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Network Structure, Collaborative Context, and Individual Creativity[1]

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ABSTRACT

The debate on whether bonding or bridging ties are more beneficial for acquiring knowledge that is conducive to individual creativity has mostly overlooked the context in which such ties are formed. We challenge the widespread assumption that closed, heavily bonded networks imply a collaborative attitude on the part of the embedded actors, and propose that the level of collaboration in a network can be independent from that network's structural characteristics, such that it moderates the effects of closed and brokering network positions on the acquisition of knowledge that supports creativity. Individuals embedded in closed networks acquire more knowledge and become more creative when the level of collaboration in their network is high. Brokers who arbitrage information across disconnected contacts acquire more knowledge and become more creative when collaboration is low. An analysis of employee-level, single-firm data supports these ideas.

***Keywords*:** Social network; ego-network collaboration; knowledge acquisition; individual creativity

INTRODUCTION

As effective knowledge mobilization and employee creativity are key components of growth and competitiveness for many organizations (Tushman & Moore, 1988), numerous researchers have attempted to identify factors that favor knowledge sharing (Reagans & McEvily, 2003; Reinholt, Pedersen, & Foss, 2011) and individual creativity (Amabile, 1996; Zhou & George, 2001). One prominent perspective suggests that network ties stimulate creative and innovative behaviors by facilitating access to others' knowledge (Ahuja, 2000; Baum, Calabrese, & Silverman, 2000; Borgatti & Halgin, 2011; Hagedoorn, 2002; Stuart, 2000). An important debate in this area focuses on which network structures are more likely to support individual creativity: Bonded networks with actors embedded in closed and mutually reinforcing ties, or brokered networks in which actors bridge distant, unconnected contacts (Fleming, Mingo, & Chen, 2007; Obstfeld, 2005). On the one hand, closed, socially bonded networks should strengthen trust, mutual monitoring, and interpersonal collaboration among network participants (Coleman, 1988), thereby promoting the knowledge sharing that fosters individual creativity (Obstfeld, 2005; Reagans & McEvily, 2003; Uzzi & Spiro, 2005). On the other hand, open, brokered networks that let individuals span structural holes between otherwise disconnected contacts (Burt, 1992) should give brokers access to a wide range of knowledge, an important driver of creative idea generation (Amabile, 1996; Burt, 2004).

However, much of this discussion departs from the fundamental assumption that a network's structural characteristics are reflected in a given level of collaboration among the embedded actors (Coleman, 1988). This perspective is consistent with a structuralist view of networks, where network structure is assumed to incorporate structure-specific processes and content (Burt, 1992; 2004). We challenge this structuralist assumption, and argue that the collaborative motives and behaviors of a network's embedded actors are not necessarily a product of the network's structural characteristics. Building on this intuition, and given the different benefits of closed and brokering networks, we ask: What are the effects for knowledge acquisition and individual creativity of occupying a brokering versus closed position in a high- versus low-collaboration network?

Our answer to this question follows an opportunity-realization logic (Adler & Kwon, 2002), and proposes that occupying a closed or brokering position does not immediately translate into knowledge and creativity benefits. Rather, it offers opportunities for these benefits to arise. The realization of these benefits depends on whether the closed or brokering position an individual occupies in a network fits with the collaborative attitudes of the actors embedded in that network.

By theoretically and empirically disentangling the structural properties of a network from the behavioral attitudes of its embedded actors, we contribute to the literature on the relational antecedents of knowledge mobilization (Reagans & McEvily, 2003; Reinholt et al., 2011) and individual creativity (Amabile, 1983; Perry-Smith, 2006; Woodman, Sawyer, & Griffin, 1993) in important ways. In particular, we develop the idea that the structural opportunities associated with an ego-network do not necessarily translate into realized effects, highlighting the importance of not relying on oversimplified equations of the link between network positions, and knowledge and creativity benefits. Additionally, we challenge the widely accepted idea that closed (or brokered) social structures necessarily imply that the embedded actors engage in collaborative (or non-collaborative) behaviors, and advance the understanding of ego-network collaboration as one important condition under which network structures generate knowledge and creativity benefits.

THEORY AND HYPOTHESES

Network Positions, Knowledge Acquisition, and Individual Creativity

Network research conceptualizes the organizational context as a network of social relationships, with employees as nodes that are linked to one another by relational ties

(Borgatti & Foster, 2003; Borgatti & Halgin, 2011; Brass, Galaskiewicz, Greve, & Tsai, 2004). In such a context, creativity—broadly defined as the generation of novel and potentially useful ideas (Amabile, 1983; 1996; George & Zhou, 2001; Koput, 1997; Perry-Smith, 2006; Van de Ven, 1986; Zhou & George, 2001; Zhou, Shin, Brass, Choi, & Zhang, 2009)—is not the result of isolated actions but rather the outcome of individual actors' access to useful knowledge (Schumpeter, 1942). Knowledge access can be influenced by a focal actor's network position and by the structural properties of the relationship network in which that actor is embedded.

Prior research has investigated the links among specific structural configurations, knowledge mobilization, and individual creativity, and offers several insights into factors that can lead to individual creativity. For example, disconnected actors in a brokered network are assumed to belong to distant social circles and, in turn, to possess diverse and distinct knowledge and information (Burt, 1992; 2004). Individuals who occupy a brokering position in an open network, where they connect individuals who would otherwise remain disconnected, are well positioned to access and control the diverse sources of information found in that network. By this logic, individuals who are brokers in an open network are more likely to control knowledge inputs, which are important for creativity (Amabile, 1996; Simonton, 1999). As such, they should be more creative (Borgatti & Halgin, 2011; Burt, 1992; 2004).

Alternatively, a closely bonded network structure is presumed to favor higher levels of mutual monitoring and sanctioning of undesired behaviors. Such networks are also believed to increase the level of trust and collaboration, to ease the mobilization of knowledge, and to increase employees' propensity to take risks, learn, and develop affective relationships (Coleman, 1988). These traits are also crucial components of creativity as long as the network contains a sufficient array of knowledge derived, for example from a focal employee's prior work experience (Fleming et al., 2007) or from ties to different knowledge pools (Reagans & McEvily, 2003). By this logic, individuals embedded in a closely bonded network should be characterized by more creative output (Ahuja, 2000; Fleming & Waguespack, 2007; Obstfeld, 2005).

An important contribution to this apparently divisive discussion may come from distinguishing between the potential opportunities provided by a social structure and the conditions that are critical for the realization of that potential. Social capital theory suggests that resources that may be available through networks of social ties are effectively mobilized only when the embedded individuals have not only the structural opportunity but also the willingness and ability to engage in social action (Adler & Kwon, 2002; Kang, Morris, & Snell, 2007; Kwon & Adler, 2014; Nahapiet & Ghoshal, 1998).

Building on this intuition, we propose that closed and brokering networks do not immediately translate into specific benefits for the embedded actors. Rather, they offer opportunities for those benefits to arise. We argue that the translation of these potential opportunities into realized benefits depends on the extent to which the structural characteristics of the network fit with the behavioral attitudes of its embedded actors toward collaboration. Therefore, we propose the level of collaboration in the ego-network as the key contingency that decides when the potential opportunities of both closed and brokered networks are likely to be translated into realized knowledge benefits.

