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The Emergence of Team Creativity: A Social Network Perspective

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Abstract and Keywords

Viewing teams as evolving networks of intertwined social relations, the social network perspective has been increasingly adopted to understand the emergence of team creativity in the past decades. This network lens enables creativity scholars to accurately depict how creative inputs embedded in team structures combine to take effects in collective processes and eventually form team creative outcomes in a dynamic fashion. Yet applications of this network view in team creativity research are scarce, and not closely linked to the development of social network theories. Therefore, after introducing the core concepts and principles of social network theories, this chapter reviews the status quo of team creativity research in terms of three components—creative inputs, team structure, and creative processes from a social network perspective. Furthermore, this chapter puts forward three key directions for future studies on the emergence of team creativity—specialization, integration, and dynamics.

Keywords: team creativity, social networks, input, process, structure, dynamics

Introduction

In the realm of creativity, the myth of the lone genius that has prevailed for centuries has now been debunked. Indeed, even such iconic figures as Sigmund Freud and Albert Einstein did not work alone. Freud wrote “The Interpretation of Dreams” after heated discussions with the physician Wilhelm Fliess; Einstein developed the theory of relativity in an ongoing dialogue with the engineer Michele Besso. Creative breakthroughs are typically the result of teamwork, especially in business, where project teams are more and more employed for creative tasks (Wuchty, Jones, & Uzzi, 2007). Consequently, both scholars and practitioners have become increasingly interested in team creativity and its precedents (e.g., Perry-Smith & Shalley, 2014; van Knippenberg, 2017; Zhou & Hoever, 2014), as team creativity represents a vital means for organizations to thrive in a business environment featuring fierce competition, rapid production, and continuous growth.

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Team creativity, which occurs when a group of people working on the same task produce novel and useful products, services, and solutions (Amabile, 1983, 1988), is social in nature (Perry-Smith & Shalley, 2014; Woodman, Sawyer, & Griffin, 1993). This is not just because teams obviously are social entities but also because creativity itself is a social construct emerging from social processes that synergize creative inputs into team outcomes (Perry-Smith & Shalley, 2014; Woodman et al., 1993). Creative inputs may originate from social factors within and beyond team boundaries, such as diverse career backgrounds and skills of team members (Homan, Buengeler, Eckhoff, van Ginkel, & Voelpel, 2015), and unique ideas from external connections across the organizational hierarchy and business units (Perry-Smith & Shalley, 2014; Tzabbar & Vestal, 2015). Consequently, social processes determine how teams channel the expression, reception, and compilation of creative inputs; select and develop suitable ideas into collective solutions; (p. 134) and champion team solutions in accordance with contextual requirements and supports. For instance, motivational processes like psychological safety and risk-taking culture stimulate the expression of novel and radical ideas (Nijstad, Berger-Selman, & De Dreu, 2014; Shin & Eom, 2014), whereas cognitive processes such as knowledge sharing and information elaboration facilitate the integration of diverse ideas into team creative outcomes (Hoever, van Knippenberg, van Ginkel, & Barkema, 2012; Hu & Randel, 2014). The social view of team creativity thus focuses on how team members express ideas in and obtain ideas from interpersonal interactions, and how such ideas get refined and synergized into novel solutions in social processes.

Exactly because team creativity is a social phenomenon that emerges from intertwined social relations embedded in social structures, creativity researchers have increasingly adopted the social network perspective to study team creativity. Social network theories answer the long-standing question across social science of how agentic individuals interact to form enduring and functioning entities (Borgatti, Mehra, Brass, & Labianca, 2009). This allows researchers to zoom in on the emergence of social phenomena such as team creativity, by picturing the dynamic social processes through which various individual inputs embedded in network structures draw collective attentions and combine to form social outputs. Specifically, researchers can employ network tools to (1) identify heterogeneous relational resources that individuals obtain from their network connections within and beyond team boundaries, such as information and political resources from internal and/or external connections (Oh, Labianca, & Chung, 2006; Perry-Smith & Shalley, 2014; Soda & Bizzi, 2012); (2) take into account the impact of network structures on both emergence processes and outcomes of team creativity, such as the impact of network structures on the propagation of information in creative problem-solving processes of teams (Mason, Jones, & Goldstone, 2008) and the effects of network structural patterns, such as centralization and density, on team creative outcomes (Bhattacharyya & Ohlsson, 2010; Durmuşoğlu, 2013; Jia, Shaw, Tsui, & Park, 2014); and (3) reveal the emergence process in which individual inputs continuously enter in dyadic, subgroup-level, and team-level processes to ultimately yield team creative outcomes (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2016; Leenders, Contractor, & DeChurch, 2016). These are all important yet elusive questions in the team creativity literature.

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That being said, research on team creativity has not yet fully tapped into the potential of the social network perspective. First, although network theories and methods allow us to accurately map intertwined social connections from the individual level to the subgroup level and the team level, team creativity scholars employing the network perspective often did not sufficiently specify individual differences in creative contributions. Yet current studies largely concentrate on the network resources of the entire team (Fliaster & Schloderer, 2010; Smith, Collins, & Clark, 2005; Tang & Ye, 2015). Network resources of significant individuals such as team leaders (Kratzer, Leenders, & van Engelen, 2008) and the most capable individuals (Li, Zhao, Walter, Zhang, & Yu, 2015), despite their possible disproportionate impacts on team creativity, have received little research attention. Likewise, explorations of the structural impacts on team creativity from a network perspective can certainly move beyond the unitary structural patterns at the team level to investigate more nuanced structural patterns of subgroups as well as network positions of significant individuals (e.g., network brokers; Leenders, van Engelen, & Kratzer, 2007; Soda & Bizzi, 2012; Zaheer & Soda, 2009).

Second, the social network view so far has rarely been applied in empirical studies on team creative processes, and only discussed in a few conceptual works (Kozlowski et al., 2016; Leenders et al., 2016). Shazi, Gillespie, and Steen (2015) took a network approach to examine when team members are more likely to generate and implement ideas with their colleagues in the forms of idea generation ties and idea realization ties. Yet questions of how such processes evolve and produce collective outcomes remain to be explored. Methodologically, particularly useful, though as of yet vastly underused in creativity research, are the various network analytic tools, such as subgrouping methods to detect various structural patterns (Borgatti, Everett, & Johnson, 2013) and evolution models that captures dynamic processes of relational patterns (e.g., exponential random graph modeling, stochastic actor-oriented modeling; Broekel, Balland, Burger, & van Oort, 2014). It is, therefore, vital to review the status quo of team creativity research from a network perspective and discuss how the network perspective may deepen our understanding of team creativity even further.

This chapter is organized into two sections. The first section presents a brief introduction to social network theories. It answers two main questions: (p. 135) what composes a network? What are the core principles of social network research? The second section first provides a network definition of team creativity, and then discusses how team creativity emerges from three major components—inputs, structures, and processes, in line with the traditional Input-Process-Output model of team functioning (Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Mathieu, Tannenbaum, Donsbach, & Alliger, 2014). Noticeably, although not explicitly presented in the Input-Process-Output model of team functioning, team structure and its impact will be discussed as an important component here from the network perspective. This is because team structures, defined as the repeated and regularized configurations of social relations among individual members (Kozlowski & Ilgen, 2006; Stewart & Barrick, 2000), derive from the ongoing social processes and are deployed by team members to guide their interaction patterns in team processes. In other words, team structures impact the configuration of team inputs, the occurrence of team

processes, and eventually team creative outcomes. It is totally fitting to the social network understanding of team creativity. Therefore, the social network reading of team creativity in this chapter consists of three major components: creative inputs, structural impacts, and creative processes. For each component, I will review the existing studies, summarize the network applications in this area, and discuss research directions for future studies.

