Tie and Network Correlates of

Individual Performance in Knowledge Intensive Work

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ABSTRACT

We argue that individual performance in knowledge intensive work is associated with properties of both networks and ties. Networks can yield benefit via awareness of and access to non-redundant information. Ties such as relationships crossing organizational boundaries, physical barriers and hierarchical levels, also provide opportunities to gather unique information and consider diverse perspectives when completing tasks at work. Egocentric and bounded network data from 101 engineers within a petrochemical company and 125 consultants within a strategy-consulting firm support our contention that both networks and ties are related to individual performance in knowledge intensive work.

Keywords: Social Networks, Information, Individual Performance, Knowledge Intensive Work

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Social network theory informs us that networks spanning social divides are associated with performance related outcomes (Burt, 1992). For example, research assessing individual (or egocentric) networks has established links between performance and structural holes, defined in terms of lack of connectivity among people in one's network. People with networks rich in structural holes are more likely to be promoted early, enjoy greater career mobility and adapt to changing environments more successfully (Burt, 1992; Podolny & Baron, 1997; Gargiulo & Benassi, 2000). Similarly, research assessing whole (or bounded) networks has found links between network positions and individual performance. For example, Brass (1984) found centrality in an informal communication network to be associated with promotion. More recently, Mehra, Kilduff, and Brass (2001) found centrality in a workflow network to be positively related to supervisor ratings in a high-technology company.

In considering performance related outcomes, network research has traditionally focused on the structure of *networks* (Burt, 1992; Granovetter, 1973; Sparrowe, Liden, Wayne & Kramer, 2001) and paid comparatively less attention to theoretically important features of *ties*, or relationships, within these networks (Higgins & Kram, 2001; Monge & Contractor, 2001; Adler & Kwon, 2002). In this line of inquiry, a tie's value is determined by its incremental effect on network structure (Burt, 2000: p. 353-355; Mehra, Kilduff & Brass, 2001: p. 122). Yet access to information in organizations is to some degree conditioned by structure and hierarchy (Lincoln, 1982; Nadler & Tushman, 1988; Salancik, 1995). As a result, it is reasonable to anticipate that certain ties might yield better or more relevant information than others. Ties to those higher in the organization might be valuable because superiors provide experience, novel information and legitimation (Galbraith, 1973; Brass, 1984; Stevenson & Gilly, 1991). Ties to those in other

functions might be valuable because they yield unique, project-relevant knowledge (Szulanski, 1996; Hansen, 1999). It is not clear that network structure alone captures the effect that such ties have on information acquisition and performance in knowledge intensive work.

This study was undertaken to help disentangle tie and network correlates of individual performance in knowledge-intensive work. Using social network and performance data from two organizations, we argue that properties of both ties and networks can increase the quality and relevance of information an individual receives and concurrently improve the performance of those engaged in knowledge-intensive work.

Network Correlates of Individual Performance

Information Network Position

Job performance in knowledge intensive work is, to some degree, a product of obtaining the right information to solve novel, challenging problems. In information search, cohesive or closed networks might promote consistent norms, trust, and cooperation that motivate contacts to share knowledge (Coleman, 1988; Granovetter, 1985; Reagans & McEvily, 2003). However, closed networks might also have "unintended consequences" on performance if they result in comfortable or validating interactions but not the most relevant knowledge for the task at hand (Erickson, 1988; Mizruchi & Stearns, 2001). Information networks spanning social divides should improve performance in knowledge intensive work because one is tapping into more relevant expertise when framing problems and acquiring information to solve them (Burt, 1992).

Network position might also provide an ability to help absorb knowledge acquired elsewhere. Reagans & McEvily (2003) demonstrate that having broad networks, by increasing one's perspective, can enhance the ability for people to convey complex ideas to diverse audiences. The same concept should facilitate acquisition and absorption of potentially useful knowledge. A more diverse perspective should increase the likelihood that one understands how

to use relevant information located in socially distant regions of a network. As a result, betweenness centrality, or the extent to which an individual is on the shortest information path connecting individuals who themselves are not connected, should be associated with one's ability to obtain and apply relevant information to solve problems efficiently and effectively (Mehra, Kilduff, & Brass, 2001).

