Chapter 8

A Network Approach to Studying Team Functioning

Justin M. Jones, Dorothy R. Carter and Noshir S. Contractor

Abstract

Research on organizational teamwork is increasingly highlighting the patterned nature of the relational processes (e.g., communication, backup behavior) and psychological states (e.g., trust, shared cognition) that underlie team effectiveness. However, studies of teams often rely on methodologies that do not explicitly assess the underlying patterns of relational processes and states. Social network approaches offer an appealing alternative to the typical methodologies used in team research given that network approaches provide both the theory and methodology necessary to conceptualize and investigate patterns of interactions among group members. Despite the advantages of social network approaches, many team researchers are unfamiliar with the network paradigm and its associated methodologies. The purpose of this chapter is to clarify how networks can be leveraged to answer key research questions related to the study of team functioning and effectiveness. We begin by discussing the evolution and eventual convergence of team research and network approaches. Then, we examine the current state of the literature at the intersection of teams and networks in order to identify key takeaways and remaining questions. We conclude by highlighting opportunities for the future of team network science.

Keywords: Networks; social network analysis; team processes; behavioral processes; psychological states; input-process-output model

Introduction

Organizations rely on teams to complete (achieve) important goals by integrating diverse skills, abilities, and areas of expertise (Mathieu et al., 2017). To achieve shared goals, teams leverage *interaction processes* (e.g., communication, advice) and *psychological relationships* (e.g., trust, shared cognition) among team members as well as with

The Emerald Handbook of Group and Team Communication Research, 91–110

doi:10.1108/978-1-80043-500-120211008

external entities (e.g., stakeholders, other teams, senior leaders; Ilgen et al., 2005; Marks et al., 2001). There is growing consensus in the team literature that the *patterns* of social interaction processes and psychological relationships (e.g., who influences whom, who trusts whom, who communicates with whom) within teams and across team boundaries can determine team success (e.g., Contractor et al., 2012; Crawford & Lepine, 2013; Mell et al., 2014). However, the majority of research on team functioning in organizations has relied on methodological approaches that conceptualize team phenomena as an undifferentiated "shared" state characterizing the team as a whole (Kozlowski, 2015; Kozlowski & Chao, 2012).

Social network approaches offer an appealing alternative to the methodologies that are typically used in team research given that network approaches provide both the theory and methodology necessary to conceptualize and investigate patterns of interactions among group members (Contractor & Forbush, 2017; Wasserman & Faust, 1994). Social network approaches are well suited for studying teams because such approaches allow researchers to operationalize the myriad patterns of relationships within and external to teams and test hypotheses related to the antecedents and outcomes of relationships among team members. As a result, organizational scholars are beginning to rely upon social network approaches to understand the teamwork processes and relationships that underlie team effectiveness (see Fig. 8.1). For example, team researchers have begun investigating the relationships between networks in teams and important team outcomes (e.g., Henttonen, 2010; Katz et al., 2004; Manata, 2019). Further, researchers have clarified many of the theoretical underpinnings of various network structures and the social processes that they represent (e.g., Grosser et al., 2019; Park et al., 2020; Wolfer et al., 2015) as well as the methodological avenues in conducting network research in groups (Contractor & Su, 2012).

2020b

Q1

However, the full potential of social network approaches for understanding team phenomena has not yet been realized. Indeed, there is still much to be learned about team processes and emergent states, and social network analysis provides an array of analytical tools that to date are underutilized. The purpose of this chapter is to advance understanding of the ways in which social network analysis can be applied to the study of team functioning. We begin by reviewing the history of the relationship between social network methods and the study of teams. Then, we transition to the present to review how social network analysis has recently been used to understand teams. We seek to unify the existing literature on team networks by leveraging the overarching input-process-output (I-P-O) model of team effectiveness (McGrath, 1964) that is commonly used to understand team functioning. We conclude by looking ahead to the future and outlining how social network methods can be used to answer emerging research questions critical to the advancement of network science in teams.

A Brief History of Social Network Analysis within Group Research

The formal study of groups using networks began in the 1930s when Jacob Levy Moreno and Helen Jennings brought the mathematical model of graph theory to

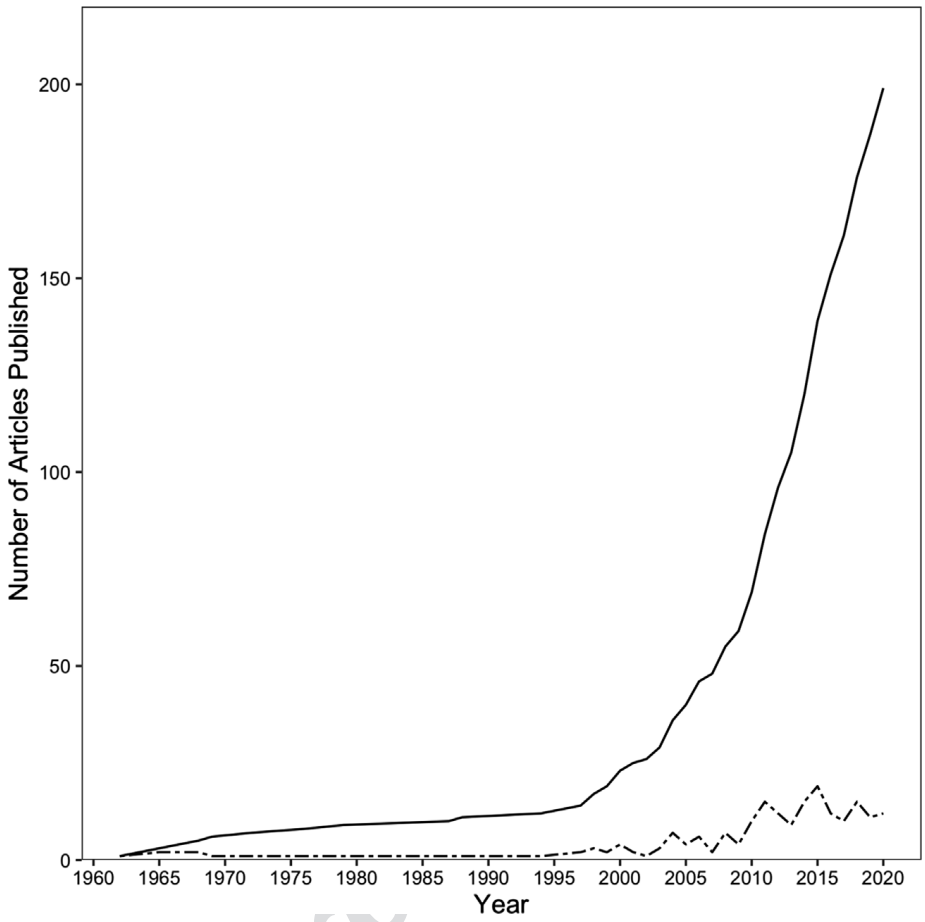

Fig. 8.1. Articles Published Using Network Methodologies. *Note*: The solid line represents the cumulative sum of articles published using network methodologies to study teams since 1960. The dashed line represents the number of articles published each year.

the study of groups through the creation of sociometry (e.g., Moreno & Jennings, 1938). Kurt Lewin followed with the theoretical contributions of field theory that drew attention to the importance of both the relationships between individuals, and the relationships between groups and their environment (Lewin, 1939). Soon after, scholars began integrating these theoretical and methodological components to investigate group functioning. Most prominently, Alex Bavelas (1950) conducted a series of studies where he compared team performance on a task under a variety of different communication structures. Ultimately, it was through the work of Bavelas that social networks began to be used not just to *describe* groups and/or an individual's position but also to analyze the impact of the structures themselves on group effectiveness.