Social Network Theories and Perspectives

The last two decades have seen a tremendous surge in research on social networks. To link the social network perspective with team creativity research, I will start with introducing important concepts and assumptions in social network theories.

Definition of Social Networks

What is a network? In essence, it is a set of nodes that are linked by ties (Wasserman & Faust, 1994). Nodes, ties, and networks come in many varieties. Depending on the conceptual focus, network nodes may refer to actors (e.g., individuals, teams, and organizations), job tasks (e.g., problem threads, ideas, and knowledge), or social events (e.g., coauthorship). This implies that social networks can be identified at any levels of analysis, from micro units such as ideas and individuals to macro units such as societies and cultures. Moreover, a network may capture social relations either within a single type of nodes, like a friendship network among individual nodes, or between two types of nodes in one network, such as an affiliation network of “inventor” nodes affiliating to various “project” nodes (i.e., a bipartite or two-mode network; Borgatti et al., 2013). Network ties, in turn, may refer to any type of dyadic phenomena (Borgatti et al., 2009), from proximity ties (e.g., who is spatially or electronically close to whom), communication ties (e.g., who gives/seeks information to/from whom), to cognitive ties (e.g., who knows whose expertise, who trusts/relies on whom), affective ties (e.g., who shares positive/negative emotions with whom), membership ties (e.g., who shares common identities or values with whom), and so on.

Networks, finally, differ in whether nodes are linked by one particular type of tie or by multiple ties in the same network (Granovetter, 1973). A classic example of networks with multiplex ties is the socializing network outside of work among employees (i.e., an overlap between work communication and social communications; Ibarra, 1995). Also, depending on the nature of network ties in question, network ties may vary in both the direction of ties (i.e., directed vs. undirected ties) and the tie strength (i.e., strong vs. weak ties; Granovetter, 1973). A directed network distinguishes the outgoing ties from the incoming ties when dyadic interactions are not reciprocal (e.g., sending vs. receiving advice; Agneessens & Wittek, 2012). In contrast, an undirected network applies to networks of shared or reciprocal connections (e.g., comembership ties). The strength of network ties can be operationalized either as a continuous score (e.g., connection frequency or in-

tensity) or dichotomized into different types (e.g., strong vs. weak ties, positive vs. negative ties).

Core Principles of Network Theories

With the basic components of a network clarified, it is now clear that most social phenomena can be conceptualized as networks of interacting nodes that affect each other through intertwined social ties. Numerous network views of social phenomena were developed for different research interests, such as neighborhood mechanisms (Entwisle, Rindfuss, & Faust, 2007), social capital (R. Lee, 2009), online communities (Centola, 2010), small groups (Katz, Lazer, Arrow, & Contractor, 2004), innovation diffusion (Valente, 1996), individual creativity and innovation (Perry-Smith & Mannucci, 2015), organizational studies (Kilduff & Brass, 2010), leadership (Contractor, DeChurch, Carson, Carter, & Keegan, 2012), and justice (Roberson & Colquitt, 2005). Despite diverse conceptual foci, these (p. 136) theories and frameworks share three fundamental assumptions of social networks—*relational*, *structural*, and *cognitive* assumptions.

The *relational* assumption refers to the fundamental belief that a network is about social relations that connect and divide network nodes (e.g., Katz et al., 2004). Network research assumes that social relations are evenly or unevenly distributed among team nodes (i.e., linking some, but not all, actors). This relational focus has led to the conceptualization of numerous relational patterns to explain the development of both network structures and social processes. It also guides network researchers to attend to the relational properties—namely the characteristics of social relations (e.g., the nature, direction, and strength of relations) and the attributes of relational partners (e.g., personalities, abilities, and motivations) in order to understand existing relational patterns and predict future alternations. Social relations and their properties together compose the core of social network research (Kilduff & Brass, 2010).

The *structural* assumption connotes both the embeddedness of social relations and the structural patterns of regularized relations. First, social network theories assume that all social relations do not exist in the vacuum, but are embedded in structures that impact the network actions of forging, renewing, and terminating social ties (Granovetter, 1985; Uzzi, 1997). This notion of *embeddedness* is a cross-level concept in the sense that, any network relation/action is embedded in a local network, which is in turn embedded in a larger network of local networks. The idea of embeddedness also implies the behavioral inertia of network connections, such that the existing relational patterns tend to repeat themselves and are difficult to change (e.g., Burt, 2005; Uzzi, 1997). For instance, a high degree of network embeddedness reduces behavioral uncertainty and the transactional cost of social interactions, and leads to strong connections and repetitive relationship (Granovetter, 1985; Uzzi, 1997).

The second component of this *structural* assumption in social network theories is the notion of *structural patterns*—relational structures that describe the regular presence and

absence of network ties among nodes. Based on the level of analysis, various structural patterns can be clustered into three subsets:

- 1.** Most common structural patterns are defined at the (team) network level, including centralization (the tendency of all network connections concentrating on one or a few nodes), density (the extent to which network nodes are all connected), core-peripheral structure (the extent to which a network is composed of a core in which actors are densely connected and a periphery in which actors are sparse and loosely connected; Borgatti & Everett, 2000), fragmentation (the tendency of an unitary network breaking into smaller subgroups; Borgatti et al., 2013), and small-world structure (a network in which clusters composed of fully linked actors are interconnected by a few ties; Watts, 1999).
- 2.** At a lower level, networks can be divided into subgroup clusters of three or more nodes. A subgroup cluster consists of a set of nodes that are closely connected with each other, but loosely connected with out-cluster nodes. At this level, a set of cluster concepts have been developed to capture such subgrouping patterns. The strictest definition of a subgroup is a clique, in which all nodes have to be mutually connected in a subgroup (Borgatti et al., 2013). Considering subgroups in reality do not always meet this requirement, network researchers later included other cluster concepts to describe cohesive yet not mutually connected subgroups such as *n*-cliques, *n*-clubs, and *n*-clans (Wasserman & Faust, 1994, pp. 258–262). For the purpose of brevity, the nuance among these “clique-like” concepts will not be elaborated here (see Table 9.1 for the definitions and illustrations). Given that connections inside subgroups are usually invariably dense, research interests are often more on the distribution of subgroups, such as the number of subgroups or the interconnections between subgroups (e.g., Soda & Bizzi, 2012; Zaheer & Soda, 2009). A particularly interesting position at the subgroup level is structural hole, which refers to the network position that exclusively bridges two or more densely connected subgroups (Burt, 1992, 2004). Noticeably, the subgroup structures can also be applied at the internetwork level to understand the dynamics between different networks by treating networks as subgroups.
- 3.** At the lowest level, network connections concern about dyads and the dyadic ties between a pair of nodes. The most often studied dyadic patterns are reciprocity (a pair of nodes that tend to reciprocate each other’s ties), structural equivalence (two nodes that are connected to the same others in networks), and Simmelian dyads (a dyad embedded in a three-person clique and therefore has a shared connection to a third node, Krackhardt, 1999; Krackhardt & Kilduff, 2002). Table 9.1 lists the definitions and illustrations of these common structural patterns across levels.

