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TIES, LEADERS, AND TIME IN TEAMS: STRONG INFERENCE ABOUT NETWORK STRUCTURE'S EFFECTS ON TEAM VIABILITY AND PERFORMANCE

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How do members' and leaders' social network structures help or hinder team effectiveness? A meta-analysis of 37 studies of teams in natural contexts suggests that teams with densely configured interpersonal ties attain their goals better and are more committed to staying together; that is, team task performance and viability are both higher. Further, teams with leaders who are central in the teams' intragroup networks and teams that are central in their intergroup network tend to perform better. Time sequencing, member familiarity, and tie content moderate structure-performance connections. Results suggest stronger incorporation of social network concepts into theories about team effectiveness.

Teams have become the basic unit through which work is carried out in organizations (Gerard, 1995). The prevalence of team structures in contemporary organizations has been paralleled by a vigorous stream of theory and applied research (Ilgen, 1999). In hundreds of studies, researchers have attempted to understand the factors contributing to team effectiveness (Kozlowski & Bell, 2003; Sanna & Parks, 1997). To take stock of these studies, researchers have conducted various meta-analyses of the antecedents of team effectiveness. Those meta-analyses affirm definitive answers about effects of some of these factors, such as collective efficacy (Gully, Incalcaterra, Joshi, & Beaubien, 2002), group cohesion (Beal, Cohen, Burke, & McLendon, 2003; Gully, Devine, & Whitney, 1995; Mullen & Copper, 1994), team-level goals (O'Leary-Kelly, Martocchio, & Frink, 1994), and interpersonal conflict (De Dreu & Weingart, 2003).

Despite this impressive and growing body of findings about determinants of team outcomes, scholars' understanding of a potentially critical set of determinants is limited. In particular, *social network structures,* or the patterns of informal connections (ties) among individuals, can have important implications for teams because they have the potential to facilitate and constrain the flow of resources between and within teams (Brass, 1984). Despite a recent resurgence of interest (e.g., Baldwin, Bedell, & Johnson, 1997; Reagans & Zuckerman, 2001), there is no consensus surrounding *what is known* about social network effects in work groups or teams—perhaps because most such studies were conducted before current researchers and their mentors were trained (Fiedler, 1954) or because of "academic amnesia" (Hunt & Dodge, 2000). Indeed, unresolved empirical questions and theoretical debates persist about whether or not some social network features yield improved task completion or longer survival in teams. For example, some investigators have found that the density of a team's network of informal social ties is associated with team performance (Reagans & Zuckerman, 2001), whereas others have not (Sparrowe, Liden, Wayne, & Kraimer, 2001). Similarly, some have proposed that a leader who is central in a team network of friendship ties has a burden of maintaining too many close relationships (Boyd & Taylor, 1998) that distracts from task productivity. A long-standing but opposing proposition says that central leaders tend to have more productive teams (Levi, Torrance, & Pletts, 1954).

Therefore, the purpose of our study was to contribute to theory by resolving these debates and uncertainties regarding the effects of social tie patterns on team outcomes. We do so by meta-analytically accumulating findings from a mixture of recent studies and lesser-known investigations from the 1950s and 1960s. Our overarching question was this: How do network structures of leaders and

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members help or hinder team effectiveness? More specifically, how important are leaders' ties with team members for facilitating team task completion (team performance)? Further, does the structure of social ties among members themselves have implications for viability and performance? Also, is a team's position in an intergroup network associated with team performance?

As social network approaches to team research gain in popularity (Borgatti & Foster, 2003), it is important to understand *when* the pattern of social ties is most influential. Therefore, in addition to the questions about main effects posed above, we asked questions about moderators that reflect temporal concerns. Does the accumulated evidence support the idea that network structures influence (predict) team performance, or vice versa? Does increasing time spent with teammates change the necessity or potency of network effects on team outcomes?

To answer these questions about social network structures' implications for team outcomes, we first outlined the relevant theoretical arguments from the social networks literature. Drawing on these key arguments and concepts, we then developed hypotheses that established specific links between social network features and team-level criteria. Further, in developing theory further, we proposed moderating roles of time for the network structure–task performance connection.

KEY NETWORK CONCEPTS: TIE STRUCTURE AND TIE CONTENT

There is no single or all-encompassing social network theory (Kilduff & Tsai, 2003). However, two central concepts in the study of interpersonal relationships are the structure and content (substance) of the dyadic *tie,* or connection, between social parties. For the study of informal networks within teams, those ties are internal, and the social parties are the members of a team and its leader. For between-team networks, those ties are external and the parties (typically) are the teams themselves (Ancona & Caldwell, 1992). A basic assumption here is that *ties serve as conduits for the flow of interpersonal resources*.

The *structure* of a social network is the pattern of connections among parties; the parties are generically referred to as *nodes* (Nadel, 1957). This pattern or social arrangement has important implications for each node and for the entire network. The extent to which nodes are connected to one another will determine the volume of resources that can move throughout the network. For example, in a clique or a network of friends where everyone is connected to everyone else, all members tend to share the same information, trust each other, and have similar attitudes (Krackhardt, 1999). In contrast, a collection of isolates (individuals who have few or no ties with each other) tends to have difficulty exchanging resources, because there are no established patterns of ties to convey these resources. The interconnectedness of nodes in a network—the ratio of existing ties between team members relative to the maximum possible number of such ties—is called the *density* of the network's structure. For example, if team A and team B both had six members, there would be 15 possible friendship ties within each team. If team A had 10 pairs of friendship ties, and team B had 4 pairs, Team A's social network would be regarded as more dense than team B's. Density is perhaps the most common way to index network structure as a whole; it reflects the level of interrelatedness, or reticulation, among all possible social ties (Scott, 2000).

Network density is conceptually different from another key team-level construct, group cohesion. Indeed, others have defined constructs such as group cohesion to "describe cognitive, motivational and affective states of teams as opposed to the nature of their member interaction" (Marks, Mathieu, & Zaccaro, 2001: 357). Network structure, unlike group cohesion, captures the *pattern* of interaction and might be thought of as an intervening or team process variable (cf. Cohen & Bailey, 1997). An emphasis on the pattern of connections makes social network analysis unique in the study of social phenomena (Mayhew, 1980).

An alternate way of looking at social structure is to shift focus away from the overall network and toward the nodes that constitute it. The position of a node in a social network influences resources and potential benefits for the party who occupies it. A node in a structurally advantageous position in the informal social network tends to receive benefits of information and control (Burt, 1992). A critical construct indicating where a node is positioned relative to others in a network is that node's *centrality* (Scott, 2000). For example, an individual who is directly tied to numerous individuals within a team is said to be central in a social network. By virtue either of having highly sought expertise or of being a close friend to many others, a central individual has greater access to, and a larger amount of, information or social support from the social network (Adler & Kwon, 2002). If that central individual is also a team's formal leader, the centrality may facilitate task performance mechanisms for the team as a whole. On the other hand, large numbers of direct ties (also called "in-degree" ties) can drain an individual's own resources because they can be laborious to maintain (Mayhew & Levinger, 1976); more ties create larger role demands. Furthermore, having many ties to others also tends to constrain individual behavior within the role defined by those ties (Krackhardt, 1999).

