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Social Ties, Knowledge Diversity and Individual Creativity

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Abstract
Integrating the concepts of social networking and creativity theory, I explore the effects of network centrality and cluster ties on knowledge diversity, which in turn influences individual creativity. Empirical data consists of 427 samples at a large R&D institute in Taiwan. The results show that network centrality is positively associated with knowledge diversity, whereas cluster ties hold a negative association. In addition, I also find that knowledge diversity is positively associated with individual creativity. The paper's theoretical contributions and empirical results increase our understanding about the connections between social network and individual creativity.

Keywords: *Network centrality, Cluster ties, Knowledge diversity, Creativity*

1. Introduction

In today's turbulent and uncertain business environment, an organization's ability to sustain its growth and competitive edge depends on the employees' creativity (Amabile, 1998). Nevertheless, the inherent structure and reward mechanisms within organizations can often stifle employee creativity and innovation. In keeping with the practical importance of creative ideas, there is a burgeoning interest by management scholars in understanding the factors that constrain or facilitate individual creative contributions in a work environment (Eisenberger & Armeli, 1997; Oldham & Cummings, 1996; Perry-Smith, 2006; Shalley & Perry-Smith, 2001). These factors focused by the scholars include individual traits (Barron & Harrington, 1981), the receipt of rewards (Eisenberger & Armeli, 1997), the complexity of tasks (Oldham & Cummings, 1996), and the use of goals (Shalley, 1995). While serving as critical motivational levers for organizations, these factors tend to emanate primarily from formal organizational systems and are less social in nature.

Outside of these factors, scholars have given much less attention—but not completely ignored—other social facets of the work environment. Three prominent creativity models (Amabile, 1988; Perry-Smith & Shalley, 2003; Woodman, Sawyer, & Griffin, 1993) propose that creativity is in part a social process, and that factors such as supervisory support and social influences resulting from group interaction are important antecedents to creativity. If creativity is one of the outputs of the social process, then focusing more explicitly on the social side of

creativity should enhance our understanding of what it takes to be creative in highly interactive work environments. A successful social psychology of creativity demands that the creative individual be placed within a network of interpersonal relationships (Simonton, 1984).

Research has highlighted close links between knowledge and individual creativity (Rodan & Galunic, 2004; Smith et al, 2005; Laursen & Salter, 2006; Nieto & Santamarı´a, 2007). In fact, creativity means applying knowledge to create new ideas (Drucker 1993; Cho & Pucik, 2005) and social relationships play an outstanding role in this process (Kogut & Zander 1992; Nonaka, 1994; Nonaka & Takeuchi, 1995). Hu & Racherla (2008, p. 303) have defined knowledge creation as 'a social process involving interactions among individuals and organizations with different backgrounds, resources, predisposition and insights'. During the 1970s and 1980s knowledge creation was considered an activity based mainly on the ability to process data and information. Most research from those decades analyses knowledge from a categorical point of view, distinguishing between data, information and knowledge. This perspective changes substantially with contributions from Nonaka (1994) and Nonaka & Takeuchi (1995), who stress the importance of the individual members of an organization as the main driving force in the process of creating organizational knowledge. Similarly Kogut & Zander (1992) consider that firm's knowledge is a social construction. Indeed, as regards sharing not only tacit but also explicit knowledge, social relationships are considered more efficient mechanisms than other corporate information and control systems (Kang et al., 2007).

Previous studies have also found a relationship between social network parameters and individual creativity (Fleming, Mingo & Chen, 2007; Madjar, 2008; Perry-Smith, 2006; Shalley & Perry-Smith, 2001; Sparrowe, Liden, Wayne, & Kraimer, 2001). In some cases, researchers find that network centrality (Ahjua, Galletta & Carley, 2003; Perry-Smith, 2006), network position (Tsai, 2001), and weak ties (Perry-Smith, 2006) help explain individual creativity, but their research falls short of reflecting the complex knowledge network (Hansen, 2002) that workers experience. Alternatively, other studies have proposed that communication and interactions with "diverse others" should enhance creativity (Amabile, 1996; Ford, 1996; Woodmana, et al., 1993). Similarly, Inkpen and Tsang (2005) find that access to a network is a necessary but not sufficient condition to acquire the knowledge it contains. On one hand, access to available knowledge also depends on the actor's position within the network's structure (Hargadon & Sutton, 1997; Tsai, 2001). On the other hand, the extent of density within the ego's network also impacts the quality of the knowledge reached. Building from this argument, we propose that diverse others (or knowledge diversity) fills the process gap between social networks and individual creativity. Therefore, the purpose of this study is to explore the black box of the social lens of individual creativity. In the next section, we propose a model where different types of social ties contribute to individual creativity due to the diversity of knowledge. Later sections then present my research setting, methodology, analysis and conclusion.