Hypothesis 1. *Greater betweenness centrality* in an information network will be positively related to that individual's performance ratings.

Awareness Network Position

In knowledge intensive work, information networks are often dynamic and shift when new projects demand different kinds of information and expertise. As new problems or opportunities arise, the set of relationships one is currently tapping for information can be less helpful than a different group of people one is aware of and able to turn to for information relevant to new tasks. Gargiulo & Benassi (2000) found that managers' ability to adapt to new challenges was in part structurally determined – more effective managers had less constrained networks. We extend this idea and suggest that in addition to patterns of current information seeking, adaptation is also a product of the network one *could* tap in the face of new problems and opportunities. A network can supplement a person's ability to respond well to new challenges when that person knows who to seek out for information or expertise relevant to a new project. Thus individuals more aware of colleagues' expertise within a network should be more likely to reach out to the right people at the right time when presented with unique challenges or opportunities.

One's awareness of another's expertise, or the extent to which one person knows what another person knows, is associated with the likelihood of seeking information that person (Borgatti & Cross, 2003), though position in an awareness network has yet to be explored in the

context of performance. Here we suggest that greater awareness of disparate expertise within a network improves one's ability to respond appropriately when new projects demand different knowledge. Specifically, betweenness centrality in a network established by awareness of colleagues' expertise should increase one's access to relevant knowledge in distant regions of a network and so help one to act efficiently and effectively when new projects demand different information or expertise.

Hypothesis 2. *Greater betweenness centrality* in an awareness network will be positively related to that individual's performance ratings.

Tie Correlates of Individual Performance

Boundary Spanning

Boundary spanning has long been known to influence how information enters organizations (Tushman, 1977; Tushman & Katz, 1980). For example, ties crossing organizational boundaries are associated with adoption of less normative strategies (Geletkanycz & Hambrick, 1997), acquisition of competitive capabilities (McEvily & Zaheer, 1999), and product innovation (Hargadon & Sutton, 1997). Information can also come from other units within the same organization but outside of one's group, thus spanning functional or business unit boundaries. Early work demonstrated the critical role of gatekeepers crossing technical boundaries (Allen, 1977). More recently, research has demonstrated the importance of ties crossing department or functional boundaries for effective knowledge transfer within organizations (Hansen, 2000; Szulanski, 1996; Tsai, 2001). Here we simply suggest that in complex work that demands integration of specialized knowledge, people with ties crossing both *organizational* and *departmental* boundaries are likely to find more relevant information and be more effective in solving problems.

Hypothesis 3a. An individual's number of ties that span *outside of the organization* will be positively related to that individual's performance ratings.

Hypothesis 3b. An individual's number of ties that span to *other departments in the organization* will be positively related to that individual's performance ratings.

Physical Barriers

Ties that span physical barriers can also expose people to more relevant information and expertise. People within the same physical location, such as colleagues who have offices down the hall from one another, are likely to share similar kinds of information as demonstrated by empirical research on propinquity (Allen, 1977; Kraut, Egido, & Galegher, 1990). Studies of the physical work environment, such as the use of walls or partitions to enclose spaces in an office, have also illustrated how working within the same location can constrain the flow of information (Davis, 1984; Zalesny & Farace, 1987). Whether it is data on market conditions in a different country or information about a client in a different city, ties that span physical barriers increase opportunities to access critical information when it is needed and so should result in improved performance for those engaged in knowledge intensive work (DeSanctis & Monge, 1999). Recent research demonstrates that task-relevant knowledge sharing with people in different geographic locations can boost performance at the project level (Cummings, 2004). We simply extend this idea to the individual and suggest that people with ties spanning physical barriers are more likely to be exposed to unique and relevant knowledge helpful in solving complex problems.

Hypothesis 4. An individual's number of ties that span *physical barriers* will be positively related to that individual's performance ratings.