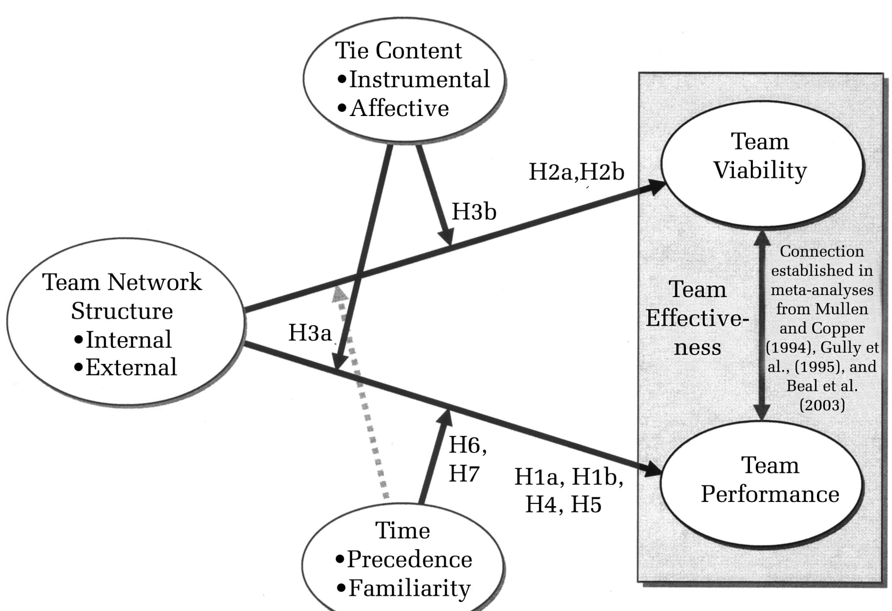
Although the structure of a social network can predict a variety of outcomes (Kilduff & Tsai, 2003), the nature of the resources that flow through that structure is equally important. That is, social network researchers classify (or measure) ties on the basis of their *content*. Two common types of tie content studied in organizations are *instrumental* and *expressive* ties (Lincoln & Miller, 1979). Instrumental ties, which are thought to be vital to effective task performance, are pathways of work-related advice (Ibarra, 1993). They might emerge from a formal relationship (e.g., leader-subordinate), and the primary content exchanged through them is information resources or knowledge that is relevant to completing one's job within a unit. In contrast, expressive ties reflect friendships. They are more affect-laden. These ties are important conduits of social support and values (Ibarra, 1993; Lincoln & Miller, 1979).

Instrumental and expressive ties are not mutually exclusive, and there tends to be an overlap in the two types of connections (Borgatti & Foster, 2003). One type of tie might even lead to the other (Krackhardt & Stern, 1988), as work contexts provide the physical proximity and opportunity for interaction that are vital to friendship formation (Festinger, Schachter, & Back, 1950). Still, the primary content of the two types of ties remains theoretically distinct; not all work colleagues are friends, and vice versa. This difference may have important implications for teams, especially in terms of the two primary types of team outcomes we study here: the more social and person-related dimension of *team viability* and the more job- and duty-related dimension of *team task performance* (Guzzo & Shea, 1992).

All major reviews of team research recognize these two independent dimensions of team outcomes as being necessary for team effectiveness (e.g., Kowlowski & Bell, 2003). The former, team viability, is defined as a group's potential to retain its members—a condition necessary for proper group functioning over time (Goodman, Ravlin, & Schminke, 1987; Hackman, 1987). The latter, team task performance, involves how well the team meets (or exceeds) expectations about its assigned charge at work. Because the two dimensions are theoretically distinct, they need not have the same determinants (Gladstein, 1984; Goodman et al., 1987; Hackman, 1987).

In the following sections, we use and contrast existing theories that address how aspects of network structure and tie content are (differently) associated with these two dimensions of team effectiveness. We show our hypotheses pictorially in Figure 1. The figure is not meant to be a full-blown theoretical model, but it does summarize and integrate some of the findings of previous research, along with our network-based predictions. For ex-

FIGURE 1
Theoretical Framework Linking Team Network Structure to Team Outcomes



ample, our viewpoint on the connection between viability (or group cohesiveness) and performance is that both constructs occupy positions in the critierion space of team effectiveness, and their relationship is potentially reciprocal. Antecedents other than network structure, such as conflict (DeDreu & Weingart, 2003), demographic diversity (Webber & Donahue, 2001), and collective efficacy (Gully et al., 2002) might also be included in an all-encompassing theory of team effectiveness. However, they are not included in the figure because they are not addressed in our study (nor could they be, for lack of effect sizes linking them to network structures).

PREDICTIONS ABOUT NETWORK STRUCTURE AND TEAM OUTCOMES

Density-Performance Hypotheses

Put simply, social ties in work teams are informal links between team members. Teams in which many members have ties to one another (i.e., high-density teams) should therefore have higher levels of information sharing and more of the collaboration necessary for successful task completion. In contrast, teams in which members do not interact with many other members (i.e., low-density teams) might be unable or unwilling to exchange vital, job-related ideas and tacit knowledge with one another (Hansen, 1999). Further, teams with sparse networks might have to rely on individuals to act as brokers between disconnected parts of the team. These brokers may engage in calculated or involuntary filtering, distortion, and hoarding of information, hampering the team's eventual task completion (Baker & Iyer, 1992; Burt, 1992).

Note that this proposed effect of the density of ties is by no means a foregone conclusion (e.g., Rosenthal, 1996). A theoretical counterargument states that process losses are more likely to occur in high-density networks (Shaw, 1964), because individuals must spend time and effort on maintaining numerous ties (Burt, 1997). This problem would be exacerbated in the case of expressive (versus instrumental) ties, as team members socialize and indulge in activities that might take them away from the task at hand. Expressive ties similarly push members toward conformity because members tend to share only acceptable and attitude-reinforcing information (Krackhardt, 1999).

The teams studied in our investigation were those created by organizations to accomplish tasks. Hence, the informal relationships among members are likely to be work-related, involving tasks to be accomplished and formal, assigned goals. The effects of such task-related links may not completely supersede the effects of informal networks, but the task-related links certainly put constraints on the social demands that the informal ties may create. That is, the task-related nature of what transpires in an organizational team is, we believe, the primary source of influence and the team's overarching concern. With such an overarching purpose, we expect that informal relationships facilitating goal attainment (per the first theoretical argument above) will be more potent than those hindering goal attainment.

Hypothesis 1a. Density of ties in a team's instrumental social network is positively associated with team task performance.

Hypothesis 1b. Density of ties in a team's expressive social network is positively associated with team task performance.

Density-Viability Hypotheses

As we outlined above, not all group effectiveness criteria are task-driven (McGrath, Arrow, Gruenfeld, Hollingshead, & O'Connor, 1993). Team viability (a team's potential to retain its members through their attachment to the team, and their willingness to stay together as a team) has also been characterized as a general dimension of team outcomes for over 50 years (Sundstrom, De Meuse, & Futrell, 1990). Viability is a broad construct that captures both the satisfaction of teammates with their membership and their behavioral intent to remain in their team (Barrick, Stewart, Neubert, & Mount, 1998; Hackman, 1987). Viability is essential for team functioning in natural settings, especially for those groups that have longer "lifetimes" and deeper or more complex charges than others (versus short-term or one-hour laboratory groups; Arrow, McGrath, & Berdahl, 2000). Team viability is supported by informal connections—both instrumental and expressive—within a team (Barrick et al., 1998). Teams with dense instrumental networks have members who frequently communicate with each other, a condition that is essential to the identification of potential sources of conflict and their resolution. Such teams would resist generally harmful relational or socioemotional conflict, which itself is an engine that drives fragmentation and loss of members (Wall & Callister, 1995). Similarly, teams with denser networks of expressive ties should be more able to provide emotional resources to those members who need them, and would be more likely to know when members need those resources (Vaux & Harrison, 1985).