2. Theory and Hypotheses

Creativity, an individual-level construct, is defined as the generation of novel and appropriate ideas, products, processes, or solutions (Amabile, 1983; Shalley, 1995). This can encompass creative solutions to business problems, creative changes to job processes, or new technologies. The study of creativity is historically rooted in the traditions of psychology (Guilford, 1950; Taylor, 1964), and is typically an effort to understand why some individuals are

more creative than others. In general it has focused on cognitive and motivational processes rather than the social perspective.

This study looks to understand the creativity of individuals from the perspective of social networks. Although innovation research at the firm level suggests that social relationships are important for creativity (e.g., Monge, Cozzens, & Contractor, 1992; Pelz & Andrews, 1966; Tushman, 1977), the assumption that creative drivers are the same at all levels may be simplistic and may incorrectly imply a compositional model of the creative process (Drazin, Glynn, & Kazanjian, 1999). Thus, researchers know little about how social context affects individuals when it comes to the generation of creative ideas or solutions.

Social Ties and Knowledge Diversity

Previous studies (Perry-Smith & Shalley, 2003; Perry-Smith, 2006) have demonstrated that the process through which social network parameters influence creativity can be linked with creativity-relevant cognitive processes and domain-relevant knowledge. A creativity-relevant cognitive process is any problem-solving approach that helps one imagine alternative solutions to a problem. It has been described as an individual's search of his or her mind and surroundings in order to generate potential responses (Amabile, 1983). Domain-relevant knowledge is an individual's knowledge of facts, circumstances, and issues surrounding a given problem or area (Amabile, 1983). It involves technical expertise and the experience necessary to create feasible solutions to a given problem. When individuals have more domain-relevant knowledge, incidents of creative performance are enhanced (Mumford & Gustafson, 1988; Simonton, 1999). Similarly, researchers have found that managers' participation in cross-functional interfaces positively relates to their 'ambidexterity' (Gibson and Birkinshaw, 2004) by offering opportunities to exchange knowledge (Egelhoff, 1991; Gupta and Govindarajan, 2000). For example, marketing research shows that product managers with more knowledge of a marketing environment produce more creative marketing programs (Andrews & Smith, 1996). Mom, van den Bosch and Volberda (2009) also asserted that cross-functional interfaces offer opportunities for managers to refine their existing knowledge by acquiring knowledge that is related to their own knowledge base.

One way to increase domain-relevant knowledge is to cultivate social networks with other experts. Cross, Rice and Parker (2001) have found that people usually acquire and create knowledge by way of social contact. These interactions should enhance one's understanding of a domain, and facilitate the generation of feasible and unique approaches. Accordingly, both creative-relevant cognitive processes and domain-relevant knowledge emphasize the importance of knowledge sources, which range from individual contacts to embedded networks.

The fundamental explanatory tenet of the social network perspective is that the structure of social interactions enhances access to valued resources (Brass, 1984; Ibarra, 1993). Mom et al. (2009) find that an increasing size of a manager's network of direct contacts across hierarchical levels and organizational units is associated with increasing possibilities for that manager to identify and acquire knowledge for both exploration and exploitation purposes (Hansen, Podolny & Pfeffer, 2001; Nahapiet & Ghoshal, 1998; Subramaniam & Youndt, 2005).

Although the social network perspective recognizes that many individuals are part of a number of networks that give access to knowledge, markets, technology, reputation or influence (Young, Charns, & Shortell, 2001; Inkpen & Tsang, 2005), the opportunities offered by networks for each individual to assess the resources depend on the network position individual possess and the structure contexts (Mors, 2010). In social network studies, there are a variety of ways to

assess different types of social interactions. The concept of network centrality is considered a basic characterization of social relationships (Sparrowe et al., 2001). Centrality refers to how strategically placed an actor is within a network. Researches in management and marketing have used the centrality concept to show the importance of the position of an influential individual in a communication network, or an interdepartmental purchasing decision (Money, 1998). Centrality in social networks reflects an individual's involvement in exchanging resources with others. An example includes knowledge resources, which are valued and embedded in social networks (Hansen, 2002). In this study, we are interested in the network position of social interactions that influence access to valued resources. An individual who is centrally positioned in a social network is, over time, able to reach diversified knowledge. Their access to more information should enhance their domain-relevant knowledge (Glynn, 1996; Simonton, 1999). Accordingly, we argue that the more network ties an individual has, the greater his or her access to diverse knowledge resources. Thus we propose the following hypothesis:

Hypothesis 1: Network centrality is positively related to a person's knowledge diversity.