Collaboration in the Network: A Structure Versus Content Perspective

Prior research indicates that employees need a work context that is supportive of their knowledge-acquisition and creative efforts (Madjar, Oldham, & Pratt, 2002; Oldham & Cummings, 1996; Tierney & Farmer, 2002). We broadly define support for collaboration as employees' perceptions that their organization and managers recognize, encourage, and invite respectful and collaborative discussions (Oldham & Cummings, 1996; Shalley, Zhou, &

Oldham, 2004). In particular, collaboration, communication, and mutual respect tend to reinforce feelings of reciprocity (Oldham & Cummings, 1996; Shalley et al., 2004). For this reason, the more an individual experiences high levels of collaboration in the immediate work context, the more likely and willing that individual will be to reciprocate that collaboration by mobilizing useful knowledge with her colleagues (Abrams, Cross, Lesser, & Levin, 2003; De Long & Fahey, 2000).

As different individuals are rarely perfect structural equivalents, the alters linked to the focal employee (ego) of each ego-network are often distinctive. The experiences and perceptions of collaboration can be determined by a multitude of factors related to each employee’s immediate work context. For example, the presence of conflicting strategic interests between a given employee and her managers or contacts may result in the transfer of limited and distorted knowledge (Phelps, Heidl, & Wadhwa, 2012) and, in turn, in low perceived collaboration. Collaboration may also depend on asymmetries in experience or competence between an employee and her contacts. More senior or more successful employees may be more likely to collaborate with their colleagues and to push for a highly collaborative culture in their teams because they do not feel the need to compete with their colleagues due to their already superior performance. Furthermore, the willingness to collaborate with colleagues in the workplace might be affected by expectations of reciprocity (Simmel & Wolff, 1950). Therefore, individuals tied to colleagues who expect their collaboration to be reciprocated might experience higher levels of collaboration. Lastly, different parts of an organization can be characterized by subcultures that vary widely (van Maanen & Barley, 1985) even though they coexist in the same organization (Cauldron, 1992). These local conditions may lead to different collaborative attitudes and experiences. For example, more competitive teams or departments that work under pressure or conditions of uncertainty may have lower levels of collaboration simply because of the scarcity of time or incentives to engage in collaboration. Therefore, depending on whether the members of a given ego-network are, for example, operating in high- or low-pressure settings, they may experience higher or lower levels of collaboration. Taken together, these considerations suggest that although organizations may have a common vision of how individuals should collaborate with one another, variations are likely at the local level of individual ego-networks.

Collaboration assumptions in network theory. Network theory often incorporates assumptions about the collaborative behavior of actors embedded in specific structures. For example, Coleman's (1988) model of social capital assumes that closely bonded networks ease knowledge sharing because actors in those networks tend to trust and collaborate with one another, in part because cohesive structures enable the collective sanctioning of uncooperative behaviors. One of the most influential views on cohesion holds that a network's structural closure reflects its level of collaboration, trust, and reciprocal knowledge exchange (Fleming et al., 2007; Obstfeld, 2005; Podolny & Baron, 1997). This view suggests that people in a closed social network of densely interconnected colleagues are more likely to collaborate with one another precisely because they are embedded in a highly closed structure (Coleman, 1988; Obstfeld, 2005). In this vein, Fleming et al. (2007, p. 448) refer to closed networks as having a "cohesive collaborative structure." Conversely, brokered networks and, more broadly, ties that link distant and distinct social circles are normally associated with an opportunistic, competitive context (Xiao & Tsui, 2007), where the Machiavellian idea of *divide et impera* (divide and conquer) is considered a foundational trait of brokerage. As Simmel and Wolff put it, a broker is a third party who "intentionally produces the conflict in order to gain a dominating position" (Simmel & Wolff, 1950, p. 162).

Structure versus content. Although the structural characteristics of an ego-network may influence the emergence of collaboration, the connection between network structure and collaborative behavior may be less predictable than previously assumed. Structure and content remain two distinct concepts (Borgatti & Foster, 2003). Structure captures the configuration of the social ties that connect actors in a network, while content captures the information that flows through those ties and, implicitly, the substantive connections among actors. Thus, the supposedly linear relationship between the structural properties of closed or brokered networks, and the degree of collaboration among the actors embedded in those structures should not be taken for granted.

The structural characteristics of a network do not necessarily predict the motives and behaviors of its embedded actors for several reasons. First, the formation of social networks cannot be exclusively attributed to individuals' intentions and motivations (Burt, 2000), which implies that structural characteristics can be exogenous to social actors' motives (Brass & Burkhardt, 1993). Thus, two individuals can occupy the same structural position in the social space but have entirely different motives and behaviors. Second, the monitoring logic behind the high (low) collaboration assumption in the closed (brokered) models (Coleman, 1988) should not be insensitive to the nature of the content mobilized via the social network (Borgatti & Foster, 2003), and in particular to the possibility that the larger social environment can identify and sanction misbehavior. For example, consider a closed network in which the knowledge mobilized is entirely tacit in nature and, hence, difficult to identify, measure, capture, or formalize (Nonaka, 1994). Even if they are closely bonded with one another, the alters of an ego who strategically declines to share her tacit knowledge will find it difficult to sanction that ego simply because it will be hard for them to know whether ego is sharing. Therefore, such an ego will incur a much lower risk of social sanctioning than an ego who occupies a structurally identical position but mobilizes knowledge that is highly explicit in nature, such that ego's sharing can easily be measured by alters. Third, research highlights that relationship-specific, non-structural factors can play a key role in driving individual motivations and behaviors. For example, research on the affective nature of ties (Casciaro & Lobo, 2008) suggests that a key determinant for collaboration in a work context might be the emotionally positive or negative nature of the ties that develop in that context, regardless of the network's structural configuration. Thus, interacting with "jerks" or "fools" (Casciaro & Lobo, 2005) may lead to fundamentally different attitudes toward collaboration among network actors, irrespective of their specific positions. Taken together, these considerations suggest that ego-network collaboration should not be treated as endogenous to a network's structural properties.

Hypotheses

Closed versus brokering positions in high-collaboration networks. Consider the implications of an elemental brokered triad in a high-collaboration ego-network in which ego (E) is tied to two alters (A1, A2) but A1 and A2 are not tied to each other. Also consider an elemental closed triad in which E, A1, and A2 are all tied to each other. As the level of collaboration is high, all alters in the network should, in principle, be willing to mobilize knowledge. Furthermore, the relatively high level of collaboration implies that the social actors will likely expect and value mutual respect, reciprocity, and trust (Abrams et al., 2003; De Long & Fahey, 2000).

However, brokering across structural holes (i.e., E's position in the elemental brokering triad) is conventionally associated with entrepreneurial strategic and individualistic behavior to the extent that it starts from the premise of an independent self, prioritizes individual goals over collective goals, focuses on the fulfillment of self-interest rather than the accommodation of social norms and obligations, and values task achievement more than harmonious relationships (Burt, 2004; Xiao & Tsui, 2007). The individualistic undertone of structural holes theory is particularly clear with respect to the control function of bridging relationships. As Burt suggests, the *tertius* who bridges a structural hole is an actor who "plays conflicting demands and preferences against one another and builds value from their disunion" or who even "broker[s] communication while displaying different beliefs and identities to each contact" (Burt, 2004, p. 354).

Based on this, we argue that A1 and A2 in the elemental brokered triad will find the brokerage position of E inconsistent with the broader collaborative environment and, therefore, worthy of sanction (Xiao & Tsui, 2007). This sanction will take the form of a reduction in the knowledge flowing from A1 and A2 to E. Thus, while the average level of knowledge mobilization in the high-collaboration network should be high, little of that knowledge will be shared with the broker. This view is consistent with Podolny and Baron's insight that structural holes may be less beneficial "in strong culture organizations where a sense of belonging and a clear organizational identity may be crucial" (Podolny & Baron, 1997, p. 690).

