also involves reviewing (1) that the different components are distinct from each other and (2) that the items intended to measure a particular component are related to each other and their underlying subdimension, but not to items/underlying subdimensions of other components. Usually, internal structure validity evidence is collected

by performing reliability and exploratory or confirmatory factor analysis depending on the robustness of the theories that support the scale (MacKenzie, Podsakoff, and Podsakoff, 2011; DeVellis and Thorpe, 2021).

Reliability refers to the capacity of a scale to render results that represent (to some degree) the true scores of the construct they are measuring (DeVellis and Thorpe, 2021). Higher reliability indices reflect that the scale is measuring the construct with lower levels of measurement error. One of the most common ways to check reliability for multi-item scales is to check for the internal consistency of the items, that is if the items are measuring the same underlying construct, using Cronbach's (1951) Alpha (Tavakol and Dennick, 2011). We also tested the internal consistency using McDonald's (1999) Omega because Cronbach's Alpha has been questioned because of its unidimensionality and tau-equivalence assumptions (i.e., that all items in the scale have the same relationship with the latent construct; Hayes and Coutts, 2020). Exploratory Factor Analysis and Confirmatory Factor Analysis with a maximum-likelihood estimator was used to check the relationships between items (observed variables) and the dimensions (latent factors) (Brown, 2015). Lastly, measurement invariance tests were used to check for the psychometric equivalence between the two languages of the survey in terms of their configural, metric, and scalar levels (Cheung and Rensvold, 2002; Putnick and Bornstein, 2016). Configural invariance examines if the configuration of dimensions (number of factors) and the specific items loaded onto them are equivalent across samples (Luong and Flake, 2022). Metric invariance tests determine if the loadings of the items in their respective subdimensions are equivalent between the samples, in addition to the restrictions of the configural invariance. In other words, it checks if the relationship between each item and its associated underlying subdimension stays the same between the samples. While maintaining the previous restrictions, scalar invariance tests that the intercept of the items is equivalent between the samples. When scalar invariance is achieved, different

samples or groups can be compared using their observed or latent results for the constructs tested (Luong and Flake, 2022).

Individual-level – Spanish Language Sample

An online survey was distributed using a snowball sampling strategy on social media platforms (i.e., LinkedIn, Instagram, Facebook, among others). The inclusion criteria for participation were that participants were over 18 years old, were working as part of work teams, and were native speakers of Spanish. We received 303 responses after deleting careless responses. Participants were 60% females, their average age was 34.80 years old (SD = 9.6), 98% have undergraduate studies or above, their average organisational tenure was 4.36 (SD = 5.8), average team tenure was 3.4 (SD = 4.6), and 52% stated that their organisation was in the service sector.

English Language Sample

An online survey was distributed through the Prolific platform to people who were over 18 years old, native speakers of the English language and working as part of work teams. After deleting cases that did not pay close attention to the survey, the final sample consisted of 302 individuals. Participants were 51% females, their average age was 38.6 years old (SD = 12.0), 70% have undergraduate studies or above, their average organisational tenure was 7.15 (SD = 6.9), average team tenure was 4.50 (SD = 4.5), and 61% stated that their organisation was in the service sector.

Results

As shown in Table 2, analyses of the Spanish and English-speaking samples showed adequate levels of reliability based on Cronbach's Alpha and McDonald's Omega indices (>.70) for all the subscales (Taber, 2018). Exploratory Factor Analyses using oblimin rotation showed that the items loaded onto their respective latent variable or factor (please see Appendix D for the detail of each item). Regarding the Confirmatory Factor Analysis, Mathieu and Taylor (2006) propose that values of CFI < .90 and SRMR >. 10 are deficient;

values of CFI from .91 to .95 and SRMR between .10 and .08 are acceptable, and values of

CFI $\geq$ .95 and SRMR $\leq$ .08 are excellent. Considering this, our tests showed excellent fit

indices for the 8-dimension model in the Spanish-speaking sample χ^2 (224) = 372.97, $p <$

.01, RMSEA = .05, SRMR = .05, CFI = .96, TLI = .95; and the English-speaking sample χ^2

(247) = 350.24, $p <$ .01, RMSEA = .04, SRMR = .04, CFI = .98, TLI = .98. Additionally, all

items presented factor loadings above .60 ($p <$ .01) on their respective subscales (see Table

1). Correlations between the latent factors in the Spanish-speaking sample ranged from -.13

to .45 and from -.42 to .46 in the English-speaking sample. These results showed adequate

distinction between the eight different subscales.

Table 2

Sample Sizes, Means, Standard Deviation and Reliability Indices of the Team Communication

Actions Scales in the Spanish and English-speaking Samples

Scales	Spanish-speaking Sample					English-speaking Sample				
	N	**M**	**SD**	α	ω	*N*	**M**	**SD**	α	ω
Verbal and non-verbal communications	303	3.92	.78	.81	.83	302	4.00	.81	.84	.86
Written communications	303	3.92	.72	.72	.74	302	3.54	.94	.88	.89
Graphical communications	303	2.74	.98	.82	.82	302	2.37	.99	.92	.92
Speed of exchanges	303	3.85	.76	.89	.90	302	4.05	.67	.85	.87
Multiple participants	303	3.64	.83	.84	.85	302	3.82	.74	.87	.87
Simultaneous communications	303	3.00	1.08	.92	.92	302	3.46	.97	.95	.96
Refining messages	303	3.63	.91	.87	.89	302	3.85	.79	.89	.90
Reviewing messages	303	2.94	.93	.85	.86	302	3.38	.85	.88	.89

Chen (2007) proposed the following cut-off points for testing measurement invariance with adequate sample sizes (≥ 300) and with equal-sized samples between groups: Δ CFI $\geq$ -.010, Δ RMSEA $\leq$ .015, Δ SRMR $\leq$ .010. Our analyses (see Table 3) showed that the two measurements were invariant at the metric level (loadings) but not at the scalar level (intercepts). We reviewed the intercepts with large differences across samples and let the second item of the written communication scale be freely estimated (Putnick and Bornstein, 2016). After this adjustment, results showed that both scales presented partial invariance at the scalar level. One potential explanation for the differences in intercepts of this item between the two samples is that for the Spanish-speaking survey, this item was presented as the last (sixth) item of the subdimension scale, while in the English survey, it was presented in the second place (see the Discussion section for further details on this topic).

Team level - Internal Structure Validation

Analysis Strategy

     Samples from two different organisations were collected (see below for descriptions of each sample). Like the individual-level analyses, reliability, exploratory and confirmatory factor analyses were used to test the internal structure validity of the scales at the team level. Because of the large sample size ($N > 200$) requirements of confirmatory factor analyses, we tested the measurement invariance between the samples from the two organisations to check if we could group them together. Our analysis (see Table 4) showed that there was invariance between the two organisations using Chen's (2007) stricter guidelines for samples with less than 300 cases (Δ CFI $\geq$ -.005, Δ RMSEA $\leq$ .010, Δ SRMR $\leq$ .005).

Table 3

Measurement Invariance Test of the Team Communication Actions Scales between Spanish and English-speaking Samples

Invariance	χ^2 (df)	CFI	RMSEA	SRMR	$\Delta \chi^2$ (df)	Δ CFI	Δ RMSEA	Δ SRMR
Configural	694.48 (448)**	.971	.043	.045				
Metric	743.75 (464)**	.967	.045	.049	49.26 (16)**	-.004	.002	.004
Scalar	872.34 (480)**	.954	.052	.053	128.59 (16)**	-.013	.007	.004
Scalar - partial	817.20 (479)**	.961	.048	.051	73.46 (15)**	-.007	.004	.002

Note. ** $p < .01$; * $p < .05$. The partial scalar invariance test allows the intercept of the second item of the using written communications subdimension to be freely estimated across the two samples.

Table 4

Measurement Invariance Test of the Team Communication Actions Scales between Manufacturing and Insurance Companies and between

Spanish and Portuguese-speaking Samples

Invariance	χ^2 (df)	CFI	RMSEA	SRMR	$\Delta \chi^2$ (df)	Δ CFI	Δ RMSEA	Δ SRMR
Manufacturing vs. Insurance company								
Configural	1041.97 (494)**	.968	.048	.037				
Metric	1067.30 (511)**	.967	.048	.038	25.33 (17)	-.001	.000	.001
Scalar	1127.11 (528)**	.965	.049	.039	59.81 (17)**	-.002	.001	.001
Spanish-speaking vs Portuguese-speaking								
Configural	960.52 (494)**	.960	.052	.041				
Metric	1001.96 (511)**	.958	.053	.043	41.44 (17)**	-.002	.001	.002
Scalar	1041.44 (528)**	.956	.053	.043	39.48 (17)**	-.002	.000	.000

Note. ** $p < .01$; * $p < .05$.

Because every team member is rating a team-level construct (referent-shift consensus model; Chan, 1998), we calculated Interrater Agreement and Interrater Reliability indexes (i.e., intraclass correlations, ICCs, average deviations, and r_{WG}) to check the suitability of aggregating items and subscales to the team level (LeBreton and Senter, 2008). ICC1 represents the "reliability of an individual's rating of the group mean" (Mathieu *et al.*, 2020, p. 410) and also the effect size of team membership on the variance of the item/subscale (i.e., the proportion of variance attributable to team membership). LeBreton and Senter (2008) proposed that values ≥ .01 can be considered as a small effect, values ≥ .10 as a moderate effect, and values ≥ .25 as a large effect. Several researchers recommend reporting values of ICC2 for clarity, consistency, and transparency (Bliese, Maltarich and Hendricks, 2018; LeBreton, Moeller and Wittmer, 2023). ICC2 represents the stability or reliability of the group mean rating, allowing researchers to assess how effective group mean scores are at distinguishing between the different groups of the sample (Bliese, 2000; LeBreton, Moeller and Wittmer, 2023). Based on these analyses, most of our items and scales presented small effect sizes (.01 - .10), except for using quick exchanges and refining messages, which presented ICC1 values of .00 (see Table 5).

While ICCs provide information about interrater reliability, they should not be confused with measurements of interrater agreement (LeBreton and Senter, 2008). Specifically, researchers cannot attribute low ICC values to a lack of agreement between raters because they depend at least partially on the between-group variance (Mathieu *et al.*, 2020). Considering this, several measurements of interrater agreement have been proposed to address this limitation. The most used in the literature is the r_{WG} index developed by James, Demaree and Wolf (1984). r_{WG} is a measure of agreement based on the proportional reduction in error variance. The main assumption of r_{WG} is "that each higher-level unit (e.g., team) has a single 'true score' on the focal construct (e.g., justice). Thus, any observed variance within

units… may be attributed to random error variance (LeBreton, Moeller and Wittmer, 2023, p. 244)". Then, the agreement is estimated by contrasting the observed variance within each higher-level unit to the variance that would be expected if the raters' scores were due entirely to random error (James et al., 1984). The most used distribution is a null rectangular (or uniform) distribution. We followed the guidelines proposed by Mathieu et al. (2020) of median r_{WG} values over .70 for multi-item scales to justify aggregation and median r_{WG} values of .60 for single items. As shown in Table 5, all our items and subscales were above these values.

Although r_{WG} is the most used index of interrater agreement, it has been criticised because it uses an arbitrary distribution to calculate the agreement of raters (LeBreton, Moeller and Wittmer, 2023). Considering this, we used the Average Deviation (AD) index as a second measure of interrater agreement. AD, developed by Burke *et al.* (1999), represents a more pragmatic measurement of agreement because it estimates agreement in the metric of the original scale of the items (Burke and Dunlap, 2002). ADs were computed based on the mean of the groups' raters. Higher values indicate lower levels of agreement, while scores of zero represent perfect agreement. LeBreton and Senter (2008) proposed that values below .80 represent enough levels of agreement to justify the aggregation of responses to higher-unit levels for 5-point scales. As shown in Table 5, all items and scales presented values below this cutoff point.

Considering the results mentioned above, we aggregated team members' responses at the team level. The final dataset over which the reliability and exploratory/confirmatory factor analyses were performed comprised 268 teams, with team sizes ranging from 2 to 16 (M = 5.6; SD = 3.0) and number of responses per team ranging from 2 to 13 (M = 3.6; SD = 1.9).

Table 5

Means, Standard Deviations, Indices of Interrater Agreement and Reliability, and Factor

Loadings of the Items at the Team Level

Items	M	SD	ICC1	ICC2	r_{WG}	AD	Loadings
VNC1	4.3	0.4	.00	.00	.83	.44	.62
VNC2	4.1	0.5	.03	.94	.83	.45	.76
VNC3	4.4	0.4	.00	.00	.85	.37	.84
VNC4	3.7	0.6	.01	.87	.67	.63	.59
WC1	3.5	0.6	.07	.97	.75	.55	.75
WC2	3.7	0.6	.04	.96	.75	.54	.92
WC3	3.9	0.5	.03	.93	.83	.45	.80
GC1	3.1	0.6	.06	.97	.75	.61	.91
GC2	3.1	0.6	.03	.94	.67	.61	.96
GC3	3.2	0.6	.04	.95	.67	.61	.89
SE1	4.1	0.5	.00	.37	.83	.42	.86
SE2	4.3	0.5	.00	.55	.83	.40	.95
SE3	4.2	0.5	.00	.00	.83	.42	.88
MP1	4.2	0.5	.01	.79	.83	.37	.86
MP2	4.1	0.55	.01	.80	.83	.43	.85
MP3	4.1	0.5	.02	.91	.83	.41	.85
SC1	3.7	0.6	.01	.87	.75	.58	.90
SC2	3.6	0.6	.01	.85	.73	.63	.86
SC3	3.6	0.6	.01	.83	.75	.61	.92
RFM1	4.2	0.4	.00	.00	.83	.43	.95
RFM2	4.2	0.4	.00	.00	.83	.42	.93
RFM3	4.1	0.5	.00	.00	.83	.43	.84
RVM1	3.4	0.6	.02	.92	.75	.60	.90
RVM2	3.3	0.7	.03	.93	.75	.60	.96
RVM3	3.3	0.6	.01	.85	.75	.60	.89

Note. N = 951 members / 268 teams. VNC = Verbal and non-verbal communications. WC =

Written communications. GC = Graphical communications. SE = Speed of exchanges. MP =

Multiple participants. SC = Simultaneous communications. RFM = Refining messages. RVM

= Reviewing messages.

Manufacturing Company

The first organisation that agreed to participate is a large paper manufacturing company (1610 workers) that has its central headquarters in Chile and workers distributed across Latin America. The whole organisation was invited to answer an online survey with the final version of the scale (priming task and 25 items) and relevant teamwork scales for the discriminant and predictive validation (e.g., transition processes, coordination, intrateam trust, conflict). Because the company has workers from Spanish-speaking countries (Chile, Peru, Argentina, Uruguay, Mexico, Colombia, and Ecuador) and one Portuguese-speaking country (Brazil), we translated the survey from Spanish to Portuguese using a double-blind back translation procedure.

We received 842 full responses to the survey (52% of the organisation). After removing cases from teams with just one response and with very low response rates (< 20%; Nesterkin & Ganster, 2015; Timmerman, 2005), the final sample consisted of 690 team members in 200 teams. Participants were 54% females, their average age was 38.5 years old (SD = 9.8), their average organisational tenure was 6.3 (SD = 7.6), average team tenure was 4.1 (SD = 5.3), and their nationalities were: 23% Brazilians, 22% Chileans, 15% Peruvians, 11% Mexicans, 9% Colombians, 7% Ecuadorians, 6% Uruguayans, 5% Argentinians, and 1% Venezuelans. Due to the large number of Brazilian participants who answered the survey in Portuguese, a measurement invariance test between the Spanish and Portuguese-speaking samples was performed. Results (see Table 4) showed that there was invariance between the two groups using Chen's (2007) guidelines for unequal sample sizes. Thus, we decided to group all the organisation together (i.e., Spanish and Portuguese-speaking workers). Team sizes (see Table 6) ranged from 2 to 16 team members (M = 5.1; SD = 2.9), and the number of responses per team ranged from 2 to 13 (M = 3.5; SD = 1.8).

Insurance Company

The second organisation that agreed to participate is an insurance company with 938 workers from Chile. Like the first organisation, we invited the whole organisation to answer an online survey and received 303 full responses to the survey (32% of the organisation). After removing cases from teams with just one response and with very low response rates (< 20%), the final sample consisted of 261 team members in 68 teams. Participants were 73% females, their average age was 47.0 years old (SD = 9.9), their average organisational tenure was 4.8 (SD = 3.3), and average team tenure was 4.3 (SD = 6.3). Team sizes ranged from 2 to 15 team members (M = 6.8; SD = 2.5), and the number of responses by team ranged from 2 to 12 (M = 4.4; SD = 2.5).

Results

As reported in Table 6, results showed adequate levels of reliability based on Cronbach's alpha and McDonald's omega indices (>.70) for all the subscales at the team level. Exploratory Factor Analysis using oblimin rotation showed that the items loaded onto their respective latent variable or factor (please see Appendix D). Confirmatory Factor Analysis testing the 8-dimension model χ^2 (247) = 448.61, $p < .01$, RMSEA = .06, SRMR = .04, CFI = .96, TLI = .95 showed excellent fit indices based on Mathieu and Taylor (2006) guidelines. Correlations between the latent factors ranged from -.04 to .56, which shows adequate distinction between the eight different scales of the team's communication actions. As shown in Table 5, all factor loadings were above .60 ($p < .01$) except for item 4 of verbal and non-verbal communication scale (.59, $p. < .01$). We tested alternative models in which we combined the dimensions of multiple participants and simultaneous communications, χ^2 (254) = 1150.72, $p < .01$, RMSEA = .12, SRMR = .09, CFI = .85, TLI = .81, written and graphical communications, χ^2 (254) = 763.12, $p < .01$, RMSEA = .09, SRMR = .07, CFI = .91, TLI = .89, non-verbal and verbal communications, and speed of exchanges, χ^2 (254) = 709.70, $p <$

.01, RMSEA = .08, SRMR = .07, CFI = .92, TLI = .90, and refining and reviewing messages, $\chi^2 (254) = 1183.99$, $p < .01$, RMSEA = .12, SRMR = .11, CFI = .83, TLI = .80. Lastly, we tested an alternative model in which we combined all the dimensions related to convergence of meaning processes into one factor, and all the dimensions related to the conveyance of information in another factor $\chi^2 (274) = 3553.09$, $p < .01$, RMSEA = .21, SRMR = .19, CFI = .40, TLI = .34. All the alternative models presented worse fit indices (Chen, 2007) than the 8-dimension model and, therefore, these results supported working with eight independent dimensions of team communication actions.

Team level - Discriminant and predictive validity

Analysis Strategy

To check the discriminant and predictive validity of the scale, the same sample of 268 teams for the team-level internal structure validation was used. In the survey used to collect information from that sample, we also measured relevant dimensions of team virtuality, such as technological reliance and geographical distance (Gibson *et al.*, 2014; Raghuram *et al.*, 2019). Measuring technology reliance was relevant because Perez-Sepulveda et al. (article 1) argue that team communication actions allow for a more nuanced and in-depth understanding of the impact of communication media usage when compared to this dimension of team virtuality. This way, we also tested the incremental validity of team communication actions by comparing their predictive power to technology reliance over relevant team functioning variables that have been considered in the team virtuality literature. Past research has linked team virtuality with transition processes, such as planning and strategy formulation (Gilson *et al.*, 2015; Brown, Prewett and Grossenbacher, 2020); action processes, such as coordination and information sharing (Cummings, Espinosa and Pickering, 2009; Mesmer-Magnus *et al.*, 2011; Brown, Prewett and Grossenbacher, 2020); and interpersonal variables, such as intra-

team trust and conflict (Peñarroja *et al.*, 2013; Stark, Bierly and R. Harper, 2014; Morrison-Smith and Ruiz, 2020; Purvanova and Kenda, 2022).

Table 6

Means, Standard Deviations, Indices of Interrater Agreement and Reliability of the Team

Communication Actions Scales, Team Virtuality and Teamwork Variables at the Team Level

Scales/Variables	M	SD	α	ω	ICC1	ICC2	r_{WG}	AD
Verbal and non-verbal communications	4.1	0.4	.78	.84	.01	.88	.92	.47
Written communications	3.7	0.5	.85	.86	.06	.97	.86	.57
Graphical communications	3.1	0.6	.94	.94	.05	.96	.85	.61
Speed of exchanges	4.2	0.4	.92	.92	.00	.32	.94	.41
Multiple participants	4.1	0.4	.89	.89	.02	.88	.94	.40
Simultaneous communications	3.6	0.6	.95	.95	.01	.87	.86	.61
Refining messages	4.2	0.4	.93	.93	.00	.00	.94	.43
Reviewing messages	3.3	0.6	.94	.94	.02	.92	.88	.59
Technology reliance	71.9	16.0	-	-	.12	.98	-	-
Geographical dispersion (site)	1.3	0.7	-	-	-	-	-	-
Geographical dispersion (isolation)	.05	0.2	-	-	-	-	-	-
Geographical dispersion (imbalance)	.03	0.1	-	-	-	-	-	-
Transition processes	4.4	0.4	.89	.90	.00	.00	.94	.41
Coordination	4.4	0.5	.92	.92	.01	.79	.94	.44
Information sharing	4.2	0.4	.88	.88	.00	.69	.94	.45
Trust	4.3	0.5	.93	.95	.04	.95	.95	.44
Relationship conflict	1.8	0.6	.97	.97	.03	.93	.92	.54
Task conflict	2.3	0.6	.92	.92	.01	.82	.87	.57

Note. N = 951 members / 268 teams

Additionally, including a measure of geographical dispersion was relevant when considering that workers from the manufacturing company are distributed across different work locations in Latin America. Indices of configurational distribution were used because there is evidence that this could be a better indicator of the issues team members face when working in different locations than the pure geographical distance (measured in miles or kilometres, for example) between each pair of team members (O'Leary and Cummings, 2007; O'Leary and Mortensen, 2010). Discriminant, predictive and incremental validity of the scales were tested using correlation and hierarchical regression analyses.

Measures

Technology reliance was measured by asking each team member to assess the proportion of time they interact using some type of information and communication technology (e.g., email, chat, video calls, phone calls) as opposed to face-to-face communication (Maynard *et al.*, 2019). This index ranges from 0 to 100, with values of 0 indicating that all interactions occur face-to-face and values of 100 that all interactions occur through technologies.

Geographical dispersion was assessed using three configurational dimensions (O'Leary and Cummings, 2007): sites, isolation, and imbalance. Sites represent the total number of work locations represented in teams. Isolation is calculated as the percentage of team members with no other members in their work location. The isolation index varies from 0 when all team members work in the same location to 1 when all members work alone at their work locations. The imbalance index represents the imbalance in the distribution of team members across the different work locations (e.g., 2 team members in one location and 5 in another). This is calculated by dividing the standard deviation of the total number of team members in each location by the total number of members in the team. For teams with less than 25 members, this index will usually vary from 0 to .65 (O'Leary and Cummings,

2007), with values of 0 representing that work locations presented the same number of members in the different work locations (e.g., 3-3 or 4-4-4-4). Higher values represent a large degree of imbalance within the team.

Regarding teamwork variables, we measured transition processes (see Table 6 for interrater agreement and reliability indices) using Mathieu *et al.* (2020) three-item scale (e.g., "To what extent does our team actively work to … Identify the key challenges that we expect to face?"); team coordination using Mathieu *et al.* (2020) three-item scale (e.g., "To what extent does our team actively work to … Coordinate our activities with one another?"); information sharing within the team using Bunderson and Sutcliffe (2002) three-item scale (e.g., "Information used to make key decisions was freely shared among the members of the team"); intra-team trust using Kirkman *et al.* (2006) four-item scale (e.g., "Team members have a high degree of trust between each other"); task conflict using Jehn and Mannix (2001) three-item scale (e.g., "There is a lot of conflict of ideas in my work group"); and relationship conflict using Tekleab et al. (2009) four-item (e.g., "There is friction among members of my team") adaptation of Jehn's (1995) scale.

All scales presented Cronbach's Alpha and McDonald's Omega indices above .70, as shown in Table 6. Confirmatory Factor Analysis supported the adequate internal structure validity of the scales χ^2 (154) = 272.60, p < .01, RMSEA = .05, SRMR = .03, CFI = .98, TLI = .97. Alternative models combining transition processes and action processes in a single factor, χ^2 (163) = 577.08, p < .01, RMSEA = .10, SRMR = .05, CFI = .92, TLI = .91; interpersonal variables in a single factor, χ^2 (163) = 1124.81, p < .01, RMSEA = .15, SRMR = .13, CFI = .82, TLI = .80; and all items in a single factor, χ^2 (168) = 1416.19, p < .01, RMSEA = .17, SRMR = .13, CFI = .77, TLI = .74, presented all worse fit indices.

Results

Table 7 presents the correlation matrix of the variables in the study. Technological reliance was positively related to all team communication actions, with correlations ranging from $r = .16$ to $r = .41$, except for verbal and non-verbal communication ($r = .12$, $p = .05$). Configurational dispersion variables were not related to any of the team communication actions with correlations ranging from $r = -.06$ to $r = .11$ ($p > .05$). Correlations between team communication actions and teamwork variables ranged from $r = -.42$ to $r = .56$. Although speed of exchanges presented strong correlations with coordination ($r = .54$, $p < .01$), and trust ($r = .56$, $p < .01$), these results supported the adequate discriminant validity of the scales.