Another important shift in the study of teams using networks was acknowledging *external* influences such as through Granovetter's (1973) theory of weak ties. Whereas previous research had focused on *strong* proximal relationships such as close friends, Granovetter's theory argued that individuals possess different forms of connections in their networks. Granovetter suggested that *weak* ties may also have explanatory power for understanding the function of social systems, and examining networks both within a team as well as across team boundaries helps to clarify how teams interact with their embedding environments to secure resources that are critical for team performance.

At the same time that research on networks in groups was developing, research on team functioning and effectiveness was also emerging as a discipline in its own right. Fundamental to this growth were heuristic frameworks depicting team effectiveness such as the I-P-O model (McGrath, 1964). The I-P-O model describes teams as systems that take individual, group, and organizational resources as well as team member characteristics as inputs and directs these inputs by enacting processes in order to accomplish tasks (Kozlowski & Ilgen, 2006; McGrath, 1964). The processes that convert inputs to team outcomes, such as performance and viability, consist of observable behavioral processes as well as more unobservable psychological mediators such as affective, cognitive, and motivational states (Marks et al., 2001).

Today, team researchers have started to leverage network approaches to study team processes and emergent states in order to clarify the drivers of team effectiveness. From a social network perspective, individual team members are often the *actors* or *nodes* in a network. The psychosocial relationships among team members and/or with other external entities are the *ties*. Networks are often created by collecting relational data characterizing the connections among all of the actors in a defined sample (e.g., a team). These data are then used to recreate the network of relationships among the different actors.

Research on teams from a network perspective is guided by the foundational theoretical work of Kozlowski and Klein (2000), which proposed that groups are subject to top-down environmental influences that constrain behavior and bottom-up (i.e., emergent) processes where the interactions between individuals coalesce to create group-level phenomena. They further clarified that bottom-up processes can be compositional or compilational in nature. Compositional emergence reflects the convergence of team members toward a shared state, such as a similar perception of the team's ability to perform tasks. Compilational emergence reflects patterned properties where through interaction individual affect, behavior, motivation or cognition become increasingly heterogeneous. For example, as transactive memory systems emerge within a team, team members develop increasingly specialized knowledge.

Following this seminal work, several scholars began to develop and test patterned conceptualizations of many of the processes and states, which had conventionally only been studied through compositional aggregational approaches (e.g., Cooke et al., 2013; Crawford & LePine, 2013). Further, team scholars also began to leverage networks to look beyond the team, acknowledging the influential role of the embedding environment. For instance, the multiteam system (e.g.,

Mathieu et al., 2001; Poole & Contractor, 2011), multiteam membership (Lungeanu et al., 2018), social capital (Oh et al., 2004), and boundary-spanning (e.g., Ancona & Caldwell 1992; Carter et al., 2020; Joshi et al., 2009) literatures have all, to some degree, relied upon networks to examine internal and external influences on team resources, processes, and performance.

Review of Research on Team Functioning from a Social Network Approach

To better understand the current application of social network approaches to the study of teams, we conducted a literature search for articles on teams leveraging social network analysis published between the years 1950 and 2020 within the fields of applied psychology, communication, ergonomics and/or human factors, management, sociology, and sport psychology. Articles within these fields were retained only if they were from a journal with an impact factor greater than 1. We searched for articles referencing the following keywords in the Web of Science, PsycInfo, and Business Source Complete databases to identify articles: teams or groups and configural, networks, social networks, or patterned. Then, we examined the reference lists of relevant team/network review articles to identify any articles that we may have missed. Once our initial list was compiled, the first author read the abstracts of each article to eliminate any articles that met the search criteria but were not relevant. Only empirical articles were considered, although many methodological and/or review papers were identified. This resulted in a final list of $n = 199$ articles.

Our literature review revealed that the themes which gradually emerged at the intersection of social networks and groups – mapping patterns of relationships among team members and examining the causes and consequences of relational patterning both inside and outside groups – continue to pervade today's research. However, we also find that social network research on teams is beginning to converge with the broader literature on teams which has long relied on I-P-O thinking. Specifically, we find that scholars use networks as antecedents, indicators, and outcomes of both behavioral processes and psychological states. In the following sections, we highlight several studies that exemplify how networks have been used to advance our understanding of each facet of the I-P-O framework for explaining the effectiveness of teams.

Networks as Antecedents, Indicators, and Outcomes of Team Behavioral Processes

Team behavioral processes refer to team members' efforts to synchronize their actions and transform resources into outcomes (Marks et al., 2001). Importantly, recent theoretical work has emphasized that behavioral processes can be conceptualized as networks of interaction (e.g., Crawford & LePine, 2013). Behavioral processes represented the most commonly investigated group process/state in the literature at the intersection of team functioning and social

networks. Of these behavioral processes, the most popular were communication, coordination, and leadership.

Networks as Antecedents of Team Behavioral Processes

Twenty-five of the articles (12%) identified in our literature review investigated social networks as influencing the behavioral teamwork process. Several studies used these networks to predict coordination processes. For example, Enemark et al. (2014) conducted a laboratory study that manipulated both the collaboration network structure of the team and the amount of information about the network structure provided to team members, and then assessed its effect on distributed coordination. Their findings demonstrated that the amount of knowledge about the network structure had a positive relationship with coordination, but that this relationship was moderated by the type of actual network structure. Networks predicting coordinative behaviors, such as monitoring and backup, were also investigated. Li et al. (2015) looked at the impact of the network position of a star team member (i.e., a high-performing member) on team member monitoring and backup behavior. They found that the influence of the team member with the greatest helping and voice behavior was moderated by their network position, such that star team members exerted the greatest influence on team monitoring and backup behavior when they held central network positions in the team's workflow network. Finally, several studies used networks as antecedents of leadership emergence. For instance, Friedrich et al. (2016) investigated the impact of both leader individual differences and team network structure on functional leadership behaviors. Through the use of a sales simulation, they found that network size, density, and embeddedness were predictive of communication behaviors.