We find a very different scenario if E does not occupy a brokering position, but rather occupies a position that is structurally identical to A1's and A2's position (i.e., the elemental closed triad). A1 and A2 will not perceive E's position in this elemental closed triad as inconsistent with the larger collaborative context. Therefore, A1 and A2 will not reduce the amount of knowledge shared with E. Thus, when ego-network collaboration is high, individuals occupying a brokering position should obtain less knowledge than individuals occupying a closed position.

Closed versus brokering positions in low-collaboration networks. Next, we compare an elemental brokered triad with an elemental closed triad in a low-collaboration ego-network. The "public good" aspect of knowledge mobilization typical of collaborative networks leaves space for a "private good" approach in non-collaborative networks, wherein a reduced level of reciprocity and trust leads to less knowledge being shared (Abrams et al., 2003; De Long & Fahey, 2000; Oldham & Cummings, 1996). Actors embedded in this ego-network should, in principle, be less willing to mobilize knowledge from one another regardless of their work-related ties. For example, an employee may have a work-related tie with a superior but, due to the low level of collaboration in the network, that employee may strategically decline to mobilize valuable information via that tie.

In the elemental closed triad in this setting, E should obtain exactly as much (or as little) knowledge as A1 and A2. All actors in this network are structurally identical. Thus, assuming that the average level of knowledge mobilized is low, there is no reason to expect E to obtain more (or less) knowledge than A1 or A2. However, in the elemental brokered triad, E is structurally different from A1 and A2. Given the generally limited knowledge mobilized by all actors embedded in this network, ego has: Access, by virtue of having more ties than her alters; control, because if A1 needs to coordinate with A2 (or vice versa), they need E, who can put a price on that coordination; and autonomy, as E can engage in strategic behaviors with A1 (A2) while keeping A2 (A1) unaware. Thus, when ego-network collaboration is low, individuals occupying a brokering position should obtain more knowledge than individuals occupying a closed position.

In conclusion, brokering positions are more beneficial in ego-networks with low collaboration, while closed positions are more beneficial in ego-networks with high collaboration.

Hypothesis 1. The more (less) collaborative the ego-network, the more a closed (brokering) position will enhance ego's knowledge acquisition.

Knowledge Acquisition and Individual Creativity. In line with the intuition that knowledge eases creative efforts (Amabile, 1983; Hennessey & Amabile, 2010), social capital and network research suggests causal links among structural positions, knowledge mobilization, and creative outputs (Adler & Kwon, 2002; Kwon & Adler, 2014; Perry-Smith, 2006; Perry-Smith & Shalley, 2003). These predictions draw on different theoretical mechanisms. However, they share the core insight that knowledge mobilization shapes the relationship between an individual's network position and that individual's creative performance (Borgatti & Halgin, 2011).

However, most research on the creative potential of various ego-network positions has inferred the role of knowledge mobilization for individual creativity rather than measured it directly. This is an important, often criticized aspect of network research, in response to which some key contributions have explored the direct impact of structural configurations on knowledge mobilization (Hansen, 1999; Reagans & McEvily, 2003).

A core tenet of network research is that networks shape creative outcomes by affecting the acquisition and recombination of knowledge (Baum et al., 2000; Burt, 2004; Powell, Koput, & Smith-Doerr, 1996; Uzzi & Spiro, 2005). Knowledge acquisition influences creativity by influencing individuals' cognitive structures (Amabile, 1983; Perry-Smith & Shalley, 2003; 2014). Individuals with broader access to knowledge are exposed to more perspectives, which stimulate new knowledge combinations (Perry-Smith & Shalley, 2003; Taylor & Greve, 2006). Good knowledge flow and knowledge acquisition help individuals maintain flexibility and reduce the risk of cognitive entrenchment. As Perry-Smith argues (2006, p. 86): "Social interactions with others in a domain should enhance one's understanding of the area and facilitate the generation of approaches that are feasible and unique." It follows that network ties that facilitate knowledge acquisition should be particularly valuable in creative and innovative contexts.

Ties that allow individuals to share knowledge within an organizational domain should be highly useful for producing domain-relevant knowledge that is more contextualized and aligned with organizational goals. A long research tradition shows that individuals with access to domain-relevant knowledge are more likely to generate solutions and analyze them to determine their appropriateness (Perry-Smith, 2006; Simonton, 1984). For example, Andrews and Smith (1996) find that product managers with more knowledge of a marketing environment produce more creative marketing programs. Conversely, individuals who lack access to domain-relevant knowledge may be more likely to hamper conceptual combinations and reconfigurations, thereby limiting their exploration of new solutions and approaches (Hayton, Carnabuci, & Eisenberger, 2012).

Based on these insights, we theorize that the amount of knowledge acquired by virtue of network ties is a fundamental element that nurtures individual creativity.

Hypothesis 2. More knowledge acquisition leads to higher levels of individual creativity.

METHODS

Data Collection and Research Site

We obtained our empirical data from ChemDan (a fictitious name), a Danish chemical firm that operates internationally and manufactures products for the pharmaceutical industry. ChemDan is a vertically integrated firm offering customized solutions that draw on the knowledge and creativity of its employees. All activities are located at the same site, as the firm views close proximity as an important driver of knowledge sharing and creativity.

By collecting data from a single firm, we keep constant external and firm-varying factors that might affect knowledge acquisition and creativity. The data were collected in close collaboration with the firm, which was planning a reorganization and was interested in learning more about the determinants of employee creativity and knowledge sharing. The data were collected through a web-based questionnaire, which we prepared based on a focused literature review. The network questions followed Burt’s (1992) design, and used the standard method of name-generator and name-interpreter items (Marsden, 1990). Respondents were asked to list contacts (alters) with whom they had one or more criterion relationship(s) (name generators). They were then asked to characterize their relationship with each listed person (name interpreters). All questions were translated into Danish and back-translated into English (Brislin, 1986). Finally, the questionnaire was pretested with managers and representatives of ChemDan to ensure that our items were easily understood and made sense within the firm.

Our sample comprised the entire organization and amounted to 93 individuals. This sample size is appropriate for a complete network study based on survey data, and prior research with similar data has used samples of comparable size (Carnabuci & Dioszegi, 2015; Hayton et al., 2012; Mehra, Kilduff, & Brass, 2001; Perry-Smith, 2006). An invitation to take part in the survey was uploaded on the front page of the firm's intranet, and all employees received a personal email from the CEO and the HR director encouraging them to complete the questionnaire. After one week, a reminder was sent to employees who had not yet responded. We also collected performance-rating data via a second questionnaire sent to the 15 managers with direct reports. Response rates were 80 percent for the questionnaire sent to managers and 86 percent for the questionnaire sent to all employees. Due to missing values, the number of cases used in the analysis was 74 (overall response rate of 80 percent).

We obtained individual self-assessments of behavior as well as managers' assessments of (the same) behavior for 49 of the 74 employees whose responses we use in this research. We conducted a test for mean differences among the groups of employees that had and had not been assessed by their managers. In this test, we compared gender, age, tenure, education, and experience outside the company, and found no significant differences. In all cases, the F-value for the test of mean differences was insignificant (varying from 0.11 to 0.76).

We examined the risk of non-response bias in multiple ways. First, we discussed the results and the demographic breakdown of respondents with firm representatives, who confirmed the absence of visible demographic biases that differentiated the respondents from the overall distribution of employees. Second, we conducted a wave analysis comparing the demographic variables for first-week and second-week respondents (Rogelberg & Stanton, 2007), assuming that the late respondents would be more similar than the early respondents to the non-responding group. However, the analysis of variance (ANOVA) of the difference in means for the two groups showed that the hypotheses of differences in the means can be rejected (F-values < 2).

