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

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ABSTRACT

How do social network structures of members and leaders of teams help or hinder effectiveness? We answer that question via a meta-analysis of 37 studies, involving 63 effect sizes that span six decades and 3098 teams working in natural contexts. Teams with dense rather than sparse configurations of interpersonal ties attain their goals (team task performance) better, and are more committed to staying together (team viability). In addition, teams with leaders who are central in the intragroup network, and teams that are central in the intergroup network, tend to be better performers. Time ordering and the content of network ties moderate structure -- performance connections. Results augur for stronger incorporation of social network concepts into theories about team effectiveness.

Keywords: Social networks, team performance, team viability.
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, various meta-analyses of the antecedents of team effectiveness have been conducted. Those meta-analyses affirm definitive answers about effects of some antecedents, 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, our understanding of a potentially critical set of determinants is limited. Namely, 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 nor awareness 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 longer survival or improved task completion 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 the 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 opposing proposition says that central leaders tend to have more productive teams (Levi, Torrance, & Pletts, 1954).

Therefore, the purpose of our paper is 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 is: how do network structures of leaders and 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 main effects questions posed above, we ask moderator questions 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 how social network structures can have outcome implications for teams, we first outline the relevant theoretical arguments from the social networks literature. Based on these key arguments and concepts, we then develop hypotheses
that establish specific linkages between social network features and team-level criteria. Further, we propose 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 each of the team's members and the 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 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 one another, 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) would have difficulty exchanging resources, because there are no established patterns of ties to convey these resources. The interconnectedness of nodes in a network, or, the ratio of existing ties between team members relative to the maximum possible number of such ties, is called the *density* of the network structure. For example, if Team A and Team B both had six members, there would be fifteen possible friendship ties within each team. If Team A had ten pairs of friendship ties, and Team B had four 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 (c.f. 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 from the overall network to the nodes that constitute it. The position of a node in the social network will influence the resources and potential benefits for the party who occupies it. A node that is in a structurally advantageous position in the informal social network tends to receive information and control benefits (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 the social network. Either by virtue of having highly sought expertise or being a close friend to many others, a central individual has greater access to, and a larger amount of, information or social support that she can draw from the social network (Adler & Kwon, 2002). If that central individual is also the team's formal leader, it may facilitate task performance mechanisms for the team as a whole. On the other hand, large numbers of direct ties (also called in-degree) can drain an individual's own resources because they can be labor intensive 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 resources that flow through that structure are 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 are pathways of work-related advice (Ibarra, 1993) and are thought to be vital to effective task performance. Instrumental ties might emerge from a formal relationship (e.g. leader-subordinate) and the primary content exchanged through such ties is information resources or knowledge that is relevant to completing one's job within a unit. In contrast, expressive ties reflect friendships and 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 the work context provides the physical proximity and opportunity for interaction 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, or 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 or person-related dimension of team viability and the more job- or 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 effective teams (e.g., Kowlowski & Bell, 2003). The former --
team viability -- is defined as the 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 they 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 (differentially) 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 example, our viewpoint on the viability (or group cohesiveness) - performance connection is that both constructs occupy positions in the "team effectiveness" criterion space, and their relationship is potentially reciprocal. Antecedents other than network structure, such as conflict (DeDreu & Weingart, 2003), demographic diversity (Webber & Donahue, 2001), or collective efficacy (Gully, et al., 2002) might also be included in an all-encompassing theory of team effectiveness, but 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).

----- Insert Figure 1 here -----

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 collaboration necessary for successful task completion.
In contrast, teams in which individuals do not interact with many other members (i.e. low density teams) might be unable or be unwilling to exchange vital, job-related ideas or 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). There is a theoretical counterargument stating that process losses are more likely to occur in high-density networks (Shaw, 1964), because time and effort must be spent on maintaining so many 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 towards conformity as members tend to share only acceptable or attitude-reinforcing information (Krackhardt, 1999).

The teams studied here are those created by an organization to accomplish tasks. Hence, the informal relationships among members are likely to be work-related -- in which there are tasks to be accomplished and there are formal goals assigned. These task-related links might not completely supersede the effect of the informal networks, but certainly put constraints on the social demands that such ties might create. That is, the task-related nature of what transpires in organizational teams 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 (the first theoretical argument above) will be more potent than those hindering goal attainment (the second theoretical argument above).
Hypothesis 1a. Density of ties in a team's instrumental social network will be positively associated with team task performance.