Table 8 presents the hierarchical regression analyses of the team virtuality, and the team communication actions over the teamwork variables. Regarding transition processes, the model including only team virtuality variables was not significant ($R^2 = .04$, $p = .08$), while the one including the team communication actions was significant, explaining 31% of the transition processes variance ($p < .001$). Specifically, verbal and non-verbal communications ($\beta = .26$, $p < .001$) and speed of exchanges ($\beta = .25$, $p < .001$) were significantly related to transition processes.

Table 7

Correlations of the Team Communication Actions Scales, Team Virtuality and Teamwork Variables at the Team-level

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. VNC	-																
2. WC	-.08	-															
3. GC	.15*	.48**	-														
4. SE	.45**	.20**	.20**	-													
5. MP	.43**	.29**	.36**	.50**	-												
6. SC	.11	.28**	.28**	.14*	.42**	-											
7. RFM	.33**	.22**	.23**	.42**	.32**	.15*	-										
8. RVM	.10	.19**	.24**	.05	.25**	.45**	.30**	-									
9. TECH	.12	.36**	.34**	.26**	.41**	.29**	.16*	.21**	-								
10. D-S	-.01	.04	.06	-.05	.03	.04	-.03	-.05	.04	-							
11. D-ISO	.00	.07	.00	.05	.06	.04	.00	-.11	.00	.58**	-						
12. D-IMB	-.02	.05	.09	-.06	.09	.05	-.06	.00	.06	.54**	.28**	-					
13. TP	.41**	.14*	.27**	.44**	.31**	.11	.29**	-.01	.15*	.08	.11	.04	-				
14. COO	.37**	.13*	.19**	.54**	.30**	.06	.39**	.03	.24**	.04	.12**	.00	.68**	-			
15. IS	.42**	.17*	.30**	.49**	.37**	.12*	.40**	.06	.26**	.06	.13*	.06	.72**	.72**	-		
16. Trust	.40**	.25**	.34**	.56**	.41**	.07	.39**	.08	.33**	.08	.13*	.08	.57**	.72**	.65**	-	
17. RC	-.24**	-.15*	-.08	-.39**	-.20**	.00	-.23**	.07	-.15*	-.09	-.15*	-.01	-.46**	-.51**	-.42**	-.61**	
18. TC	-.21**	-.10	-.02	-.42**	-.17*	.03	-.27**	.12	-.12*	-.10	-.21**	-.01	-.44**	-.46**	-.41**	-.53**	.69**

Note. N = 268. ** $p < .01$; * $p < .05$. VNC = Verbal and non-verbal communications. WC = Written communications. GC = Graphical communications.

SE = Speed of exchanges. MP = Multiple participants. SC = Simultaneous communications. RFM = Refining messages. RVM = Reviewing messages.

TECH = Technology reliance. D-S = Dispersion (site). D-ISO = Dispersion (isolation). D-IMB = Dispersion (imbalance). TP = Transition processes.

COO = Coordination. IS = Information sharing. RC = Relationship conflict. TC = Task conflict.

Table 8

Hierarchical Regression Analyses of the Team Virtuality and Team Communication Actions over the Teamwork Variables

Variables	Transition processes		Coordination		Information sharing		Trust		Relationship conflict		Task conflict	
Virtuality												
ORG	.04 (.12)	.04 (.06)	.02 (.07)	.02 (.06)	.01 (.07)	.00 (.06)	.37 (.07)**	.37 (.06)**	-.50 (.09)**	-.54 (.09)**	-.31 (.17)**	-.34 .(08)**
TECH	.00 (.00)*	.00 (.00)	.01 (.00)**	.00 (.00)	.01 (.00)**	.00 (.00)	.01 (.00)**	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
D-S	.01 (.05)	.02 (.04)	-.03 (.05)	.00 (.05)	-.03 (.05)	-.01 (.04)	-.04 (.06)	-.01 (.04)	-.01 (.07)	-.04 (.07)	.01 (.07)	-.01 (.06)
D-ISO	.22 (.17)	.11 (.15)	.41 (.19)*	.27 (.16)	.38 (.18)*	.27 (.16)	.31 (.19)	.18 (.15)	-.41 (.25)	-.21 (.23)	-.68 (.24)**	-.46 (.22)*
D-IMB	-.05 (.35)	.00 (.30)	-.19 (.38)	.00 (.32)	.14 (.37)	.24 (.31)	-.04 (.39)	.09 (.31)	.76 (.50)	.54 (.46)	.64 (.49)	.36 (.44)
Scales												
VNC		.26 (.07)**		.16 (.07)*		.22 (.07)**		.26 (.07)**		-.27 (.10)**		-.13 (.10)
WC		.00 (.05)		-.02 (.06)		-.02 (.06)		.00 (.06)		-.09 (.08)		-.02 (.08)
GC		.11 (.04)*		.04 (.05)		.13 (.05)**		.09 (.05)*		.12 (.07)		.13 (.07)
SE		.23 (.06)**		.40 (.07)**		.26 (.07)**		.38 (.06)**		-.37 (.10)**		-.44 (.09)**
MP		-.01 (.07)		-.06 (.07)		.00 (.07)		.03 (.07)		.05 (.11)		.08 (.10)
SC		.03 (.04)		-.03 (.05)		-.01 (.05)		-.08 (.04)		.01 (.07)		.01 (.06)
RFC		.09 (.06)		.19 (.06)**		.21 (06)**		.17 (.06)**		-.16 (.09)		-.24 (.09)**
RVC		-.09 (.04)*		-.03 (.05)		-.06 (.04)		-.01(.04)		.11 (.07)		.14 (.06)*
Effect Size (R^2)	.04ns	.31**	.08**	.36**	.09**	.37**	.22**	.53**	.15**	.31**	.10**	.31**
ΔF (Δdf)	12.29 (8)**		14.04 (8)**		14.57 (8)**		20.75 (8)**		7.52 (8)**		9.27 (8)**	

Note. $N = 268$. Unstandardised estimates. Standard errors in parenthesis. ** $p < .01$; * $p < .05$. Organisation is coded: 0: Insurance, 1: Manufacturing. TECH = Technology reliance. D-S = Dispersion (site). D-ISO = Dispersion (isolation). D-IMB = Dispersion (imbalance). WC = Written communications. GC = Graphical communications. SE = Speed of exchanges. MP = Multiple participants. SC = Simultaneous communications. RFC = Refining communications. RVC = Reviewing communications.

Regarding action processes, team virtuality variables were significantly related to coordination, particularly technological reliance ($\beta = .24$, $p < .001$) and isolation ($\beta = .16$, $p = .031$). However, when adding the team communication actions, these effects were no longer significant, with team communication actions explaining 28% more of the coordination's variance. Verbal and non-verbal communications ($\beta = .14$, $p = .024$), speed of exchanges ($\beta = .39$, $p < .001$), and refining messages ($\beta = .18$, $p = .003$) were all positively related to coordination. About information sharing, technological reliance ($\beta = .26$, $p < .001$) and isolation ($\beta = .15$, $p = .042$) were significantly related to it in the model including only team virtuality variables. When including the team communication actions, the effect of technological reliance was no longer significant. The team communication actions were significantly related to information sharing, in particular verbal and non-verbal communications ($\beta = .20$, $p = .001$), graphical communications ($\beta = .16$, $p = .007$), speed of exchanges ($\beta = .26$, $p < .001$), and refining messages ($\beta = .20$, $p = .001$). The model including team communication actions explained 28% more variance of information sharing than the base model with just team virtuality variables.

Regarding interpersonal variables, technological reliance was significantly related to trust ($\beta = .21$, $p < .001$) in the team virtuality model. However, when considering the team communication action, this relationship was no longer significant. In this model, verbal and non-verbal communication ($\beta = .26$, $p < .001$), speed of exchanges ($\beta = .33$, $p < .001$), and refining messages ($\beta = .17$, $p = .004$) were all positively related to trust. The model, including the team communication actions, helped explain 31% more variance of trust than the model with only team virtuality variables. Regarding conflict in teams, team virtuality variables were not related to relationship conflict, while the team communication actions were significant. Specifically, verbal and non-verbal communications ($\beta = -.17$, $p = .008$) and speed of exchanges ($\beta = -.26$, $p < .001$) were negatively related to relationship conflict. In

contrast, graphical communications ($\beta = .15$, $p < .05$) were positively related to relationship conflict. The model with team communication actions explained 16% more variance. Lastly, isolation was negatively related to task conflict ($\beta = -.20$, $p = .005$) when considering only team virtuality variables. Nevertheless, when adding the team communication actions, this effect was no longer significant. Reviewing communications ($\beta = .14$, $p = .023$) was positively related to task conflict, while the speed of exchanges ($\beta = -.33$, $p < .001$) and refining communications ($\beta = -.17$, $p = .006$) were negatively related to task conflict. The model, including the team communication actions, helped explain 21% more of the variance of task conflict.

Discussion and Conclusion

In this article, our goals were to develop and validate a new scale to measure the novel construct of team communication actions and its eight dimensions (Perez-Sepulveda, Axtell and Dawson, article 1) in English and Spanish. We developed an initial set of 50 items and followed a multi-step approach to validate the scale. Evidence of content validity was collected based on the revision of subject experts and naïve judges representative of the population in which the scale will be used. The experts' revision allowed us to ensure that each item measured the intended construct, that all the relevant contents were being captured by the scale, and that items were clearly formulated. Reviewing the content validity using a naïve sample was also relevant because it offers evidence that the construct being measured and the items that intend to measure it make sense to the target population (Colquitt *et al.*, 2019).

Using Anderson and Gerbing's (1991) methodology for the naïve sample revision, we found evidence of strong content validity for most items of the scale in both languages. Only item 3 of the reviewing messages ("Usually, we see or listen to the communications from other members many times") presented consistent evidence of weak content validity and was

usually associated with the simultaneous communication dimension by naïve judges. However, when reviewing internal structure validity, we tested alternative models in which this item was considered as part of the simultaneous communication dimension. The fit of all these models was worse than when considering the item as part of the reviewing messages dimension, which presented adequate levels of adjustment. This shows that when the item is used as a part of the scale, it presents adequate psychometric properties.

The internal structure validity of the scale was assessed using reliability and confirmatory factor analyses in English-speaking and Spanish-speaking samples at the individual level. The analysis showed strong psychometrical properties of the scale and the adequate distinction between the eight different team communication actions (dimensions). A measurement invariance test was also performed to check the psychometrical equivalence of the scale in the two languages. The analysis showed that the scale was invariant at the metric (loadings) but not at the scalar (intercepts) level. However, the scale was partially invariant if the second item of the written communications ("Usually, we interact with each other through written messages") subscale was allowed to be freely estimated across the two samples. One potential explanation for this is that for the Spanish-speaking sample, this item was presented as the last one of a larger set of items (six) for this dimension. For the English-speaking sample, this item was presented in second place in the dimension. To test this hypothesis, an additional measurement invariance test was performed between the English-speaking sample and the Spanish-speaking sample at the team level. Results showed invariance between the two samples following Chen (2007) guidelines (Δ CFI $\geq$ -.010, Δ RMSEA $\leq$ .015, Δ SRMR $\leq$ .010). The internal structure validity of our scale at the team level was also tested using a sample of 268 teams from two organisations in Latin America. Again, the analyses showed strong psychometrical properties of the scale and subscales based on reliability and Confirmatory Factor Analyses. All items presented significant and large factor loadings on

their respective dimensions. We did not hypothesise second-order factors, and additional analyses did not reflect the existence of second-order factors.

Using the team-level sample, we also examined the discriminant and predictive validity of the scales. Several teamwork variables that previous research has linked to team virtuality were incorporated as criterion variables to test predictive validity, such as transition processes (e.g., planning), action processes (e.g., coordination and information sharing), and interpersonal variables (e.g., trust and conflict). To test discriminant validity, two dimensions of team virtuality were measured: technological reliance and configurational dispersion (sites, isolation, and imbalance). Our analyses indicate that team communication actions were related but distinguishable from the technological reliance component of team virtuality and from the teamwork variables. Additionally, correlations and hierarchical regression analyses showed that the team communication actions were significantly related to the teamwork variables after controlling for team virtuality components. Team communication actions helped to explain between 16% and 31% more of the variance of teamwork variables over team virtuality dimensions, which shows that this new construct offers incremental validity over past conceptualisations.

The above results show that team communication actions represent a more fine-grained approach to understanding the use of communication media within teams and its impact on teamwork variables beyond the dichotomous view of face-to-face interactions versus technology. This offers support to the propositions made by Perez-Sepulveda *et al.* article 1) in the original article presenting the construct of team communication actions. Specifically, the authors proposed that the measurement of technology reliance using dichotomous views of face-to-face versus ICT-mediated interactions does not allow the differences in the capabilities that media offer to be captured. Also, by using a deterministic view of media that ignores the role of human agency, past approaches cannot capture the

118

variation in the way that different teams may use media depending on their specific needs and goals (Leonardi, 2011; Evans et al., 2017). Considering all this, team communication actions can be a relevant research avenue for untangling the mixed results found to date in the team virtuality research due to its more refined understanding of media usage within teams.

Contributions

This scale contributes to the literature by offering several advantages. First, it allows the collection of information on the novel construct of team communication actions based on team members' perceptions using a 25-item Likert scale. By relying on team members' perceptions, this scale offers a flexible and easy-to-use tool that can be measured in physical or digital surveys without needing high levels of training. This way, it can be a valuable tool for researchers looking to examine the impact of communication media within teams, but also for practitioners who need information to manage the way that communication media is being used in teams and/or organisations. Second, this article validated the English and Spanish versions of this scale and offered partial evidence of validity for the Brazilian Portuguese version. Therefore, this scale can be used in different languages, contexts, and countries, which should allow the further advancement of research into team communication actions. Moreover, due to its briefness, researchers can validate this scale with relative ease in other languages if required.

Third, this scale can also help to promote future research to examine how team communication actions are related to other variables that were not considered in this article, such as other relevant components of team virtuality (e.g., cultural diversity or temporal distance; Gibson and Gibbs, 2006) or relevant teamwork outcomes (e.g., team performance; Purvanova and Kenda, 2022). Additionally, more complex mediational and/or interactional models can be tested to further examine how communication actions impact team functioning. This article showed that some team communication actions are related to

transition, action, and interpersonal processes. This way, future research can explore if team communication actions are related to team performance directly or indirectly through their impact on teamwork processes. Additionally, future research can also test the moderating role of team communication actions on the effect of team virtuality variables, such as geographical or temporal dispersion. For example, using high levels of speed of exchanges can play a protective role in the challenges that geographical dispersion poses to teams by allowing team members to maintain fluid communications even if they are in separate locations. However, for teams that present temporal dispersion, having quick exchanges may be a challenge. In this context, they can benefit from highly refining their communications, which should facilitate the understanding of messages even when they cannot contact other team members to clarify the meaning of the messages.

Limitations and Future Research

This study also presents some limitations which are important to mention. First, we tested the internal structure validity at the team level using a Spanish-speaking sample but not an English-speaking sample. This way, our study cannot guarantee the adequate functioning of the English version of the scale when used at the team level. Future studies can aim to validate the scale in this context. Second, to test the discriminant and predictive validity, we used a cross-sectional methodology, which can be a source of Common Method Variance (Podsakoff, MacKenzie and Podsakoff, 2012). This reflects the common variability added to the different variables of a study when they are measured using the same instrument. This can affect the relationships found between the variables by artificially inflating or deflating their relationships (Podsakoff *et al.*, 2024). Future studies should try to test these relationships using longitudinal and multisource designs, which will allow for the control of this type of bias.

Lastly, the scale developed in this article measures team communication actions based on the overall perceptions of team members. Although this offers a flexible and quick way of measuring the phenomenon, there are several biases that can affect the perceptions of team members regarding how communication actions take place in the team. For example, if a team member dislikes the media used in the team due to personal preferences, he/she may offer lower values of team communication actions regardless of what is happening in the team. Alternative ways of measuring this phenomenon can be developed or used in future studies to address this issue, such as the use of observational approaches. For instance, researchers can record team members' interactions during a meeting and then rate the levels at which team communication actions occur.

Conclusion

The idea of team communication actions represents a new theoretical advancement that can help to better understand how the use of multiple media within teams can impact team functioning (Perez-Sepulveda, Axtell and Dawson, article 1). We hope that researchers find this new scale useful to continue advancing this line of work and that it can contribute to accumulating more and better evidence that can inform practitioners' decisions to manage the use of multiple media in teams.

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ARTICLE 3: HYPOTHESES TESTING ARTICLE

Team Communication Actions and Their Impact on Teamwork Processes and Team Performance

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Abstract

Modern teams use multiple communication media, blending face-to-face interactions and information and communication technologies (ICTs). However, the literature has often dichotomised face-to-face and ICTs, overlooking the unique capabilities of ICTs and how team members may use media in unexpected ways. The novel concept of team communication actions attempts to address these limitations, but it lacks empirical support regarding its relationship with team effectiveness variables. This study, involving 517 members in 143 teams from two organisations, aimed to examine these relationships. Results suggest that some team communication actions impact transition, action, and interpersonal processes differently depending on team tenure, while others have consistent effects for teams in all stages. For instance, verbal and non-verbal communications, together with refining communications, enhance transition processes for all teams, while graphical communications are beneficial only for early-stage teams. Moreover, results showed that some team communication actions can impact the performance of the team through their effect on teamwork processes. Verbal and non-verbal communications and refining communications positively impact team performance through transition processes and interpersonal trust. Some of our hypotheses were not supported, and therefore, we discuss how these results can expand the idea of team communication actions, considering avenues for future research. These findings, as a whole, offer a more nuanced understanding of the use of communication media within teams, which has relevant implications for future research and to guide practitioners' media usage decisions.

Keywords: team communication actions, teamwork processes, team performance, team virtuality.

Introduction

The advancements in information and communication technologies (ICTs, e.g., emails, chat, video calls, and collaboration tools) have changed how work teams operate in modern organisations. They have allowed team members to continue working interdependently even under conditions of temporal and geographical distance (Chamakiotis, Panteli and Davison, 2021). This phenomenon has been usually labelled and studied as team virtuality, a multidimensional construct comprised of technological reliance, geographical and temporal distance, and cultural diversity, among others (Gibson *et al.*, 2014; Gibbs and Navick, 2023). The study of this phenomenon gained an increased relevance because of the COVID-19 pandemic as team members across the world were forced to work in isolation from their homes and, therefore, had to rely mainly on ICTs to communicate with each other (Nordbäck *et al.*, 2021). After the end of the pandemic, many organisations and workers have continued using home-office setups, either entirely or in a hybrid way (i.e., combining home-office with work in offices) (McKinsey, 2022; Office for National Statistics, 2022). Due to this, and because workers have become more proficient in how to work virtually and use ICTs during the pandemic, it is likely that team members are relying on ICTs more than ever before.

Although the study of team virtuality has helped to better understand the effects of using ICTs in work teams, this research has presented some limitations. First, it has combined several somewhat independent dimensions into one construct (Gibson and Gibbs, 2006). This independence is reflected in the fact that teams with some degree of geographical distance may still communicate face-to-face, and teams with all members collocated can rely heavily on ICTs, too (Gibson *et al.*, 2014). Another limitation of team virtuality research is that when focusing on technology reliance, it has commonly adopted a dichotomous view of ICTs versus face-to-face without considering the unique capabilities that they offer and the actual

way in which team members use them (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008). Researchers have usually assumed that ICTs offer fewer social and contextual cues due to reduced media richness (Daft and Lengel, 1984) and, therefore, will perform poorly when compared to face-to-face interactions (Gibbs and Navick, 2023). However, this ignores that some ICTs can offer similar capabilities to face-to-face (e.g., video calls) and that ICTs can present unique features that may be instrumental to the effectiveness of teams (Dennis, Fuller, and Valacich, 2008). Lastly, team virtuality research has also neglected the argument of several researchers to incorporate the role of people's agency when analysing the use of technology (Orlikowski, 2000, 2010; Leonardi, 2007). This research has commonly measured technology usage by asking the proportion of time that team members use ICTs instead of face-to-face (e.g., Rapp *et al.*, 2010; Maynard *et al.*, 2012), yet this assumes that the use of ICTs is equivalent between different teams. Therefore, this way of measuring media usage does not take into consideration the differences that can occur when people with varying characteristics and needs use communication media. For instance, team members can use ICTs in ways that do not follow their 'objective' attributes due to a lack of knowledge on how to use their attributes (unintentional) or because they think they do not need certain features (intentional).

To address some of these limitations, Perez-Sepulveda, Axtell and Dawson (article 1 in this thesis) proposed the idea of team communication actions to examine team members' actual use of media within their teams, which can combine both face-to-face and ICTs. These are a set of actions that team members perform to shape their communications and interactions when performing their tasks. Additionally, they argued that communication actions emerge from the interplay of several factors: (a) the capabilities of the media that team members use, (b) the intentions, characteristics, and preferences of team members, (c) the task that they are performing, and (d) the context in which the team is immersed. This

way, communication actions are not determined by any of these aspects but emerge from the interplay between all of them. Building on the capabilities identified by Media Synchronicity Theory (Dennis, Fuller, and Valacich, 2008), they derived eight different communication actions: using verbal and non-verbal communications, speed of exchanges, involving multiple participants, having simultaneous communications, using written communications, using graphical communications, refining communications, and reviewing communications.

Team communication actions may help untangle some of the ambiguous results in the literature regarding the impact that team virtuality has on team functioning, such as teamwork processes and performance. For example, Brown *et al.* (2020) found positive effects of virtuality on transition and action processes, while others have found it impairs knowledge sharing and coordination (e.g., Cummings, Espinosa and Pickering, 2009; Mesmer-Magnus *et al.*, 2011). Similarly, evidence regarding interpersonal aspects also varies. Morrison-Smith & Ruiz (2020) found lower trust levels, while Stark *et al.* (2014) found that virtuality increases conflict. In contrast, Brown *et al.* (2020) linked technology reliance positively to interpersonal processes and negatively to conflict, and Purvanova and Kenda's meta-analysis (2022) found no clear link between virtuality and trust. Regarding performance, Ortiz de Guinea *et al.* (2012) observed worse overall performance, yet Purvanova and Kenda (2022) found no significant relationship. By considering the communicational requirements of teams in earlier and later developmental stages, Perez-Sepulveda *et al.* (article 1) proposed several relationships between different types of communication actions and transition, action, and interpersonal processes. However, these ideas have not yet been empirically tested.

Considering the above, the main objective of this study is to examine the relationships between team communication actions, teamwork processes, and team performance depending on team tenure using a dataset of 517 team members in 143 teams. Specifically, this study will examine 1) the direct effects of team communication actions on transition, action, and

interpersonal processes, 2) the moderating role of team tenure on these effects, and 3) the indirect and conditional indirect effects of team communication actions on team performance through transition, action, and interpersonal processes. This article contributes to the literature in several ways. First, it is the first study to empirically test the novel concept of team communication actions and its relationships with relevant team variables. The more nuanced nature of team communication actions in comparison to the dichotomous view of technology reliance used in team virtuality allows us to better understand the effects of the use of different types of media in teams. Furthermore, because some of our results do not align with the propositions of Perez-Sepulveda *et al.* (article 1), this article provides theoretical explanations that can help to continue developing the idea of team communication actions and its links with teamwork processes and performance. Lastly, our results also indicate more complex interactions between team communication actions and teamwork processes, which can encourage further empirical studies on the subject in the future.

Theoretical Background

Team Communication Actions

Team communication actions represent "a set of actions that team members perform using communication media, which shape the way in which they interact with each other while performing their tasks" (Perez-Sepulveda, Axtell and Dawson, article 1, p. 48). Using the five capabilities systematised by Media Synchronicity Theory (Dennis, Fuller, and Valacich, 2008), the authors identified eight different team communication actions. It is important to note that while related to capabilities, these actions are not directly determined by the objective attributes of media. As several non-deterministic theories have proposed, the actions that users perform over the material attributes of technology, and in this case, media, will emerge from the interplay between the material attributes and the human agency, such as the goals and needs of users (Orlikowski, 2000; Leonardi, 2011). For team members, several

compositional characteristics will be relevant in shaping the communicational goals and needs of team members, such as geographical/temporal dispersion, cultural backgrounds and diversity within the team, team design (e.g., autonomy, interdependency), individual preferences and past knowledge with the media and other team members, among others.

The eight communication actions identified by Perez-Sepulveda *et al.* (article 1) are (1) verbal and non-verbal communications, that is, the degree that "team members use the team's media to interact using their voice, facial and body expressions (e.g., smiles and gestures)" (p. 52); (2) speed of exchanges defined as the degree that "team members use the team's media to reply to other members' messages quickly, or slowly, to other members' messages" (p. 52); (3) multiple participants, representing the degree that "team members use the team's media to involve multiple members in their interactions. Lower levels in this subdimension indicate that team members communicate often in dyads rather than involving the whole team." (p. 52); (4) simultaneous communications, that is, the degree to which "team members use the team's media to have multiple simultaneous communications through one or more media. Lower levels of this subdimension indicate that team members usually focus on just one communication at a time." (p. 52); (5) written communications, namely, the degree that "team members use the team's media to send written messages and information (e.g., documents, tables, and numerical reports)." (p. 52); (6) graphical communications, defined as the degree that "team members use the team's media to send images, pictures, and graphs" (p. 52); (7) refining communications reflecting the degree that "team members use the team's media to edit and refine their messages before communicating them" (p. 52); and (8) reviewing communications representing the degree that "team members use the team's media to access other members' communications multiple times after receiving them" (p. 52).