Networks as Indicators of Team Behavioral Processes

Behavioral processes have also been examined by looking at the resultant network structures that form within the team. Eleven articles in our review (5%) leveraged a network indicator of a team behavioral process. Communication networks were one of the most commonly used indicators of behavioral processes. Barth et al. (2015) conducted a study of surgical team adaptation processes where they found that as teams adapted their teamwork to changing complexity and task demands their communication networks also changed to reflect these adaptations, becoming flatter (e.g., decentralized). Networks were also studied as indicators of leadership behaviors in teams. For example, Zhang and Peterson (2011) looked at the predictors of advice networks in teams, finding evidence supporting their hypothesis that transformational leadership behaviors would predict team advice network density and that advice network density would predict team performance.

Outcomes of Team Behavioral Process Networks

Fifty of the articles (25%) examined outcomes of team behavioral process networks. These articles operationalized a team behavioral process using a network

approach and investigated the outcomes of such networks. Communication was one of the most prevalent team processes investigated in the studies from our review. Grippa et al. (2018) conducted a study of the communication networks between and within health-care teams at a hospital. They found that the most successful teams focused on internal communication, and limited the number of communications with those external to the team. Argote et al. (2018) examined the effect of communication network structures on team performance and found that the relationship between communication network structure and performance was moderated by turnover, such that highly centralized communication networks were more accepting of new team members' contributions, while dense communication networks disregarded new team members due to their lack of understanding of the team's coordination processes.

The outcomes of informal leadership networks have also received attention. Mehra et al. (2006) studied different leadership structures and their impact on team performance. They found that distributed leadership did not have an incremental effect on team performance over centralized leadership, but that teams with distributed-coordinated leadership (i.e., where emergent and formal leaders shared reciprocated leadership ties) did have greater team performance. Networks have similarly been used to look at the influence of behavioral processes that are centralized around a particular team member. For example, Kane and Borgatti (2011) found that proficient team members had a greater impact on team performance when they held central positions in the team workflow and communication networks. Other studies have examined networks of coordination and helping behaviors. Pasarakonda et al. (2020) studied the coordination networks of surgical teams under different types of demands. In doing so they found that it was detrimental for teams performing complex tasks to distribute leadership throughout coordination networks, and that it was similarly detrimental for leaders to be centralized in the coordination network when performing in uncertain conditions.

In sum, the vast majority of papers looking at the outcomes of behavioral networks have focused on leadership and communication. However, there is still more to be learned about other team behavioral processes (e.g., backup behavior networks; conflict management networks). Our review suggests that there is a need for more research that leverages network approaches to understand the patterns of team behavioral processes and leverages methodologies that allow investigation of the antecedents of team behavioral network emergence.

Networks as Antecedents, Indicators, and Outcomes of Team Psychological States

Team psychological states represent the cognitive, affective, and motivational emergent properties of a team. Examples of some of the states investigated in this review include the affective states of trust (Costa et al., 2018) and cohesion (Beal et al., 2003); motivational states, such as efficacy and potency (Gully et al., 2002); and cognitive states, such as mental models and transactive memory systems

(TMSs; DeChurch & Mesmer-Magnus, 2010). Several scholars have recently encouraged the use of networks to investigate these emergent states (Monge & Contractor, 2003; Yuan et al., 2010, 2014), and have highlighted the critical role of communication in their development (e.g., Pilny et al., 2017; Yan et al., 2021). Overall, our review revealed a small but growing body of research using networks to study team psychological states, positioning networks as antecedents and indicators of team psychological states, and investigating outcomes of networked team psychological states.

Networks as Antecedents of Team Psychological States

In our review, 35 articles of the 199 identified (17%) used networks as antecedents of affective, motivational, or cognitive team emergent states. One of the most commonly investigated cognitive states was TMSs. For example, Lee et al. (2014) studied the role of network structures on the development of TMSs. They found that the density of the team information sharing network was negatively related to TMS development and team performance, but that reciprocity in the information sharing network was associated with the number of transitive triads in the network and subsequent TMS quality. Networks have been similarly shown to predict affective emergent states such as cohesion, trust, and conflict. Mclaren and Spink (2020) showed that communication networks were associated with task cohesion. Moreover, Susskind and Odom-Reed (2019) found that formal and informal communication network centrality predicted team member perceptions of team cohesion and conflict. Overall, while much of the research using networks as antecedents of team psychological states has looked at affective and motivational psychological states, there is a need for more research using networks as antecedents of team cognitive emergent states, as well as looking beyond TMSs.

Networks as Indicators of Team Psychological States

Eleven (5%) of the articles we reviewed used networks as indicators of team psychological states. Although there is a relative dearth of research on the relationship between cognitive emergent states and team network structures, several studies have used networks as indicators of motivational and affective emergent states. For example, Nelson (1989) found that teams with different forms of conflict exhibited different internal and external network structures. Q3 Brenneke and Rank (2016) found that the source of team member motivation (e.g., internal/external) predicted knowledge exchange networks. Liu et al. (2014) demonstrated that intrateam trust perceptions were predictive of the structure of procedural justice networks. Finally, Schulte et al. (2012) showed that perceptions of team psychological safety predicted the formation of advice, friendship, and conflict ties.

Outcomes of Networked Team Psychological States

Fifteen (8%) of the articles we identified used a network approach to operationalize a team's psychological state and examined the outcomes of that

psychological state network. We identified several emergent themes in this realm of research, including the use of networks to study the outcomes of knowledge, cohesion, and trust among other team psychological states. Team performance was the most widely investigated outcome of networked team psychological states. Huang and Cummings (2011) found that knowledge network centralization was negatively related with team performance, and that this relationship was moderated by the team's diversity and the type of knowledge the network represents. Chung and Jackson (2013) found evidence for a curvilinear relationship between internal trust networks and team performance. Hood et al. (2017) examined multiplex networks of conflict and friendship and showed that relational conflict among friends had a negative relationship with team performance, and task conflict had no effect on team performance among friends. However, relational and task conflicts among nonfriends had a positive relationship with team performance. Wise (2014) operationalized team cohesion as the density of e-mail networks found an inverse curvilinear relationship between cohesion and team performance.

and

Future Directions for Social Networks and Group Research

Research at the intersection of social networks and teams has led to important findings regarding the antecedents, indicators, and outcomes of both behavioral processes and psychological states. However, our review indicated that even when researchers use social network–based methodologies they predominantly incorporate *descriptive network indices* into traditional modeling frameworks. Examples of these practices include using counts of network structures, such as ties as predictors in a regression, paths in a structural equation model, or as dependent variables in an analysis of variance. Unfortunately, the reliance on network descriptive indices may be limiting the types of research questions that can be answered and the inferences that can be drawn. To advance research at the intersection of teams and social networks, researchers may need to leverage additional social network methodologies. In the final section of this chapter, we highlight relatively nascent ways of using networks and social network methodologies that may allow team scholars to address emerging research questions related to team processes and states in terms of their (a) mechanisms, (b) evolution over time, and (c) role in new forms of teamwork, such as with robots and/or other forms of technology.