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Table 9.1. Common Structural Patterns in Social Networks

Structural Patterns	Definition	Illustration
Centralization (network)	It measures the tendency of all network connections centralizing on one or a few nodes.
Density (network)	It measures the extent to which all network nodes are all connected.
Core-periphery structure (network)	It measures the extent to which a network has a core of densely connected nodes and a periphery of sparse and loosely connected nodes.
Fragmentations (network)	It measures the tendency of breaking into smaller subgroups.
Small-world network (network)	It measures the extent to which clusters of dense connected nodes are interconnected by a few bridging ties in a network (Fleming et al., 2007; Uzzi & Spiro, 2005).
Cliques (subgroup)	It measures the cluster in which all nodes are mutually connected.	<p>Cliques: {1,2,3}, {1,3,4}, and {3, 4,5,6}</p>

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Clique-like clusters (subgroup)	<ul style="list-style-type: none"> • n-clique refers to the subset in which the largest length of the shortest path between any two nodes is no greater than n; • n-clan refers to the subset in which the shortest path between any two nodes in the subset is no greater than n for paths <i>within</i> the subset; • n-club refers to the subset in which the distance between all nodes <i>within</i> the subset is no greater than n	<p>2-cliques: {1,2,3,5,6} and {2,3,4,5,6} 2-clan: {2,3,4,5,6} 2-clubs: {1,2,3,6}, {1,2,5,6}, and {2,3,4,5,6}</p>
Structural hole (sub-group)	It refers to the network position that connects two otherwise disconnected clusters of densely connected nodes.	<p>● : the structural hole</p>
Reciprocity (dyadic)	It refers to a pair of nodes that tend to reciprocate each other's ties.
Structural equivalent (dyadic)	It refers to a pair of two nodes that are connected to the same others in networks.	<p>● : structural equivalent nodes</p>
Simmelian dyads (dyadic)	It refers to a dyad embedded in three-person cliques and therefore has a shared connection to a third node	<p>● : Simmelian dyad</p>

(p. 137) (p. 138) (p. 139) Moreover, the *structural* assumption of both embeddedness and structural patterns points to the significance of multilevel network studies (Brass, Galaskiewicz, Greve, & Tsai, 2004; Contractor, Wasserman, & Faust, 2006; Kilduff & Brass, 2010). Although scholars may focus on one analytical level (i.e., internetwork, network, subgroup, dyadic, and individual) for theoretical reasons, all structural patterns are embedded in a macro network environment and therefore are multilevel. The existence of Simmelian dyads is a perfect example: connections between two nodes can be explained by the reciprocity principle at the dyadic level (i.e., the social exchange theories), yet from a multilevel view this can also be interpreted as the consequence of both nodes con-

necting to a common third node (i.e., balance theory). This structural assumption therefore could lead scholars to analyze team networks from a multilevel perspective. For instance, Contractor et al. (2006) suggested, in their multitheoretical multilevel framework of organizational network analysis, that scholars ought to include not only the relational properties of the focal network units (defined as endogenous variables) but also the characteristics outside the focal network units (defined as exogenous variables) when interpreting and predicting organizational networks. Such multilevel network models are also supported by the advance of network methods (Su, Huang, & Contractor, 2010; Wang, Robins, Pattison, & Lazega, 2013).

The third assumption of networks as *cognitive* refers to the cognitive processes of network nodes making sense of network connections and acting on their perceptions (Nahapiet & Ghoshal, 1998). Social networks are agentic. Crucially, the dynamics of network patterns are driven by agentic actors who interpret network dynamics and consequentially develop and maneuver network flows according to their own motives and preferences (Borgatti & Cross, 2003; Wegner, 1995). As pointed out in prior literature, even members in the same network do not necessarily share the same understandings of network configurations, such as asymmetric perceptions of dyadic conflicts in networks (Jehn, Rupert, & Nauta, 2006) and different understandings of who knows what in team networks (i.e., transactive memory systems; J.-Y. Lee, Bachrach, & Lewis, 2014; Lewis & Herndon, 2011; Ren & Argote, 2011). This *cognitive* assumption plays an important role in capturing team members' perceptions of network configurations and in predicting individuals' network actions correspondingly. For example, central members may have a more accurate picture of the network resources than peripheral members and therefore are more likely to make strategic decisions. It is also implemented in ego network research, which concerns individuals' personal understandings of all his/her network connections and the connections among them and explains individuals' network actions from this cognitive view.

Team Creativity: A Social Network Perspective

To understand the emergence of team creativity from a network view, the first and foremost challenge is to define relevant networks from which team creativity emerges. Following the understanding of team creativity as collective endeavors of a group of people to generate novel and useful products, services, ideas, and solutions (Perry-Smith & Shalley, 2003, 2014), the most intuitive network reading is to view team creativity as products of team networks in which individual members synergize diverse resources into team creative solutions. Such team networks involve network nodes of individual members and network ties that denote various types of interpersonal flows, from cognitive flows (e.g., knowledge, advice, and cultural experiences), to relational flows (e.g., preference, friendship, and shared identity), and emotion flows (e.g., emotion and energy). Creativity researchers have been progressively defining creativity-relevant networks in empirical tests (e.g., Kratzer, Leenders, & van Engelen, 2005; Leenders, van Engelen, & Kratzer, 2003; Salazar, Lant, Fiore, & Salas, 2012; Smith, Collins, & Clark, 2005).

Alternatively, team creativity can also be understood as the product of idea networks, in which existing ideas are selected and combined to form a team creative solution (Hargadon & Bechky, 2006; Hargadon & Sutton, 1997). In this line, team creativity refers to the most unconventional and functional combinations of ideas that emerge from idea networks of interconnected ideas. Network nodes are ideas (or knowledge units) instead of team members, and network ties refer to the knowledge similarity/dissimilarity between any two ideas rather than social relations. The research question of team creativity then becomes how work teams recognize connections between ideas, bridge disconnected ideas, and establish and adopt the most creative combinations of ideas. For example, Haas and Ham (2015) examined how peripheral knowledge can be combined and integrated into core knowledge in knowledge networks. Although it directly addresses the (p. 140) construal connections between knowledge elements and knowledge outputs, this network definition of team creativity as idea networks is less favored because it takes little notice of complex social interactions among team members in forming team creative solutions. For the same reason, this chapter employs the former network reading of team creativity to discuss the emergence of team creativity from various social networks of team members in three aspects: creative inputs, structural impacts, and creative processes.

Creative Inputs: A Social Network Perspective

History of Creative Inputs Research

Creative inputs, in a broad sense, refer to factors (e.g., physical, cognitive, emotional, motivational, social, etc.) that enter in team processes for creative successes. In the early stage of team creativity research, empirical endeavors were driven to identify possible facilitators and impeters of team creativity, and thus tested the direct effects of various team inputs, such as individual creativity (Triandis, Bass, Ewen, & Mikesell, 1963), team diversity (Bantel & Jackson, 1989), and team leadership (Andrews & Farris, 1967). So far, the pool of creative inputs has been greatly expanded and specified to five major categories: (1) individual differences, (2) task characteristics, (3) team leadership, (4) team climate, and (5) macro environment.

Individual differences stand as the most traditional type of creative inputs. Its history can be traced back to Amabile's componential theory that proposed three main dispositional predictors of individual creativity—creative abilities, task-related skills, and motivations (Amabile, 1983, 1988). The logic of individual difference as creative inputs asserts that team creativity relies on creative ideas and collective capabilities to recognize and process them. Both the original ideas and processing capabilities derive from individual members' knowledge repositories, cognitive abilities, and psychological states such as epistemic motivation and positive mood (e.g., individual creative abilities: Taggar, 2002; demographic factors: Shin & Zhou, 2007; motivational states: van Kleef, Anastasopoulou, & Nijstad, 2010; affects: Tsai, Chi, Grandey, & Fung, 2012).