Hierarchical Ties

A final characteristic of ties that may increase the value of information acquired through a network is hierarchy or formal chain of command. Social resource theory suggests that those in higher status positions have desirable resources such as wealth, prestige, power, and access to others, and that ties to such people can improve job reward outcomes (Lin, 1999; De Graff & Flap, 1988; Marsden & Hurlbert, 1988). In terms of information flow, those higher in the hierarchy often have access to information not available at lower levels of an organization by virtue of reports or periodic administrative meetings to which they are privy (Galbraith, 1973; Mintzberg, 1973). Senior managers also tend to have more contacts outside of an organization as well as to other managers in different units (Stevenson & Gilly, 1991; Carroll & Teo, 1996). Thus those higher in the hierarchy are likely to have greater breadth of information and perspective than those lower in the hierarchy. Further, contacts higher in the hierarchy can be valuable for the legitimacy they provide to information. Obtaining information from those of higher status might confer legitimacy to either a person or an idea and thereby help people put their plans into action (Brass, 1984; Cross, Rice & Parker, 2001; Feldman & March, 1981).

Hypothesis 5. An individual's number of ties that reach to *higher hierarchical levels* will be positively related to that individual's performance ratings.

METHODS

Sample

We conducted our research with engineers in a petrochemical company and consultants in a strategy-consulting firm. Preliminary interviews, observation and existing documentation on the organizations confirmed that work in each setting was highly knowledge intensive and collaborative in nature. Further, these sites were willing to provide quality performance data. We surveyed the engineering function supporting drilling efforts within the petrochemical

organization. A total of 101 out of 106 respondents (95% response rate) completed the entire survey, 90.1% of whom were men. The average respondent had worked in the organization for 17 years. We also surveyed a major office within the strategy-consulting firm. A total of 125 out of 127 employees in the consulting firm (98% response rate) completed the entire survey, 70.4% of whom were men. The average respondent had worked in the organization 41 months.

Data Collection

Data were collected via two e-mail surveys that respondents reported taking 40-55 minutes to complete. Participants were guaranteed that their responses would be held confidential. All surveys were returned directly to the lead author. In the engineering group, a pre-test with 18 respondents was conducted to ensure correct use of relevant language and interpretation of the instrument. In the consulting organization, a pre-test with 23 respondents was also conducted. Results from both pre-tests suggested consistent interpretation of items.

Two days prior to administration, a senior executive sent out an e-mail notification of the survey requesting that all employees participate and indicating that all responses would be completely confidential. The initial survey then obtained background information and ego-centric data on each respondent's unique set of relationships (Marsden, 1990). Here we followed a standard two-step name generator/interpreter methodology to elicit and then characterize respondents' relations (Scott, 1990; Wasserman & Faust, 1994). The survey instructed respondents to:

> Please identify up to twenty people that are important in terms of providing you with information to do your work or helping you think about complex problems posed by your work. These may or may not be people you communicate with on a regular basis and can come from within [the organization] or outside (e.g., clients, friends in other organizations, former work colleagues, family, etc.).

Respondents were given 20 blank lines to list people. The maximum number of names recalled was 15 (M= 10.1; s.d.= 4.9 for the engineers; M= 5.8; s.d.= 1.8 for the consultants).[1] Four name interpreters asked questions of the people respondents had listed. This initial survey was critical for establishing boundary-spanning ties that reached outside of the department but inside the organization and those that reached outside of the organization.

We collected structural data via a second bounded network survey. This allowed us to compute betweenness centrality based on each respondent's perceptions of their relationships as opposed to relying on a respondent to be able to accurately report on associations among people in their network. Though this approach potentially constrains respondents' networks, we felt this was acceptable due to the improvement in accuracy of reports on indirect relationships.

Within a few days of receiving the initial survey, the bounded network survey was administered via e-mail, and asked respondents to rate all other members of either the engineering group or the consulting office on three network questions. The first two questions provided data on: a) the set of relationships that the respondent indicated relying on for information (GetInfo) and b) the set of relationships that the respondent indicated providing information to (GiveInfo). This allowed us to consider both perspectives in constructing a "verified" information-seeking network. The third question was drawn from Borgatti and Cross (2003) and allowed us to assess each person's awareness of others' expertise (i.e., the item asked people to rate the extent to which they were aware of the knowledge and skills of each person in either the engineering group or consulting office). Overall there was no substantial reason to be

[1] One explanation for the difference in egocentric network size derived from follow-on interviews is the nature of the work in each setting. Projects in the strategy consulting firm were often very different from one to the next in terms of both industry and client problems. As a result, interviewees suggested that they had fewer core relationships repeatedly sought out for information and expertise but a larger group of people that they might turn to on a one-off basis depending on the demands of the project. In contrast, in the engineering function, though problems were complex they were often of a similar nature. Thus there tended to be a larger group of people one could seek out for information or expertise on a recurring basis.

concerned about non-response when we assessed: 1) non-respondent versus respondent characteristics, and 2) non-respondents' position in the network established by respondents.