Hypothesis 2a. Density of ties in a team's instrumental social network is positively associated with team viability.

Hypothesis 2b. Density of ties in a team's expressive social network is positively associated with team viability.

Of the two, the instrumental network conveys the most work-relevant information, and it therefore should be the more strongly associated with task performance (Guzzo & Shea, 1992). Unlike team task performance, team viability is primarily affect-, attitude-, or emotion-laden (Barrick et al., 1998). Its association with expressive ties should therefore be stronger than its association with instrumental ties. Together, these two notions suggest that *tie content moderates the relationship between network density and team outcomes.* More formally,

Hypothesis 3a. Relationships between network density and team outcomes reflect a match of tie content in that instrumental network density is more strongly related (than expressive network density) to team task performance.

Hypothesis 3b. Relationships between network density and team outcomes reflect a match of tie content in that expressive network density is more strongly related (than instrumental network density) to team viability.

Leader Centrality–Performance Hypothesis

Assigned or formal team leaders (including supervisors, managers, and so on) can rely on a number of power sources for influencing members to accomplish tasks (Raven, 1993; Raven, Schwarzwald, & Koslowsky, 1998). The most effective leaders (1) rely more on informal power, such as expert and referent power, than on formal power sources, such as hierarchical position or authority (Argyris, 1971; French & Raven, 1959; Rahim, 1989), and (2) provide their teams not only with direction and goals to attain, but also with the resources to facilitate their attainment (House, 1971, 1996). Formal leaders can benefit from being informal leaders as well. Individuals who occupy central nodes in an informal network tend to have access to diverse data that may facilitate a leader's power or provide the leader with the information resources necessary for successful task completion (Balkundi & Kilduff, 2005; Krackhardt, 1996). For example, central leaders (those whom subordinates seek for advice or friendship) tend to have relatively comprehensive views of the social structures of their teams, and this insight might help them make better decisions (cf. Greer, Galanter, & Nordlie, 1954). Central leaders occupy structurally advantageous positions in the informal social networks, where they can be gatekeepers and regulators of resource flow, dispensing what is needed to other nodes—team members—as they need it (Krackhardt, 1996). That is, central leaders can use their informal power, which is in part provided to them by their network position, to dispense information and guide team members toward common team goals, and thereby, positively affect team performance (Friedkin & Slater, 1994; Levi et al., 1954).

However, an opposing theoretical argument highlights the potential pitfalls of a team having a central leader. Actors in the center of a social network are pivotal to the network as a whole (Baker & Iyer, 1992). When central team members lack task knowledge, or fail to pass along critical information in ways that help other members to pursue team goals, the performance of the entire network or team is likely to suffer. More importantly, central leaders may be constrained by their connections to subordinates and may be unwilling to punish subordinates (Fiedler, 1957; Taylor, Hanlon, & Boyd, 1992). This constraint may stem from a leader's apprehension about a backlash from subordinates. Also, the leader may be influenced by subordinates to such an extent that leader and subordinates think alike; therefore, the leader may be unable to discern poor performance (Dobbins & Russell, 1986; Krackhardt & Kilduff, 1990). Either way, the leader's own position in the social network may constrain his or her ability to act in ways that improve team performance. That is, leader centrality might be associated with lower team performance.

Which of the above two arguments is most prescient in organizational settings? We suggest that leaders who are central (that is, have high in-degree, or many incoming ties) should tend to have *more* rather than *less* productive teams. Primarily, the teams studied in organizational research are task-oriented. They are parts of larger organizations that have production or service goals to achieve (Ilgen, 1999). Teams are formed to help accomplish those goals, and roles are assigned within teams to help attain them. Hence, patterns of relationships between team members start with a task-based backdrop and context (Brass, 1985). Reiterating our logic for the density hypotheses above, we might expect the degree to which a leader's interpersonal relationships are formed in ways that hamper goal achievement might be eclipsed by the degree to which they are formed to facilitate it.

Hypothesis 4. Centrality of a team's formal leader in a team's informal social network *is positively associated with team task performance.*

We do not mean this to be a universal prediction. If we were studying families, friendship groups formed outside work, or social clubs, the relationship might swing the other way. That is, when relationship maintenance is the team's or group's primary goal, formation of a large number of informal ties might constrain the resources necessary to carry out tasks.

Team Centrality–Performance Hypothesis

Networks of connections *between* teams may also contribute to effectiveness. Although other, more formal coordination mechanisms might exist to help facilitate flows of resources between teams (Thompson, 1967), informal ties between teams can be sources of key resources such as knowledge and personnel exchange (Kilduff & Tsai, 2003). Like their leaders, teams can occupy more or less central positions in such an intergroup social network (Tsai, 2000). A central team has access to unique knowledge—including an understanding where such knowledge is located elsewhere inside and outside the organization, and how to obtain it (Hansen, 2002). This, in turn, might have important implications for the team's own task (Ancona & Caldwell, 1992; Pearce & David, 1983). Examples of such critical knowledge may include market trends, hostile forces in the environment, and information about potential new products and suppliers (Tsai & Ghoshal, 1998). With such information, the team can make better strategic and operational decisions, improving its performance. Similarly, a team's central location in an intergroup network might allow it to restrict the flow of the knowledge to other teams that serve as competitors (also called "tertius gaudens" [Burt, 1992]).

Hypothesis 5. Team centrality in an intergroup network is positively associated with team task performance.

The density-performance and centrality-performance hypotheses broached above deal with members having (more) unfettered access to what is available to other nodes in a network. By bridging unconnected nodes or by having more connections, such structures play an *integrative* role for a team; that is, they *promote or ease exchange and sharing of resources* necessary for task completion. For example, central leaders tend to link team members who might not otherwise interact with one another. Leaders in such positions can convey information and resources between subordinates who do not communicate directly. Thus, by bridging unconnected nodes, central leaders act as resource-integrating mechanisms. Similarly, we have proposed that central teams in an intergroup network tend to be better performers because they have access to more, and more unique, resources through their connections to other teams (Tsai, 2000). By bridging unconnected teams, central teams also tend to play an integrative role in an intergroup network. Finally, as mentioned earlier, a dense team tends to have higher numbers of connected team members (given team size), again helping the team to integrate or bridge members for easier information sharing and perhaps distributed information storage (Austin, 2003). That is, we move up a level of abstraction and consider both dense structures and high centrality for leader or team structures as *resource integrative*. In the following section, we consistently use the term "integrative" to describe such social structures.