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Next to individual differences, the other four categories of creative inputs have arisen from the surging interests in the contextual impacts on team creativity as a social product (e.g., Ancona & Caldwell, 1992). From task requirements to managerial support and environmental constraints, these four categories together capture the contextual inputs that explain whether and when team environment stimulates the expression and configuration of creative individual resources in team processes and outcomes. First, task characteristics define the boundaries of team creativity through task requirements, resources, and structural settings (e.g., task structure: Rietzschel, Nijstad, & Stroebe, 2006; task interdependence: Zhang, Hempel, Han, & Tjosvold, 2007; membership change: Choi & Thompson, 2005; job demands: Sacramento, Fay, & West, 2013). Second, team leadership inputs identify whether and when leadership styles and behaviors encourage and clear up hindrance to the creative expressions of team members (e.g., transformational leadership: Chen, Farh, Campbell-Bush, Wu, & Wu, 2013; empowering leadership: Burpitt & Bigoness, 1997; servant leadership: Yoshida, Sendjaya, Hirst, & Cooper, 2014; leader's emotions: Madrid, Totterdell, Niven, & Barros, 2015; leader-member exchange: Gajendran & Joshi, 2012). Third, team climate inputs focus on creative climate, team norms, and creativity-oriented culture that set up behavioral patterns and expectations within teams for individual members to work creatively (e.g., creative climate: Bain, Mann, & Pirola-Merlo, 2001; collectivistic culture: Goncalo & Staw, 2006; political correctness norm: Goncalo, Chatman, Duguid, & Kennedy, 2015). Last but not the least, macro environment investigates the cross-level impacts of organizations, industries, and societies in which team functions are embedded in (e.g., organizational support: West & Anderson, 1996; technology usage: Giambatista & Bhappu, 2010; environmental uncertainty: Sung & Choi, 2012; HR practices: Chi, Huang, & Lin, 2009).

In the past decades, investigation on creative inputs has progressively become more specific and more integrative. The trend of specialization is manifested as twofold: while early literature examined the creative inputs through general team phenomena such as team leadership and team creative climate (Andrews & Farris, 1967; West & Anderson, 1996), research now has developed a clearer focus on creativity-specific sources, such as psychological safety climate and risk-taking norms that encourage the expression and pursuit of unconventional thoughts (e.g., Nijstad, Berger-Selman, & De Dreu, 2014; Tjosvold & Yu, 2007). As a consequence, our understandings of the functions of creative inputs are also getting more fine-grained. For instance, individual creative abilities (Pirola-Merlo & Mann, 2004; (p. 141) Taggar, 2002) were found to promote team creativity via generating novel ideas, whereas other inputs such as collaborative communications (Lovelace, Shapiro, & Weingart, 2001) and creative constraints (Rosso, 2014) were argued to contribute by channeling the expression of creative ideas in team processes.

Such a trend of specialization is also reflected in the growing recognition of individual differences in team creative inputs. Challenging the traditional assumption that all team members equally participate in and contribute to generating team creativity (Drazin, Glynn, & Kazanjian, 1999), scholars are increasingly aware of the individual difference that some members may devote and contribute more than the others. This notion of heterogeneous individual inputs has been proposed in team research for long yet left under-

attended until recent years (Aime, Humphrey, DeRue, & Paul, 2014; Kozlowski & Bell, 2003; Kozlowski & Klein, 2000). In exploring heterogeneous individual inputs, a few studies examined different models of compiling individual inputs into team creativity, such as the disjunctive and conjunctive models that underscore the impacts of the most capable member and the least capable member, respectively (Schilpzand, Herold, & Shalley, 2011; Taggar, 2001), and the dispersion model that looks at the variance across individual inputs (Hoever et al., 2012; Shin & Zhou, 2007).

Besides specializing distinctive creative inputs, researchers have more and more adopted an integrative view to examine the interplay between various creative inputs (Anderson, Potočnik, & Zhou, 2014; Zhou & Hoever, 2014). Creative inputs, ranging from individual creative resources to contextual factors, relate to different aspects of team creativity and may interact with each other. For instance, van Knippenberg (2017) proposed how motivational resources such as creative norms moderate the influence of cognitive resources like creative abilities on team creativity. Integrating opposing impacts of different creative inputs on team creativity is also an intriguing direction, such as the joint effect of centrifugal and centripetal inputs (Sheremata, 2000), and ambidextrous leadership impact such as opening and closing leadership behaviors (Zacher & Rosing, 2015).

Network Perspective in Creative Inputs Research

The relational aspect of social networks has greatly expanded the pool of creative inputs by including network resources in terms of quantity and quality. The quantity of network resources refers to network connections that supplement teams' diverse and unique perspectives to generate novel ideas, both within team boundaries (Aalbers, Dolfma, & Leenders, 2016; Fliaster & Schloderer, 2010; Smith et al., 2005), and beyond team boundaries (Soda & Bizzi, 2012; Tang & Ye, 2015). It aligns with the diversity logic that team creativity benefits from the combination of diverse job inputs (Hülshager, Anderson, & Salgado, 2009; van Dijk, van Engen, & van Knippenberg, 2012). The quality of network resources, on the other hand, explains team creativity with different social capital embedded in network connections. One obvious way is to distinguish the effects of strong ties from that of weak ties: strong ties encourage team members to exchange and process information in repetitious and trustworthy interactions, whereas weak ties are often found advantageous to distribute unique and unusual information. For example, empirical tests have evidenced positive relationships between team creativity and both teams' strong ties in knowledge networks (Smith et al., 2005) and the proportion of weak ties that team members possess (Perry-Smith & Shalley, 2014).

The structural aspect of social networks also advances research on creative inputs via identifying the structural positions of creative inputs. Social network theories clearly asserted that not all network positions are connected to the others and, therefore, not all network resources can be directly mobilized. In this way, creative inputs, particularly significant inputs, ought to be properly positioned for team members to retrieve and process. Despite various well-connected positions in social network theories, creativity scholars so far have mainly been concerned with the central positions in networks—positions that provide most comprehensive understandings of workflows in team networks

(Brandon & Hollingshead, 2004) and the widest influence over other members via direct interactions (Borgatti & Everett, 2006). At the organizational level, scholars also found out that center positions of work teams in organizational networks bring in knowledge advantages and increase team creativity (Durmuşoğlu, 2013). Moreover, few studies examined the impact of central positions for particular individual members to drive team creativity. For example, the central position of the team leader in a team network enhances his/her leadership impact on team innovation (Kratzer et al., 2008). Likewise, the central position of the most helping/voicing (p. 142) member in the workflow networks facilitates his/her impact on team creativity via improving team monitoring (Li et al., 2015).

Future Directions of Creative Inputs Research from a Network Perspective

Variety of Network Resources

Although team creativity researchers have broadened the scope of creative inputs with the quantity and quality of network resources, it is worthwhile to note that network resources as creative inputs are not limited to what has been found. First, an embedded view of team networks would bring in more network resources that have not yet been associated to team creativity. For instance, Aalbers et al. (2016) scrutinized creative inputs of external network connections from not only external team units (i.e., cross-team ties) but also senior management (i.e., cross-hierarchical ties) in project teams, and evidenced their impacts on team creativity. This extends the notion of external network resources both horizontally (other network units at the same level) and vertically (higher or lower organizational hierarchical levels). This embedded view is also consistent with the increasing call for multilevel explorations in creativity research (Anderson et al., 2014).