Finally, we considered the possibility that the extent to which respondents tend to over-report for any given variable may influence the extent to which different (self-reported) variables show inflated correlations with self-reports of creativity (Ng & Feldman, 2012; Podsakoff, MacKenzie, & Podsakoff, 2012). In this regard, two of our three key predictors should be non-problematic. First, ego-network collaboration measures the average perceived collaboration of the immediate neighborhood of each focal employee cleaned of the focal employee's own perceptions, which are not factored into the measure. Second, brokerage is computed in UCINET (Borgatti, Everett, & Freeman, 2002) as constraint (Burt, 1992) using the entire network matrix, which includes ego's mentioning of ties and all other actors' mentioning of ties. This dramatically reduces the weight of ego's own perceptions in the measure. Taken together, these considerations suggest that the effects captured in our model should not be driven by common method variance.

Measures

In addition to demographic and relational information, our data include employees' assessments of collaboration, knowledge acquisition, and creativity, and managers' assessments of employees' knowledge acquisition and creativity. All variables in our models were operationalized using the self-reported employee survey. Self-reported measures have well-known weaknesses but remain an accepted way of capturing employee perceptions and behaviors (Howard, 1994). Employees are arguably the most aware of the knowledge they acquire, and of the subtle factors that make them more or less creative (Janssen, 2000;

Shalley, Gilson, & Blum, 2009). In addition, even though self-reported creativity measures are subject to bias, they tend to be closely correlated with creativity ratings from supervisors (Axtell et al., 2000). This is also the case in this study, where the interclass correlation coefficient (ICC) of the self-reported measures, and the measures of managers' assessments of employee creativity and knowledge acquisition are high and satisfactory, as outlined below.

Respondent biases are an important limitation of self-reported measures. However, the questionnaire used different scales, some of which were reversed, thereby diminishing the risk of bias. In addition, we conducted several statistical analyses to examine the severity of respondent biases. First, a Harman's one-factor test indicated that common methods bias was not an issue. Multiple factors were detected and the variance did not stem from the first factors (Podsakoff & Organ, 1986). Specifically, the 13 variables in the model (listed in Table 2) form multiple factors with an eigenvalue > 1, where the first two factors only capture 22 and 16 percent of the total variance. Second, we ran a partial least square (PLS) model, including a common method factor in which the items encompassed all of the construct's items, as suggested in Podsakoff et al. (2003). The PLS model provided information on each item's variance as explained by the constructs and the common method factor. While the average method variance was around 0.01 for all items, the average of substantive variance explained by the constructs was between 0.56 and 0.72. Therefore, the ratio of substantive variance to method variance was very high, increasing our confidence that the data do not suffer from major respondent biases. Third, we matched individual employees' self-assessments of creativity and knowledge acquisition with managers' assessments for the same individuals, and tested for inter-rater reliability. We obtained high and satisfactory values for the ICC, which is a measure of agreement between the two raters (Gwet, 2014). Finally, we attempted to control for error covariances with our instrument variables in the 3SLS model.

While these statistical tests do not eliminate the possibility of respondent biases, they suggest that our results are not predominantly driven by common method variance. Furthermore, our results were derived through complex estimations involving a system of two equations, multiple independent variables, and an interaction term. It is highly unlikely that the results of such complex models emerge solely as a result of common methods bias (Evans, 1985; Siemsen, Roth, & Oliveira, 2010). Lastly, employees were assured that all questionnaires were returned directly to the researchers, that individual responses would not be disclosed within the firm, and that the survey instrument and the server were located outside the firm, which further reduces the likelihood of biased responses (Podsakoff et al., 2003; 2012).

Dependent variables

Creativity is a multi-item measure calculated using employees' self-assessments of individual creative behavior. Each employee was asked to use a seven-point scale (1 = completely disagree, 7 = fully agree) to assess the following items developed by Zhou and George (2001): "I provide new ideas to improve the department's performance," "I suggest new ways of optimizing processes and routines," "I suggest new ways to increase quality," and "I come up with creative solutions to emerging problems." The Cronbach's alpha value for this construct was 0.83 and the composite reliability was 0.82, with an AVE-value of 0.53. These measures suggest that the construct is reliable and characterized by convergent validity. Managers were also asked to evaluate employees' creativity. However, as each manager had to assess multiple employees, we used a reduced set of items to limit respondent fatigue. Thus, employees were assessed on the same seven-point scale using three of the four aforementioned items: "The employee provides new ideas to improve the department's performance," "The employee suggests new ways to increase quality," and "The employee comes up with creative solutions to emerging problems."

Although we had both self-reports and external ratings of employee creativity for 49 employees, the empirical analysis is conducted on the self-reported measure in order to maximize the number of observations. While potentially subject to biases, self-reported creativity measures have been used in recent research (Axtell et al., 2000; Baer, Dirks, & Nickerson, 2012; Shalley et al., 2009) based on the consideration that employees are likely to have a more sophisticated understanding of their own creative behaviors than their supervisors (Janssen, 2000; Shalley et al., 2009).

In addition, we conducted an inter-rater reliability analysis of the creativity measure for the 49 individuals who were evaluated by their managers and also self-reported their creative output. We obtained satisfactory ICCs for the three items of 0.76, 0.74, and 0.79, respectively, which are consistent with results found in prior research (Axtell et al., 2000).

The average creativity level in the self-reported measure was 5.73 on a seven-point scale. While this may seem relatively high, it is consistent with findings in other creativity research (Shalley et al., 2009). More importantly, managers' assessments of employee creativity had a similar average of 5.5, which suggests that high creativity levels are a specific characteristic of the employees in ChemDan rather than a distortion attributable to the self-assessed nature of the measure. A plausible reason for the high value might be the research-based, innovative nature of the firm, which does not offer standardized solutions but specialty chemicals adapted to each customer.

Finally, the creativity measure had a standard deviation of 0.67. This value is similar to that found by Axtell et al. (2000) but smaller than that found in other creativity research, where, once adjusted to the same scale, it tends to be around 1 (Shalley et al., 2009; Zhou & George, 2001). While variation around the median value of 5.73 is adequate, the fact that most employees are consistently and highly creative might also be due to the creative expectations and customer-specific solutions that characterize ChemDan.

Knowledge acquisition encompasses a respondent's acquisition of work-related knowledge from colleagues in his or her own department or other departments in the firm. We asked individual respondents to indicate the extent to which they "had received/used knowledge from colleagues in their own department" (two items) and "received/used knowledge from colleagues in other departments" (two items). The four items were developed by Reinholt et al. (2011) and measured on a scale anchored by 1 ("no or very little extent") and 7 ("very large extent"). The Cronbach's alpha value for this construct was 0.88, and the composite reliability was 0.88, with an AVE value of 0.64. These measures suggest the construct is highly reliable and characterized by convergent validity.

Based on the view that knowledge mobilization is normally not an output or performance variable that respondents would tend to over-report, together with the consideration that the actors involved in the knowledge-mobilization process are typically in the best position to evaluate those processes, the use of self-reports appears to be the better established and unambiguous way to measure both knowledge acquisition and knowledge provision (Foss, Minbaeva, Pedersen, & Reinholt, 2009; Reinholt et al., 2011). It is also well suited for measuring specific characteristics of the knowledge-mobilization process, such as the ease of knowledge mobilization (Reagans & McEvily, 2003) and the motivation to share knowledge (Foss, Pedersen, Reinholt Fosgaard, & Stea, 2015).

In addition, managers assessed employees' knowledge acquisition by indicating the extent to which each employee "received and used knowledge from colleagues" in his or her own department or other departments (two items) on the same seven-point scale used by Reinholt et al. (Reinholt et al., 2011). For the 49 employees for whom we could match self-assessments with managers' assessments of employee knowledge acquisition, we found high and significant ICC coefficients of 0.62 and 0.66, respectively.