Additionally, the authors followed the Media Synchronicity Theory distinction of convergence of meaning and conveyance of information communicational processes to

analyse these communicational actions (Dennis, Fuller, and Valacich, 2008). Conveyance of information refers to the sending of new and additional information (by an emitter) so the receiver of a message can form (or update) a mental model of a particular topic. On the other hand, convergence of meaning represents the discussion of the participants' individual mental models to reach a shared understanding of the topic. Based on this, Perez-Sepulveda and colleagues (article 1) proposed that verbal and non-verbal communications, quick communications, and involving multiple participants will be associated with the convergence of meaning. Verbal and non-verbal communications offer increased social and contextual cues in messages (Daft and Lengel, 1986; Sproull and Kiesler, 1986) that can help communication participants arrive at a shared understanding without having to clarify their messages multiple times. Similarly, having a high-level speed of exchanges will facilitate the back-and-forth exchanges needed to arrive at a common understanding without having to wait a long time for other member's responses (Dennis and Valacich, 1999; Dennis, Fuller and Valacich, 2009). Involving multiple participants is also relevant for the convergence of meaning in team contexts as only when most (or all) team members are included in communications will they be able to develop a shared understanding of communications' subjects.

In contrast, written and graphical communications, simultaneous communications, together with refining and reviewing communications, will be related to the conveyance of information. When team members communicate using tables, numbers and graphics, they facilitate other members to understand large and complex sets of information that, in turn, will allow them to revise and adjust their current understanding of a subject (i.e., an individual mental model) (Dennis, Fuller, and Valacich, 2008). Simultaneous communication can increase the amount of information available within the team, thus increasing the possibility that team members are creating and/or updating mental models regarding relevant

information. However, having too many simultaneous communications can also lead to informational overload, where team members receive more information than they can process (Bawden and Robinson, 2009; Ellwart *et al.*, 2015), impairing the conveyance of information. Refining communications is concerned with crafting precise messages that allow others to convey the meaning of them quickly, thus facilitating conveyance processes (Maruping and Agarwal, 2004). Lastly, as team members revise communications multiple times over time, they increase the likelihood of correctly understanding a message, especially when it contains complex or large amounts of information.

Teamwork Processes: Transition, Action, and Interpersonal Ones

Marks, Mathieu, and Zaccaro's (2001) temporal framework of team processes is one of the most influential works in systematising the processes that team members must perform to be effective in their work. This model argues that team members perform three different types of processes when executing each of their tasks: transition, action, and interpersonal processes (Salas, Rico and Passmore, 2017). Transition processes refer to a reflexive phase in which team members assess and/or determine their common goals and the activities they must perform (Mathieu *et al.*, 2017). Examples of transition processes are mission analysis, goal specification, strategy formulation and planning. Action processes involve the activities that team members perform during the phase of active execution of their tasks to ensure that they are carried out correctly (Marks, Mathieu and Zaccaro, 2001). Several action processes have received attention in the literature, such as coordination, communication, monitoring progress and resources, backup behaviours and cooperation, among others. This model argues that teams will usually cycle between transition and action processes for each of the tasks they must accomplish, performing one or the other for longer or shorter times, depending on the task (Mathieu *et al.*, 2020).

This framework also proposes that team members must perform interpersonal processes in parallel to action/transition cycles (Marks, Mathieu and Zaccaro, 2001). They represent all the actions that members perform to manage and develop their interpersonal relationships. This involves, for example, the management of conflict and/or affective experiences and the confidence building within the team. Usually, team literature has treated interpersonal emergent states and interpersonal processes somewhat interchangeably. The former represents the shared perceptions of the degree to which interpersonal variables are expressed within the team, such as the levels of trust, conflict, and emotional states of team members (Mathieu *et al.*, 2017), while the latter represents the actions that allow the emergence and/or management of the states. In general, team virtuality has put a larger emphasis on interpersonal emergent states, such as trust and conflict, than on processes (e.g., Mortensen and Hinds, 2001; Stark, Bierly and R. Harper, 2014; Benda *et al.*, 2023). Therefore, to be precise, in the next sections, we will use the term "interpersonal variables" to refer to these processes/emergent states.

Team Communication Actions, Transition Processes, and Team Performance

Transition processes, such as mission analysis, goal specification and planning, are relevant activities that teams must perform to be effective. These are of particular relevance for modern teams, which typically have to solve problems that do not have clear solutions by working collaboratively on tasks with some degree of interdependency (Fiore, Bendell and Williams, 2023). Unfortunately, transition processes have received less attention in comparison to action and interpersonal ones in the virtual teams/team virtuality literature (Gilson *et al.*, 2015), and therefore, it is unclear how the use of different communication media impacts them.

Perez-Sepulveda *et al.* (article 1) proposed that the communication requirements to perform the transition process will depend on the developmental stage of the team. Teams

that are in early stages (e.g., formation; Ilgen *et al.*, 2005) are likely to have larger communicational challenges as they will need to review sets of new information to develop a precise understanding of the tasks they must perform (i.e., develop individual mental models of their work). However, team members developing an individual understanding is not enough for the effectiveness of the team. A meta-analysis by DeChurch *et al.* (2010) found strong evidence that developing shared mental models (or shared cognition) is critical for teams to be successful in performing transition processes. Shared mental models are organised knowledge structures in team members' minds that help them understand and predict each other's behaviours (Mathieu *et al.*, 2000). To achieve this, team members will need to discuss their individual ideas, solve discrepancies, and develop a shared understanding of their tasks and goals. Then, they will also need to discuss the best way to accomplish their tasks and goals and develop a concrete plan for implementing them (i.e., strategy formulation and planning).

Considering the above, it is likely that teams in the early stages will benefit from performing both conveyance of information and convergence of meaning actions in a complementary manner. Conveyance of information should allow team members to develop their individual mental models based on the interchange of communications and information within the team, while convergence of meaning should facilitate the formation of shared mental models by discussing and adjusting individual ones. In contrast, for teams in later stages of development, the need for the conveyance of information is likely to be reduced because team members have already developed an individual understanding of their tasks and goals or at least of their formal aspects. Nevertheless, we argue that the role of convergence of meaning will still be relevant as this will allow team members to discuss and continue updating their shared cognition based on the events that occurred during previous work cycles. This way, they can discuss problems that have occurred during the performance of

their tasks and develop new strategies and plans to tackle these issues. Therefore, the following hypotheses are formulated:

Hypothesis 1: Team communication actions for the convergence of meaning will be positively related to transition processes.

Hypothesis 2: Team tenure will moderate the relationship between team communication actions for the conveyance of information and transition processes. This relationship will be positive when team tenure is lower, and there will be no relationship when team tenure is higher.

Because team communication actions have a distal relationship with team performance, it is unlikely that they will have strong direct effects on team performance. However, due to their proximal relationship with teamwork processes, and also the proximal relationship between these processes and team performance, we propose that these actions can impact performance through the mediational effect of teamwork processes (Shrout and Bolger, 2002). Specifically, transition processes have an important structuring role, as they give team members clear goals and the necessary steps to achieve them, which enable them to be successful in performing their tasks. Not surprisingly, a meta-analysis conducted by LePine and colleagues (2008) found a consistent positive effect of transition processes on team performance. Thus, the following hypotheses are stated:

Hypothesis 3: Transition processes will mediate the positive relationship between team communication actions for the convergence of meaning and team performance.

Hypothesis 4: Transition processes will mediate the relationship between team communication actions for the conveyance of information and team performance, conditional on team tenure. This indirect effect will be positive when team tenure is lower, and there will be no relationship when team tenure is higher.

Team Communication Actions, Action Processes and Team Performance

Action processes have received great attention in the team virtuality literature, particularly coordination and information sharing (Gilson *et al.*, 2015), and therefore, we will focus on these two variables. Similar to transition processes, the performance of these action processes will have different communication needs depending on the development stage of the team (Perez-Sepulveda, Axtell and Dawson, article 1). Previous studies have noted that the development of shared mental models is crucial for effective coordination, as well as knowledge and information sharing within teams (DeChurch and Mesmer-Magnus, 2010; Gorman, Amazeen and Cooke, 2010). When team members have similar mental models, they interpret information similarly and can anticipate each other's actions (Mohammed, Ferzandi and Hamilton, 2010). Considering this, teams in the early stages are likely to benefit from performing communication actions related to the convergence of meaning because they will facilitate the conditions for the emergence of shared mental models. In particular, the use of verbal and non-verbal cues together with high levels of speed of exchanges can enable team members' synchronous discussions about each other's expertise, skills, knowledge, and roles within the team and also reduce misunderstandings during these discussions. Moreover, involving multiple participants can guarantee that the cognitive structures of the team are developed similarly among all team members.

In later stages, when shared mental models are already formed, the need for convergence of meaning actions to perform action processes should be reduced. Nevertheless, the conveyance of information actions will likely be instrumental in this stage. The asynchronous nature of these actions will allow team members to concentrate on performing their tasks while keeping in touch with other team members. By using written and graphical communications, team members can share and store large and/or complex amounts of information for other members to review when it suits them better. Moreover, the use of

asynchronous written communications can help team members to keep others informed of their progress towards goals and, thus, facilitate the coordination of the team. Additionally, by refining their communications, team members can guarantee that the content of their messages is clear so other team members can understand them quickly without needing further communications to clarify misunderstandings. Similarly, reviewing other members' communications will guarantee that team members understand the messages and are up to date with what is going on within the team. Based on this, the following hypotheses are proposed:

Hypothesis 5: Team tenure will moderate the relationship between team communication actions for the convergence of meaning and action processes. This relationship will be positive when team tenure is lower, and there will be no relationship when team tenure is higher.

Hypothesis 6: Team tenure will moderate the relationship between team communication actions for the conveyance of information and action processes. This relationship will be positive when team tenure is higher, and there will be no relationship when team tenure is lower.

Past research has shown the relevant role of action processes in the effectiveness of teams. For example, a meta-analysis conducted by LePine *et al.* (2008) found that action processes, in general, and coordination, in particular, are positively related to team performance. Coordination has been theorised to have a substantial role in predicting team performance as higher levels indicate that team members are able to adequately orchestrate the necessary sequence of behaviours to perform their interdependent tasks (Marks, Mathieu and Zaccaro, 2001; Salas, Rico and Passmore, 2017). Information sharing has also been argued as relevant for team performance because it reflects the quality of the communications within the team, that is if key information is being shared among team members (Marlow *et*

al., 2018). Moreover, it facilitates the monitoring of the progress and resources of other team members, which in turn allows team members to perform helping behaviours if needed. Accordingly, a meta-analysis performed by Mesmer-Magnus *et al.* (2011) showed a positive effect of information sharing on team performance. Based on the above, the following hypotheses are derived:

> *Hypothesis 7: Action processes will mediate the relationship between team communication actions for the convergence of meaning and team performance, conditional on team tenure. This indirect effect will be positive when tenure is lower, and there will be no effect when tenure is higher.*
>
> *Hypothesis 8: Action processes will mediate the relationship between team communication actions related to the conveyance of information and team performance, depending on team tenure. This indirect effect will be positive when tenure is higher, and there will be no effect when tenure is lower.*

Team Communication Actions, Interpersonal Variables, and Team Performance

Interpersonal emergent states have received the most attention in the team virtuality literature, with trust and conflict being one of the most studied variables (Gilson *et al.*, 2015). This research has shown that teams that have access to convergence of meaning actions, particularly having high-level speed of exchanges and using verbal and non-verbal communications, tend to present more positive interpersonal results. Specifically, research has found that these actions tend to lead to higher trust and less conflict among team members by increasing the perceptions of co-presence and reducing misunderstandings and misattributions (Axtell, Fleck and Turner, 2004; Handke *et al.*, 2020; Keating, Cullen-Lester and Meuser, 2023). Additionally, past research has found that when teams rely heavily on conveyance of information actions, such as using written and graphical communications, interpersonal processes tend to be impaired due to the reduction of social and contextual cues

associated with these types of actions and the media that facilitate them (Yoo and Alavi, 2001; Maruping and Agarwal, 2004; Morrison-Smith and Ruiz, 2020). However, some authors have argued that these negative effects have usually been found in experimental settings in which participants do not have experience using the media and do not know others involved in communications (Carlson and Zmud, 1994). In this context, the detrimental effects of the lack of social and contextual cues are maximised. Nevertheless, in real work settings in which team members are able to learn about the media that they use and other team members over time, there is evidence that the detrimental effects are reduced (Carlson and Zmud, 1999; Carlson *et al.*, 2013). Considering this, we formulated the following hypotheses:

> *Hypothesis 9a: Team communication actions for the convergence of meaning will be positively related to intra-team trust.*
>
> *Hypothesis 9b: Team communication actions for the convergence of meaning will be negatively related to conflict.*
>
> *Hypothesis 10a: Team tenure will moderate the relationship between team communication actions for the conveyance of information and trust in such a way that this relationship will be more negative when team tenure is lower.*
>
> *Hypothesis 10b: Team tenure will moderate the relationship between team communication actions for the conveyance of information and conflict in such a way that this relationship will be more positive when team tenure is lower.*

Team research has shown that interpersonal variables have an important role in the effectiveness of teams. Specifically, several meta-analyses have found that intra-team trust has a positive and largely consistent relationship with team performance (Breuer, Hüffmeier and Hertel, 2016; De Jong, Dirks and Gillespie, 2016; Feitosa *et al.*, 2020). Interestingly, some of these studies have examined if the positive effects of trust on performance differ

between face-to-face and virtual teams. They found that the relationship between trust and team performance is positive under both conditions, with some evidence that it may be stronger in virtual settings (Breuer, Hüffmeier and Hertel, 2016). Contrary to trust, the role of conflict in predicting team performance seems to be more nuanced. Past research has distinguished between relationship conflict, involving friction between team members regarding their own unique characteristics and personalities, and task conflict, reflecting disagreements about the ideas and viewpoints on the tasks they must perform (Jehn, 1995). Some authors have argued that due to these differences, relationship conflict will be, in general, negatively related to team performance because even if the discrepancies between team members are solved, they will not offer positive insights for the performing of tasks (O'Neill, Allen and Hastings, 2013). In contrast, resolving task disagreements can facilitate insights about new ways to accomplish tasks, which can have benefits on team performance. There is some evidence that supports this view. For example, De Wit and colleagues' (2012) meta-analysis found that relationship conflict is negatively related to performance, while task conflict does not have a significant relationship. However, other meta-analyses have found consistent negative effects (De Dreu and Weingart, 2003) for both variables. Mortensen and Hinds (2001) also found that task conflict was not related to team performance in collocated teams, while it had a negative effect in distributed teams. This way, it seems that, although more context-dependent, conflict in its different forms will most of the time be negatively related to task performance. Therefore, the following hypotheses are formulated:

> *Hypothesis 11: Interpersonal states will mediate the positive relationship between team communication actions for the convergence of meaning and team performance.*
> *Hypothesis 12: Interpersonal states will mediate the relationship between team communication actions for the conveyance of information and team performance,*

depending on team tenure. This indirect effect will be more negative when team tenure

is lower.

Methods

Design and Participants

We collected data using a multisource survey study in two organisations from Latin America (see below for a description of each organisation). The full sample consisted of 517 team members in 143 teams with sizes ranging from 2 to 16 ($M = 5.2$, $SD = 2.9$) and members responses ranging from 2 to 13 ($M = 3.6$, $SD = 2.0$). Participants were 62% females, their average age was 39.3 years old ($SD = 10.3$), their average organisational tenure was 5.7 ($SD = 6.5$), and their average team tenure was 4.1 ($SD = 5.3$). Leaders were 50% females, their average age was 43.0 years old ($SD = 9.0$), and their average tenure as leaders was 3.8 (SD = 4.2). Leaders reported that 62% of their teams were doing hybrid work in which members must go to the office on the same days, 31% were doing hybrid work in which members can go to the office on different days, 6% were doing full-time collocated work, and 1% were doing full-time home-office. On average, team members reported working in the office for 2.9 days (SD = 0.8) and remotely for 2.2 days ($SD = 0.6$).

Manufacturing Company

The first organisation that agreed to participate is a large paper manufacturing company that has its central headquarters in Chile and workers distributed across different countries of Latin America. All clerical workers who were part of teams (1610) were invited to answer an online survey with questions about their team's use of different media, communication actions, and work processes (transition, action, and interpersonal). Two weeks later, team leaders were asked to rate the performance of their teams.

We received 842 full responses from team members (52% response rate) and 249 from team leaders (54%). After removing teams without answers from leaders, with less than

two responses from team members or with very low response rates (≤ 20%; Timmerman, 2005; Nesterkin and Ganster, 2015), the final sample consisted of 405 team members in 117 teams which represents a 25% of the teams approached to participate in the study. Participants were 58% females, their average age was 37.6 years old (*SD* = 9.6), their average organisational tenure was 5.8 years (*SD* = 7.1), average team tenure was 3.9 years (*SD* = 5.0), and their nationalities were: 24% Brazilians, 21% Chileans, 15% Peruvians, 11% Ecuadorians, 10% Mexicans, 10% Colombians, 5% Argentinians, 1% Uruguayans, and 1% Venezuelans. Leaders were 46% females, their average age was 41.7 years old (*SD* = 8.6), their average tenure as leaders was 3.1 (*SD* = 3.6), and their nationalities were 23% Chileans, 21% Brazilians, 14% Peruvians, 12% Colombians, 11% Mexicans, 10% Ecuadorians, 5% Argentinians, and 3% Uruguayans, and 1% Venezuelans. Team sizes ranged from 2 to 16 team members (*M* = 4.7; *SD* = 2.7), and the number of responses by team ranged from 2 to 13 (*M* = 3.5; *SD* = 1.8). Leaders reported that 57% of their teams were doing hybrid work with members going to the office on the same days, 38% were doing hybrid work in which members are allowed to go to the office on different days, 3% were doing full-time collocated work, and 2% were doing full-time home-office. On average, team members reported working in the office for 2.8 days (SD = 0.7) and remotely for 2.2 days (*SD* = 0.5).

Insurance Company

The second organisation is an insurance company based in Chile. We invited all 938 team members of the organisation to answer the same online survey from the first organisation. A week later, we invited the 128 leaders of the organisation to answer a survey to rate the performance of their teams. We received 303 full responses from team members (32%) and 41 responses from leaders (32%). After removing teams without answers from leaders, with less than two responses from team members, or with very low response rates (≤ 20%; Timmerman, 2005; Nesterkin and Ganster, 2015), the final sample consisted of 112

team members in 26 teams, which represents a 20% of the teams invited to participate in the study. Participants were 77% females, their average age was 45.6 years old (SD = 10.1), their average organisational tenure was 5.2 (SD = 3.2), and their average team tenure was 4.9 (SD = 6.1). Leaders were 65% females, their average age was 49.2 years old (SD = 8.6), and their average tenure as leaders was 5.1 (SD = 6.4). Team sizes ranged from 4 to 15 team members (M = 7.7; SD = 2.5), and the number of responses by team ranged from 2 to 12 (M = 4.3; SD = 2.5). Leaders reported that 85% of their teams were doing hybrid work but with the requirement that members must go to the office on the same days (e.g., Mondays and Thursdays), and 15% were doing full-time collocated work. On average, team members reported working in the office for 3.2 days (SD = 1.0) and remotely for 2.2 days (SD = 0.9).

Measures

Team Communication Actions. We assessed this variable using the Perez-Sepulveda, Dawson and Axtell (article 2) 25-item scale. This scale differentiates between three actions related to convergence of meaning: using verbal and non-verbal communications (M = 4.1, SD = 0.4, α = .78; e.g., "We usually communicate with each other by speaking/voice"), speed of exchanges (M = 4.2, SD = 0.4, α = .91; e.g., "Usually, we reply quickly to communications within the team"), and involving multiple participants (M = 4.2, SD = 0.4, α = .87; e.g., "Usually, multiple team members interact at the same time"); and five actions related to conveyance of information: having simultaneous communication (M = 3.7, SD = 0.6, α = .94; e.g., "We often participate in several communications at the same time"), using written communications (M = 3.8, SD = 0.4, α = .84; e.g., "In general, communications within the team are written/text-based"), using graphical communications (M = 3.2, SD = 0.6, α = .95; e.g., "We usually communicate with each other using images or charts"), refining communications (M = 4.2, SD = 0.4, α = .93; e.g., "Commonly, we check messages thoroughly before communicating them"), and reviewing communications (M = 3.3, SD =

0.6, α = .93; e.g., "We often examine the communications from other members more than once"). The 25 items were assessed using a 5-point Likert scale (1: strongly disagree, to 5: strongly agree). These items ask each team member to assess the actions that occur at the team level, which represents a referent-shift consensus model in Chan's (1998) classification.

Team Tenure. This variable (*M* = 3.4, *SD* = 3.4) was measured by asking each member the amount of time they have spent working as a part of the team. Then, team tenure was operationalised using the median tenure of the team members, which represents an additive model based on Chan's (1998) classification. The use of median instead of mean is preferable to avoid skewness when members' tenure is highly diverse. For example, in a team with three members, if two of them have a tenure of one year and the third member has a tenure of eight years, the mean of the team will be 3.33 while the median will be 1. The mean value does not represent very well the fact that 66% of the team has just one year of experience working with each other. Considering this, researchers in the past have opted to use median instead of mean to avoid this issue (e.g., Dineen *et al.*, 2007; Koopmann *et al.*, 2016)

Transition Processes. We assessed transition processes (*M* = 4.4, *SD* = 0.4, α = .88) using Mathieu *et al.* (2020) three-item measure and a 5-point Likert scale (1: strongly disagree, to 5: strongly agree) (e.g., "To what extent does our team actively work to … Identify the key challenges that we expect to face?") which captures the facets of mission analysis, goal specification, and strategy formulation and planning. This scale represents a referent-shift consensus model.

Action Processes. Coordination and information sharing were measured as past research has shown the relevance of these two variables in virtuality conditions. Coordination (*M* = 4.4, *SD* = 0.4, α = .91) was measured using Mathieu *et al.* (2020) three-item scale (e.g., "To what extent does our team actively work to … Coordinate our activities with one

another?"). Information sharing ($M = 4.2$, $SD = 0.4$, $\alpha = .88$) was measured using Bunderson and Sutcliffe's (2002) three-item scale (e.g., "Information used to make key decisions was freely shared among the members of the team"). The two scales were measured using a 5-point Likert scale (1: strongly disagree, to 5: strongly agree). These measures follow a referent-shift consensus model.

Interpersonal Variables. Intrateam trust, relationship conflict and task conflict were measured as past research has linked these variables with team virtuality. We measured intrateam trust ($M = 4.3$, $SD = 0.5$, $\alpha = .92$) using Kirkman *et al.* (2006) four-item scale (e.g., "Team members have a high degree of trust between each other"). Task conflict ($M = 2.3$, $SD = 0.6$, $\alpha = .93$) was measured using Jehn and Mannix's (2001) three-item scale (e.g., "There is a lot of conflict of ideas in my work group"). Relationship conflict ($M = 1.8$, $SD = 0.6$, $\alpha = .96$) was measured using Tekleab *et al.* (2009) four-item (e.g., "There is friction among members of my team") adaptation of Jehn's (1995) scale. The three scales were measured using a 5-point Likert scale (1: strongly disagree, to 5: strongly agree). These scales represent a referent-shift consensus model.

Team Performance. Team performance was measured in the leader survey by shifting the referent from the three-item individual task proficiency scale (Griffin, Neal and Parker, 2007) to the team level ($M = 4.4$, $SD = 0.6$, $\alpha = .93$; e.g., "The team carried out the core parts of their job well"). This scale aims to capture how well the team members are in achieving the core tasks of the team.

Control variables. We measured two relevant dimensions of team virtuality due to the characteristics of the teams and organisations that participated in the study. Technology reliance ($M = 74.4$, $SD = 13.8$) was measured by asking each team member to assess the proportion of time they interact using some type of information and communication technology (e.g., email, chat, video calls, phone calls) as opposed to face-to-face

communication (Maynard *et al.*, 2019). Geographical dispersion was assessed using three configurational dimensions (O'Leary and Cummings, 2007): sites, isolation, and imbalance. Sites (*M* = 0.12, *SD* = 0.54) represent the total number of work locations represented in teams. Isolation (*M* = .06, *SD* = .20) is calculated as the percentage of team members with no other members in their work location. The imbalance index (*M* = .03, *SD* = .08) represents the disparity in the distribution of team members across the different work locations (e.g., 2 team members in one location and 5 in another). We also controlled for team size (*M* = 5.2, *SD* = 2.9) due to its influence on teams' effectiveness (Wheelan, 2009; Aubé, Rousseau and Tremblay, 2011; Bernerth *et al.*, 2023) and the organisation to which teams belonged.