Structural resources such as team structural patterns and network positions of team members are still much underdeveloped. As reviewed in the social network section, many network positions and structural patterns hold strategic impacts on team operations, such as structural holes, core-periphery structures, and small-world networks. Nevertheless, creativity scholars have rarely examined such network resources. At the individual level, the network position of structural hole was found advantageous for individuals to express creativity and to receive more positive evaluations (Burt, 2004, 2005). Cattani and Ferriani (2008) also suggested that individuals holding an intermediate position between the core and the periphery of their networks are more likely to achieve creative performance. The small-world network structure has been associated with regional creativity and innovation at the macro levels such as industries and regions (e.g., Fleming, King, & Juda, 2007; Uzzi & Spiro, 2005), but not yet at the team level. It is certainly a promising direction to move beyond the focus on central network positions to examine a broader set of strategic positions and structural patterns.

Moreover, future studies can investigate network resources that help mobilize certain creative inputs, as team creativity is not only about accessing diverse resources for novel inputs (van Dijk et al., 2012) but also about mobilizing such novel inputs in team communications (e.g., Elsbach & Kramer, 2003). For example, instead of networking ties connecting only two members, network paths reflecting the sequence of social actions in the

forms of multiple-step ties really capture the dissemination flow of novel inputs. Future research may look at the amount and strength of two-step ties (e.g., from node A to node B to node C) that link members with external resources and those with internal supports, and examine the impact of such network resources balancing the external advantage of novel ideas and internal benefit of deep processing on team creativity.

Configuration of Network Resources

Team network resources consist of varying network assets across individual members. Given individual differences in expertise, cultural backgrounds, and network connections when accomplishing team creative tasks, it is not surprising that team members may have different types and amounts of network resources within the same network. This naturally invites future studies to investigate the configuration of network resources loaded on team members. In a pioneering attempt along this direction, Perry-Smith and Shalley (2014) examined the composition of individual network resources in student teams, and found out that team creativity increases along the proportion of members with culturally diverse ties in teams, and also along the proportion of members with weak external ties. To further reveal the complexity of this question, scholars may examine: does team creativity gain from centralized or decentralized distributions of individual network resources, and when? When and how do star members with most network resources contribute to team creativity? The composition models can also be applied to understand how various network resources combine to advance team creativity: the *additive* model that examines the sum or average of individual inputs (Tsai et al., 2012), and the *disjunctive* model that underlines the highest level of individual inputs (Triandis et al., 1963), and perhaps also the *dispersion* model that looks at the diversity of individual resources (Homan et al., 2015).

Integrative Views of Network Resources

As emphasized in social network theories, to what extent network resources facilitate the generation of team creativity is subject to both other network resources (i.e., relational or structural attributes) (p. 143) and the characteristics of the resource holders (i.e., intrapersonal or team attributes). Needless to say, research on team creative inputs will gain from combining network resources with creative resources at the team's disposal, or integrating different forms of network resources.

The structural patterns/positions of creative resources come as an obvious step for future research. What are the suitable network positions/patterns for the creative resources within teams, possessed by either the entire team or particular individuals, to shape team creativity? Empirical attempts with such integrative views are scant. One recent study presented an integrative framework in which the most creative member has a stronger impact on team creativity when located in a less elaborate subgroup of the advice network (Yuan & van Knippenberg, 2017). Such integrative framework can be extended to understand the impacts of many other creative resources. For instance, the motivated information processing in groups model (MIP-G; De Dreu, Nijstad, & van Knippenberg, 2008; Nijstad & De Dreu, 2012) emphasizes the balance between epistemic motivation

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that drives in-depth information retrieval for novel inputs and prosocial motivation that motivates information sharing among members in stimulating team creativity (De Dreu, Nijstad, Bechtoldt, & Baas, 2011). From an integrative view, researchers may examine the fit between team members' motivation and their network positions, such that whether team creativity benefits more from prosocial members instead of pro-self members positioned in network centers, because prosocial members are more inclined to share information for achieving team successes.

Moreover, scholars may take a dynamic view to observe the interplay between creative resources and network positions, by examining how team creativity varies along creative resources shifting across network positions. For instance, does team creativity benefit from the most resourceful member shifting from peripheral subgroups to core subgroups (or the other way around), or moving up or down in the network hierarchy, and how?

The integration between different forms of network resources, such as network positions and other network attributes, addresses the question on the use of network resources and therefore invites more empirical attentions. Network theories have pointed out that network resources are more likely to be considered and adopted when coming from a reliable source. Tortoriello and Krackhardt (2010) showed that external network connections increase individual innovation only when such connections refer to strong ties or are embedded in a subgroup (i.e., Simmelian ties). This raises research questions that combine network resources with other attributes such as credibility (i.e., how trustworthy such network resources are), sustainability (i.e., whether the supply of such network resources remains), implementation (i.e., how easy it is to apply such network resources), and so on.

Structural Impacts: A Network Perspective

History of Structural Impacts Research

Team structure is defined as regularized relational patterns among team members (Drach-Zahavy & Somech, 2001; Kozlowski & Ilgen, 2006). As put by Kozlowski and Ilgen (2006), "process begets structure, which in turn guides process." Team structure reflects the stable norms or patterns that iterate in team interactions and provide references for team members to communicate and collaborate with each other in order to accomplish team tasks. The role of team structure, in essence, is to guide team creative processes by signaling team members to act on creative resources—access, exchange, and integrate creative inputs. Therefore, the key questions in understanding the structural impacts on team creativity are (1) what the relevant structural patterns are and (2) when and how team structures optimize the use of creative inputs for collective outputs.

What team structure as relational patterns refers to in the context of team creativity has long been elusive. Direct examinations of structural patterns were scarce in prior studies due to the methodological constraints—detecting structural patterns of intertwined social relations in a precise manner was difficult. To indirectly capture team structures, scholars observed how team tasks require members to act and collaborate in the forms of com-

munication frequency (Drach-Zahavy & Somech, 2001), task interdependence (Zhang et al., 2007), and the functional versus fractional structure (Iseke, Kocks, Schneider, & Schulze-Bentrop, 2015). In the laboratory setting, team structure relating to team creative tasks is often manipulated as the organization of task activities in two different structure patterns: the nominal structure that set individual idea generation (i.e., no interaction at all) apart from collective idea synergy (i.e., full interactions), and the interactive structure that permits various interactions among team members all the time (Baruah & Paulus, 2008; Girotra, Terwiesch, & Ulrich, 2010; (p. 144) Kavadias & Sommer, 2009; Paulus & Yang, 2000). In the past decade, scholars have increasingly attended to more refined structural patterns, such as segregated communication patterns of subgrouping within teams. Subgrouping patterns can be either manipulated in the forms of fault lines in laboratories (e.g., Pearsall, Ellis, & Evans, 2008) or calculated in the forms of subgroup strength with diversity-based algorithms (Meyer & Glenz, 2013; Xie, Wang, & Qi, 2015). In a different approach, another line of team structure research examines the cognitive structure of work teams by looking at how team members perceive each other's expertise and the collective knowledge pools, such as transactive memory system (Peltokorpi & Hasu, 2015; Zhang et al., 2007) and structures of shared goals and values (Hu & Randel, 2014).