Cluster Ties

In addition to understanding the role an individual's social ties play in gaining knowledge, it is also important to understand the role of other network actors. Drawing on social network theory (Robert & Mark, 2005) and previous research (Cowan & Jonard, 2009), we use the concept of cluster ties to examine the impact of other actor connections on an individual's knowledge diversity.

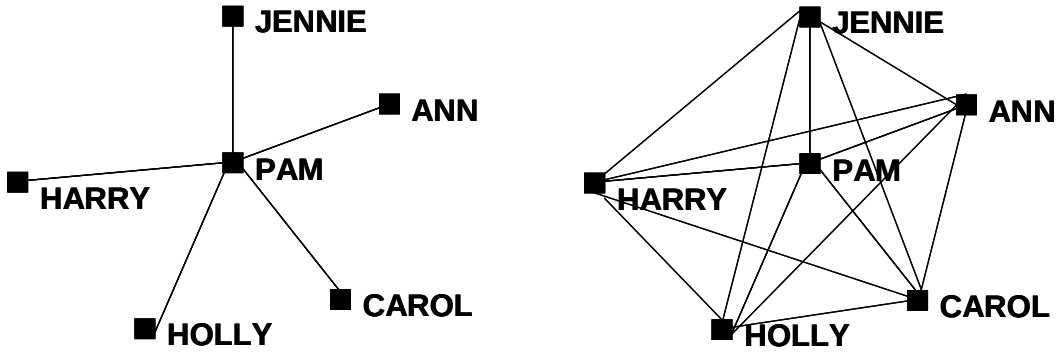
Cluster ties describe the connections of individual's direct ties. These ties calculate the extent of connections among the direct tiers (actors) of an individual. Figure 1 offers an example, where at one extreme, a low level of cluster ties signifies that the central actor (PAM in Figure 1) belongs to a spare network in which few actors are connected (**a** in Figure 1). At the other extreme, a high degree of cluster ties suggests the opposite: a central figure within a dense network, where many actors are tightly connected (**b** in Figure 1).

Mom et al. (2009) argue that increasingly dense networks diffuse strong norms, establish shared behavioral expectations, and create a dominant logic which may stifle the creative thinking (Bettis & Wong, 2003; Miller, 1993; Rowley et al., 2000). First, the dense network reduces individual openness to different opportunities, needs, and perspectives (Nahapiet & Ghoshal, 1998), which reduces their motivation and ability to host contradictions (Smith & Tushman, 2005). Second, it constrains individual to perform broad searches for acquiring knowledge and information (Jansen et al., 2005), which reduces their ability to both refine and renew their knowledge base (Hansen et al., 2001; Sheremata, 2000). Furthermore, a large and densely connected network may decrease individual ability to engage in high levels of both exploration and exploitation related activities because maintaining such a network requires time and effort to stay in touch and interact with others (Hansen et al., 2001; Uzzi, 1997). Hansen et al. (2001), for instance, show that maintaining a densely connected network is associated with reduced speed and efficiency in completing both explorative and exploitative projects.

In a dense network, people tend to know each other well through recurring interactions and interconnected ties that engender familiarity and trust (Gulati 1995; Gulati, Nohria, & Zaheer, 2000). Thus, these high levels of interactivity and interconnectedness render much of the information and resources within a network redundant. These dense connections also imply that people's knowledge of facts, circumstances, and issues surrounding a given problem or area is

similar. In other words, an individual with highly clustered ties has a lower probability of access to different knowledge areas. From this stems the next hypothesis:

Hypothesis 2: The level of cluster ties within a network is negatively related to an individual's knowledge diversity.



a: Low cluster ties **b: High cluster ties**

Figure 1： Samples of cluster ties for node PAM

Knowledge Diversity and Individual Creativity

Although previous studies have demonstrated that social network ties have a positive impact on individual creativity (Fleming, Mingo & Chen, 2007; Madjar, 2008; Perry-Smith, 2006; Shalley & Perry-Smith, 2001; Sparrowe et al., 2001), few researchers have focused on the variables between social network parameters and individual creativity. Above, we argued that knowledge diversity is the variable that connects social network parameters and individual creativity, and is thus responsible for creativity. Joshi (2006) notes that diversity within a team represents access to a assorted array of external networks. These external networks or social ties are the sources of diverse perspectives and information that enhance a team's social and knowledge-based capital, and improve team performance. Perry-Smith and Shalley (2003) argue that domain-relevant knowledge does not necessarily represent creative or novel information, but rather reflects how much a person knows about a given area. They also believe that the more diverse the information a person receives, the greater his or her base of domain-relevant knowledge. Given a problem or task, an individual with more diversified knowledge can evaluate potential responses against implemented solutions used by his or her connections. This exposure to diversified knowledge provides a greater foundation for understanding the nuances of potential solutions, which may enhance creativity.