Hypothesis 1b. Density of ties in a team’s expressive social network will be 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, the attachment to and willingness to stay together as a team, has also been characterized as a general dimension of team outcomes for over fifty 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 the 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 more in-depth or 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 the group (Barrick, et al., 1998). Teams with dense instrumental networks have members who frequently communicate with each other, which 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 from the group (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 be more likely to know when those resources are needed by such members (Vaux & Harrison, 1985).

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

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

Of the two, the instrumental network conveys the most work-relevant information, and therefore should be the most 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,

**Hypotheses 3a-b.** Relationships between network density and team outcomes will reflect a "match" in terms of tie content, such that (a) instrumental network density will be more strongly related (than expressive network density) to team task performance, and (b) expressive network density will be 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 (a) rely more on informal power such as expert and referent power than more formal power sources such as hierarchical position or authority (Argyris, 1971; French & Raven, 1959; Rahim, 1989) and (b) not only provide the team with direction or goals to attain, but also resources to facilitate their attainment (House, 1971, 1996). Formal leaders can benefit from being informal leaders as well. Individuals who occupy central nodes in the informal network tend to have access to diverse data that might have important implications for team tasks (Krackhardt, 1996), the kinds of data that would facilitate a leader's power or provide the leader with the information resources necessary for successful task completion. For example, central leaders (or those who are sought for advice or friendship by subordinates) tend to have a more comprehensive view of the social structure of their teams and
this insight might help team leaders in making better decisions (c.f., Greer, Galanter, & Nordlie, 1954). Central leaders are those leaders who occupy such structurally advantageous positions in the informal social networks. In such structurally advantageous positions, leaders 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 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 having a central leader. Actors in the center of social networks 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 to pursue team goals, the performance of the entire network (team) is likely to suffer. More importantly, central leaders might be constrained by their connections to subordinates and might be unwilling to punish subordinates (Fiedler, 1957; Taylor, Hanlon, & Boyd, 1992). This constraint might stem from leader’s apprehension about a backlash from subordinates. Also, the leader might be influenced by subordinates to an extent that leader and subordinates think alike; therefore the leader might be unable to discern poor performance (Dobbins & Russell, 1986; Krackhardt & Kilduff, 1990). Either way, the leader’s ability to act in ways to improve team performance might be limited due to the constraints imposed by the leader’s own social networks. 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 (i.e., have high indegree: or many incoming ties) should tend
to have more rather than less productive teams. Primarily, the teams studied in organizational research are task-oriented. The teams are part 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). As with our logic for the density hypotheses above, we note the overarching purpose of the team is task accomplishment. One 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 the informal social network will be 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, under the backdrop of relationship maintenance as the 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 there might be formal coordination mechanisms to help facilitate inter-group resource exchange (Thompson, 1967), informal ties between teams can be sources of key resources such as knowledge and personnel exchange (Kilduff & Tsai, 2003). As with their leaders, teams can occupy more or less central positions in such an intergroup social network (Tsai, 2000). A central team would have access to unique knowledge -- including where such knowledge is located and how to obtain it (Hansen, 2002) -- which, 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 (tertius gaudens; Burt, 1992).

_Hypothesis 5._ Team centrality in an inter-group 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 the network. By bridging unconnected nodes or by having more connections such structures play an _integrative_ role for the 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 each other. Leaders in such positions can convey information and resources from one subordinate to another who does not communicate directly. Thus, by bridging the unconnected, central leaders act as resource-integrating mechanisms. Similarly, we have proposed that central teams in the inter-group network tend to be better performers because they have access to more, and more unique resources available through their connections to other teams (Tsai, 2000). By bridging unconnected teams, central teams also tend to play an integrative role in the inter-group network. Finally, as mentioned earlier, dense teams tend 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 use the "integrative" term to describe such social structures.
The hypotheses proposed above presume networks already exist in teams, and they have an enduring relationship with team outcomes. As with 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). Further, they also assume that network structures are equally important, 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 the 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 means of communication between just-acquainted members working on novel tasks, or are they most conducive in 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) have received much less attention than static connections (Kilduff & Tsai, 2003). This dual state of affairs can lead to what McGrath, Arrow, Gruenfeld, Hollingshead, and O'Connor (1993) find and refer 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 hold up over longer observation periods in more enduring teams (e.g., diminishing effects of demographic diversity on team viability: Harrison, Price, & Bell, 1998; Harrison, Price, Gavin, & Florey, 2002). Type II temporal errors are conclusions about null effects from short term studies that underestimate the strength of long-term effects. Either type of error might manifest in investigations of network effects in the former kinds of teams (short-range, composed of relative strangers) that would instead surface in the latter kinds of teams (long-range, composed of members that know each other well: Jehn and 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 investigation, perhaps over several rounds of data collection (e.g., likelihood of 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 in different primary investigations (Mitchell & James, 2001). That is, the temporal features of original studies can be coded as moderators in our meta-analysis, and used to (a) help explain the variation in observed links between social network properties and team effectiveness, and (b) answer theoretical questions about how the medium of time
accentuates or mitigates social network -- team outcome relationships.