TIME, INTEGRATIVE NETWORK STRUCTURES, AND TEAM OUTCOMES

The hypotheses proposed above assume that networks already exist in teams and that they have a stable relationship with team outcomes. As in the majority of research on both networks (Kilduff & Tsai, 2003) and teams (Kozlowski & Bell, 2003), these hypotheses are time-insensitive. They do not incorporate arguments about the time ordering, lag, or erosion/accretion of effects on team outcomes (Mitchell & James, 2001). A further assumption is that network structures are equally important at all times, regardless of what stage of development or familiarity the team is in. Such hypotheses tend to give insights about group statics, not dynamics (McGrath, 1986).

To address this issue, in the current section we explore two time-related questions. First, what is the sequence or *temporal precedence* between integrative network structures and team task performance? That is, to help justify a social network approach to team outcomes, it is important to establish whether integrative networks actually function as inputs—facilitating, and therefore preceding performance—or as epiphenomena, offshoots of how well a team has performed in the past. If the evidence mainly supports the first interpretation, then a second time-related question is valuable. *When* (in terms of a team's developmental stage or member familiarity with tasks and one another) do integrative networks matter most? That is, are network structures most conducive in the "forming and norming" stages of development (Tuckman, 1965), as a means of communication between justacquainted members working on novel tasks, or are they most conducive in the "storming and performing" stages, when team members are well-acquainted with one another and their means for getting tasks done?

Mitigating Potential Time-Based Errors

Before answering these two questions, we briefly describe why studying time in the context of social networks and teams is important. Temporal issues have been acknowledged as one of the most neglected aspects of team research (Kozlowski & Bell, 2003; McGrath & Argote, 2001). Similarly, the dynamic nature of connections between social network structures and their purported outcomes (and to a lesser extent, their antecedents) has received much less attention than static connections (Kilduff & Tsai, 2003). This dual state of affairs can lead to what McGrath and colleagues (1993) referred to as Type I and Type II temporal errors. Type I temporal errors are positive conclusions about relationships derived from cross-sectional designs or short-lived teams that do not persist over longer observation periods in more enduring teams. The diminishing impact of "surface-level" diversity on team viability is one example of a Type I temporal error (Harrison, Price, & Bell, 1998). Type II temporal errors are conclusions about null effects from short-term studies that underestimate the strength of long-term effects, such as the growing impact of "deep-level" diversity on team viability (Harrison, Price, Gavin, & Florey, 2002). Either type of error might manifest in undetected network effects in short-range teams, composed of relative strangers, that would instead emerge in long-range teams, composed of members that know each other well (Jehn & Shah, 1997).

A primary reason for the occurrence of these time-related errors is the risk and expense associated with trying to track network features and team outcomes simultaneously throughout the same study, perhaps over several rounds of data collection and member attrition (Newcomb, 1961). However, a meta-analytic summary can alleviate some of these problems, because it allows comparison of observed relationships over the multiple time lags or observation windows used in different primary investigations (Mitchell & James, 2001). That is, the temporal features of original studies can be coded as moderators in a meta-analysis and be used to (1) help explain the variation in links observed between social network properties and team effectiveness and (2) answer theoretical questions about how the medium of time accentuates or mitigates relationships between social network factors and team outcomes.

Network Structure and Team Performance: Temporal Precedence

Perhaps the most fundamental time-related question about social networks in teams speaks to causal direction. Do integrative network structures drive team performance, or does performance push particular network configurations? All the hypotheses forwarded above imply that network structures are conducive to, and therefore antecedents of, performance. The underlying presumption is that ties in social networks provide team members access to resources through their leaders or fellow members that are valuable for team outcomes. Network ties in integrative structures are helpful for getting things done (Ibarra, 1993). Without such ties, teams would not know from where, or through whom, to get vital resources—especially the tacit knowledge or "inside" information necessary to perform and complete tasks well (Rulke & Galaskiewicz, 2000). On the other hand, the opposing explanation states that when units perform well, their leaders and teams become more central in their respective networks (see Powell, Koput, and Smith-Doerr [1996] for an example at the interorganizational level). That is, a reputation for high performance might have a positive effect on a node's centrality and eventually increase the integrative role that the node plays in the network (Hinds, Carley, Krackhardt, & Wholey, 2000).

Although this latter notion is a feasible one, we feel that logic and evidence support our forwarding network-performance, rather than performance-network, causal precedence. For the performance-network connection to be stronger than the network-performance connection, there need to be fairly substantial changes in the network after performance. However, most research on the evolution of interpersonal networks suggests that they form and ossify rather quickly (Newcomb, 1961) rather than dissolve and reconstitute after specific performance-related events (Monge & Contractor, 2003).[1] Further, there is little information in *team*-level

[1] This argument does not obviate previous meta-analytic findings, especially those about group cohesiveness and performance (Gully et al., 1995; Mullen & Copper, 1994). For example, it is reasonable to argue that successful team performance gives members a stronger sense of accomplishment and efficacy, which would induce greater positive affect and attraction to the team as a whole (one of the definitional features of cohesion), but not necessarily a different pattern of ties.

performance that would provide a member with direction or impetus to go to another *individual* team member for advice. Hence, we believe it is more likely that networks precede performance and that this order of time precedence is more potent.

Hypothesis 6. Integrative network structures have a stronger relationship with subsequent team task performance than team task performance has with subsequent integrative network structures.

Social Networks and Team Performance: Member Familiarity

Another important feature of how time may moderate the impact of networks on team outcomes is reflected in team member familiarity. Different causal mechanisms are presumed to operate depending on how much time team members spend with each other doing their tasks relative to their initial charge (Gersick, 1988; Tuckman, 1965). Time allows members to gain both task and interpersonal familiarity (Harrison, Mohammed, McGrath, Florey, & Vanderstoep, 2003). When teams are initially composed of unfamiliar members, or when previously unacquainted team members first begin their work and define their roles, resources provided through the paths of informal social networks should be especially crucial to effective task completion (Guzzo & Dickson, 1996). However, as team members spend time with one another working on the same set of tasks, their roles become clearer (Harrison et al., 2003).

This clarity of "heedful interrelating" may substitute for actual interactions, in that team members develop a shared understanding of their task requirements (Weick & Roberts, 1993). This more fully developed, *shared* cognitive structure of who needs to do what within a team, without depending on the exchange of information or support resources through dyadic ties, would tend to mitigate the influence of network structures. Overall, the initial dependence of social structure diminishes with time. This line of reasoning leads to our final hypothesis:

Hypothesis 7. Member familiarity weakens the relationship between integrative social network structures and team task performance.

METHODS

Identification of Studies

To test our hypotheses, we identified relevant studies using multiple approaches. First, we used combinations of keywords such as "ties," "sociometry" "peer nominations," "buddy ratings" (a term often used in the early research on team network structure), "social networks," and "dyads," along with "group," "team," or "unit" in searching various databases in the social and behavioral sciences. Those databases included ABI/Inform, Academic Ideal, Current Contents, Dissertation Abstracts, EBSCO, ERIC, Science Direct, ProQuest, PsycLit, PsycInfo, Sociological Abstracts, JSTOR, and Web of Science. Second, we manually searched all the issues of the journals *Social Networks* and *Sociometry*, as both specialize in publishing network-based studies. Third, we consulted existing (early) reviews (Fiedler, 1957; Gibb, 1954; Mouton, Blake, & Fruchter, 1955) and reference lists of current papers to manually search for articles. To avoid overlooking unpublished or in-press papers, we sent solicitations to members of the Academy of Management's Organizational Theory Division and to the Social Networks listservs and posted our request on the Web site of the Organizational Behavior Division of the Academy. Finally, we contacted authors who had published articles in this area. This multipronged strategy provided 37 studies with 63 effect sizes involving 3,098 teams.[2]

Criteria for Inclusion

An original study had to meet multiple criteria to be relevant to and included in our investigation. First, the sample had to be constituted of intact teams of adults, working in their jobs or on specially assigned projects. That is, we only included investigations of teams working in their natural contexts. Second, the study must have operationalized informal networks using sociometric or social network methodology, including the centrality of teams' leaders, the centrality of teams, or the density of team members' ties to one another. Third, the team outcome variable in the study had to be team-level (either measured directly at the team level or aggregated from the individual level, but not still at the individual level itself). That is, we were interested in studies for which the network-related independent variables and effectiveness-related dependent variables were congruent (Klein, Dansereau, & Hall, 1994). More importantly, the dependent variable had to be some form of task performance or team viability. We excluded studies that had other outcomes, such as intergroup conflict (e.g., Labianca, Brass, & Gray, 1998).