The other question of when and how structural patterns impact on team creative outcomes, surprisingly, has only entered into empirical view in the past decade. For instance, Kavadias and Sommer (2009) demonstrated in simulation experiments that the impacts of two brainstorming structures (i.e., nominal vs. interactive) on team creativity depend on team characteristics (i.e., functional diversity) and job features (i.e., job complexity). In a field study, Jia and colleagues (2014) evidenced the moderating role of task complexity on the positive impact of dense communication patterns on team creativity. A few studies also looked into the mechanisms of team structural patterns. For instance, Pearsall and colleagues (2008) found that gender fault lines impede team creativity via creating emotional conflicts, and shared goals and values were found to shape team creativity by promoting knowledge sharing among team members (Hu & Randel, 2014). Moreover, Zhang and colleagues' (2007) study linked two types of structural patterns by showing how task interdependence promotes team creativity via improving the transactive memory system within teams.

Past decades' studies have largely revolved around the accurate picture of team structures (e.g., subgrouping), and the relational functions of team structures. Obviously, both directions can be advanced by the social network perspective, which allows a "high-resolution" picture of the structural patterns and their impacts on team interactions. As our understanding of the structural impacts on team creativity deepens, integrative views that combine the structural impacts with creative dispositions and social processes will obviously be the next step. Next, I will review how the network perspective has been applied to disentangle the structural impacts and can contribute further in future.

Network Perspective in Structural Impacts Research

The application of social network perspective is less prosperous in structural impacts research than in the domain of team creative inputs. Conceptually speaking, the network perspective enables us to not only accurately diagnose structural patterns of team networks but also, more importantly, examine the holistic picture of how structural patterns determine the configuration and integration of creative inputs in dynamic processes. Yet so far, the network view has been mainly adopted to identify various structural patterns of work teams. Except for Durmuşoğlu's (2013) study examining the position of work teams embedded in organizational networks, most empirical studies focused on the structural patterns of team networks. Specifically, two types of network structures have been widely discussed—centralized structure (network centralization), which refers to highly centralized communication on one or a few members, and dense structure (network density/cohesiveness), which captures the closeness of social connections among all team members. Empirical tests on centralized structure tend to agree on its detrimental effect on team creativity, because it prohibits noncentral members from challenging central authority and common knowledge and therefore hinders the diffusion and use of novel ideas (Leenders et al., 2003, 2007; Tang & Ye, 2015). This seems to favor the notion of dense structure that advocates widely interconnected members in teams. Yet empirical findings have shown inconsistent effects of network density on team creativity. Some studies argued that a moderate level of network density (cohesiveness) was optimal for team creativity in either communication and knowledge networks (Bhattacharyya & Ohlsson, 2010), or friendship networks (Kratzer et al., 2005), whereas Jia and colleagues (2014) found that network density only benefits team creativity when the team task is highly complex.

Besides these two structural patterns that shape members' accesses to creative resources, network structures that emphasize the efficiency of network connections within networks are also noteworthy (Hargadon & Sutton, 1997). Optional network structure allows sufficient accesses to creative resources, yet bears no redundant relational patterns. Such a notion is captured by network efficiency—the trade-off between network benefits (p. 145) and networks costs of time and cognitive resources (Fliaster & Schloderer, 2010; Hansen, Podolny, & Pfeffer, 2001). Conceptually, network efficiency was suggested to increase team creativity, for excessive network activities spare team members little cognitive resources and time for complex creative endeavors (Sternberg, 1988, p. 142). Nevertheless, this research question has not received much attention. Fliaster and Schloderer's (2010) study on two-person student teams tested and supported this positive link. Friedrich, Griffith, and Mumford (2016) also pointed out the positive effect of network efficiency on general team performance of student teams, yet did not report any result on team creative performance.

On the other hand, research interests in subgrouping patterns are particularly aligned with the network approach. As reviewed earlier, social network theories have developed a number of tools to analyze the fragmentation of team networks into smaller units of subgroups, cliques, and clusters (Borgatti et al., 2013),¹ which can disentangle subgrouping patterns such as the number of subgroups, the membership of each subgroup (including

overlapped memberships), strengths of subgroups, and connections between subgroups within work teams. Yet creativity scholars have not much identified subgroup structures with network tools. Leenders and colleagues (2007) found that team creativity is negatively related to the number of cliques (i.e., members of no more than 3-step paths in between). But their operationalization of subgroup did not reflect the natural formation of subgroups with different sizes. Indirectly, a few studies investigated the strategic individual position at the subgroup level—structural holes that stand between two otherwise disconnected subgroups (see Table 9.1 for its definition and illustration). The findings, however, are mixed, with Zaheer and Soda (2009) supporting the positive link between team creativity and the number of structural holes in team, and Leenders and colleagues (2007) as well as Soda and Bizzi (2012) rejecting it. Such inconsistent findings certainly underscore the complexity of subgroup patterns and their impacts on team creativity.

Future Directions of Structural Impacts Research from a Network Perspective

Subgrouping Patterns

As reviewed previously, our understanding of the impacts of subgrouping of subgrouping patterns is very little. Despite the growing recognition of the significance of subgroup dynamics in team research (Carton & Cummings, 2012, 2013; van Knippenberg & Mell, 2016), team creativity scholars have only looked into the number of subgroups (Leenders et al., 2007), leaving subgroup dynamics nearly untouched. Particularly, team creativity in essence is one type of positive deviance (Potočnik & Anderson, 2016). It is not surprising that some individuals, as well as some subgroups, may carry disproportionate impacts on team creative outcomes. For instance, team researchers suggested that the core subgroup has a strategic role in assessing the problem and mobilizing resources to develop team solutions in general (Humphrey, Morgeson, & Mannor, 2009). Does team creativity benefit from having one clear-cut core subgroup (i.e., core-peripheral structure)? Although direct tests on this question are lacking, a recent empirical study suggested that status asymmetry among team members—the degree to which innovative productivity centers on a few key members—impairs team creativity and hinders the conversion of diverse inputs into team creative performance (Tzabbar & Vestal, 2015). This seems to oppose the concentration of creative resources in one core subgroup. Alternatively, does it suggest the advantage of a more balanced structure, such as having several subgroups interconnected (i.e., small-world network)? These questions call for scholars to disentangle the complexity of structural patterns and their roles in shaping team creativity.

Cognitive Network Structures

Cognitive networks (e.g., who knows what, transactive memory system; who agrees/disagrees with whom in terms of team functioning, shared mental models) and their structural patterns represent another direction of future research. Cognitive structures were pitched as important for the emergence of new knowledge, because it determines with whom team members exchange, process, and generate information. Take the transactive memory system as an instance: team members often have different understandings of who knows what (i.e., metaknowledge). Particularly, such metaknowledge is likely to be

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concentrated within a few members such as team leaders and experts (Mell, van Knippenberg, & van Ginkel, 2014). We may infer that the impact of cognitive structures can be extended to team creativity as well. Nevertheless, little is known about how transitive memory systems shape team creativity or innovation (Argote & Guo, 2016).