Opportunity 1: Mechanisms

Our review demonstrated that research at the intersection of teams and social networks predominantly focuses on group-level network structures (e.g., density, centralization) as antecedents of team processes and states as well as the associated outcomes of these networks. However, describing team-level configural properties does not explain how these structures *emerge*. Indeed, collective structures develop through the interaction between multiple mechanisms at

multiple levels of analysis (i.e., Contractor et al., 2006; Monge & Contractor, 2003). As such, research on teams may need to incorporate methodologies that allow researchers to handle this complexity and advance theoretical mechanisms to explain how team processes, states, and behaviors emerge.

One methodology that allows scholars to investigate the structural signatures that drive team level configural patterns is a class of models known as exponential random graph models (ERGMs). ERGMs enable tests of hypotheses about why certain structural signatures (e.g., reciprocity, transitivity) emerged, and how these structural signatures help to explain patterns at the network level. Several articles from our review utilized ERGMs in this manner (e.g., Kalish & Luria, 2016; Lusher et al., 2014; Zhu et al., 2013). To develop the nomological net of team networks, however, more research needs to be done. For example, communication scholars can use ERGMs to examine the networked patterns of team behavioral processes. That said, ERGMs do have their limitations. For example, they only examine a snapshot of team property emergence, although recent developments in separable temporal exponential random graph models (STERGMs) are overcoming these limitations (e.g., Antone, Gupta et al., 2020; Krivitsky & Handcock, 2014).

Opportunity 2: Evolution over Time

Another finding from our review was that more attention needs to be paid to the dynamic nature of team functioning, such as how processes and states emerge over time. Many of the studies on teams in general as well as those using social network methodologies specifically focus on cross-sectional relationships. However, this limits the ability of scholars to clarify the causal sequence. For example, does the network cause the process/state, or vice versa (Katz et al., 2004)? This may be due in part to the continued use of the temporally agnostic I-P-O framework. Theoretical advancements such as the Input, Moderator, Output, Input (IMOI) model propose that team effectiveness can alternatively be described as a nonlinear sequence with interacting components and environmental influences (Ilgen et al., 2005). Integrating recent theoretical and methodological advancements may help to advance our understanding of the dynamic and complex nature of teams.

To study the temporal sequences that drive the emergence of team configural properties scholars can utilize computational methods such as agent-based models (ABMs), relational event models (REMs), or stochastic actor-oriented models (SAOMs). Briefly, ABMs are a class of computational models that enable scholars to provide simulated individuals (i.e., agents) with a set of theoretically derived rules guiding their actions. Through the use of simulations, scholars can then examine how the behaviors of the individual agents interact to influence collective properties (Harrison et al., 2007; Macy & Willer, 2002). ABMs were leveraged to investigate networks in teams in a small selection of the articles that we reviewed. For example, Contractor and Seibold (1993) developed a computational model to explain the emergence of norms about the use of group decision

support systems within teams. Moreover, Dionne et al. (2010) developed an ABM to evaluate the role of participative leadership in mental model convergence. Several other examples also used ABM to examine phenomena ranging from learning (Fang et al., 2010) and group behavior (Goldstone et al., 2008), to creativity (Zu et al., 2019), emergence of shared leadership in multiteam systems (Sullivan et al., 2015), affective and hindrance ties (Antone, Lungeanu et al., 2020) and TMS (Palazzolo et al., 2006). There are still, however, numerous opportunities for scholars to advance our understanding of all forms of team processes and emergent states through ABM.

Q4

Butts, 2008

REM is similarly conducive to our understanding of team processes (Leenders et al., 2016; Pilny et al., 2016). For example, Schecter et al. (2018) used REM to investigate the relationship between team emergent states and rates of communication. More recently, Pilny et al. (2020) utilized REM to examine the role of process-based communication networks on team coordination. For a more in-depth review of REM to study interaction in group networks, we refer the reader to Schecter (Chapter 23, this volume).

Finally, several studies demonstrated the value of using SAOMs to investigate how team member attributes coevolve with team processes and emergent states and network structures. For example, Carnabuci et al. (2018) used an SAOM to investigate the emergence of leadership in teams, finding that individuals change their leadership attributions toward other team members depending on the alignment of these relationships with their leadership schema. Similarly, Kalish et al. (2015) investigated communication networks in teams where they found that an individual's perceived stress influenced their communication ties, which further impacted their stress levels.

All of these network dynamic methods provide distinct advantages over other static methodologies for studying teams. First, aligning with more processual approaches to understanding organizational phenomena, dynamic network methodologies challenge scholars to make their theoretical assumptions explicit, turning them into either structural signatures or rules that can be tested over time (Van de Ven & Poole, 2005). Second, such models enable scholars to empirically test these theoretically derived, temporally based, microprocesses that underpin team network structures. Given the relative nascency of the study of networks over time, there is ample opportunity for communication scholars to contribute to our understanding of the dynamic nature of team processes by leveraging these methodologies.

Opportunity 3: Robots and Other Technology

Research is increasingly acknowledging the impact of technology on team behavioral processes such as communication (e.g., Dobosh et al., 2019; Hollingshead & Contractor, 2002). However, teams (and their respective networks) are still often assumed to only consist of people (Contractor et al., 2011; Larson & DeChurch, 2020). Yet, the nature of teamwork is changing as people are now teaming with technology to complement human capabilities and

address complex challenges (Jones et al., 2020). Unfortunately, our understanding of human–robot teams is still in its infancy. What we do know from preliminary research is that teaming with technology changes team processes and states. For example, Burke et al. (2004) found that team members engaged in search and rescue efforts with a robot team member struggled to develop situational awareness, and altered their communication structure to obtain information the robot could not provide. More fundamentally, the incorporation of technology into teams highlights that our current theories of group functioning are limited to teams composed of humans. While research on human–robot interaction and its impact on behavioral processes (Breazeal et al., 2005) and psychological emergent states (de Visser et al., 2020; Jung et al., 2015) continues to grow, there is still a clear need for these questions to be examined through the lens of team theory in order to fully understand the implications.

Perhaps most importantly, our current understanding of teams is predicated on the assumption that interactions among team members drive team performance, and ultimately influence collective constructs (i.e., emergence; Kozlowski & Klein, 2000). To adapt current teams theorizing to the changing nature of teamwork, scholars will need to investigate how technology influences these patterns of interaction between team members. For example, communication scholars might clarify how human–robot teaming influences information sharing networks. Doing so will require methodologies that account for the various forms of interactions that can occur, such as human-to-human, human-to-robot, and robot-to-robot. For instance, although robots may influence human-to-human patterns of interaction, humans may also behave differently toward robots, and groups may engage in different behaviors toward robots than they would toward individual humans (Sebo et al., 2020). Integrating social networks with theories of teams and human–robot interaction will be crucial to our understanding of these emerging forms of teamwork. Luckily, theoretical frameworks that integrate our current understanding of human–robot interaction and models of team effectiveness have started to surface (Sebo et al., 2020; You & Robert, 2017). As with teams, it will be important for our understanding of human–robot team functioning to test theoretical models such as these in order to clarify the influence of human/robot team composition on team behavioral, cognitive, and motivational states – and ultimately team-related outcomes and boundary conditions.