[2] The list of studies and codes are available on request.

Coding Scheme and Study Characteristics

We developed a system for identifying the content of the independent variables (e.g., advice/instrumental versus friendship/affective ties) following procedures recommended by Lipsey and Wilson (2001) and by Martocchio, Harrison, and Berkson (2000) for time-based coding. After pilot-testing and refining the system, we had two coders rate the studies on multiple dimensions, including type of network measure and sample characteristics.

All primary studies provided enough information to classify tie content, usually through description of network-related questions asked to respondents. Responses to such questions as "Whom do you go to for work-related advice?" or "Whom would you want to work with to accomplish the job most efficiently?" were coded as measuring instrumental ties. Answers to questions such as "Who are your friends?" or "Whom do you have close interpersonal relationships with?" were coded as involving expressive ties.

The raters also coded whether the network structure in a given study was a measure of network density or centrality. Although there are multiple types of centralities (see Wasserman and Faust [1994] for a review), in the studies summarized here, a majority (16 out of 19) used in-degree as the centrality measure (Wasserman & Faust, 1994). The interrater reliability for coding the type of network structure was .97.

Outcome variables were coded on the basis of how they reflected the primary dimensions of effectiveness we identified and defined constitutively above: team task performance and team viability. Criteria described as assessing some element of output productivity, speed, or quality (e.g., bombing accuracy for flight crews [Hemphill & Sechrest, 1952]) were regarded as measures of team task performance. All such measures were rated, judged, or counted by someone external to the teams in their respective studies, such as supervisors (e.g., Tziner & Vardi, 1982). When group member satisfaction, team climate or atmosphere, team commitment, or indicators of group cohesion were assessed as team outcomes (Kozlowski & Bell, 2003), we regarded them as measures of team viability (e.g., Chemers & Skrzypek, 1972). Intercoder agreement for the ascription of outcomes as performance or viability measures was 95%.

For temporal precedence, the coders rated whether networks were assessed prior to, concurrent with, or after team outcomes (agreement = 89%). Data about temporal precedence were gathered from details in the Method sections of primary studies. In most cases it was obvious whether networks were measured before (the time lag was coded as 1), during (0) or after (−1) performance (Fiedler [1954] was an exception). All cross-sectional survey studies were coded as if networks and performance were measured simultaneously (with a lag of 0). For temporal sequence, distribution was balanced, with 12, 10, and 12 studies across the three categories of predictive, concurrent, and "postdictive" designs.

The raters coded member familiarity as a monotonic variable for which larger numbers reflected increasing amounts of either task or team member experience (Harrison et al., 2003). Teams based on prior friendship or acquaintance, but no task familiarity, were coded as 1 (e.g., Jehn & Shah, 1997). Intact teams that had not completed a full version performance cycle, as defined by Marks and colleagues (2001)—that is, they had moderate task familiarity because they had been working on a task together, but they had not yet completed a product or deliverable and had not received performance feedback about it—were coded as 2 (e.g., Shrader, Dellva, & McElroy, 1989). Finally, intact groups that had completed a performance cycle, and therefore had high interpersonal and high task familiarity, were coded as 3 (e.g., Tsai & Ghoshal, 1998). The interrater agreement on member familiarity was .86, and any disagreements were eventually addressed by going back to the original articles and resolving them via discussion. The number of studies across the three levels of familiarity was 4, 6, and 25, respectively.

To understand the nature of the teams sampled in the various studies, we coded team type using the typology proposed by Sundstrom (1999) (agreement = 71%). According to Sundstrom (1999), teams can be classified into six types on the basis of their position in an organizational hierarchy, tenure, and other structural features. The first type of team, the management team, has the greatest authority and is generally in the upper echelons of the organization; top management teams are an example. Unlike management teams, project teams (e.g., new-product teams) tend to have varying levels of authority; their salient feature is their eventual dissolution once the project is accomplished. In contrast, production teams (e.g., assembly teams) tend to have indefinite tenure but low authority. Like production teams, service teams (e.g., retail sales teams), tend to be low in their organizational hierarchy, but they interact with their organization's customers. Teams such as surgery teams and military teams are classified as action teams. Different from all the above are parallel teams, groups whose members are primarily associated with other work units but come to work as team members occasionally; quality circles are an example of the parallel team type. Of the 37 studies reviewed here, in 11 studies the team members were in the military or were in military training (and were action teams [e.g., Levi et al., 1954]). Top management teams were studied in 7 studies (e.g., Godfrey et al., 1957). Results in 9 studies were based on project teams (e.g., Hansen, 1999), and in 7 studies the researchers used production and service teams (e.g., Balkundi et al., 2003). The remaining 3 studies sampled multiple types of teams, including production and service teams (e.g., Sparrowe et al., 2001). Further, the typical study included here involved 83 teams; the minimum was 4, and the maximum was 1,245). Finally, the teams in our source studies ranged in size from 3 to 15 members, with the average team size being 8 members.

Meta-Analytic Techniques

We calculated effect sizes using the methods described by Hunter and Schmidt (1990), which allow for corrections to study artifacts such as unreliability. In our case, those corrections involved the dependent variables, team task performance and viability. If necessary, we transformed reported statistics, including means and standard deviations, chi-square values (when performance was dichotomized), *t*'s, *F*s, and *p*'s into product-moment correlations. Each effect size was then transformed to a Fisher's *z* before we averaged values. We then transformed the Fisher's *z's* back to correlations before compiling them to be reported. (Table 1, below, presents these correlations.)

To ensure that effect sizes were independent, we included only one effect size for each meta-analyzed relationship, usually by taking a composite correlation (Hunter & Schmidt, 1990). For example, the Baldwin et al. (1997) study had multiple operationalizations of team task performance, yielding multiple correlations between task performance and social network structure. In such cases, we converted the multiple product-moment correlations within a study into Fisher's *z* values and then averaged the values to obtain one effect size for a relationship per study. Further, when conducting the moderator analyses involving the integrated social network structures, we sometimes obtained multiple effect sizes from the same study (e.g., Mehra, Dixon, Robertson, & Brass, 2004). We retained only one effect size from each such study so as to maintain independence of effect sizes.