Analysis Strategy

We used a three-step analysis strategy. First, the team communication actions, transition, action, and interpersonal processes are constructs defined at the team level of analysis but measured through team members' individual perceptions of the team. Thus, their operationalisation as team-level variables, using a referent-shift consensus composition model, required testing the interrater reliability and agreement among team members' ratings (Chan, 1998; LeBreton, Moeller and Wittmer, 2023). Accordingly, we used the Intraclass Correlation Index (*ICC1* and *ICC2*) to determine the effect size of team membership on the variance of the variable (i.e., the proportion of variance attributable to team membership) (Bliese, 2000). While Intraclass Correlation provides information about interrater reliability, researchers cannot attribute low ICC values to a lack of agreement between raters because they depend at least partially on the between-group variance (Mathieu *et al.*, 2020). Therefore, the examination of interrater agreement has been proposed to justify the aggregation of individual ratings to capture team-level constructs (LeBreton and Senter, 2008). We examined this using r_{WG} and Average Deviation (*AD*) indices (Burke and Dunlap, 2002; Dunlap, Burke and Smith-Crowe, 2003).

Second, confirmatory factor analyses at the team level were conducted to determine the adequate internal structure and discriminant validity of the scales (Brown, 2015). Lastly, this study's hypotheses were tested using path analyses with maximum likelihood to assess models of direct, moderation, mediation, and moderated mediation effects together with simple slope tests at specific values depending on the hypotheses (Bauer and Curran, 2005). Path analyses were conducted using Structural Equation Modelling (SEM) in R software. To examine the effects of team communication actions on teamwork processes, each model included all control variables and team communication actions. Interaction terms were subsequently added in a second set of models to explore potential moderating effects. Similarly, to assess the impact of teamwork processes on team performance, all control variables, team communication actions, and teamwork processes were included in the initial model, with interaction terms introduced in a second model to evaluate any interaction effects. Indirect and conditional indirect effects of the mediational models were examined using Monte Carlo confidence intervals (CI) based on 20000 iterations as past research has shown it produces accurate results even when using small sample sizes while also being less demanding computationally compared to bootstrapping techniques (MacKinnon, Lockwood and Williams, 2004; Preacher and Selig, 2012; Tofighi and MacKinnon, 2016).

Results

Interrater Agreement and Reliability

Results supported the aggregation of ratings to the team level of verbal and non-verbal communications, $ICC1 = .01$, $ICC2 = .74$, $r_{WG} = .87$, $AD = .46$, speed of exchanges, $ICC1 = .00$, $ICC2 = .00$, $r_{WG} = .88$, $AD = .42$, multiple participants, $ICC1 = .00$, $ICC2 = .00$, $r_{WG} = .89$, $AD = .42$, simultaneous communications, $ICC1 = .01$, $ICC2 = .78$, $r_{WG} = .71$, $AD = .63$, written communications, $ICC1 = .04$, $ICC2 = .91$, $r_{WG} = .81$, $AD = .49$, graphical communications, $ICC1 = .01$, $ICC2 = .67$, $r_{WG} = .73$, $AD = .61$, refining communications,

ICC1 = .00, *ICC2* =.00, r_{WG} = .87, *AD* = .44, reviewing communications, *ICC1* = .01, *ICC2* = .72, r_{WG} = .77, *AD* = .59, transition processes, *ICC1* = .00, *ICC2* = .00, r_{WG} = .89, *AD* = .40, coordination, *ICC1* = .01, *ICC2* = .69, r_{WG} = .85, *AD* = .43, information sharing, , *ICC1* = .00, *ICC2* = .00, r_{WG} = .85, *AD* = .44, intra-team trust, *ICC1* = .02, *ICC2* = .81, r_{WG} = .87, *AD* = .45, relationship conflict, *ICC1* = .01, *ICC2* = .73, r_{WG} = .79, *AD* = .55, and task conflict, *ICC1* = .00, *ICC2* = .19, r_{WG} = .74, *AD* = .59.

Internal Structure and Discriminant Validity

Confirmatory factor analysis supported the 15-factor measurement model at the team level based on measures of team communication actions, transition processes, action processes, interpersonal states, and task performance, $\chi^2(974)$ = 1571.04, $p < .01$, RMSEA = .07, SRMR = .05, CFI = .91, TLI = .90. This goodness-of-fit was superior to alternative models in which measures were loaded in a smaller number of factors: a) a model with all items in a single factor: $\chi^2(1079)$ = 5362.53, $p < .01$, RMSEA = .17, SRMR = .16, CFI = .35, TLI = .32, b) a model with all team communication actions combined in a single factor: $\chi^2(1051)$ = 3569.42, $p < .01$, RMSEA = .13, SRMR = .13, CFI = .62, TLI = .59, c) a model with transition, action, and interpersonal processes combined in a single factor: $\chi^2(1034)$ = 2689.06, $p < .01$, RMSEA = .11, SRMR = .09, CFI = .75, TLI = .73, d) a model with team communication actions, transition, action, and interpersonal processes combined in a single factor: $\chi^2(1078)$ = 5026.71, $p < .01$, RMSEA = .16, SRMR = .15, CFI = .40, TLI = .37, and e) a model with task performance and transition, action, and interpersonal processes combined in a single factor: $\chi^2(1043)$ = 3031.35, $p < .01$, RMSEA = .12, SRMR = .10, CFI = .70, TLI = .67.

Direct and Moderated Effects of Team Communication Actions on Transition Processes

Table 1 presents the correlations of the variables in the study. Hypothesis 1 stated that team communication actions related to convergence of meaning will be positively related to

transition processes. Correlation analyses showed that using verbal and non-verbal communications ($r = .44$, $p < .001$), speed of exchanges ($r = .41$, $p < .001$), and involving multiple participants ($r = .38$, $p < .001$) are positively related to transition processes. Using path analysis to control for the effect of other team communication actions, results of Model 1 (see Table 2) showed that only verbal and non-verbal communications are positively related to transition processes ($b = .25$, $p = .003$), but not speed of exchanges ($b = .08$, $p = .398$) or multiple participants ($b = .13$, $p = .157$). Therefore, hypothesis 1 was only partially supported.

Table 1

Correlations of the Study's Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. ORG	-																				
2. TTEN	-.05	-																			
3. TSIZE	-.40**	.06	-																		
4. TECH	.23	-.01	.03	-																	
5. D-S	.20	-.14	-.02	.03	-																
6. D-ISO	.15	-.12	-.25**	-.06	.61**	-															
7. D-IMB	.18*	-.12	.02	.05	.63**	.22*	-														
8. VNCᵃ	-.10	-.16	-.04	.04	-.06	-.01	-.02	-													
9. SEᵃ	.05	-.09	-.10	.14	-.03	.09	-.05	.49**	-												
10. MPᵃ	.03	-.07	.01	.34**	.02	.04	.11	.40**	.50**	-											
11. SCᵇ	.08	-.11	.07	.19*	.00	-.04	.01	.01	.09	.42**	-										
12. WCᵇ	.24**	-.03	-.10	.33**	.03	.04	.04	-.03	.14	.33**	.27**	-									
13. GCᵇ	.14	-.02	-.01	.18*	-.01	-.10	.11	.29**	.17	.32**	.23*	.38**	-								
14. RFCᵇ	.01	.01	-.03	.07	-.01	.01	-.09	.41**	.53**	.30**	.10	.17*	.33**	-							
15. RVCᵇ	.02	-.04	.08	.14	-.11	-.18	-.04	.05	.06	.25**	.53**	.28**	.35**	.21*	-						
16. TP	.11	.07	-.08	.13	.07	.16	.01	.44**	.41**	.38**	.10	.12	.30**	.44**	-.01	-					
17. COO	.15	.07	-.08	.19	.05	.16	-.04	.38**	.54**	.32**	.06	.09	.14	.46**	-.07	.72**	-				
18. IS	.16	.14	-.12	.10	.12	.19*	.10	.43**	.46**	.27**	.04	.14	.34**	.47**	.01	.71**	.70**	-			
19. Trust	.35**	.06	-.29**	.13	.10	.17*	.07	.41**	.56**	.31**	.05	.21*	.30**	.48**	.00	.62**	.73**	.72**	-		
20. RC	-.28**	.11	.15	.07	-.16	-.21*	-.08	-.23*	-.38**	-.12	-.03	-.13	.03	-.27**	.10	-.43**	-.54**	-.40**	-.57**	-	
21. TC	-.20*	.14	.19*	.00	-.16	-.26**	.00	-.19*	-.42**	-.09	.06	-.06	.08	-.24**	.25**	-.37**	-.47**	-.37**	-.49**	.76**	-
22. Task	.46**	.04	-.22*	.15	.04	.10	.07	.15	.19*	.10	.00	.08	.15	.17*	.12	.31**	.23*	.27**	.41**	-.23**	-.19*

Note. $N = 143$. ** $p < .01$; * $p < .05$. ᵃ = Action related to Convergence of Meaning. ᵇ = Action related to Conveyance of Information. ORG = Organisation (0 = Insurance, 1 = Manufacturing). TTEN = Team tenure. TSIZE = Team size. TECH = Technology reliance. D-S = Dispersion (site). D-ISO = Dispersion (isolation). D-IMB = Dispersion (imbalance). VNC = Verbal and non-verbal communications. WC = Written communications. GC = Graphical communications. SE = Speed of exchanges. MP = Multiple participants. SC = Simultaneous communications. RFC = Refining communications. RVC = Reviewing communications. TP = Transition processes. COO = Coordination. IS = Information sharing. TC = Task conflict. RC = Relationship conflict. Task = Team performance.

Table 2

Direct and Interactional Effects of Control Variables, Team Tenure, and Team

Communication Actions on Transition Processes

Variables	Transition Processes	
	Model 1	Model 2
Control variables		
Organisation (0:Insurance; 1: Manufacturing)	.11 (.08)	.11 (.08)
Team size	.00 (.01)	.01 (.01)
Team tenure	.02 (.01)*	.01 (.01)
Technology reliance	.00 (.00)	.00 (.00)
Geographical dispersion (sites)	.00 (.09)	.01 (.08)
Geographical dispersion (isolation)	.30 (.18)	.31 (.17)
Geographical dispersion (imbalance)	-.18 (.45)	-.30 (.43)
Direct effects		
Verbal and non-verbal communications[a]	.25 (.09)**	.34 (.09)**
Speed of exchanges[a]	.08 (.09)	.09 (.09)
Multiple participants[a]	.13 (.09)	.15 (.09)
Simultaneous communications[b]	.06 (.06)	.07 (.06)
Written communications[b]	-.02 (.07)	-.01 (.07)
Graphical communications[b]	.11 (.06)	.11 (.06)
Refining communications[b]	.22 (.08)**	.17 (.08)*
Reviewing communications[b]	-.13 (.06)*	-.12 (.06)*
Moderation effects		
Simultaneous communications[b] X Team tenure		-.02 (02)
Written communications[b] X Team tenure		.02 (.02)
Graphical communications[b] X Team tenure		-.04 (.02)*
Refining communications[b] X Team tenure		-.01 (.02)
Reviewing communications[b] X Team tenure		.02 (.02)
R-squared	**.39**	**.45**

Note. N = 143. Unstandardised estimates. Standard errors in parenthesis. ** *p* < .01; * *p* <

.05. [a] = Action related to Convergence of Meaning. [b] = Action related to Conveyance of

Information.

Hypothesis 2 proposed that team tenure will moderate the relationship between team communication actions for the conveyance of information and transition processes, such that the relationship will be positive when team tenure is lower. Results of Model 2 (Table 2) show that team tenure moderates the relationships between graphical communications ($b = .04$, $p = .015$) and transition processes but not simultaneous communications ($b = -.02$, $p = .217$), written communications ($b = .02$, $p = .424$), refining communications ($b = -.01$, $p = .536$), or reviewing communications ($b = .02$, $p = .313$). As shown in Figure 1, the relationship between graphical communications and transition processes is positive when team tenure is one year old, which represents the first quartile of the sample, $b = .20$, $SE = .06$, $p = .001$, and two years old (second quartile), $b = .16$, $SE = .06$, $p = .005$, but not significant when team tenure is four years old (third quartile), $b = .08$, $SE = .06$, $p = .147$. Thus, hypothesis 2 was supported for graphical communications but not for other conveyance of information actions.

Figure 1

Interactional Effects of Graphical Communications and Team Tenure on Transition Processes
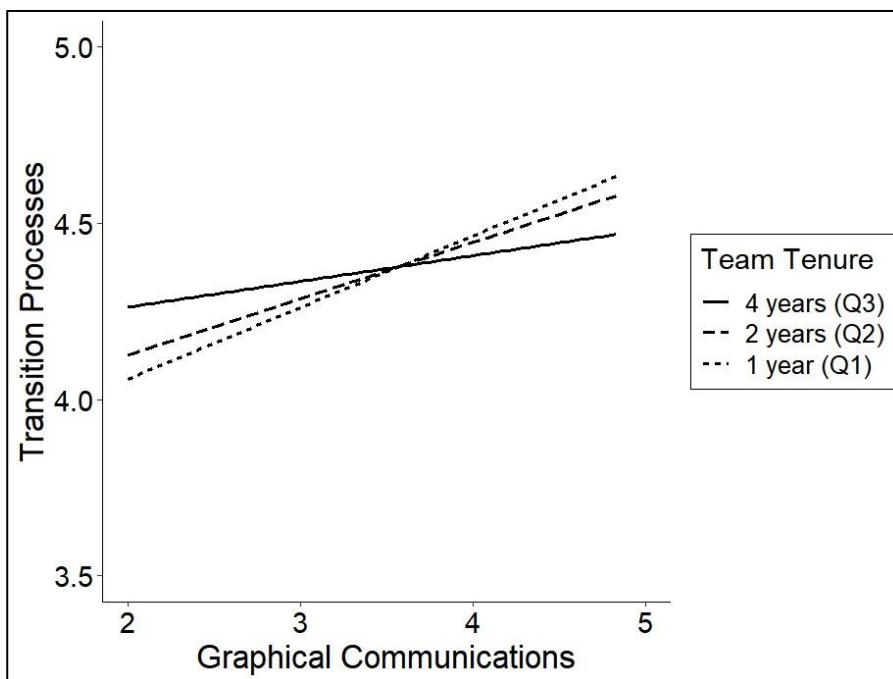
Mediational Effects of Transition Processes

Hypothesis 3 proposed that transition processes would mediate the positive relationship between the team communication actions for the convergence of meaning and task performance. Results of Model 3 (Table 3) showed that transition processes are positively related to task performance, $b = .45$, $SE = .18$, $p = .012$. Thus, a Monte Carlo CI was computed for the indirect effect of verbal and non-verbal communications, the only variable significantly related to transition processes in previous analyses. Results showed a significant indirect effect on task performance through transition processes, $b = .11$, $SE = .05$, CI 95% [.03, .23]. Therefore, hypothesis 3 was partially supported for verbal and non-verbal communications, but not for other convergence of meaning actions.

Hypothesis 4 proposed that transition processes will mediate the conditional relationship of conveyance of information communication actions on task performance depending on team tenure. We tested the conditional indirect effect of only graphical communications depending on team tenure because the other actions for the conveyance of information did not have a moderated effect on transition processes. Monte Carlo CI showed that the index of moderated mediation for the interaction between graphical communications and team tenure was statistically significant, $b = -.02$, $SE = .01$, CI 95% [-.04, -.002]. The conditional indirect effect of graphical communications on team performance through transition processes was positive and significant when team tenure was one year, $b = .09$, $SE = .04$, CI 95% [.02, .18], and two years old, $b = .07$, $SE = .02$, CI 95% [.02, .15], but not when tenure was four years, $b = .04$, $SE = .03$, CI 95% [-.01, .10]. These results offer partial support to Hypothesis 4 for graphical communications.

Table 3

Direct and Interactional Effects on Task Performance

| Variables	Task Performance		
	Model 3	Model 4	Model 5
Control variables			
Organisation (0: Manufacturing; 1: Insurance)	.65 (.14)**	.62 (.14)**	.67 (.14)**
Team size	.01 (.02)	-.01 (.02)	.01 (.02)
Team tenure	.01 (01)	.00 (.01)	.02 (.01)
Technology reliance	.00 (.00)	.00 (.00)	.01 (.00)*
Geographical dispersion (sites)	-.19 (14)	-.18 (.13)	-.25 (.13)
Geographical dispersion (isolation)	.36 (.29)	.42 (.29)	.43 (.28)
Geographical dispersion (imbalance)	.58 (.74)	.44 (.72)	.74 (.70)
Direct effects			
Verbal and non-verbal communications[a]	.09 (.15)	.06 (.15)	.00 (.14)
Speed of exchanges[a]	.04 (.16)	.05 (.17)	.02 (.17)
Multiple participants[a]	-.07 (.15)	-.07 (.15)	-.20 (.15)
Simultaneous communications[b]	-.13 (.10)	-.12 (.10)	-.14 (.09)
Written communications[b]	-.15 (.12)	-.16 (.11)	-.21 (.11)
Graphical communications[b]	-.05 (.10)	-.04 (.10)	.00 (.09)
Refining communications[b]	.02 (.13)	.08 (.14)	.07 (.13)
Reviewing communications[b]	.23 (.10)*	.11 (10)	.24 (.10)*
Transition processes	.45 (.18)*	.40 (.15)*	.38 (.17)*
Coordination	-.32 (.19)	-.23 (.12)	-.14 (.18)
Information sharing	-.12 (.17)	.00 (.12)	-.20 (.16)
Trust	.43 (.18)*	.29 (.16)	.41 (.17)*
Relationship conflict	.03 (.12)	.01 (.11)	.00 (.08)
Task conflict	-.04 (.11)	-.02 (.11)	-.02 (.08)
Moderation effects			
Coordination X Team size		.10 (.06)	
Information sharing X Team size		.03 (.06)	
Information sharing X Simultaneous communications[b]		-.03 (.23)	
Information sharing X Written communications[b]		.21 (.28)	
Information sharing X Graphical communications[b]		-.04 (.25)	
Information sharing X Refining communications[b]		.15 (.22)	
Information sharing X Reviewing communications[b]		.44 (.21)*	
Relationship conflict X Verbal and non-verbal communications[a]			-.37 (.31)
Relationship conflict X Speed of exchanges[a]			-.31 (.32)
Relationship conflict X Multiple participants[a]			.69 (.36)
Task conflict X Verbal and non-verbal communications[a]			1.13 (.30)**
Task conflict X Speed of exchanges[a]			.17 (.29)
Task conflict X Multiple participants[a]			-.85 (.31)**
R-squared	**.37**	**.44**	**.45**

Note. $N = 143$. Unstandardised estimates. Standard errors in parenthesis. ** $p < .01$; * $p < .05$. [a] = Action related to Convergence of Meaning. [b] = Action related to Conveyance of Information.

Although only the graphical communications effect was moderated by team tenure, we did find direct effects of refining communications and reviewing communications on transition processes, as shown in Table 2. Considering this, we computed Monte Carlo CIs to test the existence of indirect effects of these two variables on team performance through transition processes. Results showed that refining communications has an indirect effect, $b = .08$, $SE = .04$, CI 95% [.008, .18], but not reviewing communications, $b = -.05$, $SE = .03$, CI 95% [-.12, .002].

Direct and Moderated Effects of Team Communication Actions on Action Processes

Hypothesis 5 states that team tenure will moderate the relationship between the team communication actions for the convergence of meaning and action processes in such a way that the relationship will be positive when team tenure is lower. As shown in Model 5 and Model 7 (Table 4), no significant interactions were found between team tenure and these actions predicting coordination or information sharing ($p > .05$). Therefore, hypothesis 5 was not supported. However, while no interactional effects were found, Model 6 and Model 8 (Table 4) show that verbal and non-verbal communication and speed of exchanges were both positively related to coordination ($b = .18$, $p = .048$; $b = .33$, $p < .001$, respectively) and information sharing ($b = .29$, $p = .001$; $b = .24$, $p = .013$, respectively).

Hypothesis 6 states that team tenure will moderate the relationship between the team communication actions for the conveyance of information and action processes in such a way that the relationship will be positive when team tenure is higher. As shown in Model 7 and Model 9 (Table 4), no significant interactions were found between team tenure and conveyance of information actions predicting coordination or information sharing. Thus, hypothesis 6 was not supported. Nevertheless, Model 6 (Table 4) shows that refining communications is positively related to coordination ($b = .26$, $p = .002$), while reviewing communications has a negative effect ($b = -.14$, $p = .027$). Additionally, Model 8 shows that graphical communications ($b = .14$, $p = .014$) and refining communications ($b = .25$, $p = .003$) are positively related to information sharing.

Table 4

Direct and Interactional Effects of Control Variables, Team Tenure, and Team Communication

Actions on Action Processes

Variables	Coordination		Information Sharing	
	Model 6	Model 7	Model 8	Model 9
Control variables				
Organisation (0:Insurance; 1: Manufacturing)	.16 (.08)*	.16 (.08)*	.12 (.08)	.14 (08)
Team size	.01 (.01)	.01 (.01)	.00 (.01)	.00 (.01)
Team tenure	.02 (.01)*	.01 (.01)	.03 (.01)**	.03 (.01)**
Technology reliance	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
Geographical dispersion (sites)	-.02 (.09)	-.01 (.09)	-.05 (.09)	-.04 (.09)
Geographical dispersion (isolation)	.29 (.19)	.31 (.19)	.42 (.19)*	.40 (.19)*
Geographical dispersion (imbalance)	-.21 (.47)	-.28 (.46)	.67 (.47)	.59 (.47)
Direct effects				
Verbal and non-verbal communications[a]	.18 (.09)*	.24 (.09)*	.29 (.09)**	.31 (.10)**
Speed of exchanges[a]	.33 (.10)**	.36 (.10)**	.24 (.10)*	.25 (.10)*
Multiple participants[a]	.02 (.10)	.03 (.09)	-.10 (.10)	-.09 (.10)
Simultaneous communications[b]	.07 (.06)	.08 (.06)	.04 (.06)	.04 (.06)
Written communications[b]	-.04 (.07)	-.04 (.07)	.01 (.07)	.03 (.08)
Graphical communications[b]	-.01 (.06)	.01 (.06)	.14 (.06)*	.12 (.06)*
Refining communications[b]	.26 (.08)**	.20 (.08)*	.25 (.08)**	.25 (.09)**
Reviewing communications[b]	-.14 (.06)*	-.14 (.06)*	-.08 (.06)	-.06 (.06)
Moderation effects				
Verbal and non-verbal communications[a] X Team tenure		-.04 (.02)		.01 (.02)
Speed of exchanges[a] X Team tenure		.03 (.03)		-.02 (.03)
Multiple participants[a] X Team tenure		-.02 (.03)		.01 (.03)
Simultaneous communications[b] X Team tenure		.00 (.02)		.01 (.02)
Written communications[b] X Team tenure		.00 (.02)		.02 (.02)
Graphical communications[b] X Team tenure		.00 (.02)		-.03 (.02)
Refining communications[b] X Team tenure		-.01 (.03)		.00 (.03)
Reviewing communications[b] X Team tenure		.01 (.02)		.02 (.03)
R-squared	**.43**	**.47**	**.46**	**.47**

Note. N = 143. Unstandardised estimates. Standard errors in parenthesis. ** *p* < .01; * *p* < .05. [a] = Action

related to Convergence of Meaning. [b] = Action related to Conveyance of Information.

Mediational Effects of Action Processes

Hypothesis 7 proposed that action processes will mediate the relationship between team communication actions for the convergence of meaning and task performance depending on team tenure. Similarly, hypothesis 8 stated that action processes would mediate the relationship between team communication actions for the conveyance of information and task performance depending on team tenure. As stated before, no significant interactions were found predicting coordination or information sharing. Additionally, Model 3 (Table 3) shows that coordination ($b = -.32$, $p = .092$) and information sharing ($b = -.12$, $p = .477$) were not significantly related to task performance when controlling for control variables, team communication actions, and other teamwork processes. Therefore, hypotheses 7 and 8 were not supported.

Direct and Moderated Effects of Team Communication Actions on Interpersonal Variables

Hypothesis 9a stated that team communication actions for the convergence of meaning would be positively related to trust. Correlation analyses (Table 1) show that using verbal and non-verbal communications ($r = .41$, $p < .001$), speed of exchanges ($r = .56$, $p < .001$) and involving multiple participants ($r = .31$, $p < .001$) are positively related to trust. When adding control variables and other team communication actions, results of Model 10 (Table 5) show that only verbal and non-verbal communications ($b = .24$, $p = .004$) and speed of exchanges ($b = .39$, $p < .001$) are positively related to trust, but not multiple participants ($b = .05$, $p = .556$). All these results offer partial support for Hypothesis 9a.