*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 assume 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, & Smith-Doerr, 1996; for an example at the interorganizational level). That is, the reputation of being a high performer might have a positive effect on the node’s centrality and eventually increases 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 supports us forwarding a 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). Further, there is little information in team-level performance that would provide a member with direction or impetus to go to another (different) team member for advice. Hence, we believe the precedence of networks before performance is more likely and more potent as a time ordering, although this does not rule out performance-network effects.

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 might 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 that 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 act as a substitute for actual interactions, in that team members develop a shared understanding of their task requirements (Weick & Roberts, 1993). The more fully developed, shared understanding of who needs to do what without

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1 This argument does not obviate against previous meta-analytic findings, especially about group cohesiveness and performance (Gully, et al., 1995; Mullen & Copper, 1994).
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 the 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.

**METHOD**

**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 these journals 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, solicitations were sent to members of the Organizational Theory division (Academy of Management) and Social Networks list servers, and posted on the website of the Organizational Behavior division of the Academy. Finally, we contacted authors who had published articles in this area. This multi-pronged strategy provided 37 studies with 63 effect sizes involving 3098 teams.

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2 The list of studies and codes are available on request.
Criteria for Inclusion

An original study had to meet multiple criteria to be relevant 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 that took place under conditions of teams working in the "field," in their natural contexts. Second, the study must have operationalized informal networks using sociometric or social network methodology, including centrality of the leader, team, or density of team members' ties to one another. Third, the team outcome variable in the study had to be group-level (either measured directly at the group level or aggregated from the individual level, but not 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 inter-group conflict (Labianca, Brass, & Gray, 1998).

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 Martocchio, Harrison, and Berkson (2000) for time-based coding. After pilot testing and refining the system, two coders rated 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 questions that asked “who do you go to for work-related advice?” or “who would you want to work with to
accomplish the job most efficiently?” were coded as measuring instrumental ties. Answers to
questions that asked “who are your friends?” or “who do you have close interpersonal
relationships with?” were coded as involving expressive ties.

The raters also coded whether the network structure 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 reviewed here, a majority (16 out of 19) used indegree as the centrality
measure (Wasserman & Faust, 1994). The inter-rater reliability for coding the type of network
structure was .97.

Outcome variables were coded based on how they reflected the primary dimensions of
effectiveness we identified and defined constitutively above: team task performance and team
viability. Criteria that were 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 team (e.g., supervisor: 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 (time lag coded as 1), during (0) or after (-1)
performance (except for Fiedler, 1954). All cross-sectional survey studies were coded as if
networks and performance were measured simultaneously (lag of 0). For temporal sequence there was balanced distribution 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 with 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 of what Marks et al. (2001) refer to as performance cycle (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 et al., 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 the disagreement by discussion. The number of studies across the three levels of familiarity was 4, 6, and 25 respectively.

To understand the nature of the teams studied across the several papers, we coded for team types based on the typology proposed by Sundstrom (1999) (agreement = 71%). According to Sundstrom (1999), teams can be classified into six types based on their position in the organizational hierarchy, tenure, and other structural features. The first type of team is the management team and it has the greatest authority and is generally in the upper echelons of the organization (e.g. top management teams). Unlike management teams, project teams (e.g., new product teams) tend to have varying levels of authority but 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 their authority tends to be limited. Like production teams, service teams (e.g., retail sales teams), tend to be low in the organizational hierarchy but they interact with the organization’s customers. Teams such as surgery teams, and military teams are classified as action teams. Different from all the above teams are the parallel teams as the members are primarily associated with other work-units but come to work as team members occasionally (e.g., quality circles). Of the 37 studies reviewed here, in 11 studies the team members were in the military or were in military training (i.e., action teams; e.g., Levi et al., 1954). Top management teams were studied in 7 articles (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 (min 4, and max 1245). Teams studied in these papers ranged in size from 3 members to 15 members, with the average team size being 8.