Also, following Hunter and Schmidt's (1990) recommendations, we corrected the individual correlations for study artifacts such as unreliability of the dependent variables. Methodological research has shown that it is best to correct effect sizes for such unreliability within each study and then aggregate the corrected effects when coming up with the best estimate of ρ (rho, the population parameter of interest). For those studies that did not report reliability values, we used the average reliability estimate of other studies that explored the same relationship (a type of imputation). So, if 11 of 14 studies included a reliability estimate for team task performance, we used the average of these reliabilities as the best estimate of performance reliability in the remaining three studies.

We tested for the presence of moderators for each meta-analytic estimate by calculating the *Q*-statistic for heterogeneity in effect sizes (Hedges & Olkin, 1985). The presence of a significant *Q*-statistic suggests the possibility of moderators as the effect sizes are not estimating the same population mean (Lipsey & Wilson, 2001). To test the effects of proposed moderators, we regressed the observed effects on the moderator variables after weighting each effect size by sample size (Glass, McGaw, &

TABLE 1
Meta-Analytic Relationship of Social Network Properties with Team Performance and Team Viability

Variable	*k* Studies	Total *n*	Mean *r*	Variable *r*	95% Confidence Interval	Estimated ρ	Failsafe *k*
Team performance							
Hypothesis 1a: Density of instrumental ties	17	2,442	.13	.02	(.09, .17)	.15	285
Hypothesis 1b: Density of expressive ties	9	515	.20	.02	(.12, .28)	.22	56
Hypothesis 4: Team leader centrality	13	505	.27	.27	(.19, .35)	.29	130
Hypothesis 5: Team centrality in intergroup network	10	440	.13	.05	(.04, .22)	.13	12
Team viability							
Hypothesis 2a: Density of instrumental ties	10	1730	.14	.02	(.09, .18)	.14	116
Hypothesis 2b: Density of expressive ties	4	178	.45	.01	(.33, .57)	.55	48

Smith, 1981). This procedure allowed us to examine the fit of our Hypotheses 3a, 3b, 6, and 7 by assessing the study-level impact of tie content, temporal precedence, and team member familiarity on the strength of network effects.

RESULTS

Using the meta-analytic techniques described above, we tested each of our propositions about the connections between social network structure and team effectiveness outcomes. Table 1 presents results for the relationships between network structures, team task performance, and team viability.

Density-Performance: Hypotheses 1a and 1b

Recall that Hypotheses 1a and 1b assert that teams with denser social networks tend to perform better (see Table 1). As predicted by Hypothesis 1a, the density of a team's network of instrumental ties was positively, albeit not strongly, related to team task performance. The average corrected correlation was $\rho = .15$ ($k = 17$, $N = 2{,}442$ teams, 95% CI = .09–.17). The failsafe k in Table 1 suggests that, although the correlation is not high, at least 285 similarly sized studies with null findings would need to be conducted before the hypothesis would lose statistical support. Hypothesis 1b was supported as well. Density of a team's network of expressive ties was positively and moderately related to team task performance. The corrected correlation was $\rho = .22$ ($k = 9$, $N = 515$, 95% CI = .12–.28). Clearly, "thicker" concentrations of member ties in a team are associated with superior pursuit of the team's assigned goals.

Density-Viability: Hypotheses 2a and 2b

Do social network features also facilitate team viability, following Hypotheses 2a and 2b? The results in Table 1 show they do. Our meta-analytic findings support the prediction that teams with denser instrumental ties have greater team viability. The average corrected correlation for ten studies ($k = 10$, $N = 1{,}730$) was $\rho = .14$ (95% CI = .09–.18). Similarly, we found support for Hypothesis 2b ($\rho = .55$, $k = 4$, $N = 178$, 95% CI = .33–.57). That is, the density of expressive ties between team members is strongly and positively associated with team viability. Both findings are resistant to unpublished null effects, with failsafe k's of 116 and 48 for Hypotheses 2a and 2b, respectively.

Match of Tie Content to Team Outcomes: Hypotheses 3a and 3b

We reasoned that the impact of network structures depends on the tie content in those networks. Hypothesis 3a predicts that a team's instrumental tie density will be a stronger predictor of team task performance than expressive tie density (see Table 1). However, we did not find support for this prediction ($\beta = -0.08$, $p = .74$). Indeed, the task performance implications of instrumental ties were no different from those of expressive ties ($\rho_{\text{instrumental}} = .23$; $\rho_{\text{expressive}} = .21$, $k = 21$, t-test $p > .10$). Hypothesis 3b predicts that a team's expressive tie density has a larger impact than instrumental tie density on team viability. The meta-analytic data support this contention ($\beta = 0.63$, $p = .03$). Team viability was more strongly connected to networks of expressive ties ($\rho_{\text{expressive}} = .53$) than to networks of advice ties ($\rho_{\text{instrumental}} = .35$, $k = 13$, t-test $p < .05$).

Centrality-Performance: Hypotheses 4 and 5

The next set of ideas dealt with the potential resource advantages gained by teams whose leaders are central in the team's instrumental social network (Hypothesis 4) and by teams that are central in an intergroup network (Hypothesis 5). Does leader or team centrality matter for task performance? The meta-analytic conclusion in both cases is yes. Leader centrality is positively associated with team task performance; the average, corrected correlation was $\rho = .29$ ($k = 13$, $N = 505$, 95% CI = .19–.35). The failsafe k for this hypothesis is 130, suggesting that this finding is robust to a large number of "file drawer" null effects. Also, team-level centrality in interteam networks benefits team task performance; $\rho = .13$ ($k = 10$, $N = 440$, 95% CI = .04–.22). Twelve studies with an average effect size of zero would need to be conducted to undermine fully this evidence for Hypothesis 5.

Moderating Effects of Time: Hypotheses 6 and 7

Our final hypotheses dealt with how time—via the causal sequences of the investigated variables and via the familiarity of team members working with one another—tempers the strength of social network–performance links. Table 2 presents results for time-based moderators of integrative network structures and team performance.

Hypothesis 6 proposes that having a more integrative network structure is beneficial for *future* team task performance but is not as likely to reflect *past* performance. We tested this hypothesis in a

TABLE 2
Time-Based Moderators Predicting Relationship between Integrative Network Structures and Team Performance

Variable	Model 1	Model 2
Precedence	.41*	
Familiarity		−.40*
R^2	.17*	.16*
k	34	35

* $p < .05$

sample-size-weighted regression analysis (Glass et al., 1981), regressing effect size on the coded lags (−1, 0, 1) described above. Results were consistent with the hypothesis. Network structures that ease the sharing of resources are more facilitative of future team task performance than vice versa ($\beta = 0.41$, $k = 34$, $p < .05$). The corrected effect size for network-performance (predictive) relationships ($\rho_{\text{predictive}} = .28$, $k = 12$, 95% CI = .20–.36) was substantially higher than for performance-network (postdictive) relationships ($\rho_{\text{postdictive}} = .09$, $k = 12$, 95% CI = .04–.14), although the latter was still positive.

Our final prediction was that familiarity would grow to serve as a substitute for network structure. The greater the familiarity of team members with each other and their task (moving from "forming" and "norming" to "storming" and "performing"), the weaker we expected the performance impact to be for integrative network structures. To test this proposition, we again used our familiarity codes as predictor values in a sample-size-weighted regression. The regression results uphold our prediction. For newly acquainted or inexperienced team members, informal ties were more critical to performance. As team members gained experience with one another and their work, effects of those ties declined ($\beta = -0.40$, $k = 35$, $p < .05$).