Table 5

Direct and Interactional Effects of Control Variables, Team Tenure, and Team Communication Actions on Interpersonal Variables

Variables	Trust		Relationship Conflict		Task Conflict	
	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15
Control variables						
Organisation (0: Manufacturing; 1: Insurance)	.31 (.08)**	.32 (.08)**	-.49 (.13)**	-.51 (.13)**	-.26 (.13)*	-.23 (.13)
Team size	-.02 (.01)	-.02 (.01)	-.01 (.02)	-.01 (.02)	.01 (.02)	.01 (.02)
Team tenure	.02 (.01)	.02 (.01)*	.01 (.01)	.01 (.01)	.01 (.01)	.02 (.01)
Technology reliance	.00 (.00)	.00 (.00)	.01 (.00)	.01 (.00)**	.00 (.00)	.00 (.00)
Geographical dispersion (sites)	.00 (.08)	.01 (.08)	-.05 (.14)	-.07 (.14)	-.11 (.14)	-.12 (.13)
Geographical dispersion (isolation)	.15 (.18)	.14 (.18)	-.21 (.30)	-.16 (.29)	-.26 (.29)	-.25 (.28)
Geographical dispersion (imbalance)	.33 (.44)	.33 (.44)	-.26 (.75)	-.14 (.74)	.55 (.73)	.60 (.71)
Direct effects						
Verbal and non-verbal communications[a]	.24 (.08)**	.27 (.09)**	-.28 (.14)	-.34 (.15)*	-.10 (.14)	-.14 (.14)
Speed of exchanges[a]	.39 (.09)**	.40 (.09)**	-.46 (.15)**	-.44 (.15)**	-.60 (.15)**	-.53 (.15)**
Multiple participants[a]	-.05 (.09)	-.04 (.09)	.15 (.15)	.14 (.15)	.17 (.15)	.20 (.15)
Simultaneous communications[b]	.03 (.06)	.03 (.06)	-.11 (.10)	-.11 (.10)	-.08 (.10)	-.09 (.09)
Written communications[b]	.06 (.07)	.07 (.07)	-.25 (.12)*	-.26 (.12)*	-.14 (.11)	-.15 (.11)
Graphical communications[b]	.08 (.06)	.08 (.06)	.21 (.09)*	.19 (.09)*	.14 (.09)	.10 (.09)
Refining communications[b]	.23 (.08)**	.20 (.08)**	-.21 (.13)	-.17 (.13)	-.16 (.13)	-.16 (.13)
Reviewing communications[b]	-.09 (.06)	-.08 (.06)	.15 (.10)	.17 (.10)	.29 (.10)**	.35 (.10)**
Moderation effects						
Simultaneous communications[b] X Team tenure		-.02 (.02)		.02 (.03)		.02 (.03)
Written communications[b] X Team tenure		.01 (.02)		.04 (.03)		.08 (.03)*
Graphical communications[b] X Team tenure		-.01 (.02)		.03 (.03)		.00 (.03)
Refining communications[b] X Team tenure		-.01 (.02)		.04 (.04)		-.02 (.04)
Reviewing communications[b] X Team tenure		.03 (.02)		-.04 (.04)		.02 (.04)
R-squared	**.56**	**.57**	**.33**	**.37**	**.35**	**.39**

Note. N = 143. Unstandardised estimates. Standard errors in parenthesis. ** $p < .01$; * $p < .05$. [a] = Action related to Convergence of Meaning. [b] = Action related to Conveyance of Information.

Hypothesis 9b stated that team communication actions for the convergence of meaning would be negatively related to conflict. Regarding relationship conflict, correlation analyses showed that verbal and non-verbal communications ($r = -.23$, $p = .007$) and quick communications ($r = -.38$, $p < .001$) had significant negative relationships, but multiple participants ($r = -.12$, $p = .164$) was not significant. Model 12 shows that when controlling for other actions, only the speed of exchanges ($b = -.46$, $p = .003$) is negatively related to relationship conflict; verbal and non-verbal communications ($b = -.28$, $p = .051$) and multiple participants ($b = .15$, $p = .326$) did not have significant effects. Considering task conflict, correlations showed that verbal and non-verbal communications ($r = -.19$, $p = .023$) and speed of exchanges ($r = -.42$, $p < .001$) had significant negative relationships, but multiple participants ($r = -.09$, $p = .305$) did not. Model 14 shows that when controlling for other actions, only the speed of exchanges ($b = -.60$, $p < .001$) is negatively related to task conflict, while verbal and non-verbal communications ($b = -.10$, $p = .454$) and multiple participants ($b = .17$, $p = .256$) are not related to it.

Hypothesis 10a states that the relationship between the conveyance of information communication actions and intra-team trust will be moderated by team tenure. We did not find significant interactions between the conveyance of information actions and team tenure predicting trust (see Model 11 in Table 5). Therefore, hypothesis 10a was not supported. Important to note is that refining communications had a significant positive relationship with team trust ($b = .23$, $p = .003$), as shown in Model 10.

Hypothesis 10b states that the relationship between conveyance of information communication actions and conflict will be moderated by team tenure. Regarding relationship conflict, we did not find significant interactions between the conveyance of information actions and team tenure (see Model 13). It is worth noting that written communications had a negative effect on relationship conflict ($b = -.25$, $p = .035$), while graphical communications

had a positive effect ($b = .21$, $p = .024$). Regarding task conflict, we found a significant

moderation of using written communications and team tenure (Model 15; $b = .08$, $p = .009$)

but not for other conveyance of information actions. As shown in Figure 2, the relationship

between written communications and task conflict is negative when team tenure is one year

(Q1), $b = -.35$, $SE = .14$, $p = .010$, and two years old (Q2), $b = -.27$, $SE = .12$, $p = .027$, but

not significant when team tenure is four years (Q3), $b = -.10$, $SE = .12$, $p = .365$. These

results go against what was stated in Hypothesis 10b, which argued that the conveyance of

information actions would increase conflict in early-stage teams, and thus, it was not

supported. Additionally, a significant and positive direct effect of reviewing communications

on task conflict was found ($b = .35$, $p = .002$), as shown in Model 14.

Figure 2

Interactional Effects of Written Communications and Team Tenure on Task Conflict
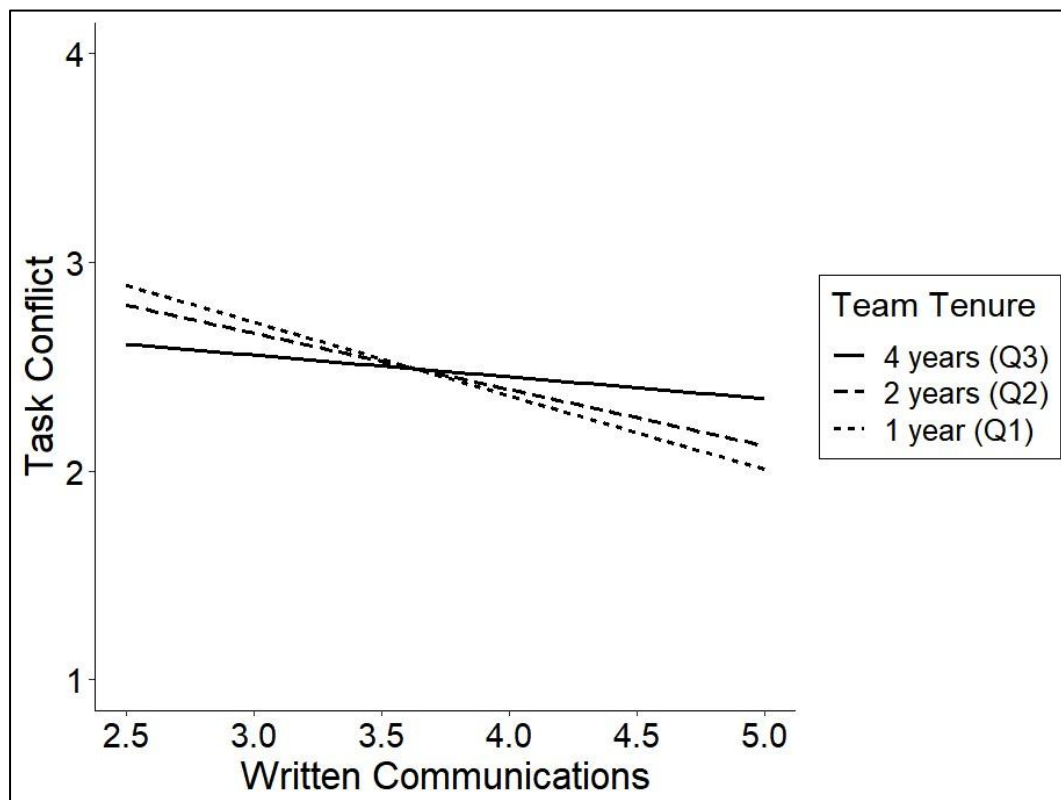
Mediational Effects of Interpersonal Variables

Hypothesis 11 proposed that interpersonal states will mediate the positive relationship between team communication actions for the convergence of meaning and task performance. Results of Model 3 (Table 3) showed that trust is significantly (and positively) related to task performance ($b = .43$, $p = .019$) but not relationship conflict or task conflict. Therefore, we only tested the mediation for intra-team trust. Monte Carlo CIs showed a significant indirect effect on task performance of verbal and non-verbal communications, $b = .10$, $SE = .04$, CI 95% [.02, .21], and of the speed of exchanges, $b = .17$, $SE = .07$, CI 95% [.05, .31]. These results offer support for Hypothesis 11.

Hypothesis 12 stated that interpersonal states will mediate the conditional effects of the conveyance of information actions on team performance depending on team tenure. No interactions between the conveyance of information actions and team tenure were found to predict intra-team trust. Also, there were no direct effects of conflict on team performance. This way, there were no conditional indirect effects to test, so Hypothesis 12 was not supported.

Additional Analyses

We ran additional analyses to identify potential moderators that could explain the lack of significant relationships between coordination, information sharing, relationship conflict, and task conflict with task performance. We focus on team size as past literature has shown it is a relevant moderator of the effect of action processes (LePine *et al.*, 2008). Additionally, we considered the conveyance of information actions as potential moderators of information sharing because we argue that understanding the content of the information can be a necessary condition for its impact on the effectiveness of the team. Results in Model 4 (Table 3) showed that the relationships between coordination and information sharing with team performance were not moderated by team size. However, reviewing communications does

moderate the effects of information sharing on team performance ($b = .44$, $p = .038$). As shown in Figure 3, information sharing was positive and significantly related to team performance at the highest value of reviewing communications (5), $b = .74$, $SE = .38$, $p = .049$, but not related at the lowest value (1.67), $b = -.73$, $SE = .37$, $p = .051$.

Figure 3

Interactional Effects of Information Sharing and Reviewing Communications on Team Performance
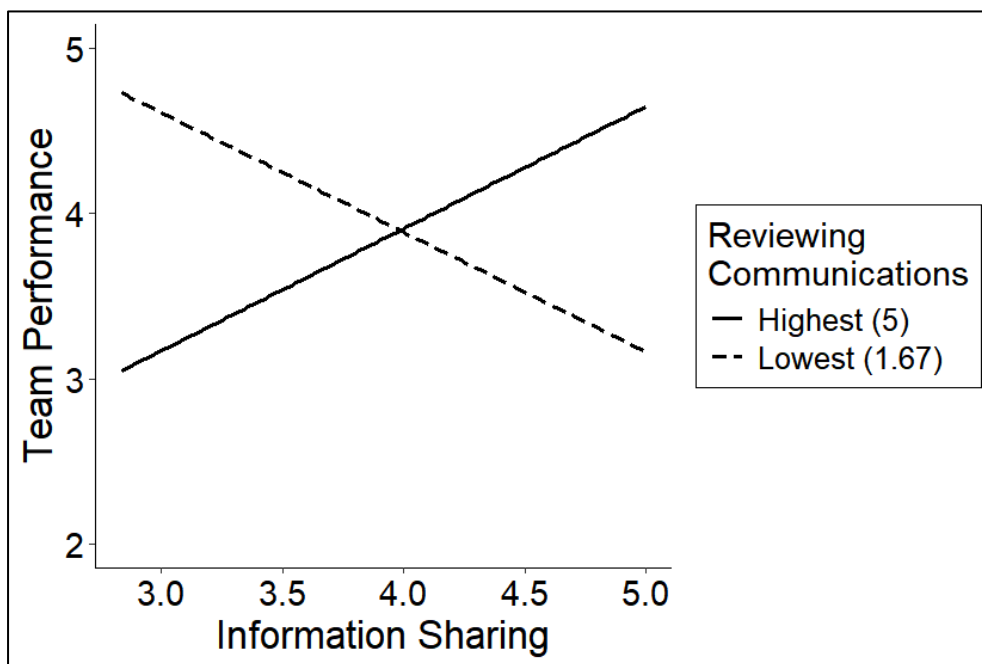
Regarding conflict, we argue that communication actions for the convergence of meaning could be relevant moderators for its impact on team performance. The higher levels of social and contextual cues, together with the potential for clarifications that high levels of speed of exchanges offer, can allow team members to resolve misunderstandings, disagreements, and issues once they arise. This way, they can reduce the negative impact of relationship conflict and can enable the positive effects of solving task conflict, too. However, due to the sensitive interpersonal nature of conflicts, it is likely that involving multiple participants can have a detrimental effect on the adequate resolution of them within the team. This is of particular relevance when the conflict occurs between dyads and not the whole

team (Maruping and Agarwal, 2004). Results in Model 5 (Table 3) showed that the effect of relationship conflict on team performance was not significantly moderated by any of these actions. However, verbal and non-verbal communications ($b = 1.13$, $p < .001$) and multiple participants ($b = .85$, $p = .038$) moderated the effect of task conflict on team performance. As shown in Figure 4a, the relationship between task conflict and team performance was negative and significant at the lowest value of verbal and non-verbal communications in the sample (2.75), $b = -1.59$, $SE = .42$, $p < .001$, and at moderate values (3), $b = -1.31$, $SE = .35$, $p < .001$, but positive and significant at very high values (4.5), $b = .40$, $SE = .14$, $p = .024$. Figure 4b shows that the relationship between task conflict and team performance was positive and significant at the lowest value of multiple participants (2.67), $b = 1.02$, SE = .51, $p = .047$; not significant at moderate values (3), $b = -.26$, $SE = .14$, $p = .050$; negative and marginally significant at very high values (4.5), $b = -.26$, $SE = .14$, $p = .050$; and negative and significant at the highest value (5), $b = -.61$, $SE = .29$, $p = .033$. These results show that the effects of task conflict on team performance depend on the way in which team members communicate to solve these issues. The use of verbal and non-verbal communications and involving fewer participants when solving conflict seems to be instrumental in enabling the positive effects of task conflict on team performance.

Discussion and Conclusion

Using the more nuanced perspective of team communication actions regarding the use of media within teams, this study examined: a) the effects of team communication actions on teamwork processes, such as transition, action, and interpersonal ones, b) the moderating role of team tenure on these effects, and c) the indirect and conditional indirect effects of team communication actions on the task performance of teams through teamwork processes. Our results offer relevant insights into how communication actions have differential effects depending on the teamwork process being performed and the developmental stage of the

team. By impacting teamwork processes in various forms, these actions also have different

mechanisms through which they impact teams' performance.

Figure 4

Interactional Effects of Task Conflict and Convergence of Meaning Actions on Team

Performance
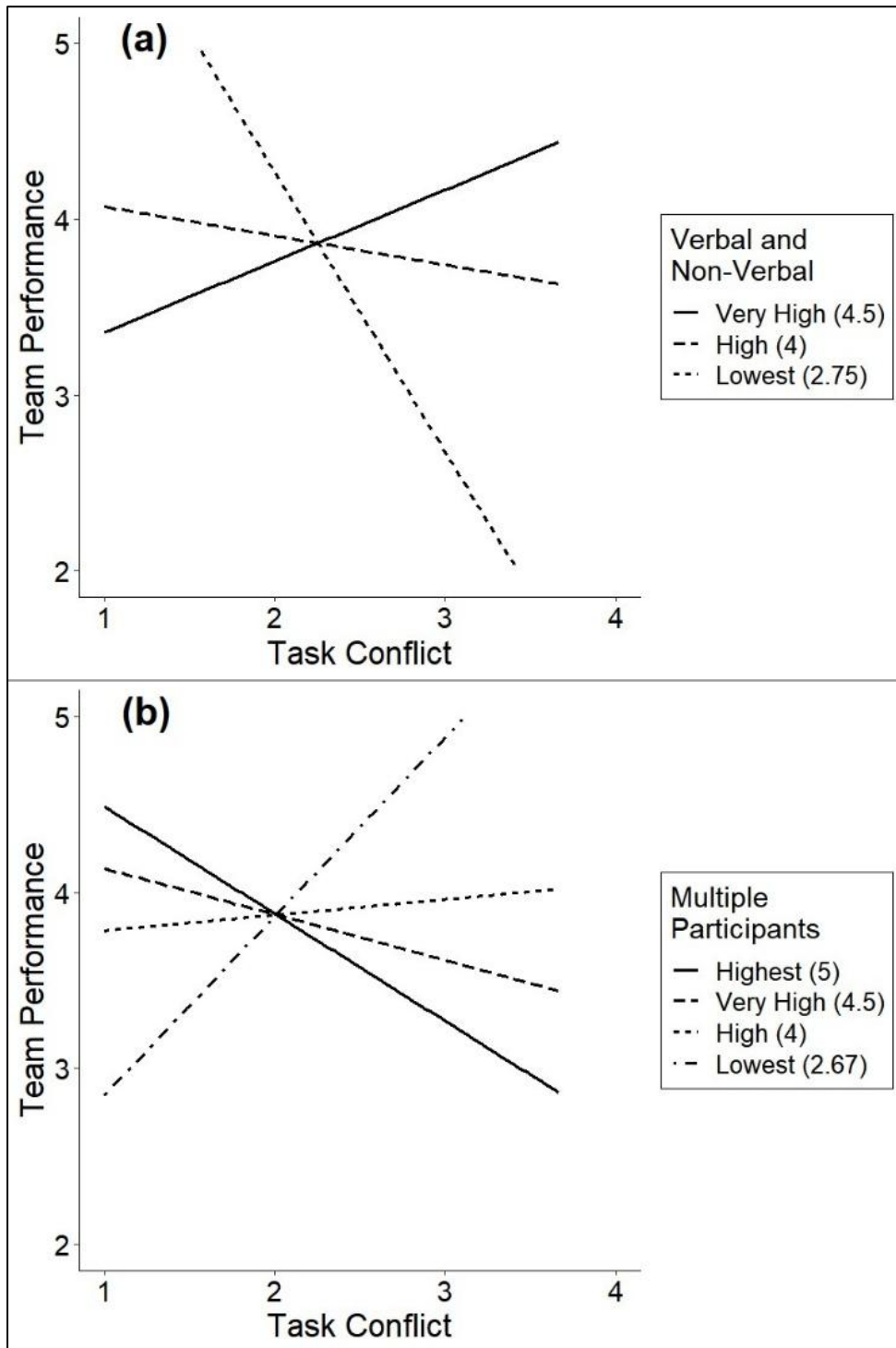
Team Communication Actions, Transition Processes, and Team Performance

This study's hypotheses proposed that teams will have different communicational needs to be successful in performing transition processes, such as planning, goal specification, and strategy formulation. Specifically, members of teams in formation stages will need to develop individual mental models regarding the tasks and goals they must perform and, therefore, are likely to benefit from the conveyance of information actions (Mathieu *et al.*, 2000). Moreover, they will also need to discuss and arrive at a common understanding regarding these goals (shared mental models), thus needing convergence of meaning actions, too (DeChurch and Mesmer-Magnus, 2010). Teams in later stages are likely to continue benefiting from the convergence of meaning actions to discuss necessary changes to their goals and the best strategy to achieve them based on past work cycle issues and effectiveness, but benefit less from the conveyance of information.

Our results offered partial support to the above statements. First, they showed that using verbal and non-verbal communications is instrumental for transition processes, but not other convergence of meaning actions such as having quick communications and involving multiple participants. Additionally, using verbal and non-verbal communications had an indirect effect on team performance through transition processes. This way, it seems that for teams to be able to perform adequate transition processes (e.g., their mission, goals, and an adequate strategy), it is crucial to be able to discuss these issues using verbal and non-verbal components of communication, such as voice intonation, body language and facial gestures. Past research has argued that all these aspects allow for the reduction of misunderstandings and misattributions in messages (Daft and Lengel, 1986; Robert and Dennis, 2005). It is worth noting that, when controlling for other communication actions, having quicker exchanges was not related to transition processes. This is of relevance because high-level speed of exchanges has also been argued to reduce misunderstandings in communications and

to facilitate their quick resolution (Dennis, Fuller, and Valacich, 2008). However, these results suggest that certain delays in communications are not necessarily detrimental when performing transition processes.

The above may be explained because when performing transition processes, team members need to develop an individual understanding of complex sets of information, which is often done in an asynchronous manner (i.e., by having communication delays) (Dennis, Fuller, and Valacich, 2008). After developing this individual understanding, team members are able to discuss with others to develop shared views about their ideas. Our results regarding the conveyance of information actions showed support for this argument, as some of them were positively related to transition processes. Specifically, we found that refining communications had a positive impact on team performance through their effect on transition processes, while the use of graphical communications had a positive indirect impact on team performance for newer teams but not for teams that are more mature. This suggests that teams in the early stages of development benefit from reviewing information in multiple forms, including clearly crafted messages together with graphs, figures, and images. As figures and graphs allow the expression of complex information in simple terms, this can help team members have a quicker grasp of the meaning of messages when they are accessing them for the first time (Dennis, Fuller and Valacich, 2009). This result also indicates that in later stages, the relevance of graphical communications is reduced, but sending well-crafted messages continues to be crucial.

It is important to note that the use of written communications and reviewing communications were not correlated with transition processes, and when controlling for other communication actions, reviewing communications had a negative impact on these processes for teams in all stages. This may be explained by the inherent complexity of communications associated with transition processes, which require high levels of abstraction and critical

thinking. During these instances, team members must reflect on past work cycles to determine issues they faced, and at the same time, they must analyse those problems to arrive at potential solutions and contingency plans for future work cycles (Marks, Mathieu and Zaccaro, 2001). In contrast to other communications in which the focus is mostly on the present (e.g., when a member updates others about his/her progress in a task), in transition processes, team members must be able to think critically about the past and be creative to produce strategies for the future. Additionally, they must be able to agree on their ideas because the mission, vision and strategy developed during transition stages are only going to be effective in structuring the team's work if they are shared by all members. Considering all this, if messages are not clearly formulated, and because of this, team members need to review them multiple times to understand their content, it will interfere with the critical and creative thinking and the emergence of shared understandings necessary for adequate performance of transition processes.

Team Communication Actions, Action Processes, and Team Performance

Regarding action processes, we argued that members from teams in the early stages need to develop a shared cognition regarding other members' expertise, knowledge, skills, and roles, which will facilitate the coordination and sharing of information in the team (DeChurch and Mesmer-Magnus, 2010; Salas, Rico and Passmore, 2017). Later, when this shared cognition is developed (to some extent), we argued that team members would benefit from having communications with low levels of synchronicity so communications concerning coordination and information sharing do not distract them from performing their tasks. Based on this, we hypothesised that convergence of meaning actions will be instrumental in earlier team stages but not in later stages, and the opposite is true for the conveyance of information actions. However, we did not find a significant moderation of team tenure on these actions predicting coordination or information sharing. Notwithstanding, we did find significant

positive direct effects of verbal and non-verbal communications, speed of exchanges, refining

communications, and a negative direct effect of reviewing communications on coordination.

These results seem to indicate that for adequate coordination, team members will benefit

from not having delays in their communications and from using verbal and non-verbal

communications, which offer more social and contextual cues that allow them to quickly

understand messages (Kock, 2004). Moreover, the refinement of communications allows

clear messages to be communicated within the team, reducing the need for further

clarifications (Dennis, Fuller, and Valacich, 2008). If messages need to be reviewed multiple

times, adding delays to communications will hinder coordination.

When analysing the relationships between information sharing and convergence of

meaning communication actions, we found that using verbal and non-verbal communications,

and having quick communications have a positive direct effect on information sharing.

Regarding conveyance of information actions, graphical communications and refining

communications have positive effects on information sharing. These results seem to suggest

that the sharing of relevant information within teams occurs in multiple formats: through

communications in which team members can see and hear each other (e.g., face-to-face,

video calls, phone calls), well-crafted messages, and figures containing relevant information.

Additionally, in case of misunderstandings of the information, team members also benefit

from having quicker exchanges, which allow them to clarify these quickly.

Contrary to our arguments, the positive relationship of convergence of meaning

actions on action processes for teams in all stages seems to indicate that the development of a

shared cognition is a continuous self-updating process which benefits from adjustments

during all team stages. This is consistent with the literature that proposes that the emergence

of team cognition is a dynamic and constant process (e.g., Hollnagel, 2002; Fiore, Bendell

and Williams, 2023). This way, it seems like every task-related communication within the

team represents an opportunity to revise and update the mutual understanding regarding the knowledge structures within the team. Unfortunately, team cognition was not measured in this study to directly test this. Future research could help to further clarify the intricacies of the links between team communications, shared mental models, and action processes.

When controlling for other variables, including transition and interpersonal processes, action processes were not related to team performance. This may be due to the fact that action processes have some degree of overlap with transition processes and interpersonal variables (Salas, Rico and Passmore, 2017). For example, determining adequate goals and strategies (transition) can facilitate coordination and information sharing within teams (action) as they offer team members a purpose to perform these actions. Similarly, the development of intra-team trust (interpersonal) can facilitate the willingness of team members to share information and coordinate their actions with each other.

Past research has also shown that the impact of action processes may be dependent on other variables, such as team size or interdependency (LePine *et al.*, 2008; Kanse *et al.*, 2023). Considering this, we tested for the potential moderating role of team size. Also, we explored the moderating role of conveyance of information actions on the relationship between information sharing and team performance, as understanding the meaning of the information shared is likely to be crucial in enabling its positive effects. We did not find a significant moderation of team size on coordination or information sharing, but we did find a moderation of reviewing communications on information sharing predicting performance. The effect of sharing information was positive when team members reviewed the communications multiple times, which supported our argument. These results are interesting because they show that when team members do not have adequate time to review the information shared within the team, it will lead to negative effects on performance. One explanation for this is that receiving high volumes of information without the required time to

review it can lead to information overload (Ellwart *et al.*, 2015). This occurs when a person receives more information than they can process and is characterised by a sense of lack of control regarding the situation, high levels of anxiety and stress, and reduced attention to the information (Bawden and Robinson, 2009). However, when team members have the time to review the information, sharing information will lead to better performance. These results also highlight the double-edged role of reviewing communications, as its impact seems to depend on the required levels of synchronicity for the performance of a communicational task.