To ensure reliability, questions were specific and provided detail as to the construct of interest. In the information seeking networks, we assessed typical interactions (Freeman, Romney & Freeman, 1987), as research has demonstrated respondents to be poor at accurately recalling interactions occurring in specific time intervals (Bernard, Killworth, & Sailer, 1982).

Variables

Outcome variable. Both organizations had very similar annual employee evaluation processes based on several points of data for each employee. First, at the conclusion of each project (whether an engineering project or consulting study) the manager in charge of the work completed an evaluation of each employee's performance in terms of quality of output, efficiency, innovativeness, and ability to work well with peers. Second, where a project involved more than one employee, peer feedback was collected from relevant team members and occasionally customers (internal customers for the petrochemical organization) to obtain different perspectives on employee performance. Finally, objective measures appropriate to the project were also tracked during the course of a year (e.g., hours billed to engineering efforts or consulting projects). At year-end, an annual evaluation was conducted based on these points of data by a supervisor who did not typically work with the person under review to remove biases in the evaluation. At the conclusion of this process an overall rating was given, on a 5-point scale, and this forms our dependent variable (engineers: M=3.63, s.d.=0.74; consultants: M=3.75 s.d.=0.91).

Independent variables. The boundary spanning variables were constructed from the egocentric network data. Other tie and network variables were derived from a respondent X respondent matrix for information flow (GetInfo and GiveInfo) and awareness. Though we could

have used the egocentric network data to establish all of the tie variables, we chose to use the bounded network where possible given the verification procedure we conducted with this data. However, both egocentric and bounded network variables yielded the same significant results.

In terms of the information network, for each pair in the network (*i*,*j*), we assessed on a 5-pt scale (1: strongly disagree, 5: strongly agree) the extent to which person *i* claims to turn to person *j* for information ("Please indicate the people below that *you typically turn to* for information or knowledge on work-related topics") as well as whether person *j* indicates that person *i* turns to him/her for information ("Please indicate the people below that *typically turn to you* for information or knowledge on work-related topics"). In terms of the awareness network, respondents were also asked to assess on a 5-pt scale (1: strongly disagree, 5: strongly agree): "I understand this person's knowledge and skills. This does not necessarily mean that I have these skills or am knowledgeable in these domains but that I understand what skills this person has and domains they are knowledgeable in." We dichotomized the information and awareness network data at greater than three (the neutral value), and we used an estimate pooling technique to lessen potential response biases. For the information network, our bounded network data is based on relations where agreement exists between the GetInfo matrix and the transpose of the GiveInfo matrix (Borgatti, Everett and Freeman, 1999).

Boundary Spanning. Based on the ego-centric network survey, this variable was constructed from the number of ties a) outside either the engineering function or consulting office but inside the specific organization, and b) outside the organization.

Physical Barriers. Based on the bounded network survey, this variable was constructed from the number of relationships outside of the respondent's office floor, which previous research suggests is a breaking point for spontaneous communication (Allen, 1977). Consultants were dispersed across three floors and engineers across four floors in an office building.

Hierarchical Ties. Based on the bounded network survey, this variable was constructed from the number of ties to those higher in the hierarchy.

Information Network Position. Derived from the bounded network data for information, this variable was based on flow betweenness computed in UCINET 6 (Borgatti, Everett & Freeman, 1999). The network employed in this calculation was the verified information network per the procedure outlined above. Following Mehra, et al (2001), we used betweenness centrality because of the metric's ability to assess the effect of ties beyond one remove from the person.

Awareness Network Position. Derived from the bounded network data for awareness (i.e., respondents indicating their awareness of the knowledge and skills of each person in either the engineering group or consulting office), this variable was based on flow betweenness computed in UCINET 6 (Borgatti, Everett & Freeman, 1999). Betweenness centrality was used given its ability to account for direct and indirect ties thereby potentially capturing greater access to expertise than metrics such as out degree.