DISCUSSION

Do network structures matter for team effectiveness? If so, how? The purpose of this meta-analysis was to answer these questions, often in cases where different theoretical approaches made opposing predictions, and where trends in existing studies were not clear. We collected results from several decades of studies conducted in existing teams acting in their natural contexts. Our findings provide compelling support for the view that social networks have important effects on performance and viability. Networks do matter for teams. Teams with dense configurations of ties tend to better attain their goals, and they are more likely to stay together than teams with sparse configurations. In addition, teams with leaders who are central in intragroup sets of connections tend to be more productive. Being a central team in an intergroup network is also conducive to performance. As we hypothesized, and as some branches of social network theory would predict (Coleman, 1988), these integrative arrangements of ties appear to provide teams with advantages in acquiring and applying the resources that are necessary to do well.

We also tested for three theory-driven moderators that may govern the strength (or direction) of network effects on team outcomes. Contrary to one of our predictions (Hypothesis 3a), we found that the *content* of interpersonal ties within teams was less critical to task performance than their *pattern*. That is, expressive (friendship) tie density had roughly the same effect on team performance as instrumental (advice) tie density. However, in keeping with Hypothesis 3b, expressive tie density had a stronger relationship with team viability than instrumental tie density.

The results also indicate that time plays two distinct and systematic roles in the network-effectiveness relationships at the team level. First, temporal precedence, or causal sequencing, is crucial. Theory suggests and the meta-analytic data show that integrative network structures are more strongly positioned in time as *antecedents* to team performance, rather than as by-products of it (Jehn & Shah, 1997). Second, another form of time—familiarity, or developmental stage in a team—neutralizes network effects. As team members become more familiar with each other, the impact of integrative social structures on team task performance weakens, perhaps as other cognitive or routinized processes substitute for the initial, facilitative role that networks serve.

Strong Inference

Scientists have been arguing for years about what constitutes high-quality research and scientific advancement (Popper, 1959). One way to evaluate scientific advancement is to see whether alternative explanations for phenomenona of interest have been proposed and tested against each other (Platt, 1964). When the empirical testing of alternative explanations leads to the rejection of one explanation, subsequent research can build on the validated explanation (Priem & Rosenstein, 2000). This meta-analysis provides evidence that network analysis has reached such an advanced state, as alternative explanations have been proposed that might have kept the effects we observed from coming to light, or perhaps even steered them in a different direction.

For example, some researchers have proposed that the effect of social network density on team task performance (Hypotheses 1 and 3) is *negative.* This opposing argument states that having a dense network might hinder team performance because of the maintenance costs and resource drain problems that steer resources toward keeping relationships from deteriorating, rather than toward getting the task done (Shaw, 1964). Further, the triads inherent in dense networks of ties bind individual team members into mutual consensus or lack of disagreement with one another (Krackhardt, 1999), even when an opposing viewpoint is vital to performance.

In a similar way, there have been *negative* predictions about the impact of a leader's position in an informal network (relative to our Hypothesis 4). Some have argued that being in the center of a social network might constrain a leader's freedom to make difficult but necessary decisions (those with negative implications for closely tied team members) and that therefore this position will hamper task performance (Fiedler, 1957; Hughes, Ginnett, & Curphy, 1999). Finally, the putative role of social structures as an antecedent rather than a consequence (or merely a covariate) of team task performance has also been debated. Some theorists have proposed that success might foster positive attributions and potentially more integrative social structures; hence, performance would more likely drive social network structures in teams rather than structures driving performance (cf. Hinds et al., 2000; Lawler, 2001; Mullen & Copper, 1994).

There were opposing theoretical drumbeats in each case, setting the stage (one for which meta-analysis is well suited) to provide a strong inference. That is, in all cases, theory implied one set of relationships, and we found support for the reverse of the contentions listed above. In that sense, therefore, our results contribute to management theory by settling portions of what is known and unknown about the effects of social networks on team effectiveness in organizations. Moreover, these findings show how those effects differ systematically given (1) the content of ties and the focal dimension of effectiveness, (2) the timing of network structure relative to the execution of team tasks, and (3) member familiarity or time spent interacting with one another on tasks.

Future Contributions to Theory

Paralleling the increasing organizational reliance on teams, management researchers' interest in studying teams, and the sophistication of that research, have been increasing (Kozlowski & Bell, 2003). Yet two weaknesses in that research effort stand out. One weakness is the lack of synthesis between attribute-based approaches (Barrick et al., 1998) and network or relation-based approaches (Cummings & Cross, 2003) to team outcomes. The attribute approach incorporates individual team member personality and other relevant characteristics to explain team-level outcomes. In contrast, the studies reviewed here used the relational approach, which focuses on the interactions among members and overlooks individuals' attributes such as dispositions or attitudes. Although there have been attempts at integrating the attribute and relational approach at the individual level (Mehra et al., 2001), no sustained effort has been made at the team level. One of the obstacles to such synthesis may have been lingering doubts about the real potency of network structures in teams (or a lack of recognition of them, perhaps stemming from the fact that many of the seminal network studies were conducted a half-century ago).

The current meta-analysis should lay those doubts to rest and bring the weight of network variables to the fore. The magnitude of the effect sizes estimated in the current study (which are likely underestimates, given our inability to correct network variables for predictor unreliability, which is more easily calculated in attribute variables) ranged from a $\rho = .14$ for the effect of the density of instrumental ties on team viability to $\rho = .55$ for the effect of the density of expressive ties on team viability. The mean effect is $\rho = .41$. These values compare quite favorably to meta-analytic effects of attribute variables and team outcomes, such as group cohesion ($\rho = .32$ with team task performance [Gully et al., 1995]), group efficacy ($\rho = .41$ with performance [Gully et al., 2002]), group goal difficulty ($\rho = .41$ with performance [O'Leary-Kelly et al., 1994]), task conflict ($\rho = -.32$ with team member satisfaction), and relational conflict ($\rho = -.54$ with satisfaction [De Dreu & Weingart, 2003]).

However, in its theoretical contribution, this meta-analysis is distinct from the above studies on multiple dimensions. First, previous work has shown that team performance predicts group cohesion (Mullen & Copper, 1994). However, we found a stronger effect of network structures on team performance than the reverse. One way to reconcile this apparent contradiction is to recognize that group cohesion is more similar to our conceptualization of team viability (group cohesion is one of the dimensions of team viability). Thus, previous meta-analyses of group cohesion have explored the correlations between the two *dependent* variables in our study (see Figure 1). Second, this review brings to the fore the importance of cross-level effects on team performance. In most team-level research, researchers explore how team-level constructs (those measured at or aggregated to the team level) are associated with each other. However, very few studies (especially meta-analyses) look at cross-level effects of an individual actor on the collective (Rousseau, 1985). In this study, we found that a leader's position in a team's informal network has cross-level effects on the team's task performance. Finally, few meta-analyses have explored relationships at multiple levels. In this study, three separate levels were explored: individual (leader-centrality), intrateam (network density), and interteam (team-centrality).