Team Communication Actions, Interpersonal Variables, and Team Performance

Based on past research, we argued that using convergence of meaning actions will be essential for the development of positive interpersonal relationships within teams. Our results offered partial support for this when examining intra-team trust. Using verbal and non-verbal communications and having high levels of speedy exchanges were positively related to this variable, but not involving multiple participants. These results are in line with previous research that has shown the relevance of seeing and hearing other members for the development of shared affective experiences within the team, which can lead to the development of affective-based trust within the team (Cheshin, Rafaeli and Bos, 2011; Rafaeli, Ravid and Cheshin, 2012). Additionally, having quick communications can increase the propensity to trust through both cognitive and affective-based trust (Benda *et al.*, 2023). When team members reply quickly to each other, they are implicitly showing to the other members that they care about their messages. This, in turn, can lead to the formation of positive links between members and increased perceptions of integrity and benevolence within the team (Breuer *et al.*, 2020). Moreover, having quicker exchanges can reduce misunderstandings and, therefore, can create perceptions of competency because other team members are able to understand each other's ideas and build on them. We found that these

two variables had a positive impact on team performance through intra-team trust, which is consistent with previous literature showing the instrumental role of building trust for the effectiveness of teams (Breuer, Hüffmeier and Hertel, 2016; De Jong, Dirks and Gillespie, 2016).

Regarding conflict, our results showed that only the speed of exchanges, but not verbal and non-verbal communications or multiple participants, reduced both relationship and task conflict. However, we also tested if convergence of meaning actions moderated the relationship between conflict and team performance. These analyses showed that while verbal and non-verbal communications do not reduce the occurrence of conflict within the team, they help enable the positive effects of task conflict on team performance. This resonates with previous research that has argued that because task conflict reflects disagreements about the work at hand, when they are solved correctly, they can offer a more critical reflection of the task and other team members' ideas (De Wit, Greer and Jehn, 2012). Similarly, teams that reported involving fewer team members in communications presented a positive relationship between task conflict and team performance. This seems to indicate that due to the sensitive nature of conflict, its adequate resolution is easier when fewer people are involved in it.

The above results contribute to the task conflict literature by highlighting the role of using verbal and non-verbal communication and the involvement of multiple participants as a moderator of the impact of conflict on team performance, something that has not been explored before. These results also offer support to past research that has proposed the need to differentiate between actions that prevent the emergence of conflict in teams and actions focused on the resolution of conflict once it has emerged (Behfar *et al.*, 2008). Our study indicates that having quick communications is a protective factor that avoids the development of conflict, while the use of verbal and non-verbal aspects of communication and involving

fewer members (e.g., only members who have a conflict) are relevant to adequately solve these disagreements.

Regarding the conveyance of information actions, we proposed that their effects on interpersonal variables will depend on the developmental stage of the team. Past research has shown that the use of text-based ICTs has detrimental effects on interpersonal aspects, particularly in early stages but not necessarily in later ones (Carlson and Zmud, 1999; Benda *et al.*, 2023). Our results suggest that the conveyance of information actions has divergent effects depending on the interpersonal aspect analysed. Regarding trust, we found that refining communications has a positive effect on it. Also, no significant interactions of team tenure were found, indicating that the positive effect of refining communications occurs for teams at all stages. This may be explained because crafting thorough and well-articulated messages increases the perceptions of the abilities, knowledge, and overall competencies of other team members within the team, which is a crucial component in the development of intra-team trust (Breuer *et al.*, 2020). It is worth noting that we did not find direct negative effects of written or graphical communications. This goes against past research that has proposed that such media are 'leaner' and, therefore, can be detrimental to the development and management of interpersonal relationships (Daft and Lengel, 1984, 1986; Dennis and Valacich, 1999).

The above discrepancies may be explained due to differences in the context in which past research was conducted in comparison to this study. Some of the detrimental effects in previous research were found using experimental settings in which participants communicated through just one specific medium (Sproull and Kiesler, 1986; Rice, 1992; Cheshin, Rafaeli and Bos, 2011). However, several researchers have questioned these results because variables from real work settings can modulate the effects of using leaner media (DeSanctis and Poole, 1994; Carlson and Zmud, 1999; Gibson *et al.*, 2014). For instance,

having previous experience with communication partners and the media in use can reduce the misunderstandings that can happen when using leaner media because it allows team members to better understand the reduced cues in messages and correctly interpret messages. Moreover, real work teams usually communicate through multiple media, which can reduce the negative impact of one leaner medium on the whole set. For example, Bélanger and Watson-Manheim (2006) found that in some instances, team members can use two different media to send redundant messages, which can help to enhance the understanding of the content of the messages. Thus, a team member can send a message through email (leaner medium) and communicate the same message face-to-face (richer) to ensure that the message is correctly understood by others.

Regarding the conveyance of information actions and conflict, we found that written communications reduce relationship conflict while graphical communications increase it for teams at all stages (i.e., no moderation of team tenure was found). The positive relationship between graphical communications and relationship conflict is congruent with past literature proposing that communications through images require high levels of contextual information for their correct interpretation, especially when they involve some affective content. For example, a study by Glikson and colleagues (2018) comparing the use of 'smiley' emojis to the use of facial smiles found that the use of the emoji can be seen as inappropriate in formal contexts, reducing perceptions of competency from communication partners.

The negative relationship of written communications represents a more puzzling result considering past research arguing that text-based communications may be more prone to misunderstandings and misattributions (Maruping and Agarwal, 2004; Gilson *et al.*, 2015). This may occur due to a combination of two mechanisms. First, the reduction of social and contextual cues can lead to a de-individuation of team members. While the literature has usually linked de-individuation with issues such as reduced politeness and hostile behaviours,

it can also mean that conversations are more impersonal and task-focused (Walther and Parks, 2002; Axtell, Fleck and Turner, 2004). This may reduce relationship conflicts because personal issues become less salient in comparison to task-related issues, and therefore, team members focus on them less. Second, it is possible that written communications have less inherently affective connotations than some types of graphical communications (e.g., informal ones, such as emojis or memes). This way, the reduction of social and contextual cues can lead to less relationship conflict when using written communications because the discussion is oriented to the task. However, in the case of graphical communications, it can lead to increased conflict as team members struggle to grasp the meaning of figures, particularly informal ones. Unfortunately, this study does not differentiate between the use of formal and informal communications, and therefore, future studies can help to test this hypothesis. Additionally, it is important to mention that both the effects of written and graphical communications were not significant in correlational analyses and can be potential suppression effects (MacKinnon, Krull and Lockwood, 2000). Future studies can also help to clarify this by replicating (or not) these ambiguous results.

Regarding task conflict, we found that reviewing communications was positively related to task conflict for teams in all stages. One explanation for this is that as the number of times that team members review communications increases, the number of doubts and questions regarding the content of messages increases as well, thus facilitating the emergence of task conflict. However, due to the cross-sectional design used in this study, it is also plausible that the causality of these variables is in the opposite direction (Antonakis *et al.*, 2010). In other words, because team members have misunderstandings, they need to review communications again to clarify them. Future research might be required to clarify this further.

It is important to note that due to the moderating role of verbal and non-verbal communications on the effect of task conflict on team performance, there are instances in which the increased task conflict associated with reviewing communications can be beneficial for the effectiveness of teams. Particularly, when team members have access to verbal and non-verbal communications to solve their task-related discrepancies, they will benefit from reviewing communications multiple times, which can promote doubts and questions regarding the content of messages. Solving these doubts by means of verbal and non-verbal communications can offer them valuable insights, which will, in turn, improve the performance of the team.

Lastly, we found that written communications reduced task conflict for teams in earlier stages, which goes in the opposite direction of our hypothesis. This may be explained because written communications allow for the documentation of interactions, which should be helpful in case doubts occur reducing the occurrence of task conflict between team members. Nonetheless, further studies are needed to better understand these results.

Limitations and Future Research

This study presented some limitations that are important to mention. In the first place, the relationships between communication actions and teamwork processes were tested using a cross-sectional survey design. This type of design does not allow for control of Common Method Variance bias, namely, the systematic variance introduced into the measures when they are collected using a single measurement instrument (Tehseen, Ramayah and Sajilan, 2017). This bias can 'inflate' or even 'deflate' the observed relationships between these variables (Podsakoff, MacKenzie and Podsakoff, 2012; Podsakoff *et al.*, 2024). Therefore, it is possible that some of the significant effects found in this study present smaller or non-existent relationships in real work conditions and vice-versa. Additionally, cross-sectional studies do not allow causal claims on the relationship between variables, particularly when

explaining mechanisms that need the passage of time to occur, as in this study (Antonakis *et al.*, 2010, 2014). Thus, future studies adopting longitudinal designs are necessary to continue growing our understanding of the effect of team communication actions on teamwork processes and team effectiveness.

The use of longitudinal designs in the future can also help to better understand the moderating role of team tenure on the relationship between team communication actions and teamwork processes. This study found that around the mark of four years, graphical communications no longer have a positive effect on transition processes, and written communications no longer reduce task conflict. An alternative explanation for this is that teams of four years tenure or above are teams that started working together before the start of the COVID-19 pandemic. These teams likely faced the challenge of starting their work during a time when there were increased levels of face-to-face communication, which were then suddenly stopped due to the pandemic. This way, they had to change their usual ways of working together to adapt to this new context. Therefore, these teams may have more challenges in incorporating ICTs into their daily working routines during the earlier stages of their development, in contrast to teams that started during the pandemic (or after) in which alternative work arrangements (e.g., home-office) and the use of ICTs were ubiquitous (Gibbs and Navick, 2023; Nordbäck and Nurmi, 2023). Future research using a longitudinal design to follow teams from initial to later stages could be relevant to clarify these concerns.

This research focused mainly on the moderating role of team tenure on team communication actions, yet future studies could explore other relevant moderators. The team virtuality literature suggests that geographical and/or temporal distance can alter the effect of communication actions. For example, teams that have high geographical distance and, therefore, have limited access to face-to-face interactions (Raghuram *et al.*, 2019) may benefit highly from emphasising the refinement of communications as this allows for clear

messages even in contexts with reduced verbal and non-verbal cues. The number of media that team members use and the discrepancies in media usage could also be relevant. While combining different media can offer complementary capabilities that are relevant for team members to fulfil their communication needs, they can also increase the complexity of communications inside teams. This can reduce the effectiveness of certain communication actions, specifically of the ones that already have some intrinsic levels of complexity because they are time-consuming or require increased attention (cognitive resources), such as having simultaneous communications, involving multiple participants, refining communications, or reviewing communications. Moreover, if team members' communications occur through different media, they can function as objective 'faultlines' by keeping messages inaccessible from other team members, reducing the likelihood that communications are effective (Thatcher and Patel, 2012; Thatcher and Rico, 2023).

Future research can also help to clarify the importance of involving multiple participants and simultaneous communications in teams. While we did not find consistent effects of these variables on teamwork processes, it is possible that their impact is more context dependent. Team size and interdependence may modify the effect of these variables as teams with increased levels of both these aspects can benefit more from involving multiple participants in communications. Likewise, the complexity of the communication task being performed could moderate the effect of simultaneous communication. When the content of messages is more complex, having more simultaneous messages can reduce team members' capacity to focus on the topic, thus reducing the effectiveness of the communication (Dennis, Fuller, and Valacich, 2008). All these aspects can be particularly relevant for task-related processes, such as transition and action ones. Lastly, future studies can focus on the interactions between different team communication actions. For instance, involving multiple

participants and, at the same time, having many simultaneous communications can be detrimental due to the increased complexity of the communications.

Conclusion

This study examined the relationships between the new construct of team communication actions and several aspects of team effectiveness, such as transition, action, and interpersonal processes, together with team performance. Our results indicate that team members are required to perform different communication actions depending on the teamwork process they are performing and the development stage of their team. Considering that some communication actions are more easily performed using certain ICTs (e.g., reviewing communications using text-based ICTs), these results challenge the assumption of ICTs being limited media. This way, team communication actions offer a more nuanced understanding of the role that the use of different communication media has on working teams and the stages in which they can be instrumental. However, this study also offered some new relevant research avenues and questions to deepen our understanding of this phenomenon. Specifically, future research could examine the impact that team communication actions have over other relevant team variables that were not explored in this study (e.g., team cognition) and also how they can interact with these to predict team outcomes. Additionally, researchers can explore the interactional effects that different team communication actions have on each other to predict team functioning. Considering this, the idea of team communication actions represents a promising and fruitful field of research that can continue to contribute to scholars and practitioners in the future.

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THESIS DISCUSSION AND CONCLUSION

Summary and Integration of Articles

This dissertation represents a body of work around the development of the new construct of team communication actions, which links the three articles and their contributions together. In the first conceptual article, the construct was developed and presented, explaining how it can address some of the literature gaps in the research on the use of communication media within teams. Eight different communication actions that team members can perform when using communication media were identified and presented. Additionally, this article presented several propositions on how these eight team communication actions can be relevant to understanding team dynamics and team performance, specifically focusing on their effects on teamwork processes. However, to test these propositions in an empirical way, it was necessary to develop and validate a scale to measure these eight communication actions. The second article addresses this need by developing a scale to measure them and collecting evidence of different types of validity, including content, internal structure, discriminant and predictive ones. Lastly, the third article tested the propositions that were formulated in the first conceptual article by deriving twelve empirically testable hypotheses. Team communication actions were measured using the scale developed and validated in the second article, while teamwork processes and team performance were measured using scales already validated in the literature.

Summary of Article 1: Conceptual Article

The main goal of the first conceptual article was to develop and present the new construct of *team communication actions.* This construct represents a set of actions that team members can perform when using communication media to shape the interactions they have while performing their tasks. Building on the ideas of Media Synchronicity Theory (Dennis, Fuller and Valacich, 2009) and non-deterministic views of technology (Orlikowski, 2000;

Leonardi, 2011; Faraj and Azad, 2012; Willems, 2021), this article presented eight different communication actions: using verbal and non-verbal communications, speed of exchanges, involving multiple participants, having simultaneous communications, using written communications, using graphical communications, refining communications, and reviewing communications. Additionally, some of these actions, namely, verbal and non-verbal communications, speed of exchanges, and involving multiple participants, were argued to facilitate convergence of meaning between team members, that is, the development of a shared understanding of a particular topic On the other hand, having simultaneous communications, using written communications, using graphical communications, refining communications, and reviewing communications were argued to facilitate the conveyance of information, namely, when a communication offers enough new relevant information that allows the receptor of the message to create or update an individual mental model (Dennis, Fuller, and Valacich, 2008).

This construct represents an attempt to integrate the ideas of different research streams, such as computer-mediated communication and virtual teams/team virtuality, in the teams literature. By doing so, it contributes to the literature in several ways. First, by building on the Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) and its systematisation of capabilities of different types of communication media, including face-to-face, ICTs and documents, the idea of team communication action can offer a more nuanced understanding of media usage in teams beyond the limited view of ICTs versus face-to-face. Second, by adopting a non-deterministic approach (e.g., Orlikowski, 2000; Leonardi, 2011; Gibbs and Navick, 2023) based on actions to analyse the usage of media within teams, this construct also offers a more comprehensive understanding of this phenomenon. By focusing on the actions that team members perform over media to shape their communications, this construct allows us to better capture the differences that can

occur within teams due to the role of human agency. Moreover, this construct also allows us to analyse the changes in the way that team members use the same communication media over time, which can be overlooked when using deterministic views.

Lastly, by integrating complementary research streams into the teams literature, the idea of team communication actions can be relevant to understand the dynamics that occur within all types of teams. Therefore, in this article, this construct was positioned into the Inputs-Mediators-Outputs-Inputs model (Ilgen *et al.*, 2005), one of the most influential in the teams literature. Also, several propositions were made based on the distinction between convergence of meaning and conveyance of information communicational processes, regarding how different team communication actions can be instrumental for the performance of teamwork processes (Marks, Mathieu and Zaccaro, 2001), namely, transition, action, and interpersonal ones, depending on the developmental stage of the team. These propositions can be useful to guide future research regarding the relevant role that communication media can have in the effectiveness of teams.

Summary of Article 2: Scale Development and Validation Article

This article's main goals were to develop and validate a scale to measure the new construct of team communication actions. The results of the analyses showed adequate psychometric properties of the overall scale consisting of 25 items to measure the eight distinct team communication actions in both Spanish and English language. Specifically, these results showed that items measuring one specific communication action converge while also not being strongly related to orbiting communication actions. Additionally, discriminant and predictive validity analyses were used to compare this new scale with measures of team virtuality's subdimensions (i.e., technological reliance and configurational dispersion) and teamwork variables (i.e., transition, action, and interpersonal processes). Correlational analyses showed that team communication actions are distinct from team virtuality variables

and other team-level constructs. Additionally, regression analyses showed that team communication actions consistently explained more variance of teamwork processes (between 16% and 31% more) than team virtuality variables, which offers evidence of their incremental validity.

This article offers several contributions to the literature. First, it represents a first attempt to measure the novel construct of team communication actions by offering an easy-to-use tool consisting of a 25-item Likert scale. Second, this article also offered evidence of the validity of different versions of the scale: English, Spanish and partially in Brazilian Portuguese. Due to this, the scale can be used by researchers and practitioners across different countries and languages. Third, this scale can help to promote future research to examine how team communication actions can impact team functioning. This article offered some evidence that team communication actions can be relevant predictors of teamwork processes (i.e., transition, action, and interpersonal ones). Nonetheless, this scale can be used to test more complex mediational and/or interactional effects between variables. For example, researchers can examine if team communication actions can influence team performance through their impact on teamwork processes.

Summary of Article 3: Hypotheses Testing Article

The main goal of this article was to examine the relationships between team communication actions and team effectiveness variables, such as teamwork processes and team performance. Specifically, this study examines the direct effects of team communication actions on transition, action, and interpersonal processes, the moderating role of team tenure on these effects, and the indirect and conditional indirect effects of team communication actions on team performance through transition, action, and interpersonal processes.

This article's hypotheses argued that convergence of meaning communication actions will facilitate transition processes for teams in all stages, while conveyance of information

will be relevant but only in earlier stages (i.e., moderation of team tenure). The analyses showed partial support for the convergence of meaning hypotheses because using verbal and non-verbal communication was positively related to transition processes but not the speed of exchanges and multiple participants. Regarding the conveyance of information actions, team tenure only moderated the effect of graphical communications in such a way that it was positive when team tenure was lower and non-significant when team tenure was higher. However, team tenure did not moderate the effect of other conveyance of information actions, which only offers partial support to the moderation hypotheses of conveyance of information actions. Further analyses showed that conveyance of information actions have more nuanced effects on transition processes. For instance, refining communications has a positive direct effect, while reviewing communications has a negative effect on these processes.

Regarding action processes, hypotheses stated that team tenure will moderate the effects of convergence of meaning and conveyance information actions in such a way that convergence will be relevant for teams in earlier developmental stages, while conveyance actions will be relevant for teams in later developmental stages. Results showed that team tenure did not moderate the effects of communication actions on coordination and information sharing, which goes against this study's hypotheses. However, results did show that using verbal and non-verbal communications, speed of exchanges and refining communications were positively related to coordination, with reviewing communications having a negative direct effect on this variable. Similarly, using verbal and non-verbal communications, speed of exchanges, graphical communications and refining communications were positively related to information sharing

Regarding interpersonal variables, hypotheses stated that convergence of meaning actions will have a positive impact on teams in all stages, while conveyance of information actions will have a negative effect on teams in earlier developmental stages but not on teams

in later ones. Analyses offered partial support to the hypotheses regarding the convergence of meaning actions. Verbal and non-verbal communications and speed of exchanges were positively related to intra-team trust, while speed of exchanges also reduced both task and relationship conflict. On the other hand, analyses showed that conveyance of information actions have a more complex impact on interpersonal variables compared to what was expected. Team tenure only moderated the effect of written communications on task conflict but in the opposite direction to what was expected, as it had a negative effect on task conflict for teams in earlier developmental stages. Additionally, refining communications was positively related to intra-team trust; written communications reduced relationship conflict, while graphical communications increased it, and reviewing communications increased task conflict.

This article also proposed several mediational effects of team communication actions on team performance through teamwork processes and variables. When considering transition processes, mediational analyses showed that using verbal and non-verbal communications and refining communications have a positive indirect effect on team performance through transition processes while reviewing communications did not have an indirect effect. Graphical communications also had a positive indirect effect on team performance in earlier stages but not for teams in later stages. Further, no mediational effects were found on team performance through action processes, as coordination and information sharing were not related to team performance when controlling for other variables. However, additional analysis showed that reviewing communications moderates the effect of information sharing on team performance in such a way that the effect is positive when reviewing communication is high and non-significant when it is low. Lastly, regarding interpersonal variables, mediational analyses showed that verbal and non-verbal communications, speed of exchanges and refining communications have indirect effects on team performance through intra-team

trust. Relationship conflict and task conflict were not related to team performance when controlling for other variables, and therefore, there were no mediational effects to test. Nonetheless, additional analyses showed that team communication actions can also have a relevant role in explaining the lack of direct effect of conflict on team performance. Specifically, using verbal and non-verbal communications, and involving fewer participants reduced the negative effect of task conflict on team performance.

These results show that different teamwork processes require different communication actions performed by team members, and these requirements also depend partially on the developmental stage of the team. However, some of the hypotheses about the direct effects of communication actions and the interactional effects of team tenure were not significant or were in the opposite direction from what was expected, which shows the need to continue deepening our understanding of team communication actions. Future research can address this by exploring the moderating role of other variables or by studying the role of team communication actions in specific contexts, for example, in fully virtual teams or fully co-located teams. Nonetheless, these findings offer a more nuanced understanding of the use of communication media within teams beyond the dichotomous approach used thus far in the team virtuality literature. By doing this, this study has relevant implications for future research and for guiding practitioners' media usage decisions.

Integration of Articles

While each article of this dissertation presents its own unique goals and contributions to the literature, there are also insights that arise from the integration of the ideas and findings of the whole thesis as an articulated body of work, which are important to mention. Specifically, the empirical articles (second and third) of this dissertation are relevant to assess and reflect on the ideas presented in the first conceptual article.

The results and analyses from the scale development and validation offered relevant insights into the idea of team communication actions. First, the expert revision used for the content validation of the scale offers evidence of the exhaustiveness of the eight sub-dimensions identified in the first conceptual article. Moreover, by using the Anderson and Gerbing (1991) propositions to assess content validity in samples representative of the target population of the scale, this article also offered evidence that the idea of team communication actions and the eight actions identified are sensible for team members. In general, team members were able to link the different items to their corresponding definitions while simultaneously distinguishing them from orbiting (other) communication actions. This offers partial evidence that the idea of communication actions is something that occurs in real work settings and that team members can offer information about these actions.

Second, interrater reliability and interrater agreement analyses (IRR + IRA; Burke and Dunlap, 2002; LeBreton and Senter, 2008; LeBreton, Moeller and Wittmer, 2023) performed in studies two and three also offer relevant insights into the ideas of the conceptual article. These analyses showed that there was strong agreement between team members regarding the team communication actions that occur within the team, based on r_{WG}s and Average Deviation statistics. However, not all team communication actions presented high-reliability levels (for example, speed of exchanges and refining communications) based on Intraclass Correlation Coefficients (ICC1 and ICC2). One instance in which this occurs is when there is reduced variance in the overall sample, and therefore, the differences between the higher-level phenomena (teams) are minimised. Considering that the sample of teams used in this study comes from only two different organisations, these results might indicate that within organisations, there is a tendency to homogenise the communication actions that workers perform. As proposed in the conceptual article, the organisational context of the team has a relevant role in determining the communication media that team members use and the way in

which they use them. Organisations allow certain communication media for their workers and teams while restricting others. Also, some organisations might offer specific training on how to use the media that they facilitate. All these aspects can mean that, over time, workers within the organisation develop similar patterns in the way they use communication media, and therefore, there is a reduction in the variability of communication actions between teams of a particular organisation. Considering this, future research might be able to expand the idea of communication actions to focus on higher levels of analysis (e.g., departments or whole organisations) and not only on the team level.

Third, the predictive validity analyses performed in the second article offered support to the arguments of the conceptual article that research on communication media usage in teams must go beyond the dichotomous view of technology reliance. Technology reliance was correlated to all the conveyance of information actions and to the convergence of meaning actions (except verbal and non-verbal communications), but only with effect sizes ranging from small to moderate. These results suggest that there are differences in the way that team members communicate with each other using media, which are not entirely captured by the dichotomous approach of ICTs versus face-to-face communications when measuring technology reliance. Furthermore, regression analyses showed that team communication actions consistently explained more of the variance of teamwork processes above and beyond the technological reliance dimension. This indicates that the differences in the way that team members use media, which are not adequately captured by technology reliance, are relevant to understanding teamwork processes. For example, the use of graphical communications, but not of written communications, is positively related to transition processes, yet the measurement of technology reliance cannot distinguish between them both. These results can be helpful in partially explaining why authors have found mixed effects in the team virtuality literature in the past.