(p. 146) Other than cognitive structures at the team level, how team members make sense of existing network structures and then act on their network perceptions represents another intriguing line of research on cognitive network structures (e.g., Krackhardt, 1990; Simpson, Markovsky, & Steketee, 2011). Subjective perception of network structures indicates the focal individual's understandings of the accessibility of network resources and the feasibility of making new connections (Kilduff, Tsai, & Hanke, 2006). In response to their perceptions of network structures, team members actively change their positions within the network (Abrahamsen, Henneberg, & Naudé, 2012). In team creativity research, Yuan and Zhou (2015) proposed a conceptual model in which different perceptions of team status structures impede team creativity through constraining divergent and convergent processes. Yet, no empirical study has tested relevant hypotheses. Scholars can further disentangle the question of how cognitive structures drive individual members to establish or dissolve connections in order to achieve creative success.

Link Network Structures to Creative Processes

After identifying structural patterns in creativity-relevant networks, an inevitable follow-up will be to associate structural impacts with creative processes, because structural patterns by definition exist to channel creative resources and guide creative processes. This area of research is nearly blank. Scholars assumed that different network structural patterns facilitate/impede the cognitive processes such as knowledge sharing, learning, and information elaboration (e.g., Kratzer, Leenders, & van Engelen, 2010; Salazar et al., 2012; Tang & Ye, 2015), and motivate/demotivate team members to process unconventional inputs by introducing emotional conflicts and impairing psychological safety or autonomy (Kratzer et al., 2005). It is therefore worthwhile to test these assumptions and see how structural impacts are translated into behavioral patterns in creative processes.

Team Creative Processes: A Social Network Perspective

History of Creative Processes Research

Creative process refers to the recurring actions or emergent states that translate creative inputs and structural impacts into team creative outcomes (Taggar, 2002; West, 2002). In the past two decades, creativity scholars have gradually specified creativity-relevant processes from general team processes (Taggar, 2002; West et al., 2003). Among all creativity-relevant processes, cognitive processes so far have received most attention due to the dominant view of teams as information processors in team research (Hinsz, Tindale, & Vollrath, 1997; van Knippenberg, 2017). From the cognitive view, creativity-relevant processes serve to enable the distribution, sharing, and synergy of creative inputs at disposal to generate team creative outcomes. Empirical studies have identified various cognitive processes relating to team creativity including team collaboration (Baer, Leenders,

Oldham, & Vadera, 2010), team learning (Kostopoulos & Bozionelos, 2011), information sharing (Madrid et al., 2015), information exchange (De Dreu, 2006), information elaboration (Hoever et al., 2012; Rietzschel, Nijstad, & Stroebe, 2007), knowledge integration (Gebert, Boerner, & Kearney, 2010), member influence on decision-making (Gajendran & Joshi, 2012), task reflexivity (Shin, 2014; Somech, 2006), and task conflicts (Miron-Spektor, Erez, & Naveh, 2011). In recent years, some studies began to explore dual processes that drive team creativity simultaneously, such as divergent process and convergent processes (Harvey, 2013; F. Yuan & Zhou, 2015).

Besides cognitive processes, motivational and affective processes also influence team creativity (van Knippenberg, 2017). Prior literature has pointed out that motivational and affective processes can encourage team members to express their novel inputs. For instance, team composition of sequential thinking styles (i.e., the individual propensity to follow logical and sequential routines in problem solving) creates a psychologically safe environment among team members (Post, 2012); inspiring leadership evokes a trusting environment for team members to speak up and therefore enhances team creative performance (Boies, Fiset, & Gill, 2015); teams composed of diverse nationalities and with diversity beliefs tend to develop high efficacy to achieve creative success under diversity training (Homan et al., 2015); positive affect stimulates promotion focus among team members (Shin, 2014); and professional diversity raises the awareness of professional identity (i.e., professional identity salience) that helps teams leverage the unique inputs of different professions (Mitchell & Boyle, 2015). Also, some motivational states impact team creativity by increasing/reducing the risk to express deviant ideas. For example, culturally diverse teams tend to experience more identity threats that prevent (p. 147) team members from contributing creatively (Leung & Wang, 2015); gender diverse teams generate more creative outcomes when having clear norms of political correctness, due to reduced action uncertainty among team members (Goncalo et al., 2015); or functionally diverse teams or teams with gender fault lines are inclined to develop relational or emotional conflicts that prohibit team members to share novel ideas (Hüttermann & Boerner, 2011; Pearsall et al., 2008).

As cognitive processes and motivational/affective processes represent different logics to generate team creativity, the interplay between both has become a popular topic. A few recent studies argued that motivational processes affect team creativity by activating cognitive processes. For example, Kessel, Kratzer, and Schultz (2012) suggested that team psychological safety enhances team creativity via stimulating information sharing of know-how knowledge within teams. Carmeli, Dutton, and Hardin (2015) also showed that respectful engagement processes facilitate relational information processes, which then increase team creativity. In this logic, team creativity essentially relies on the cognitive processing of team members, which is subject to contextual influences including motivational and affective processes/states. Linking to the person-context interaction patterns for individual creativity (van Knippenberg & Hirst, 2015), it is important to examine how these processes trigger, substitute, or inhabit each other in achieving team creativity.

The Emergence of Team Creativity: A Social Network Perspective

Moreover, a new line of studies on creative processes has risen to reveal the dynamics of microprocesses (Leenders et al., 2016). Creative processes are never static. Instead, they are composed of many microprocesses or activities that iterate or shift over time. For instance, it seems logical to assume that teams first engage in idea generation and then focus on idea integration activities when developing creative outputs. In empirical examinations, Kohn, Paulus, and Choi (2011) found that the idea integration process is more advantageous to team creativity when it occurred in the later stage instead of earlier, because teams are more likely to accumulate a large resource pool after repeated interactions and therefore more effectively gain from idea integration processes. This notion therefore has triggered some recent research to shed light on dynamic microprocesses in the team creative process—the duration of different microprocesses or activities as well as the shifts from one to another.

In such attempts, scholars often break down the team creative process into different sub-processes/activities. For instance, Goh, Goodman, and Weingart (2013) decomposed two major team creative processes (i.e., experimentation and validation) into activity cycles of distinct repeating patterns in a qualitative study: (1) both creative processes consist of iterative activity cycles (i.e., sequences of planning, enacting, and reviewing activities); and (2) each creative process is distinct in its function (experimentation vs. validation) and the durations of creative activities. Focusing on the duration of creative activities, Goh et al. (2013) suggested that team innovation is negatively related to the duration of the experimentation process but positively related to that of the validation process, and benefits more from reviewing activities during the experimentation process than during the validation process. In a similar but more complicated manner, Harvey and Kou (2013) loosened the assumption of fixed activity cycles in creative processes, and pointed out that the activity cycles in team creative processes are composed of iterative activities in different sequences and of different durations. Depending on the opening activity in the activity cycles, Harvey and Kou (2013) distinguished generation-centered cycles that first carry out idea generation activities from evaluation-centered cycles that first implement idea evaluation activities, and found that teams received higher creative performance ratings when implementing more evaluation-centered cycles than generation-centered sequences cycles in the team creative process. These findings have clearly pointed out a new road to identify dynamic configurations of microprocesses or activities in order to understand team creative processes.

Network Perspective in Creative Processes Research

In comparison to its applications in creative inputs research and structural impact research, the network perspective has been least deployed to reveal the complexity of creative processes, although one may define creative processes by the distribution of processing ties among team members. For instance, the distribution of external network ties possessed by team members demonstrates how team members actively engage in information processing to accomplish team creative tasks (Han, Han, & Brass, 2014). In a more complex and dynamic manner, team creative processes may manifest in the formation/alternation of relational ties. Particularly, some state-of-the-art network tools allow us

to observe the formation and evolution of interaction flows, perfectly matching with the surging interests in dynamic (p. 148) team processes and microprocesses (Leenders et al., 2016). This dynamic network view has been used to analyze the formation of knowledge ties in the research stream of knowledge management (Su et al., 2010). In the team creativity domain, however, it remains underdeveloped. The only known study is conducted by Shazi and colleagues (2015) on two Australian firms, in which they operationalized team creativity processes into idea generation and idea realization networks, and explained the formation of both idea generation ties and idea realization ties with employees' perception of the alters' characteristics (i.e., ability, benevolence, integrity).