Control variables. Four variables were included as controls: *tenure*, *hierarchy*, *gender* and *network autocorrelation* via QAD (Gabbay and Zuckerman, 1999; Lincoln 1984). We also considered a fifth variable, *egocentric network size,* but found the measure too highly correlated with the tie variables to include in the final analysis.[2]

ANALYSIS AND RESULTS

[2] For the engineers, the average correlation between network size and boundary spanning tie variables was r = .47, and for the consultants, the average correlation between network size and boundary spanning tie variables was r = .38. Moreover, in OLS regression results with network size included in the model along with control variables predicting individual performance, only 2% of the variance is accounted for in the engineers sample and only 5% of the variance is accounted for in the consultants sample. However, when the tie variables are substituted for network size, 38% of the variance is explained with the engineers and 33% of the variance is explained with the consultants. Thus, the boundary spanning tie variables account for much more variance than network size alone.

We first assessed bi-variate correlations and descriptive statistics as outlined in Table 1. In general, results show significant correlations between dependent and independent variables as well as acceptable correlation levels among the independent variables.

|Editors Note: Insert Table 1 About Here|

OLS regressions reported in Table 2 were used to test our hypotheses. The first model captures the control terms. In each case, the variance accounted for is low, 2% for the engineers and .9% for the consultants. The second model shows that our network centrality variables are statistically significant and improve the variance accounted for in each site (16% for the engineers; 30% for the consultants). The third equation tests our full model with 46% of variance accounted for among the engineers and 42% among the consultants. Results indicate in both cases that the ties significantly improve variance accounted for in each site.

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We find full support for Hypothesis 1 regarding position in the information network ($p < .01$ engineers, $p < .05$ consultants), and for Hypothesis 2 regarding position in the awareness network ($p < .05$ in both organizations). We also find full support for Hypothesis 3a and 3b, ties reaching outside of the organization ($p < .05$ engineers, $p < .05$ consultants) as well as outside of one's department but inside the organization ($p < .05$ engineers, $p < .05$ consultants) are significantly related to performance. Similarly we find full support for Hypothesis 4, that ties crossing physical barriers are related to performance ($p < .05$ for consultants, $p.<.01$ engineers). However we find only partial support for Hypothesis 5 claiming that ties reaching up in the hierarchy are related to performance ($p < .05$ in the consulting organization).

DISCUSSION

Contributions to Theory

This study sought to better understand the relationship between ties, networks, and job performance in knowledge intensive work. To that end, we offer two substantive findings. First, ties spanning aspects of organizational structure were significant in models that controlled for network centrality. It seems that organizational structure provides some with access to different information than others, and so makes some ties more valuable than others. Second, we found betweenness centrality in both information and awareness networks to be related to individual performance. Centrality in an information network reflects one's ability to tap expertise for current concerns while centrality in an awareness network reflects one's ability to take action on new opportunities by leveraging others' expertise. Thus while Krackhardt (1990) found accurate perception of ties in an advice network to be associated with reputational power, we suggest that awareness of others' expertise can affect performance by increasing the likelihood of obtaining relevant information to solve novel problems.

A strength of this research lies with our consistent findings across two organizations. In the network literature, most bounded network studies have drawn generalizations from a single organization. Here we were able to find generally consistent results across two organizations operating in different industries. Another strength of this study lies with the combination of egocentric and bounded network assessments. Network studies have typically relied on either egocentric or bounded networks. The strength of the egocentric network is that it is not constrained by a network boundary imposed by researchers. However, it is limited in its ability to consider structural characteristics of networks beyond one remove from the survey respondent and is also heavily reliant on the respondent's perception of ties among people in their network. The strength of the bounded network approach lies with an ability to consider position within an entire network yet it always entails some form of boundary specification that constrains people's

individual networks (Laumann, Marsden & Prensky, 1983). By combining approaches we hope to have captured a more holistic view of our respondents' networks.