Fourth, the whole process used for the scale development and validation offered evidence that this new construct can be quantitatively operationalised and measured in team contexts (DeVellis and Thorpe, 2021). Content validity analyses provide evidence that the final set of items can adequately capture the eight communication actions identified in the first article. Moreover, the results of the internal structure validity, specifically of the confirmatory factor analyses, showed that the items belonging to one dimension were highly correlated between them without presenting large relationships with orbiting communication actions. This offers support for the distinctiveness of the eight communication actions identified in the conceptual article. Lastly, measurement invariance analyses show that the items developed are able to measure team communication actions similarly in different languages (Spanish, English, and Brazilian Portuguese).

The third article was instrumental in testing the ideas formulated in the first conceptual article, particularly the proposed relationships between team communication actions and teamwork processes and their indirect effects on team performance. The results of this article show that team communication actions have differential effects on teamwork processes and, thus, on their indirect effects on team performance through these processes. Additionally, team tenure had a significant role in moderating the impact of certain communication actions, such as graphical communications on transition processes and written communications on task conflict. However, contrary to what was stated in article one, team tenure did not have a consistent moderating role over team communication actions predicting teamwork processes. This way, most of the significant effects of team communication actions on teamwork processes found in this article were consistent for teams in all developmental stages. Additionally, some team communications did not present relationships (direct or moderated) to any of the teamwork processes, such as simultaneous communications or multiple participants. These results, while supporting the relevance of

examining team communication actions, also suggest the need to continue deepening the theoretical development of this construct. I will expand further on this in the following section regarding some of the explored ideas during this project, the limitations, and future research derived from this dissertation.

Ethical Implications and Research Integrity

Throughout the development of this doctoral dissertation, several ethical considerations were carefully addressed, particularly given the collection of empirical data from workers and work groups within various organisations. Ensuring confidentiality and anonymity for participants was essential to avoid any potential repercussions on employees' responses. To address these concerns, data collection was structured as follows: first, the organisation and I collaborated to define a procedure ensuring confidentiality. We agreed that the research team would collect responses through an online survey, and that the organisation would receive only aggregated data with a minimum of five responses per group (e.g., department, area) to prevent the identification of individuals. The organisation provided a dataset containing employees' emails and their leaders' emails, enabling the identification of work groups for the study. Unique survey links were then sent to each worker, who was asked to complete the study scales along with demographic questions (e.g., age, organizational tenure, group tenure, gender). Upon merging the response dataset with the initial contact dataset, all emails were removed and replaced with alphanumeric identifiers to protect participants' identities.

This research has significant implications for both academia and broader society. The findings can inform organisational and managerial decisions regarding communication media best suited to support specific aspects of teamwork dynamics. For instance, verbal and non-verbal communication were found to enhance team transition processes and to facilitate the resolution of task conflicts, while refined communications had a positive impact across

several teamwork processes, such as transition processes, coordination and development of trust. However, this research also highlights the complexity introduced by human agency: workers often adapt media use beyond its intended features, meaning that organizational efforts to encourage specific media use may not always align with workers' preferences. Consequently, it may be beneficial for organisations to provide media training and emphasise the contextual advantages of certain media types rather than enforcing strict usage policies, as forcing specific media use may lead to adverse outcomes (e.g., resistance or intentional misuse).

An additional implication concerns the development of artificial intelligence in changing communication within people. For example, the action of refining communications could be influenced by AI-driven tools capable of refining messages independently without team members engaging in the refining of messages – which goes against the assumption of the construct. Such developments could affect team dynamics in ways that fall outside the scope of this study's findings, indicating a promising area for future research.

Finally, it should be noted that studies 2 and 3 in this dissertation used the same sample, with the sample for study 3 representing a subset of study 2's teams that included responses from team leaders on performance-related variables.

Reflections, Limitations, and Future Research

Although this dissertation presents several contributions to the literature on communication media usage in teams, there were also challenges, ideas I explored which did not work, and limitations that are worth mentioning. These represent opportunities for future research, so this will also be mentioned where appropriate.

Evolution of the Team Communication Actions Construct

During the beginning of my doctoral studies, my main research interest was to understand how team virtuality affects the social integration of teams, that is, the

development of positive interpersonal relationships between team members (O'Reilly III, Caldwell and Barnett, 1989; Knight and Eisenkraft, 2015). Nonetheless, while reviewing the team virtuality literature, I realised that it was necessary to address some of the limitations of this research before focusing on its impact on other team constructs. Considering this, I started familiarising myself with computer-mediated communication literature, which offers more modern and robust examinations of communication media, such as the Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008). These newer developments were not thoroughly considered in the team virtuality literature when I started my doctoral studies (Raghuram *et al.*, 2019). Nevertheless, due to the changes that the COVID-19 pandemic brought to most teams across the world, these ideas were also relevant not only for teams with some degree of geographical/temporal distance but for all kinds of teams(Garro-Abarca, Palos-Sanchez and Aguayo-Camacho, 2021; Nordbäck and Nurmi, 2023). This way, the focus of my doctoral research changed to try to integrate the ideas of Media Synchronicity Theory, and specifically the consideration of the capabilities of both ICTs and face-to-face interactions, into the teams literature.

To achieve this new goal, my first approach was to use the media capabilities from Media Synchronicity Theory (Dennis and Valacich, 1999; Dennis, Fuller, and Valacich, 2008) directly to examine how they can be relevant to the effectiveness of teams. However, due to feedback from senior scholars in different instances (e.g., Confirmation Review, conference submissions, and content validation of the scale), I realised that the examination of media capabilities is not directly applicable to the examination of team members' interactions. The main issue is that these variables are situated in different levels of analysis. Media capabilities reflect the material attributes of different communication media, while the interactions of team members represent a more complex phenomenon that depends only partially on the capabilities of the media in use. In this context, non-deterministic theories

examining the role of human agency were also relevant as they allowed me to take into account that team members do not necessarily follow the intended attributes of communication media when they use them. This way, my understanding and ideas have evolved during my doctoral studies, which is reflected in the fact that the initial conceptual article submitted to the Academy of Management Annual Meeting proposed the idea of 'Team Media Capabilities Repertoires' instead of 'Team Communication Actions' as presented in this dissertation. The label of team media capabilities repertoires reflects how, initially, I was trying to directly apply the ideas of media capabilities to the examination of team interactions (as shown in the original set of items developed for the scale development and validation article, see Appendix B). This way, the construct of team communication actions allows us to better reflect the imbrication processes between material attributes and human agency that lead to a particular way of using media (Leonardi, 2011) in teams, that is, to the emergence of team communication actions.

Working on the empirical articles of this dissertation also offered relevant feedback to the idea of team communication actions. In particular, the development and validation of the team communication action scale offered valuable insights that helped to identify the different actions that team members can perform using media. The experts' revision (content validation – see Appendix C) was relevant to distinguish between simultaneous communication and multiple participants, aspects that are derived from one single dimension when analysing media capabilities (i.e., parallelism). Their comments allowed me to note that when the parallelism capability is used in team contexts, in which communication can occur in a combination of multiple media, parallelism can result in (1) the involvement of multiple participants in the communication that occurs in one medium, and (2) that multiple simultaneous communications take place from one or multiple media. Likewise, the statistical analyses for the internal structure validation of the scale showed the need to split between

graphical and written communications, aspects that are considered as only one in the symbol sets dimension of Media Synchronicity Theory. Confirmatory factor analyses showed that the use of written communications is relatively independent of the use of graphical communications, as models in which these items were combined into one dimension presented considerably worse fit indices. All these changes have been integrated into the current version of the conceptual article presented in this dissertation.

Although the idea of team communication actions represents an important theoretical development, the results from the third article (hypotheses testing) show the need to continue building this new construct to explain some of the unsupported hypotheses and unexpected relationships. It is relevant to consider other potential moderators of the effect of these actions besides the developmental stage of the team, which here was captured using team tenure. For instance, recent research has emerged arguing the relevant role of team design aspects, such as autonomy, interdependency, and social support, for the effectiveness of teams with some degree of virtuality (Gibbs, Sivunen and Boyraz, 2017; Handke *et al.*, 2020). These aspects can also be relevant moderators of the effects of team communications. For instance, teams with higher degrees of interdependency may require higher levels of involving multiple participants in communication than teams with lower levels of interdependency. Additionally, future research can explore how team communication actions can be relevant to moderate the effects of teamwork processes and emergent states on team outcomes. As shown in the additional analyses of the third article, the use of verbal and non-verbal communications and the involvement of fewer team members in communications were relevant in mitigating the negative effects of task conflict on team performance. This way, future research can focus on more complex interactions between team communication actions and other variables related to team functioning (team processes and emergent states) to understand the effects of communication media usage on team performance.

Dispersion Component of Team Communication Actions

One aspect that was not explored in this dissertation due to time limitations but that is important to mention for future research is the role of team-level dispersion in the performance of team communication actions. The propositions developed in the conceptual article and the hypotheses of the third article were developed from a consensus model perspective (Chan, 1998). This means that the effects of team communication actions are thought of as depending on the overall level at which they occur within the team, which in this dissertation was captured by aggregating team members' perceptions using the mean. This way, when the speed of exchanges is argued to have a positive effect on intra-team trust, this is proposing that a team with a higher mean-level speed of exchanges (e.g., 4) is expected to have higher levels of trust than a team with a lower mean-level (e.g., 2 or 3). Nevertheless, recent research regarding team-level variables has started to emphasise the need to consider the dispersion of team-level variables in addition to consensus models (Schneider, Salvaggio and Subirats, 2002; Dineen *et al.*, 2007; Cole *et al.*, 2011). Two teams can have equivalent mean-level results in a particular communication action while simultaneously having different dispersion levels in their member's responses. Following the example of the speed of exchanges, imagine we need to analyse two teams with three members each. In the first team, all three members rate their speed of exchanges with a 3, offering a mean-level result of 3 for the whole team. In the second team, the first member reports a 1 in the speed of exchanges, the second member rates it with a 3, and the last one, a 5, offering the same mean level of 3 from the first team. Nonetheless, these two teams are on opposite sides of the spectrum when we consider the dispersion of their members' responses. The first team does not present variability in team members' responses (i.e., dispersion equals zero), while the second team presents the maximum degree of dispersion in terms of spread for a team with a mean-level result of 3 (Dawson, 2011).

The dispersion component of team communication actions can be instrumental in understanding the differences that occur within teams. Teams with higher levels of dispersion represent teams that may not have established protocols or norms regarding how members must communicate with each other, leading to disparate use of communication media within the unit. This could lead to less effective communication because team members do not know what to expect from other team members, which could, in turn, lead to misunderstandings, conflict, and impaired effectiveness. This way, future research should pay attention to the dispersion component of team communication actions, by calculating the most theoretically appropriate index of dispersion depending on researchers' hypotheses. For example, if researchers think that the dispersion of team communication actions will have a negative effect when there are two clear subgroups within the team performing opposing levels of actions, they can use a separation index (e.g., Standard Deviation or Coefficient of Mean Difference; Harrison and Klein, 2007; Dawson, 2011). On the other hand, if researchers think that the negative effects exist when there is one member of the team that perform levels of actions opposed to the rest of the team, they can use a disparity index (e.g., Coefficient of variation; Harrison and Klein, 2007; Dawson, 2011) to capture this. It is important to note that, due to the nature of the scales used to measure team communication actions (Likert with a range restriction, e.g., 1 through 5 scale points), the dispersion component may be biased due to range restriction (Cole *et al.*, 2011). Therefore, it is important to examine the statistical independence between the mean-level and dispersion components of a variable by calculating correlations between these two components and always control for the mean-level component when testing the effects of the dispersion variable. Moreover, it could also be relevant to explore the interactional effects between the mean and dispersion components of team communication actions to explain cases in which team communication actions were not related to teamwork processes in the third article. For instance, while the speed of exchanges

207

is expected to have a positive effect on transition processes, it is possible that this effect only occurs when there are low levels of dispersion in the speed of exchanges within teams.

Access to Organisational Data and Research Methodology

One of the main challenges faced for articles two and three was the access to organisational data to analyse team-level variables, such as team communication actions and team effectiveness variables. These articles presented some limitations regarding the methodology used to achieve their goals. For instance, in the scale development and validation article, the team-level internal structure validity was only tested using a Spanish-speaking sample, leaving its effectiveness in English-speaking contexts unverified. Future research could aim to address this issue by securing access to team-level data in English-speaking countries. Second, the study's cross-sectional methodology may introduce Common Method Variance (Tehseen, Ramayah and Sajilan, 2017; Podsakoff *et al.*, 2024), potentially distorting relationships between variables. This is particularly relevant for the revision of the discriminant and predictive validity of the scale. Longitudinal designs are recommended for future research to mitigate this bias. Lastly, the scale relies on team members' perceptions of communication actions, which can be biased by personal preferences. Future studies might employ observational methods, like recording team interactions, to measure communication actions more accurately. Unfortunately, this is something that was not feasible to do during the limited time of my doctoral studies.

In the hypotheses testing article, there were also limitations derived from the difficulty of accessing organisational data. My initial idea was to examine the relationship between team communication actions and teamwork processes by first testing the existence of common patterns among teams in the communication actions that they perform. For example, it could be possible for some teams to only perform high-level actions for convergence of meaning, or other teams may present a specific combination of convergence

of meaning and conveyance of information actions (e.g., high speed of exchanges and low refining of communications). One analysis that allows researchers to empirically test the existence of common patterns in a set of continuous variables is Latent Profile Analysis (LPA; Oberski, 2016) and its multilevel extension, Multilevel Latent Profile Analysis (MLPA; Mäkikangas *et al.*, 2018). This way, I tried testing the existence of underlying patterns of team communication actions, but there were issues with the sample size requirements to run these statistical analyses. When considering teams that have information on all the required variables, I only had access to a sample of 143 teams, while past research has recommended sample sizes of over 250 cases to perform LPA (Tein, Coxe and Cham, 2013), with other studies recommending even larger samples (e.g., 500 cases; Peugh and Fan, 2013). This way, while my analyses offered some interesting groupings based on common patterns of team communication actions, some of these groups had only 10 to 15 cases. This made it difficult to run subsequent analyses comparing these groups in terms of their impact on teamwork processes due to a lack of statistical power.

Considering the above, I had to use an alternative approach of testing the effects of each team communication action individually while controlling for the effects of the other actions. This allows us to ensure that the effects of team communication actions found in this article are independent of each other. For example, the positive effect of verbal and non-verbal communications on transition processes exists regardless of the levels of the other actions, such as speed of exchanges or refining communications. Nonetheless, the examination of the underlying combination of communication actions across teams could be a relevant area for future research. If common patterns of communication actions are found in different teams, this could allow us to test how the combination of different actions can have an impact on the effectiveness of teams. This may be a better reflection of what happens in practice where team members use multiple communication actions simultaneously rather than

independently (e.g., combining the use of verbal and non-verbal communications, together with involving multiple participants). Future research with large team samples could offer the possibility to test this research avenue.

As mentioned in this article, there were also some limitations concerning its methodology that could hinder the study. First, as in the second article, team members' perceptions of team communication actions and teamwork processes were obtained using a single survey (cross-sectional design). This way, the relationships found between these variables can be influenced by Common Method Variance bias (Tehseen, Ramayah and Sajilan, 2017; Podsakoff *et al.*, 2024). Additionally, the mediational hypotheses proposed in this article also consider the passing of time as a relevant mechanism by which one variable influence another. Nonetheless, I was not able to access longitudinal data, and therefore, I had to use a cross-sectional design. This methodology does not allow for a proper assessment of causal mechanisms, and due to this, it is not possible to conclude the directionality of the effect between variables. This way, while this article's hypotheses argued that team communication actions will have an impact on teamwork processes and ultimately on team performance, the results can also be interpreted in the opposite direction, that is, that teamwork processes affect team communication actions.

Summary and Conclusion

In summary, this doctoral dissertation offers several contributions to the literature. First, it offers a new construct called *team communication actions,* which aims to deepen our understanding of communication media usage in teams beyond the dichotomous and deterministic views that have been used thus far in the literature. This construct is also linked to team functioning variables by offering several propositions of how team communication actions can impact teamwork processes depending on the developmental stage of teams. Second, it offers a validated scale in Spanish and English to measure eight different

communication actions that team members can perform. Lastly, this dissertation also offers key empirical findings by testing the relationships between team communication actions, teamwork processes and team performance depending on the developmental stage of teams. These results show that team communication actions can have an instrumental role in shaping the effectiveness of teams as, for example, the use of verbal and non-verbal communications together with the refinement of communication are positively related to the performance of transition processes. These findings enhance our understanding of how team members can use various communication media to improve their teamwork. They also offer practical guidance for team leaders and managers on how to better support their teams' work.

While offering strong contributions, this dissertation is not without limitations. In particular, organisational access to measure teams was a challenge, and this limited the methodology of some of the studies in this dissertation. This is reflected in the fact that the scale could not be validated at the team level in an English-speaking sample and also that it was not possible to obtain longitudinal information to properly test causal relationships in the third article. Additionally, as some of the propositions and hypotheses of this thesis were not supported, this dissertation also offers avenues for future research aiming to expand our understanding of team communication actions and to clarify these results. These limitations notwithstanding, this research provides a solid foundation for future studies in the use of communication media within teams. Future research could focus on addressing the limitations of this dissertation by trying to replicate the results presented here using longitudinal designs. Additionally, future research could focus on developing and testing more complex theoretical relationships between team communication actions and other team functioning variables, which would further elucidate some of the intriguing findings of this dissertation.

In conclusion, the work presented in this dissertation advances our knowledge of communication media usage in teams. The insights gained from this research not only enhance our theoretical understanding but also offer practical solutions for the management of teams. This is of relevance as of now considering that the COVID-19 propelled the use and combination of different types of communication media, including ICTs and face-to-face interactions, more than ever before.

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Appendix A – Final Scale in English, Spanish, and Portuguese

Code	English version	Spanish version	Portuguese version
Priming task			
	The following scale aims to examine the way that members of work teams communicate with each other using the set of communication media that are available to them.	*Las siguientes escalas buscan examinar la forma en que los integrantes de un equipo de trabajo se comunican entre sí a través de los medios de comunicación que tienen a su disposición.*	*As seguintes escalas buscam examinar como os membros de uma equipe de trabalho se comunicam entre si através das mídias de comunicação disponíveis.*
	To do so, first, please, indicate how frequently the following communication media are used by the members of your work team to communicate with each other:	*Para esto, por favor, indique cuán frecuentemente los integrantes de su equipo usan los siguientes medios para comunicarse entre sí:*	*Por favor, indique com que frequência os membros da sua equipe usam as seguintes mídias para se comunicar entre si:*
	Face-to-face interactions (in-person)	Interacciones cara a cara (en persona)	Interações face a face (pessoalmente)
	Videocalls	Video llamadas	Videochamadas
	Phone calls	Llamadas telefónicas	Telefonemas
	Voice messages	Mensajes de voz	Mensagens de voz
	Instant messages or chat	Mensajes de texto instantáneos o chat	Mensagens de texto instantâneas ou chat
	Emails	Emails	E-mails
	Sharing documents (e.g., Google Drive)	Compartiendo documentos (p.ej., Google Drive)	Partilha de documentos (por exemplo, Google Drive)

Online collaboration tools (e.g., forums, boards)	Herramientas de colaboración en línea (p.ej., foros, boards)	Ferramenta de colaboração online (p.ej., fóruns, boards)
Other (please specify):	Otro (por favor, especifique):	Outro (por favor, especifique):

Header

Next, please, indicate the degree that the following statements describe the way you and the other members of your team communicate using the set of communication media available to you. (This set is comprised of all the communication media that you indicated in the previous question that are used to some extent within your team)

A continuación, por favor, indique el grado en que las siguientes frases describen la forma en que usted y los otros integrantes de su equipo se comunican entre sí usando el set de medios de comunicación que tienen disponible. (Este set está compuesto por todos los medios de comunicación que usted indicó que son utilizados en alguna medida dentro de su equipo en la pregunta anterior)

Por favor, indique o quanto as seguintes frases descrevem a forma como você e os outros membros da equipe se comunicam entre si usando o conjunto de mídias de comunicação disponíveis para vocês. (Note que este conjunto é composto por todas as mídias de comunicação que você indicou que são usadas em alguma medida dentro de sua equipe na pergunta anterior)

Quando os membros da minha equipe se comunicam usando as mídias de comunicação da equipe...

When members of my team communicate using the team's communication media...

Cuando los integrantes de mi equipo nos comunicamos utilizando los medios de comunicación del equipo...

Verbal and non-verbal communications

VNC1	We usually communicate with each other by speaking/voice	Usualmente, nos comunicamos entre nosotros hablando/por voz	Normalmente, nos comunicamos entre nós falando/por voz
VNC2	We often can see each other when we interact	A menudo podemos ver a los otros integrantes cuando interactuamos	Frequentemente podemos ver os outros membros quando interagimos

| **VNC3** | Usually, we can hear each other when we communicate | Por lo general, podemos escuchar a los otros integrantes cuando nos comunicamos | Geralmente, podemos ouvir os outros membros quando nos comunicamos |
| **VNC4** | We often use gestures and body language to communicate with each other | A menudo usamos gestos y lenguaje corporal para comunicarnos entre nosotros | Frequentemente usamos gestos e linguagem corporal para nos comunicar entre nós |

Written communications

WC1	In general, communications within the team are written/text-based	Por lo general, las comunicaciones dentro del equipo son escritas/basadas en texto	Normalmente, as comunicações dentro da equipe são escritas/baseadas em texto
WC2	Usually, we interact with each other through written messages	Usualmente, interactuamos entre nosotros a través de mensajes escritos	Geralmente interagimos uns com os outros através de mensagens escritas
WC3	We often share written information with each other	A menudo compartimos información escrita entre nosotros	Muitas vezes compartilhamos informações escritas uns com os outros

Graphical communications

GC1	We usually communicate with each other using images or charts	Por lo general, nos comunicamos entre nosotros a través de imágenes o gráficos	Nós geralmente nos comunicamos uns com os outros usando imagens ou gráficos
GC2	We often communicate with each other using pictures or illustration	A menudo nos comunicamos entre nosotros usando imágenes o ilustraciones	Muitas vezes nos comunicamos uns com os outros usando imagens ou ilustrações
GC3	Usually, we communicate with each other using visual representations	Usualmente, nos comunicamos entre nosotros usando representaciones visuales	Geralmente nos comunicamos uns com os outros usando representações visuais

Speed of exchanges

| **SE1** | In general, communications within the team receive prompt responses | Usualmente, las comunicaciones dentro del equipo reciben respuestas inmediatas | Geralmente, as comunicações dentro da equipe recebe respostas imediatas |
| **SE2** | Usually, we reply quickly to communications within the team | Por lo general, respondemos rápidamente a las comunicaciones dentro del equipo | Normalmente, respondemos rapidamente às comunicações dentro da equipe |

SE3	We often respond immediately to each other	A menudo nos respondemos inmediatamente entre nosotros	Muitas vezes respondemos imediatamente uns aos outros

Multiple participants

MP1	Often, multiple team members participate in the same communication simultaneously	A menudo varios integrantes del equipo participan simultáneamente en la misma comunicación	Muitas vezes, vários membros da equipe participam simultaneamente da mesma comunicação
MP2	Usually, multiple team members interact at the same time	Por lo general, múltiples integrantes del equipo interactúan al mismo tiempo	Vários membros da equipe geralmente interagem ao mesmo tempo
MP3	In general, team communications involve several members at the same time	Usualmente, las comunicaciones del equipo involucran a varios integrantes al mismo tiempo	Geralmente, as comunicações envolve vários membros da equipe ao mesmo tempo

Simultaneous communications

SC1	Usually, we are involved in several simultaneous communications	Usualmente, estamos involucrados en varias comunicaciones simultáneas	Estamos geralmente envolvidos em várias comunicações simultâneas
SC2	We often participate in several communications at the same time	A menudo participamos en varias comunicaciones al mismo tiempo	Participamos frequentemente em várias comunicações ao mesmo tempo
SC3	We usually have multiple communications at once	Por lo general, mantenemos múltiples comunicaciones a la vez	Geralmente, mantemos várias comunicações ao mesmo tempo

Refining communications

RFM1	Commonly, we check messages thoroughly before communicating them	Usualmente, comprobamos que nuestros mensajes sean claros antes de comunicarlos	Costumamos verificar se nossas mensagens são claras antes de comunicá-las
RFM2	We often check that our messages say what we mean before communicating them	A menudo comprobamos que nuestros mensajes dicen lo que queremos decir antes de comunicarlos	Muitas vezes verificamos se nossas mensagens dizem o que queremos dizer antes de comunicá-las

219

RMF3	We often refine the content of our messages before communicating them	Por lo general, refinamos el contenido de nuestros mensajes antes de comunicarlos	Geralmente, refinamos o conteúdo de nossas mensagens antes de comunicá-las
Reviewing communications			
RVM1	We often examine the communications from other members more than once	Usualmente, revisamos los mensajes de los otros integrantes en múltiples ocasiones	Normalmente, verificamos as mensagens dos outros membros em várias ocasiões
RVM2	Commonly, we review the messages from other members multiple times	A menudo examinamos las comunicaciones de otros integrantes más de una vez	Muitas vezes examinamos as observações de outros membros mais de uma vez
RVM3	Usually, we see or listen to the communications from other members many times	Por lo general, vemos o escuchamos las comunicaciones de otros integrantes varias veces	Geralmente vemos ou ouvimos as comunicações de outros membros várias vezes

Code	Item
General Symbol Sets	
GS1	We usually communicate with each other in a variety of ways (e.g., using gestures, speaking, written text, numbers, images)
GS2	Often, we only use one type of symbol to communicate with each other (e.g., only by speaking or only by written text) (r)
GS3	We usually communicate through channels that allow us to communicate in many ways
GS4	We usually send messages in a variety of ways through the team's communication channels
GS5	We commonly share information in a variety of ways through the team's communication channels
GS6	We often communicate with each other using a variety of methods of expression
GS7	We usually communicate with each other using many different forms of expression
Natural Symbol Sets	
NS1	We usually communicate with other team members by speaking
NS2	We can often see the other team member(s) when we use the team's communication channels
NS3	Usually, we can hear the other team member(s) when we use the team's communication channels
NS4	We often use gestures and body language to communicate with each other
NS5	We often communicate with each other verbally
NS6	Commonly, we use gestures and body language when we use the team's communication channels
NS7	We often communicate with each other orally through the team's communication channels
Digital Symbol Sets	
DS1	We often communicate with each other using written symbols (e.g., text, numbers, tables)
DS2	We usually communicate with each other using written messages (e.g., by email or chat)
DS3	We often share written information through the team's communication channels
DS4	We usually communicate with each other using images and pictures
DS5	We often communicate with other team members using written words
DS6	The communications we usually have with other team members are written/text-based

DS7   We usually interact with other members through written messages

Transmission Velocity

TV1   We usually have fluid communications using the team's communication channels

TV2   We often have quick two-way communications using the team's communication channels

TV3   Most communications within the team have very short time lags

TV4   We often use communication channels that allow us to respond immediately

TV5   Interactions using the team's communication channels have long time lags (r)

TV6   The team's communication channels allow to have fluid interactions with other team members

TV7   Usually, the communications within the team are immediately replied to by other members

TV8   We usually have to wait a long time before receiving a response from other team members (r)

Parallelism

PL1   We often communicate with multiple team members at the same time

PL2   We often have multiple conversations simultaneously through the team's communication channels

PL3   Most communications within the team involve several team members at the same time

PL4   We usually communicate with only one other member of the team at a time (r)

PL5   Usually, multiple team members interact simultaneously through the team's communication channels

PL6   Often, several team members participate at the same time in the communications within the team

PL7   We commonly use channels that only allow us to have one conversation at a time (r)

Rehearsability

RH1   We are able to check that our messages say what we mean before communicating them

RH2   We are able to check that our messages are clear before communicating with other team members

RH3   We usually communicate through channels that allow us to edit messages before sending them

RH4   We commonly receive clear messages through the team's communication channels

RH5   We often receive precise messages through the team's communication channels

RH6   Commonly, we check messages thoroughly before communicating them

RH7   We usually refine the content of our messages before communicating them to other team members

Reprocessability

RP1	Most of the communications we have within the team can be accessed many times
RP2	We usually review the messages that we receive from other team members multiple times
RP3	We usually check the information shared through the team's communication channels multiple times
RP4	We can check more than once the communications from other team members
RP5	We often communicate through channels that allow us to access messages more than once
RP6	We usually re-examine many times the communications from other team members
RP7	We commonly review multiple times the messages after they have been received

Note. Items marked with an 'r' are reverse scored.