Contractor et al. (2011) argue that instead of thinking of robots and technology as tools, scholars should utilize multidimensional networks whereby technologies are represented by nodes within the network alongside team members. Scholars will also have to grapple with the type of ties to use to create their networks. Different forms of tie content are one way human–robot teams can be studied. For example, bipartite (or two-mode) networks, in which ties between two classes of nodes (e.g., robots and humans) are modeled, may help to clarify how humans and robots share information or communicate while working toward an objective. Similarly, multiplex networks modeling more than one type of relationship within a single network may allow scholars to consider the complex interdependencies between different types of relationships. For instance, modeling trust and communication ties may help to explain differences in communication patterns

between human and robot team members. As such, creating networks consisting of multiple forms of ties has the potential to provide valuable insight into the relationships that drive effective human–robot teaming.

Conclusion

There is a rich history of networks in the study of groups. Indeed, networks study relationships, and teams are fundamentally defined by patterns of relationships. Although the use of networks to describe collective structural features of teams has provided important insights, the next frontier of networks in groups will be exploring the temporal and multilevel nature of teams. Research that clarifies the processes that drive the development of these features within traditional and emerging forms of teamwork will have the potential to leave an indelible mark on our understanding of teams.

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant Nos. 1853470, 2027572, and 2052366; The Army Research Laboratory (ARL) W911NF1920140; NASA Grant Nos. 80NSSC18K0511 and NNX15AM32G; and the National Institutes of Health 1R01GM137410-01.

References

Articles from the review are indicated with an asterisk (*).

*Ancona, D. G., & Caldwell, D. F. (1992). Bridging the boundary: External activity and performance in organizational teams. *Administrative Science Quarterly*, *37*(4), 634–665. https://doi.org/10.2307/2393475

Antone, B., Gupta, A., Bell, S., Dechurch, L., & Contractor, N. (2020). Testing influence of network structure on team performance using STERGM-based controls. In *Complex networks and their applications VIII* (pp. 1018–1030). Springer. https://doi.org/10.1007/978-3-030-36683-4_81

*Antone, B., Lungeanu, A., Bell, S. T., DeChurch, L. A., & Contractor, N. (2020). Computational modeling of long-distance space exploration: A guide to predictive and prescriptive approaches to the dynamics of team composition. In L. Landon, S. Kelley, & E. Salas (Eds.), *Psychology and human performance in space programs: Research at the frontier* (pp. 107–130). CRC Press.

*Argote, L., Aven, B. L., & Kush, J. (2018). The effects of communication networks and turnover on transactive memory and group performance. *Organization Science*, *29*(2), 191–206. https://doi.org/10.1287/orsc.2017.1176

*Barth, S., Schraagen, J. M., & Schmettow, M. (2015). Network measures for characterising team adaptation processes. *Ergonomics*, *58*(8), 1287–1302. https://doi.org/10.1080/00140139.2015.1009951

*Bavelas, A. (1950). Communication patterns in task-oriented groups. *The Journal of the Acoustical Society of America*, *22*(6), 725–730. https://doi.org/10.1121/1.1906679

Beal, D. J., Cohen, R. R., Burke, M. J., & Mclendon, C. L. (2003). Cohesion and performance in groups: A meta-analytic clarification of construct relations. *Journal of Applied Psychology*, *88*(6), 989–1004. https://doi.org/10/cs7dmm

Breazeal, C., Kidd, C. D., Thomaz, A. L., Hoffman, G., & Berlin, M. (2005). Effects of nonverbal communication on efficiency and robustness in human-robot teamwork. Presented at the 2005 IEEE/RSJ international conference on intelligent robots and systems. https://doi.org/10/ckm4m7

Burke, J. L., Murphy, R. R., Coovert, M. D., & Riddle, D. L. (2004). Moonlight in Miami: A field study of human-robot interaction in the context of an urban search and rescue disaster response training exercise. *Human-Computer Interaction*, *19*(1–2), 85–116. https://doi.org/10/djgxtv

Butts, C. T. (2008). A relational event framework for social action. *Sociological Methodology*, *38*(1), 155–200. https://doi.org/10/fcrx87

*Carnabuci, G., Emery, C., & Brinberg, D. (2018). Emergent leadership structures in informal groups: A dynamic, cognitively informed network model. *Organization Science*, *29*(1), 118–133. https://doi.org/10.1287/orsc.2017.1171

Carter, D. R., Cullen-Lester, K. L., Jones, J. M., Gerbasi, A., Chrobot-Mason, D., & Nae, E. Y. (2020). Functional leadership in interteam contexts: Understanding 'what' in the context of why? Where? When? And who? *The Leadership Quarterly*, *31*. https://doi.org/10.1016/j.leaqua.2019.101378

*Chung, Y., & Jackson, S. E. (2013). The internal and external networks of knowledge-intensive teams: The role of task routineness. *Journal of Management*, *39*(2), 442–468. https://doi.org/10.1177/014920631039418

Contractor, N. S., DeChurch, L. A., Carson, J., Carter, D. R., & Keegan, B. (2012). The topology of collective leadership. *The Leadership Quarterly*, *23*(6), 994–1011. https://doi.org/10/gf83kr

Contractor, N. S., & Forbush, E. (2017). Networks. In C. R. Scott & L. K. Lewis (Eds.), *The international encyclopedia of organizational communication* (Vol. 22, pp. 1–25). Wiley.

Contractor, N. S., Monge, P. R., & Leonardi, P. M. (2011). Multidimensional networks and the dynamics of sociomateriality: Bringing technology inside the network. *International Journal of Communication*, *5*, 682–720.

*Contractor, N. S., & Seibold, D. R. (1993). Theoretical frameworks for the study of structuring processes in group decision support systems: Adaptive structuration theory and self-organizing systems theory. *Human Communication Research*, *19*, 528–563. https://doi.org/10.1111/j.1468-2958.1993.tb00312.x

Contractor, N., & Su, C. (2012). Understanding groups from a network perspective. In A. Hollingshead & M. S. Poole (Eds.), *Research methods for studying groups and teams: A guide to approaches, tools, and technologies* (pp. 284–310). Taylor & Francis; Routledge.