Limitations

Of course this research has limitations. First, this study focused on complex and non-routine work, which imposes important boundary conditions on our findings. In the organizations we assessed, projects affecting an individual's performance often required integration of disparate expertise. Ties are more likely to relate to individual performance in such contexts. Similarly, we studied non-routine work where one can expect information flow networks to be dynamic and shift depending on the set of projects underway at a given point in time. In such settings, information flow might not reflect more enduring aspects of network structure, and this might account for our findings in relation to the awareness network. Other forms of knowledge work might follow policy or routines more closely and so result in scenarios where awareness is less relevant to performance than task flow networks (Mehra, Kilduff & Brass, 2001). However, we feel this limited ability to generalize findings is mitigated by the need to better understand networks and individual performance in increasingly prevalent, de-layered, project-based work environments (Cummings & Cross, 2003).

Second, we were able to only obtain a single, overall measure of each person's performance. This aggregate rating restricts our ability to develop a nuanced view of relationships between individual networks and dimensions of performance. It also potentially introduces measurement bias. However, in terms of construct validity, we feel this limitation is mitigated by the multiple observations of performance that informed each rating. The rating was not solely a product of one person's feeling toward another but derived from peer evaluations, supervisor project ratings, and objective metrics such as billable hours. We also note that this is a measure of job performance within an organization as opposed to career related outcomes. Very

few studies in organizational contexts relate bounded network data to measures of job performance (c.f., Brass, 1981; Sparrowe, et al, 2001; Mehra, Kilduff & Brass, 2001).

Third, our awareness network is simply that – a measure of the extent to which one person believes they are aware of another's expertise. This measure can be distorted if people's perceptions are inaccurate. It also does not reflect the quality or depth of a contact's expertise. Survey length precluded us from being able to measure levels of expertise, though this is something we would certainly encourage in future work. That being said, we do note that awareness is a determinant of whom one seeks out for information (Borgatti & Cross, 2003) and so helps one make informed choices of who to seek out (or avoid) in the face of a new opportunity or challenge.

Directions for Future Research and Implications for Practice

Despite limitations, we feel this work advances theory. First, this study helps establish links between network characteristics and performance. We hope that future research will continue to apply theory to more precisely understand relationships between individual network characteristics and important outcomes such as performance. We feel a fruitful line of research would be to focus on theoretical mechanisms at work in such studies as well as developing more sophisticated models of performance. It makes sense to anticipate that different network profiles might be associated with dimensions of performance such as efficiency, effectiveness, and innovation. For example, closed networks might result in more efficient and effective action when cooperation is critical, whereas in less interdependent settings efficiency and effectiveness might arise from networks providing greater informational return. Further, clarifying contingencies in terms of the type of work would also yield greater precision in our understanding of the association between networks and performance.

Second, we hope scholars will continue to study theoretically important tie characteristics. Here we found in two different organizations that ties contributed to individual performance after controlling for network centrality. While we hope scholars will continue to assess the role of ties spanning aspects of formal structure as appropriate, we also hope that more attention will be paid to expressive dimensions of relationships in networks. Expressive relations, though potentially willing to be appropriated for instrumental purposes, might have unintended consequences on performance related outcomes. For example, friends might be willing to provide information or help, but relying on friends too heavily might result in lower quality solutions if they don't have the most relevant expertise for the task at hand (Kilduff, 1992). Alternatively, we are likely to seek out those we trust for information (Levin & Cross, 2004). Yet blind or mis-placed trust can have negative implications for information acquisition and performance. We hope that future social network research will consider these and other expressive features of relationships in models of performance.

Finally, this work holds importance for practitioners. In addition to simply increasing the volume of information flow in networks, managers should look to enhance awareness of other's expertise. Encouraging employees to collaborate across boundaries represent ways managers can foster awareness of who knows what in the organization. Furthermore, individual performance may be improved if formal human resource processes such as annual development programs, staffing practices, or mentor programs focus on helping employees establish relationships that span departmental and organizational boundaries, physical barriers, or hierarchical levels.