Independent variables

Brokerage. Each respondent was asked to identify the colleagues with whom she had "communicated the most regarding work-related topics" in the past year. This item was adapted from Burkhardt and Brass (1990) and Brass (1985), and was based on the idea that work-related conversations lead to knowledge exchange and new ideas (Perry-Smith, 2006). We then created a matrix of network relations (relation = 1, no relation = 0) among employees and symmetrized the matrix according to the rule that a pair was considered to have a tie when either member nominated the other (Mehra et al., 2001; Reagans & McEvily, 2003).

Brokerage was calculated using the structural holes routine in UCINET (Borgatti et al., 2002), where we specified brokerage as the additive inverse of Burt's original constraint measure (Burt, 1992). Burt's constraint measure is a function of the network's size, density, and hierarchy, and is designed to capture the extent to which the focal actor's network lacks structural holes. This specification of the brokerage measure allows us to measure brokerage and closure as two polar opposites, where high brokerage implies low closure and vice versa (Carnabuci & Dioszegi, 2015). This operationalization is consistent with a long research tradition (Burt, 1992) and with more recent contributions that build on that tradition (Carnabuci & Dioszegi, 2015). Constraint varies from 0 to 1, and, as is customary, we used 1 minus constraint to directly measure a focal actor's involvement in a brokering position (Carnabuci & Dioszegi, 2015; Xiao & Tsui, 2007).

Ego-network collaboration captures the perceptions of all alters in each ego-network about whether their managers and organization recognize, encourage, and invite collaborative discussions. It is based on three items from Ramaswami (1996) that together form a strong construct (Alpha = 0.83, CR = 0.83, AVE = 0.63): "Managers invite collaboration among employees," "Managers invite work-related discussions," and "Managers create a climate where employees respect each other." All items were measured on a seven-point scale (1 = very limited extent, 7 = very high extent).

As there might be significant local differences in collaboration within an organization, our measure reflects the level of collaboration as experienced by each individual in his or her respective work context. In other words, our measure of collaboration targets the immediate neighborhood of the focal employee (i.e., each ego's alters) in order to capture local differences in collaboration within the organization. This allows us to ensure that the collaboration variable reflects the perceived culture of collaboration only where it is relevant for the focal ego—that is, in his or her ego-network. Furthermore, as the personal bias or affect of the focal employee may taint this evaluation, we cleaned our measure of collaboration by removing the focal employee's own perceptions. Thus, for the network of each individual employee, we averaged all alters' assessments of the three items and excluded the assessment of the focal employee. To check robustness, we also created alternative measures of collaboration by including the focal employee's perceptions and assigning different weights to his and his alters' responses (30/70, 40/60, 50/50, 60/40, and 70/30), and by using only the focal employee's answers.

Control Variables

Outside experience. The ability to complement the specific knowledge acquired in a closed network structure with non-redundant knowledge may be an important driver of creative outputs in closed networks (Fleming et al., 2007; Reagans & McEvily, 2003). We therefore controlled for the focal employee's work experience outside ChemDan. This variable was measured as age minus years of tenure in ChemDan, based on the assumption that most employees in ChemDan started working at a similar age.

Tenure. Experience may improve people's knowledge bases and cognitive structures, which may enable them to more efficiently process and recombine knowledge and information into creative thoughts (Hennessey & Amabile, 2010). Based on this logic, we controlled for tenure (number of years that the respondent had been employed by ChemDan) in order to tease out the variation in creativity that could be driven by experience.

Knowledge provision. Knowledge flows are normally bidirectional in nature, and employees engage in both acquisition and provision of relevant information. As individuals who acquire more knowledge may also tend to have more information to share with their colleagues, we controlled for an employee's knowledge provision. This variable was measured using the Likert-type scale described for knowledge acquisition. More specifically, we used four items from Reinholt et al. (2011) and asked individual respondents about the extent to which "colleagues from the their own/other departments had received/used knowledge from them." These items formed a strong construct (Alpha = 0.89, CR = 0.90, AVE = 0.68).

R&D function. As the recombination of knowledge into creative outputs can also be influenced by the potentially different requirements for creativity that may characterize environments with different research intensities, we controlled for whether the focal employee worked in research and development (= 1) or in other areas (= 0).

Task interdependence. Task interdependence might facilitate knowledge acquisition. We control for the number of people who shared the same office with the focal employee (from 1 to 7). This is a good proxy for task interdependence, as ChemDan locates employees who work intensively together in close vicinity to one another.

Network range. Another fundamental way of accessing important knowledge is via ties that link to different knowledge pools (Reagans & McEvily, 2003). For this reason, we controlled for a focal employee's network range, which we measured as the number of different departments to which the employee was exposed through his or her alters.

Leadership position. Employees occupying leadership positions may be more exposed to knowledge flows, as they might be the key referents for multiple work-related matters. We thus controlled for an employee's leadership responsibility (dummy variable; 0 = no leadership, 1 = leadership), where leadership responsibility is defined as having formal leadership responsibility over others.

Tacitness of relationships. Ties that are conducive to the mobilization of tacit knowledge might be more likely to lead to the exchange of valuable information (Nonaka, 1994). We thus control for the average tacitness of the knowledge transferred in each ego-network, which we measured by asking respondents to use a seven-point scale based on Ambrosini and Bowman (2001) to indicate the following: "To what extent is the communication with this person about knowledge that is easy to communicate and codify (= 1) or knowledge that is deeply ingrained and difficult to codify (= 7)."

Ego-network work motivation. Individuals with high levels of intrinsic motivation see their behavior as self-endorsed, and generally in line with their own values and interests (Deci & Ryan, 2000; Ryan & Deci, 2000). Intrinsic motivation in the workplace may lead to more behavioral effort and persistence (Gagné et al., 2010). Therefore, more motivated alters might be more willing to engage in knowledge sharing with an ego. For this reason, we target our measure of work motivation at the immediate neighborhood of the focal employee (i.e., each ego's alters) and control for the extent to which the actors embedded in the ego-network are intrinsically motivated in their work. The ego-network work motivation variable, as reported by all actors in the focal employee's network, consists of five items adapted from the Motivation at Work Scale (Gagné et al., 2016) that form a strong construct (Alpha = 0.86, CR = 0.87, AVE = 0.57): "I make an effort in my job because the tasks I work on are exciting," "… because my job is interesting," "… because I find it personally satisfying," "… because I feel good when I conduct my work," and "… because I like to conduct my work."

All items were measured using a seven-point scale (1 = very limited extent, 7 = very high extent). For each employee's network, we averaged all alters' assessments of these items and excluded the assessment of the focal employee. As a robustness check, we also created alternative measures of ego-network motivation by including the focal employee's perceptions, and by assigning different weights to his and his alters' responses.

The survey items with validity and reliability tests for multi-item measures are presented in Table 1.

Insert Table 1 about here

Econometric Approach

The potential correlation between knowledge acquisition and the error term in the creativity equation generates problems of endogeneity in our model. Consequently, a standard OLS model will generate inconsistent statistics. To resolve this issue, our estimation strategy employs a three-stage least squares model (3SLS) with an instrumental variables approach (Shaver, 2005; Zellner & Theil, 1962). This econometric approach implies a need for instruments correlated with the endogenous variable (i.e., knowledge acquisition) but not correlated with the error term from the regression in which the endogenous regressor appears (Stock, Wright, & Yogo, 2002). The first two instruments are alters' tenure and alters' outside experience, which have the attractive property of being theoretically more closely related to ego's acquisition of valuable knowledge than to ego's creativity. While an individual's knowledge acquisition is likely to depend on her alters' work experience inside (i.e., tenure) and outside the organization, her alters' experience is unlikely to affect her ability to convert this knowledge into creative ideas. As both knowledge acquisition and creativity are perceptual variables, we also applied instrumental variables that are "objective" in nature and, therefore, unlikely to be influenced by the individual's perceptions and behavior related to creativity and knowledge acquisition. These instrumental variables are the focal employee's tenure, age, and leadership position.