Cooke, N. J., Gorman, J. C., Myers, C. W., & Duran, J. L. (2013). Interactive team cognition. *Cognitive Science*, *37*(2), 255–285. https://doi.org/10.1111/cogs.12009

Costa, A. C., Fulmer, C. A., & Anderson, N. R. (2018). Trust in work teams: An integrative review, multilevel model, and future directions. *Journal of Organizational Behavior*, *39*(2), 169–184. https://doi.org/10/gdshmw

Crawford, E. R., & LePine, J. A. (2013). A configural theory of team processes: Accounting for the structure of taskwork and teamwork. *Academy of Management Review*, *38*(1), 32–48. https://doi.org/10.5465/amr.2011.0206

Delete

*Cummings, J. N., & Cross, R. (2003). Structural properties of work groups and their consequences for performance. *Social Networks*, *25*(3), 197–210. https://doi.org/10.1016/S0378-8733(02)00049-7

DeChurch, L. A., & Mesmer-Magnus, J. R. (2010). The cognitive underpinnings of effective teamwork: A meta-analysis. *Journal of Applied Psychology*, *95*(1), 32–53. https://doi.org/10.1037/a0017328

de Visser, E. J., Peeters, M. M. M., Jung, M. F., Kohn, S., Shaw, T. H., Pak, R., & Neerincx, M. A. (2020). Towards a theory of longitudinal trust calibration in human–robot teams. *International Journal of Social Robotics*, *12*(2), 459–478. https://doi.org/10.1007/s12369-019-00596-x

*Dionne, S. D., Sayama, H., Hao, C., & Bush, B. J. (2010). The role of leadership in shared mental model convergence and team performance improvement: An agent-based computational model. *The Leadership Quarterly*, *21*(6), 1035–1049. https://doi.org/10.1016/j.leaqua.2010.10.007

Dobosh, M. A., Poole, M. S., & Malik, R. (2019). Small group use of communication technologies: A comparison of modality on group outcomes. *Communication Research Reports*, *36*(4), 298–308. https://doi.org/10/gjgqdw

*Enemark, D., McCubbins, M. D., & Weller, N. (2014). Knowledge and networks: An experimental test of how network knowledge affects coordination. *Social Networks*, *36*, 122–133. https://doi.org/10.1016/j.socnet.2012.10.001

*Fang, C., Lee, J., & Schilling, M. A. (2010). Balancing exploration and exploitation through structural design: The isolation of subgroups and organizational learning. *Organization Science*, *21*(3), 625–642. https://doi.org/10.1287/orsc.1090.0468

*Friedrich, T. L., Griffith, J. A., & Mumford, M. D. (2016). Collective leadership behaviors: Evaluating the leader, team network, and problem situation characteristics that influence their use. *The Leadership Quarterly*, *27*(2), 312–333. https://doi.org/10.1016/j.leaqua.2016.02.004

*Goldstone, R. L., Roberts, M. E., & Gureckis, T. M. (2008). Emergent processes in group behavior. *Current Directions in Psychological Science*, *17*(1), 10–15. https://doi.org/10.1111/j.1467-8721.2008.00539.x

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, *78*, 1360–1380. https://doi.org/10/bxwqdn

*Grippa, F., Bucuvalas, J., Booth, A., Alessandrini, E., Fronzetti Colladon, A., & Wade, L. M. (2018). Measuring information exchange and brokerage capacity of healthcare teams. *Management Decision*, *56*(10), 2239–2251. https://doi.org/10.1108/MD-10-2017-1001

Grosser, T. J., Park, S., Mathieu, J. E., & Roebuck, A. A. (2019). Network thinking in teams research. In D. J. Brass & S. P. Borgatti (Eds.), *Social networks at work* (1st ed., pp. 309–327). Routledge. https://doi.org/10.4324/9780203701942-14

Gully, S. M., Incalcaterra, K. A., Joshi, A., & Beaubien, J. M. (2002). A meta-analysis of team-efficacy, potency, and performance: Interdependence and level of analysis as moderators of observed relationships. *Journal of Applied Psychology*, *87*(5), 819–832. https://doi.org/10.1037/0021-9010.87.5.819

Harrison, J. R., Lin, Z., Carroll, G. R., & Carley, K. M. (2007). Simulation modeling in organizational and management research. *Academy of Management Review*, *32*(4), 1229–1245. https://doi.org/10/dn5hjx

Henttonen, K. (2010). Exploring social networks on the team level: A review of the empirical literature. *Journal of Engineering and Technology Management*, *27*(1–2), 74–109. https://doi.org/10.1016/j.jengtecman.2010.03.005

Hollingshead, A. B., & Contractor, N. S. (2002). New media and organizing at the group level. In L. A. Lievrouw & S. Livingstone (Eds.), *The handbook of new media* (pp 221–235). Sage.

*Hood, A. C., Cruz, K. S., & Bachrach, D. G. (2017). Conflicts with friends: A multiplex view of friendship and conflict and its association with performance in teams. *Journal of Business and Psychology*, *32*(1), 73–86. https://doi.org/10.1007/s10869-016-9436-y

*Huang, S., & Cummings, J. N. (2011). When critical knowledge is most critical: Centralization in knowledge-intensive teams. *Small Group Research*, *42*(6), 669–699. https://doi.org/10.1177/1046496411410073

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annual Review of Psychology*, *56*(1), 517–543. https://doi.org/10/ctmqc7

Jones, J. M., Mohan, G., Trainer, H. M., & Carter, D. R. (2020). The changing nature of teams: Recommendations for managing twenty-first-century teamwork. In B. J. Hoffman, L. A. Wegman, & M. K. Shoss (Eds.), *The Cambridge handbook of the changing nature of work* (pp. 406–424). Cambridge University Press. https://doi.org/10.1017/9781108278034.019

Joshi, A., Pandey, N., & Han, G. (2009). Bracketing team boundary spanning: An examination of task-based, team-level, and contextual antecedents. *Journal of Organizational Behavior*, *30*(6), 731–759. https://doi.org/10.1002/job.567

Jung, M. F., Martelaro, N., & Hinds, P. J. (2015). Using robots to moderate team conflict: The case of repairing violations. In *Proceedings of the tenth annual ACM/IEEE international conference on human-robot interaction* (pp. 229–236). https://doi.org/10/gfkwcf

Delete

Kalish, Y. (2020). Stochastic actor-oriented models for the co-evolution of networks and behavior: An introduction and tutorial. *Organizational Research Methods*, *23*(3), 511–534. https://doi.org/10/ggs5mj

*Kalish, Y., & Luria, G. (2016). Leadership emergence over time in short-lived groups: Integrating expectations states theory with temporal person-perception and self-serving bias. *Journal of Applied Psychology*, *101*(10), 1474–1486. https://doi.org/10.1037/apl0000126

*Kalish, Y., Luria, G., Toker, S., & Westman, M. (2015). Till stress do us part: On the interplay between perceived stress and communication network dynamics. *Journal of Applied Psychology*, *100*(6), 1737–1751. https://doi.org/10.1037/apl0000023

*Kane, G. C., & Borgatti, S. P. (2011). Centrality-is proficiency alignment and workgroup performance. *MIS Quarterly*, *35*(4), 1063. https://doi.org/10.2307/41409973

Katz, N., Lazer, D., Arrow, H., & Contractor, N. (2004). Network theory and small groups. *Small Group Research*, *35*(3), 307–332. https://doi.org/10.1177/1046496404264941