An important contribution of the current work, therefore, is that the meta-analytic results lay the groundwork and highlight the need for theory that *simultaneously* accounts for attribute and structural (relational) influences on team effectiveness. Those influences might be parallel and independent, interactive, or serial. For instance, it may be that demographic diversity initially manifests itself in nonoptimal network structures that in turn deter performance for newly formed groups (e.g., Harrison et al., 2002). Similarly, value diversity may be most detrimental to a team when such differences emerge between members who are more central rather than peripheral in the team's network of expressive ties (Jehn, Northcraft, & Neale, 1999). As another example, the average cognitive ability or task knowledge of a team's members (Barrick et al., 1998) may be less critical than a configuration that places the most knowledgeable or "highest *g*" member in a central position in the team's social network.

Another weakness in team research has been a lack of sensitivity to time (McGrath & Argote, 2001). Such dismissiveness about time is fading (Harrison et al., 2003), and we hope the current meta-analysis hastens its departure. That is, another theoretical contribution of this article is to highlight the role of time in social networks and team performance. Theories about teams and time (Gersick, 1988) and about networks and time (Kilduff & Tsai, 2003) exist, but there is really no comprehensive theory about the interplay of networks, team processes, and team outcomes over time. Given our findings, such a theory would need to position network variables *early* in a causal chain that culminates in effectiveness; some patterns of ties enable improved performance through the ready acquisition of task-relevant resources and social support. However, those network-based contributions to performance are weakened, or perhaps even eclipsed, by other team processes as members gain familiarity with one another and with their roles in completing team tasks. Practically, these results also suggest that team- or tie-building opportunities (Weick, 1993) are most valuable immediately after teams form, rather than after storming or norming has occurred (Tuckman, 1965).

The precedence order of networks and performance provides additional support for the diminishing effects of networks as team tenure increases. Our findings suggest that networks have a stronger impact on performance than performance has on networks. Instead of seeing this in a snapshot fashion, our findings also show that networks have a reduced effect on performance over multiple performance episodes. That is, network effects attenuate over the tenure of a team. In the first performance episode, network effects on performance are the strongest. Subsequent to the completion of task and evaluation of performance, there is a weak change in network structure. Therefore, as this change in network structure is weak, the subsequent change in performance is also small. This small change in performance leads to further reduced change in network structure. Over time, network structure's effect on performance would be minimal.

Limitations and Research Directions

As is true of all other meta-analyses, our meta-analysis reflects many of the methodological advantages and disadvantages of original studies. For example, among the investigations we reviewed, there were no true experiments with randomized control conditions in the field. Therefore, there might be confounding variables that we cannot rule out, although those confounds would have to be systematically operating across studies to bias meta-analytic conclusions. The diversity of original samples and contexts, from bomber crews to assembly line groups to management consulting teams, mitigates against this problem. Still, for stronger causal conclusions to be obtained in this research area, more field experimentation is needed. One might be able to conduct such an experiment, for example, by structuring a network in virtual teams in such a way that there is limited communication between some members but not others, and so on, crossing that factor with the relative experience that team members have with one another. A further counter to this limitation on internal validity might be a meta-analytic summary of laboratory experiments on social network structures and team outcomes, many of which were also published in the 1950s (e.g., Bavelas; 1950, Leavitt, 1951). Even though at least one meta-analysis has summarized the effects of social network structures on individual-level outcomes (e.g., Mullen & Salas, 1991), there is still need to review effects at the team level.

A related limitation of meta-analyses is that they cannot pinpoint the mechanisms through which estimated relationships have their impact (Shadish, 1996). For network structures and team outcomes, those mechanisms would involve measurement of the actual resources and information that flows through ties (e.g., Hansen, 1999). Similarly, alternative mechanisms, such as the accuracy of individual and group cognition about who knows what, might mediate effects of network structure on team performance (Greer et al., 1954; Krackhardt, 1990).

Another limitation is the somewhat small sample of studies that underlies some of the estimated effects, especially those for moderator variables (a problem of second-order sampling error [Hunter & Schmidt, 1990]). However, many other meta-analyses have relied on a similar number of original studies (a similar *k*), and most have fewer teams (a smaller *N*) (e.g., De Dreu & Weingart, 2003; Gully et al., 1995; O'Leary-Kelly et al., 1994). This is a problem endemic to team-level research. The failsafe *k*'s for our reported effects are reasonably large, suggesting that an impressive body of null, or perhaps opposing, evidence would have to accumulate from this point forward to overturn most of our conclusions. That is, the *marginal* utility of a meta-analysis with a few more investigations than we have reported here needs to be weighed against the importance of the meta-analytic findings. We have argued for the importance of these findings in various places throughout this article, and we note that the marginal impact of the 25th or 26th study network effect within teams is not as crucial for statistical power as the impact of the 10th or 11th (Glass et al., 1981). We also note that the current accumulation of studies has already taken 50 years.

The small number of studies is not without casualties. We could find only one investigation of the effect of leader centrality on team viability (Borgatta, Bales, & Couch, 1954; $r = .4$, $p < .05$, $n = 33$). We could have proposed this connection as an explicit hypothesis but would not have been able to follow up the hypothesis with a meta-analytic estimate. This is one area of study that is both interesting and demands future, time-sensitive investigation: Do teams become more viable because of a central leader, or does their viability encourage the leader to adopt a central position?

This meta-analysis highlights the importance of social network structure in teams. It provides a foundation for future researchers to explore key correlates of network structure, including antecedents to network structure (Salancik, 1995). Subsequent studies also need to explore whether certain network structures (e.g., centrality) moderate the effects of other network properties (e.g., network density). In fact, we are not aware of any study that looks at the effect of the interaction between network variables on team level outcomes.[3] Similarly, there is need to understand whether tie content moderates the performance effects of teams' structural properties.

Despite these meta-analytic results about team task performance and team viability, we still do not know much about how internal configurations of social networks might facilitate (or inhibit) key team outcomes such as team efficiency (see Beal et al. [2003] for theoretical distinctions between efficiency and effectiveness), learning, and innovation. The preliminary evidence suggests a theoretical basis for expecting a connection between networks and learning. External ties facilitate knowledge acquisition that is nonredundant with what teams already know, and therefore potentially frame-breaking and a source of innovation (Ancona & Caldwell, 1992). Hansen (1999) found that weak ties facilitate only the search for complex knowledge, not its transfer. In contrast, complex knowledge is better transmitted by strong ties. Therefore, the study of networks in teams and innovation remains an area that might be a strong target for future data collection efforts. There are fairly weighty questions that might well be answered in such efforts that could link team-level phenomena with organizational learning and knowledge management (Argote, Ingram, Levine, & Moreland, 2000).

Conclusion

There is a new wave of interest in network effects on teams. At the same time, there is a lack of convergence or consensus about what is known about those effects and, hence, questions exist about where future theoretical and empirical resources should be spent. By bundling a large set of "old-wave" studies together with the more current investigations, our meta-analysis has provided answers to some of those questions. Teams with denser expressive and instrumental social networks tend to (1) perform better and (2) remain more viable. Teams perform better when their leaders are central in their intrateam network and when they, as a team, are more central in an intergroup

[3] We would like to thank one of the reviewers for suggesting this point.

network. These effects are especially potent when the network structures precede initial bouts of performance, but they diminish as time elapses and the familiarity of team members with one another grows. Given the establishment of these building blocks of social structure–team outcome connections, more elaborate theory of networks, member attributes, team effectiveness and time can be developed.

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