Meta-Analytic Techniques

We calculated effect sizes using the methods described by Hunter and Schmidt (1990), which allow for corrections due 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: means and standard deviations, $\chi^2$ values (when performance was dichotomized), $t$ tests, $F$ tests, or $p$-values into product-moment correlations. This effect size was then transformed to a Fisher’s $z$ before averaging. Fisher’s $zs$ were transformed back to correlations before we reported them in Table 1.

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, Baldwin et al., (1997) 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 $z$ values and then averaged the values to have one effect size for a relationship per study. Further, when conducting the moderator analyses involving the integrated social network structures, there were multiple effect sizes from the same study (e.g., Mehra, Dixon, Robertson, & Brass, 2004). In such cases, we retained only one effect size from the concerned studies so as to maintain independence of effect sizes.

Also, following Hunter and Schmidt's (1990) recommendations, we corrected the individual correlation for study artifacts such as unreliability of the dependent variables. Studies have 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 rho. 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. This is a fairly conventional practice in a meta-analysis.

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 weighing each effect size by
sample size (Glass, McGaw, & Smith, 1981). This procedure allowed us to examine the fit of our Hypotheses 3a-b, 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.

----- Insert Table 1 here -----

Density - Performance: Hypotheses 1a and 1b

Recall that Hypotheses 1a and 1b assert that teams with more dense social networks tend to perform better (see Table 1). As predicted by Hypothesis 1a, density of a team's network of instrumental ties was positively, albeit not strongly, related to team task performance. The average, corrected correlation was $\rho = .15 \ (k = 17, N = 2442 \text{ teams}, 95\% \text{ CI} = .09 -- .17)$. The failsafe $k$ 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 $\rho = .22 \ (k = 9, N = 515, 95\% \text{ CI} = .12 -- .28)$. 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 Hypothesis 2a-b? The results in Table 1 show they do. Our meta-analytic findings support the prediction that teams
with more dense instrument ties have greater team viability. The average, corrected correlation across $k = 10$ studies ($N = 1730$) was $\rho = .14$ (95% confidence interval ranging from $\rho = .09$ to $.18$). Similarly, we found support for Hypothesis 2b ($\rho = .55$, $k = 4$, $N = 178$, 95% CI = $.33 -- .57$). That is, 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-b**

We reasoned that the impact of network structures depended on the tie content in those networks. Hypothesis 3a predicted 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; $p = 0.74$). Indeed, the task performance implications of instrumental ties were no different than those of expressive ties: $\rho_{\text{instrumental}} = .23$; $\rho_{\text{expressive}} = .21$ ($k = 21$; t test $p > .10$). Hypothesis 3b predicted that a team's expressive tie density would have 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 provided by leaders who are central in the team's instrumental social network (Hypothesis 4) and to teams for being central in an intergroup network (Hypothesis 5). Does centrality of the leader and the team 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 \( \rho = .29 \) \((k = 13, N = 505, 95\% \text{ CI} = .19 -- .35)\). 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 inter-team networks benefits team task performance: \( \rho = .13 \) \((k = 10, N = 440, 95\% \text{ CI} = .04 -- .22)\). 12 studies with an average effect size of zero would need to be conducted to undermine 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 -- would temper the strength of social network - performance links. Table 2 presents results for time-based moderators of integrative network structures and team performance.

----- Insert Table 2 here -----  

Hypothesis 6 proposed that having a more integrative network structure would be beneficial for future team task performance, but would not be as likely to reflect past performance. We tested this hypothesis by sample-size weighted regression (Glass et al., 1981) of effect size on the coded lags (-1, 0, 1) described above. Results are consistent with the hypothesis. Network structures that ease the sharing of resources are more facilitative of team task performance than vice versa \((\beta = .41, k = 34, p < .05)\). The corrected effect size for network - performance (predictive) relationships \((\rho_{\text{predictive}} = .28, \ k = 12, 95\% \text{ CI} = .20 -- .36 )\) was substantially higher than for performance-network (postdictive) relationships \((\rho_{\text{postdictive}} = .09, k = 12, 95\% \text{ CI} = .04 -- .14)\), although the latter is still positive.