Kozlowski, S. W. J. (2015). Advancing research on team process dynamics: Theoretical, methodological, and measurement considerations. *Organizational Psychology Review*, *5*(4), 270–299. https://doi.org/10.1177/2041386614533586

Kozlowski, S. W. J., & Chao, G. T. (2012). The dynamics of emergence: Cognition and cohesion in work teams. *Managerial and Decision Economics*, *33*(5–6), 335–354. https://doi.org/10/dp28

Kozlowski, S. W. J., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological Science in the Public Interest*, *7*(3), 77–124. https://doi.org/10.1111/j.1529-1006.2006.00030.x

Kozlowski, S. W. J., & Klein, K. J. (2000). A multilevel approach to theory and research in organizations: Contextual, temporal, and emergent processes. In *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions* (pp. 3–90). Jossey-Bass.

pages :101377

Krivitsky, P. N., & Handcock, M. S. (2014). A separable model for dynamic networks. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, *76*(1), 29–46. https://doi.org/10/f5nfzx

Larson, L., & DeChurch, L. A. (2020). Leading teams in the digital age: Four perspectives on technology and what they mean for leading teams. *The Leadership Quarterly*, *31*(1). https://doi.org/10.1016/j.leaqua.2019.101377

Q6

Lazer, D., Pentland, A., Adamic, L., Aral, S., Barabási, A.-L., Brewer, D., Christakis, N., Contractor, N., Fowler, J., Gutmann, M., Jebara, T., King, G., Macy, M., Roy, D., & Van Alstyne, M. (2009). Computational social science. *Science*, *323*(5915), 721–723. https://doi.org/10/c9w2g3

Delete

Lazer, D. M. J., Pentland, A., Watts, D. J., Aral, S., Athey, S., Contractor, N., Freelon, D., Gonzalez-Bailon, S., King, G., Margetts, H., Nelson, A., Salganik, M. J., Strohmaier, M., Vespignani, A., & Wagner, C. (2020). Computational social science: Obstacles and opportunities. *Science*, *369*(6507), 1060–1062. https://doi.org/10/ghg7nj

*Lee, J. Y., Bachrach, D. G., & Lewis, K. (2014). Social network ties, transactive memory, and performance in groups. *Organization Science*, *25*(3), 951–967. https://doi.org/10.1287/orsc.2013.0884

Leenders, R. Th. A. J., Contractor, N. S., & DeChurch, L. A. (2016). Once upon a time: Understanding team processes as relational event networks. *Organizational Psychology Review*, *6*(1), 92–115. https://doi.org/10.1177/2041386615578312

Lewin, K. (1939). Field theory and experiment in social psychology: Concepts and methods. *American Journal of Sociology*, *44*(6), 868–896. https://doi.org/10/cnjcqp

*Li, N., Zhao, H. H., Walter, S. L., Zhang, X., & Yu, J. (2015). Achieving more with less: Extra milers' behavioral influences in teams. *Journal of Applied Psychology*, *100*(4), 1025–1039. https://doi.org/10.1037/apl0000010

*Liu, D., Hernandez, M., & Wang, L. (2014). The role of leadership and trust in creating structural patterns of team procedural justice: A social network investigation. *Personnel Psychology*, *67*(4), 801–845. https://doi.org/10.1111/peps.12062

*Lungeanu, A., Carter, S. R., DeChurch, L. A., & Contractor, N. S. (2018). How team interlock ecosystems shape the assembly of scientific teams: A hypergraph approach. *Communication Methods and Measures*, *12*(2–3), 174–198.

*Lusher, D., Kremer, P., & Robins, G. (2014). Cooperative and competitive structures of trust relations in teams. *Small Group Research*, *45*(1), 3–36. https://doi.org/10.1177/1046496413510362

Macy, M. W., & Willer, R. (2002). From factors to actors: Computational sociology and agent-based modeling. *Annual Review of Sociology*, *28*(1), 143–166. https://doi.org/10.1146/annurev.soc.28.110601.141117

Manata, B. (2019). The structural effects of team density and normative standards on team member performance. *Human Communication Research*, *45*(3), 309–333. https://doi.org/10.1093/hcr/hqz003

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, *26*(3), 356–376. https://doi.org/10/c3c4v3

Mathieu, J. E., Hollenbeck, J. R., van Knippenberg, D., & Ilgen, D. R. (2017). A century of work teams in the Journal of Applied Psychology. *Journal of Applied Psychology*, *102*(3), 452–467. https://doi.org/10.1037/apl0000128

Mathieu, J. E., Marks, M. A., & Zaccaro, S. J. (2001). Multiteam systems. In N. Anderson, D. S. Ones, H. K. Sinangil, & C. Viswesvaran (Eds.), *Handbook of industrial, work, and organizational psychology* (Vol. 2, pp. 289–313). Sage.

McGrath, J. E. (1964). *Social psychology: A brief introduction*. Holt, Rinehart and Winston.

*McLaren, C. D., & Spink, K. S. (2020). Examining the prospective relationship between communication network structure and task cohesion and team performance. *Group Dynamics: Theory, Research, and Practice*, *24*(2), 74–87. https://doi.org/10.1037/gdn0000110

*Mehra, A., Smith, B. R., Dixon, A. L., & Robertson, B. (2006). Distributed leadership in teams: The network of leadership perceptions and team performance. *The Leadership Quarterly*, *17*(3), 232–245. https://doi.org/10.1016/j.leaqua.2006.02.003

Mell, J. N., van Knippenberg, D., & van Ginkel, W. P. (2014). The catalyst effect: The impact of transactive memory system structure on team performance. *Academy of Management Journal*, *57*(4), 1154–1173. https://doi.org/10.5465/amj.2012.0589

Monge, P. R., & Contractor, N. S. (2003). *Theories of communication networks*. Oxford University Press.

Moreno, J. L., & Jennings, H. H. (1938). Statistics of social configurations. *Sociometry*, *1*, 342. https://doi.org/10/c5vj5z

*Nelson, R. E. (1989). The strength of strong ties: Social networks and intergroup conflict in organizations. *Academy of Management Journal*, *32*(2), 377–401. https://doi.org/10/ghw2xc

*Oh, H., Chung, M. H., & Labianca, G. (2004). Group social capital and group effectiveness: The role of informal socializing ties. *Academy of Management Journal*, *47*(6), 860–875. https://doi.org/10/ggb5x4

*Palazzolo, E. T., Serb, D. A., She, Y., Su, C., & Contractor, N. S. (2006). Coevolution of communication and knowledge networks in transactive memory systems: Using computational models for theoretical development. *Communication Theory*, *16*(2), 223–250. https://doi.org/10.1111/j.1468-2885.2006.00269.x

Park, S., Grosser, T. J., Roebuck, A. A., & Mathieu, J. E. (2020a). Understanding work teams from a network perspective: A review and future research directions. *Journal of Management*, *46*(6), 1002–1028. https://doi.org/10.1177/0149206320901573