From an empirical perspective, all instrumental variables work well as a group, as they explain an acceptable 19 percent of the variance in the endogenous regressor. We also conducted a Hausman test to compare the efficiency of the 3SLS specification of our final model (Model 3, Table 4) with that of OLS and 2SLS specifications. In so doing, we obtained test values of 26.9 and 40.5 with 14 degrees of freedom, respectively, and $p < 0.001$ in both cases, indicating that 3SLS is preferable to both OLS and 2SLS. In this case, the null hypothesis of no endogeneity was rejected, which provides support for the applied instrumental variables approach. Furthermore, in order to test for over-identifying restrictions, we regressed the residuals from the creativity equation on the instrumental variables (Sargan, 1958). The R-squared value in this regression was very low (0.03) and none of the instruments were statistically significant. Lastly, we interpreted the bivariate correlations between instruments and residuals, all of which were insignificant and had coefficients close to 0. In combination, these tests do not provide absolute proof of the absence of endogeneity, but they do suggest that the problem has been addressed in our model.

RESULTS

The correlation matrix includes descriptive statistics for all variables, as shown in Table 2. None of the independent variables have correlations that indicate problems of multicollinearity. The highest correlation is between network range and brokerage ($r = 0.48$, $p = 0.001$), which is not surprising given that networks rich in structural holes are expected to grant access to more diverse knowledge pools.

Insert Table 2 about here

Our decision to treat network structure (brokerage) and ego-network collaboration as two exogenous and separate factors was driven by the rationale described in the theory section. However, we also empirically investigated the relationship between brokerage and ego-network collaboration. After noticing the insignificant correlation coefficient of 0.10 between brokerage and collaboration, we split the variables based on their median, and created a two-by-two table with values above and below the median. As shown in Table 3, the values are evenly spread across all corners of the table, confirming the intuition that individuals with closed or brokered networks can experience both high and low levels of ego-network collaboration. The Chi-square test (values = 1.65 and 2.38, $p > 0.10$) also clearly indicates that brokerage is independent of collaboration.

The broader idea that collaboration may vary significantly within the organization was also qualitatively confirmed by some of the individuals we interviewed during our data-collection process, who noted, for example, that “while there is a general consensus on the value of collaboration, there are many reasons why people collaborate differently across our organization” and that “the need to deliver a lot and quickly makes it rather difficult at times to find the time and energy to make an extra effort to help, talk, and collaborate with those colleagues who are not immediately relevant for the task at hand.”

Insert Table 3 about here

Table 4 presents the results in a step-wise manner. Model 1 includes only the control variables. Model 2 adds the main effects of brokerage and ego-network collaboration. Model 3 includes the interaction effect between brokerage and ego-network collaboration. All models include two equations, one for knowledge acquisition and one for creativity. All of the models were run with and without mean-centering brokerage. As the results did not differ, we present the results for the non-transformed variables, which allows us to relate the coefficients to changes in the original variables. The R-squared of the knowledge-acquisition and creativity equation increased from 0.33 and 0.29 in Model 1 to 0.43 and 0.3 in Model 2, and 0.48 and 0.33 in Model 3. This indicates that Model 3 is superior to Models 1 and 2. Thus, Model 3 is the fully specified model in which the hypotheses are tested.

Insert Table 4 about here

Brokerage has a significant, positive effect on knowledge acquisition (β = 17.86, p < 0.01) and a non-significant, direct effect on creativity. Similarly, ego-network collaboration has a positive, significant effect on knowledge acquisition (β = 2.40, p < 0.01) and a non-significant, direct effect on creativity. However, the interaction of these two variables shows a negative, significant effect on knowledge acquisition (β = -2.95, p < 0.05) and a non-significant direct effect on creativity, which suggests that ego-network collaboration limits (enhances) the effect of brokerage (closure) on knowledge acquisition, thereby confirming Hypothesis 1. Thus, when seen in isolation, the positive effect of brokerage on knowledge acquisition is fully consistent with Burt's (2001) view on social capital. However, when seen in combination with the collaboration variable, it reinforces the idea that the structural characteristics of an ego-network do not immediately translate into specific benefits but rather offer opportunities for those benefits to arise.

Given the importance of this hypothesis for our theoretical model, we conducted additional analyses to further investigate the nature of the interactive effect of brokerage and ego-network collaboration. More specifically, we performed a simple slope analysis for different values of ego-network collaboration. The analysis shows that the t-value of the simple slope is positive and significant when collaboration is below (gradient 2.99, t-value 3.6, p-value 0.001 at -2 SD; gradient 1.99, t-value 3.8, p-value 0.001 at -1 SD) or equal (gradient 0.99, t-value 2.12, p-value 0.03) to the mean, and negative but not significant at high levels of collaboration (gradient -0.02, t-value -0.02, p-value 0.98 at +1 SD; gradient -1.02, t-value -0.98, p-value 0.33 at +2 SD). These results show that the hypothesized interaction of brokerage and collaboration is particularly applicable to levels of collaboration at or below the mean. Interestingly, this seems to suggest that the sanctioning mechanisms that we proposed in association with high levels of collaboration in our hypothesis formulation might, in fact, be less relevant than the access, control, and autonomy mechanisms that we highlighted in association with low levels of collaboration.

Lastly, the effect of knowledge acquisition on creativity is positive and significant ($\beta = 0.47$, $p < 0.05$), as expected, which confirms Hypothesis 2.

Robustness checks

We conducted a number of robustness checks to confirm the validity of our findings. In particular, we tested our models on a number of alternative operationalizations of the dependent and contextual variables, and we added a number of controls.

Alternative measures of creativity and knowledge acquisition. We first conducted four additional analyses using alternative measures for the two dependent variables. We developed measures for both variables based on supervisor reports, and on a combination of self- and supervisor reports as indicated in Ng and Feldman (2012) and Shalley (2000). Specifically, provided that there was convergence between self-reports and supervisor reports, we calculated multi-source measures for both variables by combining self-reports and supervisor reports of employee creativity and knowledge acquisition (Shalley et al., 2000). In particular, as the two measures used identical metrics, whenever both self-reports and supervisor reports of creativity and knowledge acquisition were available, we combined them by averaging the two values. We used these alternative measures to run our models on: (1) self-reports for knowledge acquisition and supervisor reports for creativity; (2) self-reports for knowledge acquisition and a composite measure of self-reports and supervisor reports of creativity; (3) supervisor reports for both creativity and knowledge acquisition; and (4) a composite measure for both creativity and knowledge acquisition. The use of supervisor-reported measures fully supports our findings when applied to the creativity measure and marginally supports them when applied to the knowledge acquisition measure. Furthermore, the use of composite measures fully supports our findings when applied to the creativity variable only, and when applied to the creativity and knowledge acquisition variables together. Our interpretation of these additional tests is that our findings, when taken together, are stable to important alternative specifications of our dependent variables.

Alternative measure of ego-network collaboration. We also tested our models using alternative measures of the contextual variable. To do so, we operationalized the variable based only on the focal employee's perceptions, only on alters' perceptions, and with different weights attributed to the focal employee's and alters' responses. The results were unchanged.