Our final prediction was that familiarity would grow to serve as "substitute" for network structure. The greater the familiarity of team members with each other and the 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 more experience with one another and their work, effects of those ties declined ($\beta = -.40$, $k = 35$, $p < .05$).

**DISCUSSION**

Do network structures matter for team effectiveness? How? The purpose of this meta-analysis was to answer these questions, often in cases where different theoretical approaches make opposing predictions and trends in existing studies are 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 role of social networks in performance and viability. Networks do matter for teams. Teams with dense configurations of ties tend to better attain their goals, and are more likely to stay together than teams with sparse configurations. In addition, teams with leaders who are central in their 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 patterning. That is, expressive (friendship) tie density had roughly the same effect on team performance as instrumental (advice) tie density. However, consistent 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 position or causal sequencing is crucial. Theory predicts (Jehn & Shah, 1997), and the meta-analytic data show, that integrative network structures are more strongly positioned in time as antecedents to team performance, rather than byproducts of it. Second, another form of time (e.g., familiarity or developmental stage in the team) serves as a neutralizing mechanism for 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 for years have been arguing about what constitutes good research and when does science actually advance (Popper, 1959). One way to evaluate scientific advancement is to see whether alternative explanations for the phenomenon 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. 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, the effect of social network density on team task performance (Hypotheses 1 and 3) has been proposed to be negative by some researchers. 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 towards 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 the 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 (with negative implications for closely tied team members), and therefore hamper task performance (Fiedler, 1957; Hughes, Ginnett, & Curphy, 1999). Finally, the putative role of social structures as an antecedent rather than consequence (or merely, 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 the opposing sequence (c.f., Hinds et al., 2000; Lawler, 2001; Mullen & Copper, 1994).

There were opposing theoretical drumbeats in each case, setting the stage (that meta-analysis is well-suited for) to provide a strong inference. That is, in all cases, theory predicted 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 (a) the content of ties and the focal dimension of effectiveness, (b) the timing of the network structure relative to the execution of team tasks, and (c) member familiarity or time spent interacting with one another on tasks.
Future Contributions to Theory

Comparable to the increasing organizational reliance on teams, there has been growing interest and sophistication in management research on teams (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’s personality and other relevant characteristics to explain team level outcomes. In contrast, the studies reviewed here use the relational approach that focuses on the interactions among members and overlooks the individual’s personality. Although there have been attempts at integrating the attribute and relational approach at the individual level (Mehra, Kilduff, & Brass, 2001), there has not been a sustained effort 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 effect sizes estimated in the current paper (which are likely underestimates, given the inability to correct network variables for predictor unreliability that is more easily calculated in attribute variables) range from $\rho = .14$ for density of instrumental ties on team viability to $\rho = .55$ for 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 (Gully et al., 2002, $\rho = .41$ with performance), group goal difficulty (O'Leary-Kelly et al., 1994: $\rho = .41$ with performance), task conflict ($\rho = -.32$ with team member
satisfaction), and relational conflict ($\rho = -.54$ with satisfaction; De Dreu & Weingart, 2003).

However, the theoretical contribution of this meta-analysis is distinct from the above studies on multiple dimensions. First, previous work has found that team performance predicts group cohesion (Mullen & Copper, 1994). However, we find that network structures have a stronger effect 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 have explored the correlations between the two dependent variables in our study (see Figure 1). Second, this review brings to fore the significance of cross-level effects in team performance. In most team-level research, researchers explore how team level constructs (measured at the team level 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 paper, we find that a leader’s position in the informal network has cross-level effects on the team performance. Finally, there are very few meta-analyses that explore relationships at multiple levels. In this study, three separate levels are explored -- individual (leader-centrality), intra-team (network density), and inter-team (team-centrality).

An important contribution of the current paper, therefore, is that the meta-analytic results lay the groundwork and highlight the need for theory that simultaneously accounts for attribute and structural 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 non-optimal network structures, which, in turn, deters 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 team 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 paper is to highlight the role of time in social networks and team performance. There are existing theories about teams and time (Gersick, 1988) and about networks and time (Kilduff & Tsai, 2003), 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 provide additional support to the diminishing effects of networks as the team tenure increases. Our findings suggest that networks have a stronger impact on performance than the effect of performance on network structures. Instead of seeing this in a snapshot fashion if one were to look at this finding over time (i.e.,
multiple performance episodes), one realizes that networks have a reduced effect on performance over multiple performance episodes. That is, network effects attenuate during the tenure of the team. In the first performance episode, the network effects on performance are the strongest. Subsequent to the completion of task and evaluation of performance, there would be 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. Overtime, the network structure’s effect on performance would be minimal.