Park, S., Mathieu, J. E., & Grosser, T. J. (2020b). A network conceptualization of team conflict. *Academy of Management Review*, *45*(2), 352–375. https://doi.org/10.5465/amr.2016.0472

*Pasarakonda, S., Grote, G., Schmutz, J. B., Bogdanovic, J., Guggenheim, M., & Manser, T. (2020). A strategic core role perspective on team coordination: Benefits of centralized leadership for managing task complexity in the operating

Delete

room. *Human Factors*. Advance online publication. https://doi.org/10.1177/0018720820906041

*Paxton, P., & Moody, J. (2003). Structure and sentiment: Explaining emotional attachment to group. *Social Psychology Quarterly*, *66*(1), 34–47. https://doi.org/10.2307/3090139

*Pilny, A., Dobosh, M., Yahja, A., Poole, M. S., Campbell, A., Ruge-Jones, L., & Proulx, J. (2020). Team coordination in uncertain environments: The role of processual communication networks. *Human Communication Research*, *46*(4), 385–411. https://doi.org/10.1093/hcr/hqz020

Pilny, A., Poole, M. S., Reichelmann, A., & Klein, B. (2017). A structurational group decision-making perspective on the commons dilemma: Results from an online public goods game. *Journal of Applied Communication Research*, *45*(4), 413–428. https://doi.org/10.1080/00909882.2017.1355559

Pilny, A., Schecter, A., Poole, M. S., & Contractor, N. (2016). An illustration of the relational event model to analyze group interaction processes. *Group Dynamics: Theory, Research, and Practice*, *20*(3), 181–195. https://doi.org/10.1037/gdn0000042

Poole, M. S., & Contractor, N. S. (2011). Conceptualizing the multiteam system as an ecosystem of networked groups. In S. J. Zaccaro, M. A. Marks, & L. A. DeChurch (Eds.), *Multiteam systems: An organizational form for dynamic and complex environments* (pp. 193–224). Routledge Academic.

Sebo, S., Stoll, B., Scassellati, B., & Jung, M. F. (2020). Robots in groups and teams: A literature review. *Proceedings of the ACM on Human-Computer Interaction*, *4*(CSCW2), 1–36. https://doi.org/10.1145/3415247

*Schecter, A., Pilny, A., Leung, A., Poole, M. S., & Contractor, N. (2018). Step by step: Capturing the dynamics of work team process through relational event sequences. *Journal of Organizational Behavior*, *39*(9), 1163–1181. https://doi.org/10.1002/job.2247

*Schulte, M., Cohen, N. A., & Klein, K. J. (2012). The coevolution of network ties and perceptions of team psychological safety. *Organization Science*, *23*(2), 564–581. https://doi.org/10.1287/orsc.1100.0582

*Sullivan, S. D., Lungeanu, A., Dechurch, L. A., & Contractor, N. S. (2015). Space, time, and the development of shared leadership networks in multiteam systems. *Network Science*, *3*(1), 124–155. https://doi.org/10.1017/nws.2015.7

*Susskind, A. M., & Odom-Reed, P. R. (2019). Team member's centrality, cohesion, conflict, and performance in multi-university geographically distributed project teams. *Communication Research*, *46*(2), 151–178. https://doi.org/10.1177/0093650215626972

Van de Ven, A. H., & Poole, M. S. (2005). Alternative approaches for studying organizational change. *Organization Studies*, *26*(9), 1377–1404. https://doi.org/10.1177/0170840605056907

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge University Press. https://doi.org/10.1017/CBO9780511815478

*Wise, S. (2014). Can a team have too much cohesion? The dark side to network density. *European Management Journal*, *32*(5), 703–711. https://doi.org/10.1016/j.emj.2013.12.005

Wölfer, R., Faber, N. S., & Hewstone, M. (2015). Social network analysis in the science of groups: Cross-sectional and longitudinal applications for studying intra- and

intergroup behavior. *Group Dynamics: Theory, Research, and Practice*, *19*(1), 45–61. https://doi.org/10.1037/gdn0000021

Yan, B., Hollingshead, A. B., Alexander, K. S., Cruz, I., & Shaikh, S. J. (2021). Communication in transactive memory systems: A review and multidimensional network perspective. *Small Group Research*, *52*(1), 3–32. https://doi.org/10.1177/1046496420967764

You, S., & Robert, L. (2017). Teaming up with robots: An IMOI (Inputs-Mediators-Outputs-Inputs) framework of human-robot teamwork. *International Journal of Religious Education*, *2*, 1–7. https://doi.org/10.35840/2631-5106/4103

Yuan, Y. C., Carboni, I., & Ehrlich, K. (2014). The impact of interpersonal affective relationships and awareness on expertise seeking: A multilevel network investigation. *European Journal of Work and Organizational Psychology*, *23*(4), 554–569. https://doi.org/10.1080/1359432X.2013.766393

Yuan, C., Fulk, J., Monge, P., & Contractor, N. (2010). Expertise directory development, shared task interdependence, and strength of communication network ties as multilevel predictors of expertise exchange in transactive memory work groups. *Communication Research*, *37*(1), 20–47. https://doi.org/10.1177/009365020351469

*Zhang, Z., & Peterson, S. J. (2011). Advice networks in teams: The role of transformational leadership and members' core self-evaluations. *Journal of Applied Psychology*, *96*(5), 1004–1017. https://doi.org/10.1037/a0023254

*Zhu, M., Huang, Y., & Contractor, N. S. (2013). Motivations for self-assembling into project teams. *Social Networks*, *35*(2), 251–264. https://doi.org/10.1016/j.socnet.2013.03.001

*Zu, C., Zeng, H., & Zhou, X. (2019). Computational simulation of team creativity: The benefit of member flow. *Frontiers in Psychology*, *10*, 188. https://doi.org/10.3389/fpsyg.2019.0018

Author Query Form

Queries and/or remarks

[Q1]	Please confirm which reference the citation “Park et al., 2020” refers to, as there are two different references (Park et al., 2020a, 2020b) provided in the reference list.
[Q2]	The citations “Grippa et al., 2017; Leenders et al., 2015; Jones et al., 2019; de Visser et al., 2019” has been changed to match the date in the reference list. Please check.
[Q3]	The citations “Brenneke & Rank, 2016; Contractor et al., 2006” are cited in the text but not provided in the reference list. Please provide the references in the reference list or delete these citations from the text.
[Q4]	The citations “Goldstone, 2008; Costa, 2018; Joshi, 2009” have been changed to match the author name in the reference list. Please check.
[Q5]	The References “Butts, 2008; Cummings & Cross, 2003; Kalish, 2020; Lazer et al., 2009, 2020; Paxton and Moody, 2003” are not cited in text; please indicate where a citations should appear or delete it from the reference list.
[Q6]	Please provide page range for the reference “Larson & DeChurch, 2020”.