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TABLE 1

Means, Standard Deviations and Correlations: Engineers (N=101) [a]

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1 Tenure (Months)	203.5	96.2	–											
2 Hierarchy	1.39	0.49	-.10	–										
3 Gender	0.01	0.30	-.01	-.02	–									
4 Ties Outside Organization	1.18	1.83	-.09	-.15	.10	–								
5 Ties Outside Dept In Org.	3.75	3.77	.13	.01	.09	.25•	–							
6 Ties Across Phys. Barriers	3.65	3.72	.00	-.09	.05	.17	.42••	–						
7 Ties Higher In Hierarchy	2.67	2.68	-.04	-.03	.05	.23•	.48••	.41••	–					
8 Betweenness (Info)	1.40	2.37	.13	.21•	.25•	.01	.03	-.05	.14	–				
9 Betweenness (Aware)	0.74	1.30	.22••	.15	.02	.12	.19	.13	-.01	.32••	–			
10 Autocorrelation (Info)	3.07	0.36	.03	.03	.03	-.12	-.01	-.27••	-.17	.09	.03	–		
11 Autocorrelation (Aware)	3.31	0.14	-.11	-.01	.09	.04	.06	.06	.14	.08	-.06	.02	–	
12 Performance	3.63	0.74	.11	-.03	.02	.36••	.49••	.53••	.43••	.29••	.22••	-.18	.15	–

[a] Two-tailed tests; • $p < .05$; •• $p < .01$

Means, Standard Deviations and Correlations: Consultants (N=125) [a]

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1 Tenure (Months)	40.8	46.9	–											
2 Hierarchy	2.34	1.57	.58••	–										
3 Gender	0.30	0.46	.03	-.23••	–									
4 Ties Outside Organization	0.90	1.22	-.05	.07	-.10	–								
5 Ties Outside Dept In Org.	2.02	1.96	.12	.09	-.13	-.06	–							
6 Ties Across Phys. Barriers	3.15	2.05	-.08	-.05	.06	-.09	-.08	–						
7 Ties Higher In Hierarchy	2.74	1.44	-.43••	-.17	-.11	.09	.06	.35••	–					
8 Betweenness (Info)	2.39	3.48	.09	.04	.05	.17	.34••	.26••	.07	–				
9 Betweenness (Aware)	1.40	1.39	.171	.09	.07	.07	.11	.13	.01	.33••	–			
10 Autocorrelation (Info)	3.43	0.71	.025	-.04	-.09	.01	.10	.03	-.11	.09	.08	–		
11 Autocorrelation (Aware)	3.27	0.38	-.175	.01	-.12	.01	-.07	-.09	.10	-.17	-.23•	.01	–	
12 Performance	4.01	1.08	.02	.14	-.03	.29•	.35••	.31••	.27••	.52••	.35••	.11	-.17	–

[a] Two-tailed tests; • $p < .05$; •• $p < .01$

TABLE 2
OLS Regression Predicting Individual Performance

Engineers (N=101) [a]

Variable	Model 1	Model 2	Model 3
Intercept	---	---	---
Tenure (Months)	.114	.059	.070
Hierarchy	-.015	-.100	-.049
Gender (1=F)	.020	-.027	-.091
Betweenness Information Network		.233•	.236••
Betweenness Awareness Network		.297••	.172•
Autocorrelation Info Network		-.129	-.029
Autocorrelation Aware Network		.108	.076
Ties Outside Organization			.204•
Ties Outside Dept In Organization			.235•
Ties Across Physical Barriers			.276••
Ties Higher In Hierarchy			.099
Adjusted R-Squared	.02	.156	.465
Change in Adjusted R-Squared		.154	.309
F Statistic		3.75	12.85

[a] Standardized coefficients. • $p < .05$, •• $p < .01$, ••• $p < .001$

Consultants (N=125) [a]

Variable	Model 1	Model 2	Model 3
Intercept	---	---	---
Tenure (Months)	-.084	-.172	-.007
Hierarchy	.186	.216	.159
Gender (1=F)	.016	-.011	.062
Betweenness Information Network		.444•••	.283••
Betweenness Awareness Network		.220•	.182•
Autocorrelation Info Network		.044	.032
Autocorrelation Aware Network		-.072	-.046
Ties Outside Organization			.212•
Ties Outside Dept In Organization			.204•
Ties Across Physical Barriers			.176•
Ties Higher In Hierarchy			.223•
Adjusted R-Squared	.009	.297	.419
Change in Adjusted R-Squared		.288	.122
F Statistic		11.98	5.93

[a] Standardized coefficients. • $p < .05$, •• $p < .01$, ••• $p < .001$

Bio

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