Limitations and Research Directions

As with all other meta-analyses, ours reflects many of the methodological advantages and disadvantages of the original studies. For example, in all 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 in this research area there is a need for more field experimentation. One might be able to conduct such an experiment, for example, by structuring the network in virtual teams such 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 the laboratory experiments on social network structures and team outcomes, many of which were also published in the 1950's (e.g., Bavelas, 1950). Even though there has been at least one meta-analysis that
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 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 the moderator variables (a problem of second-order sampling error: Hunter & Schmidt, 1990). However, many other meta-analyses have relied on similar number of original studies (i.e., $k$) and most have fewer number of teams (i.e., $N$), (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 fail-safe $k$ 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 paper, and we note that the marginal impact of the 25th or 26th study network effects within teams is not as crucial for statistical power as the 10th or 11th (Glass et al., 1981; we also note 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 be able to follow up the hypothesis with a meta-analytic estimate. This is one area of future 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 the 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 interaction between network variables on team level outcomes.\(^3\) Similarly, there is need to understand whether tie content moderates the performance effects of team’s 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 from effectiveness), learning and innovation. The preliminary evidence suggests that there is a theoretical basis to expect a connection between networks and learning. External ties facilitate knowledge acquisition that is non-redundant 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 in the search for complex knowledge, but 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

\(^3\) We would like to thank one of the reviewers for suggesting this point.
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 (a) perform better and (b) remain more viable. Teams perform better when their leaders are central in the intra-team network, and when they, as a team, are more central in an inter-group network. These effects are especially potent when the network structures precede initial bouts of performance, but they diminish over elapsing time and growing familiarity of team members. 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.
REFERENCES

* Studies included in the meta-analysis


*Tsai, W. 2000. Social capital, strategic relatedness and the formation of intraorganizational linkages.


### TABLE 1

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

<table>
<thead>
<tr>
<th></th>
<th>k Studies</th>
<th>Total N</th>
<th>Mean r</th>
<th>Var r</th>
<th>95% Conf. Interval</th>
<th>Est. ρ</th>
<th>Fail-Safe k</th>
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<td></td>
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<tr>
<td>H1a: Density of Instrumental Ties</td>
<td>17</td>
<td>2442</td>
<td>.13</td>
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<td>(.09, .17)</td>
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<td>9</td>
<td>515</td>
<td>.20</td>
<td>.02</td>
<td>(.12, .28)</td>
<td>.22</td>
<td>56</td>
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<tr>
<td>H4: Team Leader Centrality</td>
<td>13</td>
<td>505</td>
<td>.27</td>
<td>.27</td>
<td>(.19, .35)</td>
<td>.29</td>
<td>130</td>
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<tr>
<td>H5: Team Centrality in Inter-Group Network</td>
<td>10</td>
<td>440</td>
<td>.13</td>
<td>.05</td>
<td>(.04, .22)</td>
<td>.13</td>
<td>12</td>
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<tr>
<td>H2a: Density of Instrumental Ties</td>
<td>10</td>
<td>1730</td>
<td>.14</td>
<td>.02</td>
<td>(.09, .18)</td>
<td>.14</td>
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<td>H2b: Density of Expressive Ties</td>
<td>4</td>
<td>178</td>
<td>.45</td>
<td>.01</td>
<td>(.33, .57)</td>
<td>.55</td>
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TABLE 2
Time-Based Moderators Predicting Relationship Between Integrative Network Structures and Team Performance

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
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<tr>
<td>Precedence</td>
<td>0.41*</td>
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<tr>
<td>Familiarity</td>
<td></td>
<td>-0.40*</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.17*</td>
<td>0.16*</td>
</tr>
<tr>
<td>k</td>
<td>34</td>
<td>35</td>
</tr>
</tbody>
</table>

*p < 0.05; **p < 0.01;
FIGURE 1:
Theoretical Framework
Linking Team Network Structure to Team Outcomes

Team Network Structure
• internal
• external

Tie Content
• instrumental
• affective

Time
• precedence
• familiarity

Team Viability

Connection established in meta-analyses from Mullen and Copper (1994), Gully et al., (1995), and Beal et al. (2003)

Team Effectiveness

Team Performance
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