Additional controls. Lastly, we conducted a number of robustness checks in which we included other relational variables (multiple measures of tie strength), contextual variables (environmental stressors, such as noise and disturbances), external knowledge measures (alters' experience outside the firm, alters' tenure), demographic variables (employees' gender, education, and department), and a curvilinear specification of the brokerage variable. As none of these variables were significant and as none of them were confounding for the focal results, we decided to leave them out of the final model so as to increase the degrees of freedom. Furthermore, in line with a long research tradition, we have cast the concept of closure and brokerage as two ends of the same continuum (Burt, 1992; Carnabuci & Dioszegi, 2015), but it might be argued that the two constructs are not mirror images of each other conceptually or empirically. For example, while maximum connectedness in a network implies an absence of structural holes, minimum connectedness does not automatically equate to the presence of numerous structural holes. For this reason, we also ran our models on constraint while controlling for density (measured as the number of ties between those in the focal employee's network that did not include the focal actor divided by the number of all possible ties in the network). The results were unchanged.

DISCUSSION

While it is widely accepted that network structures may stimulate the mobilization of knowledge that is conducive to individual creativity, an important debate on social capital points to distinct reasons and contingencies that allow two deeply different positions in a network structure—a brokerage position that spans structural holes in a diffuse network and an embedded position in a closed network of densely interconnected contacts—to stimulate knowledge acquisition and individual creativity (Burt, 1997; Fleming et al., 2007; Obstfeld, 2005). We contribute to this debate in three important ways.

First, we develop the idea that the structural characteristics of an ego-network do not immediately translate into benefits, but rather offer opportunities for those benefits to arise. This is a key contribution in that it informs network research about the importance of avoiding oversimplified equations of the relationship between network positions and network effects. In particular, densely bonded networks do not necessarily lead to the more efficient acquisition of fine-grained, in-depth knowledge (Coleman, 1988). Instead, they offer the opportunity for this valuable type of knowledge acquisition to arise. Similarly, diffuse brokering networks do not necessarily lead to information, autonomy, and control advantages (Burt, 1992). Instead, they offer the opportunity for these advantages to emerge. Our results show that the translation of these potential opportunities into realized benefits depends on the fit between an individual's position in the social structure and the collaborative and behavioral attitudes of the actors embedded in his or her ego-network.

Second, we theoretically and empirically disentangle the structural properties of a network from the collaborative attitudes and behaviors of its embedded actors. By resisting the temptation to use structural considerations to make assumptions about the collaborative nature of relationships within networks, we are able to show that actors embedded in closed or brokered networks can experience high or low levels of contextual collaboration, and that this difference generates substantial variations in the knowledge individuals obtain. This important finding allows us to challenge the widely accepted idea that closed (or brokered) social structures imply collaborative (or non-collaborative) behaviors among the embedded actors. At the same time, it adds to the powerful idea (Borgatti & Foster, 2003; Borgatti & Halgin, 2011) that network research should more carefully distinguish between the social structure (i.e., the configuration of social ties connecting actors in a network) and the content mobilized in that structure (i.e., the specific substantive connections and mobilization of resources among actors).

Third, we introduce ego-network collaboration as the key contingent mechanism that, in an opportunity-realization logic, links the structural opportunities of closed and brokered networks to realized knowledge and creativity benefits. Ego-network collaboration constitutes a new, important condition under which closed and brokered networks are conducive for knowledge acquisition and individual creativity. By casting new light on the role of collaboration as a key condition for networks to generate creativity, we complement research that proffers a contingent view of the value generated by network structures inside the organization (Burt, 1997; Carnabuci & Dioszegi, 2015; Stea, Pedersen, & Foss, 2017; Xiao & Tsui, 2007), while we also advance the body of work that attempts to disentangle the mechanisms through which closed and brokered networks generate positive impacts on knowledge acquisition and creative outcomes (Fleming et al., 2007; Obstfeld, 2005; Perry-Smith, 2006; Stea & Pedersen, 2017).

Managerial Implications

Managerial decisions may affect the formation and evolution of employees' networks, as well as the establishment of a collaborative climate in the workplace. Our results show that these variables are key drivers of knowledge mobilization and employee creativity. Given the importance of knowledge mobilization and creativity for organizations, refining our understanding of the links between structure and creativity should be of key importance for practitioners.

A first important implication of this research for managers is that giving employees the opportunity to develop either closed (e.g., via intra-departmental mentoring programs) or brokering (e.g., via expatriation assignments) network positions does not necessarily ensure that the benefits of those positions will materialize. Therefore, managers should be aware of the potential risks inherent in strategizing with employees' networks without also carefully observing employees' abilities to leverage their network opportunities.

As second implication can be derived from the intuition that many of the rationales used to link the density of a social structure to the level of collaboration among the embedded actors may, in fact, not apply, especially in knowledge-intensive contexts where limited collaboration can be difficult to diagnose. For this reason, managers who attempt to develop a trustful, collaborative atmosphere in their teams by facilitating social interactions (e.g., via frequent joint projects or regular team meetings) should be aware that people may still not collaborate or trust one another even when they are densely interconnected. Conversely, managers should avoid assuming that high levels of trust and collaboration cannot exist in networks characterized by low levels of interconnectedness.

A third implication is that managers should recognize the importance of fit between network structure and collaboration, and they should factor this understanding into their decision making. Managers not only need to ensure that employees have a chance to develop either closed or brokered networks, but they also need to ensure that these structures are not dissonant with the level of collaboration in the network. For example, if managers want their employees to develop dense networks of closed relationships, they should also foster the creation of a highly collaborative workplace. On the other hand, managers who want their employees to establish relatively open, brokered patterns of collaboration should be aware that those types of networks are not fully effective when embedded in highly collaborative environments.

Lastly, practical implications can also be drawn by looking at our findings from the employee's viewpoint. While employees are arguably less able than their managers to influence the larger social context in which they operate, they can influence the structure of their own networks. For example, an employee who decides not to engage in distant work relationships will be less likely to take on a brokering role. The simple but powerful implication of our study in this regard is a need to be aware that consistency between employees' positions in the social structure and the larger social environment is necessary for employees to fully realize the creative potential that might be associated with a given network position.

Limitations and Future Research

This study is not free from limitations, which in turn highlight opportunities for future research. First, as our data are cross-sectional, the direction of causality in our model cannot be fully ascertained. In other words, although we theorize that social structure and collaboration influence knowledge acquisition and creativity, alternative causal explanations are possible. For instance, our measure of creativity may reflect pre-existing individual characteristics, such that very creative individuals may tend to pursue brokered social contexts to enhance their access to diverse knowledge. However, our arguments move in the opposite direction, in line with strong research evidence supporting the intuition that creativity is a malleable characteristic that may be influenced by contextual, personal, and socio-structural factors (Amabile, 1983; Amabile, Conti, Coon, Lazenby, & Herron, 1996; Perry-Smith, 2006; Perry-Smith & Shalley, 2003; Shalley et al., 2004). Even though our results are consistent with the theoretical insights of an abundant stream of research, our empirical design did not enable us to exclude alternative explanations. Longitudinal or experimental data are needed to confirm the direction of causality that we propose.

Second, an important debate in social network research revolves around the identification of two fundamental forces that drive network modifications (Ahuja, Soda, & Zaheer, 2012). The first force is agency, which refers to a focal actor's deliberate and purposive engagement in actions that shape existing relationships, establish beneficial connections with other actors in the potential network of relations, and dissolve unprofitable connections (Emirbayer & Mische, 1998). The second force takes the pressures of the larger social environment into account. It highlights the fact that social structures tend to persist and reproduce themselves through norms, rules, and social conventions, which eventually results in inertial pressures that shape and constrain individual behavior (Parsons, 1951). For example, densely bonded social structures give rise to shared norms, common identities, routines, and social pressures that may constrain an actor's ability to renew the composition of her network (Gargiulo & Benassi, 2000). Unfortunately, the cross-sectional nature of our data does not allow us to ascertain the role that agency and inertia, together with firm-specific factors, may play in deciding if and how individuals adjust their networking strategies to achieve a better fit with the larger social context. Nevertheless, this remains an important and fascinating topic.