Appendix C – Experts Revision of Original Set of Items

Code	Relevance							Clarity of Formulation							Comments
	R1	R2	R3	R4	R5	R6	Total	R1	R2	R3	R4	R5	R6	Total	
TV1	2	2	2	1	2	1	**1.67**	2	2	3	1	2	1	**1.83**	R1: These items remind me of a problem that we faced when trying to write virtuality items. The definition for transmission velocity refers to the capabilities of the medium but many of these items could also be influenced by team member processes (e.g., Slack allows for rapid messaging with teammates but my experience of this might be influenced by how we use the tool). In this way, the speed at which we interact is more attributable to individual behavior / team processes rather than the capability of the tool itself. I do not know if these elements can be fully parsed out, but just my two cents. R2: I'm not really sure everyone would understand what you mean with the word fluid - does it mean interactive? Or smooth? R3: As a media capability, transmission velocity describes a communication medium rather than the act of communication. Therefore, the phrasing should reflect that it is a capability of the medium itself rather than the act of communicating. For example, compare "We usually have fluid communications..." to "Email offers the ability to communicate fluidly...". R4: For me, the term "fluid" does not suggest speed of delivery and response. It more suggests whether messages are sent/received without misunderstanding or other problems to effective/smooth communication. R5: We have very fluid communication over calls - but less so in the written channels, so in average I

															would respond moderate This item may of course be dependent on other things than the technology, such as language proficiency differences, so might be good to ensure that they think about the media.
TV2	3	3	2	3	3	2	**2.67**	3	3	3	3	3	2	**2.83**	R4: Is "using the team's communication channels" redundant. If that is in the initial stem of the question that introduces the item set, then it is not needed in every item. For example: Using the team's communication channels: we often have quick two-way communications next item next item.
TV3	3	3	2	3	3		**2.80**	3	3	3	3	3		**3.00**	R6: not clear what you mean by short time lags.
TV4	3	3	3	2	3	3	**2.83**	3	3	3	2	3	3	**2.83**	R1: I think this item and item 6 are the best representations of transmission velocity. R4: As noted above, is communication channels needed in the item, if it is in the step of the question? This item seems to assess what the communication channels allow, whereas the other items up to now are focused on what actually happens--i.e., how the communication channels are actually used. To be consistent, this item should read: "We often respond immediately to each other" [using the stem of "Using the team's communication channels:". R6: I think this may be the best option.
TV5	3	3	2	3	3		**2.80**	3	3	3	2	2		**2.60**	R4: Somewhat unclear with regard to who the interactions are between. For example, it could also refer to interactions between the team and others outside the team. If the intent for the item to be general, then that is OK. Otherwise, it might be necessary to be more precise--e.g., Communications between team members have long time lags".

													R5: Not sure interactions can have long time lags? Or is it responses that have long time lags? I understand you want to use the term interactions for this item, perhaps think about other end than time lags? R6: Prefer the earlier one.
TV6	3	2	2	1	3	**2.20**	3	2	3	1	2	**2.20**	R2: See my comment on item 1. R3:" The relevance of this item is high, but the phrasing (e.g., "allow to have") makes it awkward. R4: Same comment as with item 1 regarding the term "fluid." Also, the item is not grammatically correct because it says "allow to have" but is not clear who is allowed to have. I think it should read "allow the team to have" or "allow team members to have." That said, I have the same concern as in item 4 regarding the use of the term "allow," which puts the focus on the properties of the communication channel rather than how they are used. What is the intent? R4: allow who? And is other team members still intra-team members? I understand you dont have the questions from an "I" perspective but want the person to think about it at the team level? Is that right? Then "The team's communication channels allow US to have fluid interactions with other team members" (and I would still change the other team members perhaps with each other, or something like that. I might be overthinking this, perhaps because I am such a multi-teamer. The next question without team before other members is again clearer. R6: As mentioned 'fluid' is problematic for me.
TV7	2	3	1	3	3	**2.40**	3	1	3	2	3	**2.40**	R2: Not really sure what this is supposed to mean and also sounds a little weird to reply to a

226

Item							Mean							Mean	Comments
															communication (rather than a message that has been sent). Not really sure what a better wording would be though because I assume you don't want to use the term message? R4: I would use active rather than passive voice: "Usually, team members reply immediately to communications within the team". R6: The sentence is somewhat convoluted/ passive voice. How about 'Team members reply immediately'.
TV8	2	3					**2.40**							**2.60**	R4: Why include "have to?" The item works without it and seems clearer. The use of the term "we" makes it sound as though this is a different group to those included in the "other team members" at the end of the sentence. It might be clearer to say "Team members wait a long time to receive answers to their communications in the team." R5: Not sure the "We" start works here because I am wondering who this "we" is.
			1	3	3			3	3	3	2	2			
GS1	3	3	2	3	3	3	**2.83**	3	3	3	3	3	3	**3.00**	
GS2	3	3	2	3	3	1	**2.50**	2	3	2	3	3	3	**2.67**	R1: The phrase "one type of symbol" is a bit technical but the parenthetical examples are helpful. R4: I wonder how realistic this is. Teams seldom limit communication to only one form of symbol set. Will there be variance on this item?
GS3	2	3	3	2	3	3	**2.67**	2	3	3	2	3	3	**2.67**	R4: Inserting "different" in front of ways might help. Also, it might not be clear that different symbols sets is what is meant here. For example, communicating using email and text is "different ways" but both are text. It might help to put in parenthesis (e.g., text, speaking, seeing each other). If there are instructions and a stem for the question that clarifies what yo are loo.

							Avg							Avg	Comments
GS4	2	3	3	2	3	1	**2.33**	3	3	3	1	3	1	**2.33**	R4: I think people are more likely to interpret this as text-based communication (e.g., email, text, social media, etc.). I think the use of the term "message" conjures up thoughts of text-based communication mostly.
GS5	3	3	2	2	3	1	**2.33**	3	3	3	2	3	1	**2.50**	R2: I think either this item or the one before is enough, I don't really see the value in having two so similar items. R4: As with item 3, I tend to think about different communication media (e.g., text, email, etc.) rather than different types of symbols. Again, how it is interpreted will depend on the instructions and item stem.
GS6	3	3	2	1	3	2	**2.33**	3	2	2	1	3	3	**2.33**	R4: Methods of expression sounds more like you are asking about how the message is phrased rather than different symbols.
GS7	3	3	1	1	3	2	**2.17**	3	3	2	1	3	3	**2.50**	R4: Same as comment above.
NS1	3	3	1	3	3	3	**2.67**	3	2	2	3	3	3	**2.67**	R2: I wonder if it would help to clarify by adding something like "...(as opposed to e.g., writing)". R6: through speech?
NS2	3	3	3	3	3	3	**3.00**	3	2	3	3	3	3	**2.83**	R2: Wonder if this is clear enough because I can also "see" the other team member's icons/avatars or similar when communicating through e.g., instant messaging/email.
NS3	3	3	3	3	3	3	**3.00**	3	2	3	3	3	3	**2.83**	R2: maybe add "voices", so it's even clearer.
NS4	3	3	1	1	3	3	**2.33**	3	3	2	1	3	3	**2.50**	R4: Phrasing sounds a little odd. What seems important is whether team members have the opportunity to see gestures and body language. Different team members may use gestures and body language to different degrees. Maybe phrase the question as "We can see gestures and body language when we communicate with each other.
NS5	3	3	1	3	3	3	**2.67**	3	3	2	3	3	3	**2.83**	

NS6	3	3	3	1	3	3	**2.67**	3	2	3	1	3	3	**2.50**	R2: Having the word "use" in there twice sounds a little weird and also like it's optional to use gestures/body language with every channel when really the channel dictates whether you can use body language or gestures Maybe sth like: "we use communication channels that allow for gestures and body language"? R4: Similar comment to item 4.
NS7	3	3	3	3	3	3	**3.00**	3	3	3	3	3	3	**3.00**	
DS1	3	3	1	3	3	3	**2.67**	3	3	2	3	3	3	**2.83**	
DS2	3	3	1	3	3	3	**2.67**	3	3	2	3	3	3	**2.83**	
DS3	3	3	3	3	3	3	**3.00**	3	3	3	3	3	3	**3.00**	
DS4	3	3	1	3	3	3	**2.67**	3	3	2	3	3	3	**2.83**	R5: (I thought these were included in the previous set of questions when thinking about a variety of ways, maybe that was OK?)
DS5	3	3	1	3	3	3	**2.67**	3	3	2	3	3	3	**2.83**	
DS6	3	3	3	3	3	3	**3.00**	3	3	3	3	3	3	**3.00**	
DS7	3	3	2	3	3	3	**2.83**	3	3	2	3	3	3	**2.83**	
PL1	3	3	2	3	2	3	**2.67**	3	3	3	3	2	3	**2.83**	R4: General comment: I am not sure how well parallelism translates to using the set of communication channels in the team. I think that this will be rated high by all teams because doesn't using different communication channels by default allow team members to have more than one conversation at a time (e.g., sending an email and while on a conference call or simultaneously responding to a text). Also, since most teams have regular team meetings, I think most teams will respond that multiple team members often participate at once in team communications. But maybe this is just my assumption. Finally, it is worth considering whether you are tapping into two different things that need to be assessed separately: (1) multiple team members

participating at once in the same conversation and (2) having different conversations with different team members at the same time. These seem like substantively different things.

R5: I am not sure how I would respond to this question - I would perhaps interpret it like this - yes we are several members in meetings - so yes we communicate with multiple members at the same time (i.e. the same time would not really get at the parallelism that you are after).

R6: use simultaneously.

PL2	3	3	2	3	3		**2.80**	2	3	3	3	3	1	**2.50**	R5: This again, is much clearer! R6: is the emphasis on simultaneous conversations or on use of channels?
PL3	3	3	1	3	3	1	**2.33**	3	3	3	3	2	1	**2.50**	R5: My reaction to this is a bit similar as to the first question.
PL4	3	3	2	3	3	1	**2.50**	3	3	3	2		1	**2.40**	R4: The use of the term "we" makes it sound like this is someone outside the team. Suggestion: "Team members usually communicate with one other member of the team at a time". R5: Is it "I usually communicate" - or who does this "we" refer to?
PL5	3	3	3	3	3	3	**3.00**	3	3	3	3	3	1	**2.67**	R4: I would expect this would be high for all teams because most teams have regular team meetings that involve all team members. R6: media used is unclear - is it multiple media?
PL6	3	2	1	3	3	3	**2.50**	3	1	2	3	3	1	**2.17**	R2: Once again, not a native speaker but to "participate in the communications" sounds weird to me. And also not sure that this applies strictly to channel parallelism because technically, if a team is communication, all members are participating. They are just not all actively transmitting information through a channel at the same time. R4: See comment for previous item.

														R5: This is clear - but it seem to me that it is the case of a normal meeting (i.e. multiple members present in the same space) R6: participate in what?
PL7	1	3	3	3	3	3	**2.67**	2	3	3	3	3	3	**2.83**	R1: This one is a little tricky because most channels allow for some degree of parallelism (maybe excluding phone or face-to-face) even if you typically only use them for one conversation at a time. I think the wording of item 4 is a better version of this question.
RH1	3	3	3	3	3	3	**3.00**	3	2	3	3	3	3	**2.83**	R4: I might struggle to answer this for the team's overall set of communication channels because I can clearly do this through email, but maybe not as much in a team meeting. Although, maybe that is the point? That is, it ultimately depends on the extent to which the team uses high vs. low rehearsability media? You will need clear instructions to help the user understand how to approach these items. The wording of the item definitely seems biased toward text-based communication. I am not sure I would consider other forms of communication when answering the question. R6: We or I? I cannot comment on what others do.
RH2	3	3	3	3	3	1	**2.67**	3	2	3	2	2	1	**2.17**	R2: It think it should also be "before we communicate them to other team members", right? Otherwise it's not quite clear that it's about the message sent to others. R4: See my previous comments regarding "we" and "other team members." R5: (I'll not make same comments twice - e.g. the "other team members" commented on before. I guess its the "We" and then "other" in the end of the

															sentence which confuses me whether other refer to ingroup or outgroup. R6: what do mean by clear? why is team context relevant?
RH3	3	3	3	3	3	3	**3.00**	3	3	3	3	3	2	**2.83**	R4: Same comment as for item 4.
RH4	1	3	1	1	3	1	**1.67**	2	3	2	1	3	1	**2.00**	R4: I don't think receiving clear messages indicates rehearsability because it is possible to receive a clear message because the sender is a clear communicator and not necessarily because the sender took time to edit, etc.
RH5	1	3	1	1	3	1	**1.67**	2	3	2	1	3	1	**2.00**	R1: Items 4 and 5 could also be affected by team members' ability to communicate with one another or carelessness in messaging (while the other items are focused more on the channel itself). I don't think that you want those other judgments as part of this scale but that is just my opinion.
RH6	3	3	2	2	3	3	**2.67**	3	3	2	2	3	1	**2.33**	R4: This is different to saying "we are able to check" because one could be communicating using channels that allow for rehearsability, but not take the time to edit. This relates to some of my previous comments in the transmission velocity section regarding the distinction between what the channel allows and how team members use the channel. R6: communicating or sending? We or I?
RH7	3	3	2	2	3	2	**2.50**	3	3	3	2	2	2	**2.50**	R4: same as previous comment for item 6.
RP1	3		3	3	3	3	**3.00**	3		3	3	3	3	**3.00**	R2: To me it would sound a little better to say "multiple" rather than "many" times because it's about being ABLE to go back to a message and not HAVING TO do it.
RP2	2	3	2	2	2	1	**2.00**	3	3	2	2	2	3	**2.50**	R4: Item 1 is about what is possible "we can access" and item 2 is about what is actually done. This may be two different things. R5: Or we have the possibility to... (since the way it is framed taps into behaviors and there may be

							Avg							Avg	Comments
															individual differences in relation to how often people review messages).
RP3		3	2	2	2	2	**2.20**		3	2	2	2	3	**2.40**	R4: Same comment as for item 2. R5: Same as above (I cannot answer for my team members - whether they check often or not).
RP4	3	3	2	3	3	1	**2.50**	2	2	1	3	3	3	**2.33**	R1: The wording here seems a little awkward - something like "We can check the communications from other team members more than once" feels a little more clear. R2: "more than once" belongs at the end of the sentence, right? Also not exactly sure: are you talking about the messages sent BY or TO other team members? R4: I would reword to "we can check the communications from other team members more than once".
RP5	3	3	3	3	3	1	**2.67**	3	3	3	3	3	1	**2.67**	
RP6	3	3	2	2	3	1	**2.33**	2	2	2	2	2	1	**1.83**	R1: Similar comment as for item 4. R2: "Many times" belongs at the end of the sentence in my opinion. Also not quite sure if this is about what has been sent or received? R4: Same comment as for item 2.
RP7	2	3	2	2	3	3	**2.50**	2	3	2	2	2	1	**2.00**	R2: Multiple times belongs after "the messages". R4: Same comment as for item 2. R6: This will make more sense to me: We commonly review the messages multiple times after they have been received

Appendix D – Exploratory Factor Analyses

Individual-level Spanish-speaking sample - Exploratory Factor Analysis

Items	VNC	WC	GC	SE	MP	SC	RFM	RVM
VNC1	**.60**	-.09	.15	.16	-.04	-.02	.01	-.02
VNC2	**.82**	-.07	-.01	-.03	.04	.01	.02	-.02
VNC3	**.77**	.09	-.04	.02	.08	-.03	.00	.00
VNC4	**.68**	.04	.01	-.06	-.09	.10	.001	.07
WC1	-.13	**.63**	.08	.00	-.05	.12	-.02	.12
WC2	.03	**.85**	-.01	-.01	.04	-.04	.02	-.08
WC3	.06	**.53**	.08	.14	-.04	-.01	.02	.14
GC1	.05	.00	**.89**	.03	.00	-.01	-.03	.00
GC2	-.07	.03	**.75**	-.08	.04	.02	.06	.00
GC3*								
SE1	-.02	-.01	.04	**.83**	.01	.02	-.01	-.02
SE2	.00	.04	-.03	**.91**	.04	-.02	.02	.00
SE3	.03	-.03	-.02	**.81**	-.03	.04	.03	.03
MP1	.05	-.02	.02	.04	**.86**	-.04	.03	.00
MP2	-.03	-.03	.01	.04	**.85**	.05	-.04	.04
MP3	.01	.11	-.01	-.12	**.65**	.08	.03	.03
SC1	.00	-.02	-.03	.01	.06	**.86**	.02	-.02
SC2	.03	.01	.01	.02	-.03	**.97**	-.03	.00
SC3	-.03	.00	.02	-.01	.03	**.81**	.03	-.01
RFM1	.01	-.01	.05	.02	-.02	.02	**.93**	.00
RFM2	.00	.02	-.03	.00	.05	-.01	**.92**	-.04
RFM3	.04	.02	-.03	.02	-.10	.01	**.60**	.24
RVM1	-.01	-.03	.02	.00	.02	-.04	-.03	**.93**
RVM2	-.01	.00	.01	-.06	.04	.05	.16	**.72**
RVM3	.05	.06	-.04	.08	.00	.02	-.03	**.71**

*Note. VNC = Verbal and non-verbal communications. WC = Written communications. GC = Graphical communications. SE = Speed of exchanges. MP = Multiple participants. SC = Simultaneous communications. RFM = Refining messages. RVM = Reviewing messages. * Item 3 of graphical communications was developed after reviewing the content and individual-level internal structure validity in the Spanish-speaking sample.*

Individual-level English-speaking sample - Exploratory Factor Analysis

Items	VNC	WC	GC	SE	MP	SC	RFM	RVM
VNC1	**.72**	-.10	-.06	.03	.05	-.04	.02	.05
VNC2	**.89**	.00	-.02	-.01	-.02	-.03	.03	-.05
VNC3	**.73**	.02	.02	.04	.01	-.03	.03	.01
VNC4	**.72**	.02	.06	-.03	-.02	.12	-.09	.02
WC1	-.06	**.86**	.03	.00	-.01	-.03	-.01	.03
WC2	.02	**.98**	-.01	-.01	.01	.00	-.01	-.02
WC3	.00	**.60**	.07	.08	.01	.11	.09	.03
GC1	.00	.09	**.83**	-.01	-.01	.04	-.02	.01
GC2	.00	-.04	**.95**	.00	.01	-.02	.00	.03
GC3	.00	-.01	**.86**	.01	.01	-.02	.03	.04
SE1	-.03	.01	.00	**.83**	.03	-.02	.01	.02
SE2	.05	.02	-.01	**.96**	-.03	.00	-.02	-.01
SE3	-.07	-.07	.01	**.67**	.04	.05	.06	-.01
MP1	-.02	-.01	.03	.01	**.77**	.04	.01	-.02
MP2	.01	.03	-.02	-.03	**.90**	-.02	.03	.01
MP3	.01	-.02	.02	.03	**.80**	.01	-.05	.01
SC1	-.01	.01	-.01	.02	.08	**.87**	-.01	.00
SC2	-.02	-.04	.03	.01	-.02	**.95**	.02	-.01
SC3	.02	.03	-.02	-.02	-.02	**.97**	-.01	.01
RFM1	-.01	-.02	.01	.01	.01	.00	**.97**	-.04
RFM2	.01	.05	.00	.03	-.02	.02	**.84**	.01
RFM3	.03	-.01	-.01	-.02	.01	-.02	**.73**	.12
RVM1	-.02	.03	-.03	.02	.03	-.04	-.04	**.93**
RVM2	.02	.05	-.01	-.05	-.03	.03	.20	**.69**
RVM3	.02	-.05	.07	.01	-.01	.05	-.02	**.84**

Note. VNC = Verbal and non-verbal communications. WC = Written communications. GC = Graphical communications. SE = Speed of exchanges. MP = Multiple participants. SC = Simultaneous communications. RFM = Refining messages. RVM = Reviewing messages.

Team-level sample - Exploratory Factor Analysis

Items	VNC	WC	GC	SE	MP	SC	RFM	RVM
VNC1	**.48**	-.03	.05	.21	.07	-.07	-.05	.02
VNC2	**.77**	.02	-.06	.04	.03	-.02	.03	.07
VNC3	**.70**	.04	-.03	.00	.20	-.01	.08	-.07
VNC4	**.64**	-.14	.15	.01	-.12	.09	.02	.02
WC1	-.16	**.68**	.05	.00	.00	-.05	.05	.11
WC2	.02	**.97**	-.03	.00	-.03	.04	.01	-.02
WC3	.05	**.70**	.13	.02	.10	.02	-.03	-.04
GC1	-.03	.05	**.86**	.02	.03	.02	-.01	.04
GC2	.03	-.02	**.98**	.01	.00	-.01	.02	-.03
GC3	-.02	.04	**.86**	-.03	.01	.01	.00	.02
SE1	.01	.02	.07	**.87**	-.06	.01	.01	-.07
SE2	-.03	-.01	-.03	**.98**	.00	.02	.00	.02
SE3	.07	-.01	-.04	**.74**	.15	-.03	.05	.04
MP1	.11	.05	.02	.05	**.75**	.00	.01	.02
MP2	.00	.01	-.03	.06	**.81**	.05	-.04	.05
MP3	-.01	-.02	.09	-.03	**.83**	.03	.06	-.02
SC1	.01	.05	-.02	.01	.00	**.90**	-.01	-.02
SC2	-.01	-.03	-.01	.02	.00	**.97**	.01	-.02
SC3	.00	.00	.04	-.02	.03	**.87**	-.01	.06
RFM1	-.01	.01	.00	.03	.02	.02	**.93**	-.03
RFM2	-.03	-.03	-.01	-.01	.04	.00	**.95**	-.01
RFM3	.09	.05	.03	.02	-.09	-.03	**.79**	.09
RVM1	-.05	-.03	-.02	-.02	.07	.03	.07	**.86**
RVM2	-.03	.00	.03	.02	.01	-.03	-.02	**.98**
RVM3	.11	.04	-.01	-.02	-.05	.06	-.01	**.86**

Note. VNC = Verbal and non-verbal communications. WC = Written communications. GC = Graphical communications. SE = Speed of exchanges. MP = Multiple participants. SC = Simultaneous communications. RFM = Refining messages. RVM = Reviewing messages.