Future Directions of Creative Processes Research from a Network Perspective

Divided Subprocesses

The growing recognition of divided team operations exists not only in the diagnosis of subgroup structures but also in that of subgroup processes, which remains elusive in current empirical tests (van Knippenberg & Mell, 2016). For example, when mapping knowledge management processes in team networks, Su and colleagues (2010) found that both information retrieval and information allocation processes involve mainly a small set of members rather than the entire team. Team creativity scholars, however, have not taken this into account. To identify subgroup processes, scholars first need to map out the subgroup structures and then analyze the collective processes within the subgroup of question. A recent study by Yuan and van Knippenberg (2017) demonstrated this approach by operationalizing the information elaboration process of the subgroup around the most creative individual within a team. This allows future studies to precisely examine the processes of selected subgroups, such as the most influential subgroups (core subgroup), star subgroups (around star performers), brokerage subgroups (with most external connections) and so on. It also inspires future studies to consider the role of between-subgroup processes: if creative activities are scattered across different subgroups, how do different subgroup processes connect to each other and aggregate to the team level?

Dynamic Microprocesses

Network evolution models can be applied to better understand dynamic creative processes, in the forms of emerging and evolving microprocesses across creative stages and time. Evolution models explain the tendency of forming or dissolving network connections that capture creative activities between any two team members with two categories of factors: endogenous factors of network structural patterns (e.g., popularity, reciprocity, and transitivity) and exogenous factors of both relational characteristics (e.g., similarities/dissimilarities and social relations) and individual attributes (e.g., creative skills). The advantage of analyzing dynamic creative processes from a network perspective is clear: on the one hand, such microprocess dynamics are realized by the smallest unit of social relations—dyads; on the other hand, scholars can separate the influence of interpersonal patterns from the endogenous impact of “structural inertia” that social structures tend to affirm existing relational patterns. Scholars can apply such evolution models to analyze

the development of various processes from information elaboration networks to more creativity-specific processes such as idea generation and idea realization networks in Shazi and colleagues' (2015) study. It may be particularly helpful to detect the emergence of creativity-specific processes, such as idea sharing networks (who shares novel ideas with whom), idea inspiration networks (who inspires whom to generate new ideas), idea refinement networks (who builds on whose ideas), idea championing networks (who champions whose ideas), and idea evaluation networks (who endorses whose novelty). Methodologically, the common analytical tools to model the evolution of team processes include exponential random graph models (ERGMs) and stochastic actor oriented models (SAOMs; Lusher, Koskinen, & Robins, 2013; Snijders, Steglich, & Schweinberger, 2007).²

Interplay Between Different Creative Processes

Besides the aforementioned directions, it is equally important to understand the interactions between different creative processes. Intuitively, the definition of creativity as the combination of novelty and usefulness inherently implies tensions between different creative processes, such as internal communications versus external connections (Ancona & Caldwell, 1992), exploratory versus exploitative learning (Kostopoulos & Bozionelos, 2011), and divergent versus convergent processes (Harvey & Kou, 2013). Understanding the interplay between different processes, particularly these seemingly incompatible processes, is thus of great importance to team creativity research. For example, in order to (p. 149) model the interplay between two creative processes, one analytic option is to treat one process (e.g., idea generation network) as the focal network and treat the other process (e.g., idea elaboration network) as the characteristics (e.g., capabilities or propensity to refine and elaborate existing ideas) of network nodes or as relational attributes of network ties (e.g., frequency or strength of idea elaboration between any two members) in an evolution model. Alternatively, scholars can examine both processes simultaneously in a coevolution model (e.g., whether generating novel ideas co-occurs with refining existing ideas between two members). The later approach also enables us to understand the mutual influences of different creative processes.

Conclusion

More than 30 years' exploration has provided many insights into team creativity in terms of individual inputs, structural impacts, and creative processes (Anderson et al., 2014; van Knippenberg, 2017; Zhou & Hoever, 2014). The social network perspective has been increasingly employed to understand these three aspects of team creativity, mostly in creative inputs research and least in creative processes research. As reviewed in this chapter, the trajectories of our understandings about these three aspects display some common trends:

1. *Specialization.* All these three aspects of team creativity research are moving toward the same high-resolution view, which refers to a clear picture of "who contributes what to which, where and when." Creativity-specific factors (e.g., team creative climate) are distinguished from general performance factors (e.g., general team

climate). Individual differences are receiving more recognition than ever, in terms of contribution (e.g., different aspects of creative contributions), participation (e.g., divided processes and therefore disproportionate roles), and influence (e.g., core vs. peripheral positions).

2. Integration. Integration is also a common trend, as team creativity is a joint product of many factors. The traditional view of considering predictor factors in isolation is being more and more challenged (van Knippenberg, 2017). Specifying creativity-relevant factors also helps us understand the interdependence between them. For instance, specific creative inputs must be properly placed in order to express their functions, indicating the interplay between creative inputs and structural impacts; the impacts of structural patterns depend on the nature of collective processes embedded in given structures.

3. Dynamics. The dynamic view is another trend in team creativity research (Cronin, Weingart, & Todorova, 2011). Although there are few empirical studies on this topic, time as a dimension in understanding the development of team creativity has long attracted great interest (Cronin, 2015; Mueller & Cronin, 2015; Perry-Smith & Shalley, 2003). The dynamic view can be integrated in studying any of these aspects, such as the emergence of creative states/relationships (Shazi et al., 2015), the flexibility of network structural patterns (shift between dense networks and centralized networks), or in the joint effects of different predictors like the variation of creative resources in structural patterns (e.g., the upward vs. downward moves of resourceful team members in team network structures).

Noticeably, such trends may not be unique to the phenomenon of team creativity. In fact, it is more a common theme across all domains of team research (Leenders et al., 2016). Team creativity represents one of the complex cognitive tasks in teams. The generation of team creativity reflects the emergence of a collective system—lower-level inputs are embedded in the system and interact to form higher-level patterns (e.g., subgroups, teams) and dynamics, which essentially lead to the formation of team creative outcomes. Theories of its development, to a large extent, can be extended to other team phenomena such as knowledge management, decision-making, and general team performance. Moreover, the development of team creativity research from the network perspective, admittedly, is much driven by the advance of methodological tools that make it possible to draw accurate and dynamic pictures of how microinteractions are embedded in larger networks and iterate along time to form new patterns. Such methodology can absolutely be applied to team research in general. For team research in general, the introduction of the social network view directs future studies to further develop along the directions of specialization, integration, and dynamics.

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Notes:

(1.) To avoid confusion, I use “subgroup” as a general term to refer to all subteam units. Nuance among these subgrouping terms were elaborated in the previous section of social network theories.

(2.) Relational event modeling (REM; Butts, 2008; Leenders, Contractor, & DeChurch, 2016) also allows the modeling of dynamic processes. As REM works on a sequence of social events instead of complete networks, I will not discuss it here because of the focus of network modeling.

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