Lastly, one perspective on the debate about whether closed or brokered networks are more likely to support individual creativity (Fleming et al., 2007) moves from the recognition that brokered networks "present both an opportunity structure for generating new ideas and an action problem […] because the dispersed, unconnected people found around structural holes are inherently more difficult to mobilize or coordinate, especially around novel ideas" (Obstfeld, 2005, p. 101) to make the argument that different network structures may be beneficial at different points in the innovative process (Kijkuit & van den Ende, 2007). However, given that each employee is structurally embedded within a single network position, she should normally be able to mobilize only one kind of social capital, regardless of the phase of the creative process with which she is dealing. Therefore, the recognition that brokered or closed networks might be differentially beneficial in different phases of the creativity process does not provide a definitive answer to the question of which network structure is most conducive to creative performance at the level of the individual employee (Carnabuci & Dioszegi, 2015). We theorize and find in our study that, regardless of whether the employee occupies a brokering or closed network position, the extent to which she will be able to benefit from her position in the social space is highly contingent on the fit between that position and the collaborative nature of the social context. In this sense, our findings cut across and complement the important discussion about the relative advantages of brokered structures and closed structures by introducing a fit perspective that applies to the overall structure-creativity link. Nevertheless, the nature of our data does not allow us to adopt a process perspective on how individuals obtain knowledge and translate it into creative ideas. It would be interesting for future research to further develop our contingency arguments by more explicitly taking different stages of knowledge acquisition and creative idea generation into account.

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TABLE 1

Multi-item Measures

	SL	CR	AVE	A
Creativity		0.82	0.53	0.83
I provide new ideas to improve the department's performance.	0.70			
I suggest new ways of optimizing processes and routines	0.71			
I suggest new ways to increase quality.	0.79			
I come up with creative solutions to emerging problems.	0.71			
Knowledge acquisition		0.88	0.64	0.88
I received knowledge from colleagues in my own department.	0.95			
I used knowledge provided by colleagues in my own department.	0.94			
I received knowledge from colleagues in other departments.	0.55			
I used knowledge provided by colleagues in other departments.	0.60			
Knowledge provision		0.90	0.68	0.89
Colleagues from my own department have received knowledge from me.	0.93			
Colleagues from my own department have used knowledge provided by me.	0.98			
Colleagues from other departments have received knowledge from me.	0.67			
Colleagues from other departments have used knowledge provided by me.	0.68			

SL: standardized loadings, CR: construct reliability, AVE: average variance extracted, A: Cronbach's alpha.

TABLE 2

Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Creativity	1												
2. Knowledge acquisition	0.31	1											
3. Brokerage	0.15	0.34	1										
4. Ego-network collaboration	0.2	0.26	0.1	1									
5. Outside experience	0.12	0.1	0.1	0.07	1								
6. Tenure	–0.10	–0.13	0.01	0.06	–0.37	1							
7. Knowledge provision	0.4	0.4	0.42	0.08	0.17	–0.02	1						
8. R&D function	0.15	-0.06	0.01	0.03	0.03	0.13	0.14	1					
9. Task interdependence	0.11	0.26	0.06	0.14	0.1	–0.19	0.09	0.32	1				
10. Network range	0.09	0.21	0.48	0.01	0.01	–0.01	0.42	-0.07	–0.07	1			
11. Leadership position	–0.01	0.01	–0.14	0.02	0.09	–0.01	–0.15	0.07	0.3	–0.33	1		
12. Tacitness of relationships	0.23	0.02	–0.20	–0.01	0.17	–0.11	–0.01	-0.12	–0.01	–0.06	0.1	1	
13. Ego-network work motivation	0.29	0.08	–0.07	0.28	–0.04	–0.08	0.14	0.14	0.14	–0.07	0.01	–0.14	1
Mean	5.73	5.41	0.66	5.72	36.9	8.46	5.24	0.38	2.51	3.53	0.82	4.82	6.27
St dev	0.67	1.19	0.21	0.34	8.04	7.17	1.23	0.49	1.73	1.56	0.38	0.85	0.29
Min	4	1	0	4	22	0.1	1	0	1	1	0	2.4	5.3
Max	7	7	0.85	6.6	59	29	7	1	7	7	1	7	7

n = 74; all coefficients above |0.23| are significant at the 5 percent significance level.

TABLE 3

Frequency Table Based on Median Split of Brokerage and Ego-network Collaboration

		Ego-network collaboration	
		Low	High
Brokerage	Low	23	14
	High	14	23

The medians are 0.74 for brokerage and 5.7 for ego-network collaboration.

TABLE 4

3SLS Model with Knowledge Acquisition and Creativity as Dependent Variables

	Model 1: Controls		Model 2: Main effects		Model 3: Interaction effect	
	Knowledge Acquisition	Creativity	Knowledge Acquisition	Creativity	Knowledge Acquisition	Creativity
Brokerage			1.45* (0.68)	0.28 (0.50)	17.86** (6.46)	9.37 (5.44)
Ego-network collaboration			1.02* (0.40)	-0.22 (0.31)	2.40** (0.72)	0.57 (0.55)
Brokerage * ego-network collaboration					-2.95* (1.31)	-1.60 (0.95)
Knowledge acquisition				0.55** (0.19)		0.47* (0.19)
Outside experience	-0.02 (0.02)	-0.01 (0.01)	-0.03 (0.02)	0.01 (0.01)	-0.03 (0.02)	0.01 (0.01)
Tenure	-0.05** (0.02)	-0.01 (0.01)	-0.07** (0.02)	0.03 (0.02)	-0.07** (0.02)	0.02 (0.02)
Knowledge provision	0.39** (0.12)	0.20** (0.07)	0.35** (0.11)	0.16* (0.08)	0.26* (0.12)	0.12 (0.08)
R&D function	-0.33 (0.28)	0.14 (0.16)	-0.22 (0.26)	0.21 (0.19)	-0.13 (0.26)	0.25 (0.19)
Task interdependence	0.14 (0.08)	-0.01 (0.05)	0.10 (0.08)	-0.03 (0.06)	0.09 (0.07)	-0.03 (0.05)
Network range	0.04 (0.09)	-0.01 (0.05)	-0.02 (0.09)	-0.05 (0.07)	0.05 (0.09)	-0.01 (0.07)
Leadership position	0.13 (0.36)	-0.01 (0.21)	0.24 (0.34)	-0.01 (0.24)	0.31 (0.33)	0.03 (0.23)
Tacitness of relationships	-0.01 (0.16)	0.21* (0.09)	0.03 (0.14)	0.23* (0.10)	0.02 (0.14)	0.22* (0.10)
Ego-network work motivation	0.06 (0.44)	0.59* (0.25)	0.60 (0.48)	0.65 (0.35)	0.39 (0.48)	0.75* (0.35)
Intercept	4.41 (3.12)	0.06 (1.79)	1.85 (3.02)	-2.41 (2.29)	-7.28 (5.01)	-7.10 (3.63)
F-value	3.55**	2.06*	4.32***	2.05*	4.64***	2.25*
R-squared	0.33	0.29	0.43	0.30	0.48	0.33

n = 74
* p < .05
** p < .01
*** p < .001