According to Mom et al.(2009), a manager may benefit from using network contacts by acquiring new and diverse knowledge to, for instance, develop new competences (Floyd & Lane, 2000), pursue radical innovations (Subramaniam & Youndt, 2005), or find innovative solutions to problems (Sheremata, 2000). A manager may also benefit from using network contacts by obtaining related and complementary knowledge to, for instance, improve and refine existing competences (Floyd & Lane, 2000), pursue incremental innovations (Subramaniam & Youndt, 2005), or reinforce existing beliefs and decisions (Rivkin & Siggelkow, 2003).

Another way that diversified knowledge may specifically facilitate creativity is through more likely access to diverse perspectives. These diverse perspectives can help individuals strengthen creative-relevant cognitive processes (Perry-Smith & Shalley, 2003)). Cognitive processes relevant to creativity involve remote association, which is the ability to see connections between seemingly different concepts; divergent thinking, which is the tendency to present solutions that move away from established ways of doing things (Guilford, 1950; Mumford & Gustafson, 1988); and flexible thinking, which is the capacity to come up with different categories of responses to a single problem (Torrance, 1974). Taken as a whole, a person with diversified knowledge should represent a heterogeneous collection of different backgrounds and ways of doing things, and as a result, should provide access to a breadth of perspectives and facilitate a variety of processes helpful for creativity. From this, we propose the following hypothesis:

Hypothesis 3: Individual's knowledge diversity is positively related to creativity.

3. Method

Setting

The hypotheses in this paper were tested by surveying the research and development (R&D) personnel in one of Taiwan's defense-oriented R&D institutes, tasked with developing new weapon systems. The institute consists of 21 departments with both administrative staff and research fellows. Each department has its own identity and could be considered as a closed network. Among the 21 departments, 13 are involved with research and development and experience a lot of knowledge interactions among personnel. The remaining 8 departments with administrative functions have fewer interactions among themselves. Because we am interested in the role of knowledge interactions on social networks and creativity, the 8 administrative departments are excluded from the sample.

With support from the senior officers of the institute, we collected data through a web survey distributed by email to all research personnel on their internal system. The survey's response rate was 95 percent with 427 samples from the 13 departments. This is a high response rate, relative to typical rates between 65 and 90 percent for other social network studies (Stork & Richards, 1992). Of the respondents, 85.9 percent were male, and 80.1 percent were between 21 to 40 years old. The average tenure among employees was 13.6 years (SD = 6).

Measures

Network ties

We asked employees to look through a list of institute members and identify those whom they ask for advice during their workday. From this advice data, we constructed a social network matrix and created a social ties variable. Here, Cell Xij in the advice matrix represents whether i goes to j for advice (cell value = 1) or not (cell value = 0). Based on this matrix, we calculated two network variables using UCINET software (Borgatti, Everett & Freeman, 2002).

Network centrality: network centrality is the amount of network ties for each member within the R&D institute. We computed normed in-degree centrality scores for each individual to allow for comparison across departments of different size. The in-degree centrality represents the amount of social ties initiated by other members, and thus does not suffer from the limitations of self-reports, as with out-degree centrality (Sparrowe et al., 2001).

Cluster coefficient: the cluster coefficient represents the tie condition among the direct ties of each individual. It is defined as the ratio of the number of direct ties divided by the number of pairs among the direct ties of each individual's network. That is, the clustering coefficient calculates the proportion of all possible dyadic connections actually present in each individual's network. The greater the clustering coefficient, the denser the connections among direct ties.

Knowledge diversity

Knowledge diversity is defined as the number of knowledge categories that each individual can reach from his network. Survey respondents were requested to choose one of ten knowledge bases that exactly match their expertise. These ten categories include mechanical engineering, chemistry, electrical engineering, aerospace studies, computer science, material science, project management, industrial engineering, quality control, and other. Based on these responses, we computed Blau's (1977) index of heterogeneity for the knowledge base of each individual to represent the extent of knowledge diversity each individual can reach from his or her social networks. Blau's index ranges from 0 (indicating all other network members are of the same knowledge base) to 1(indicating all other network members are from different knowledge bases).

Individual creativity

To measure individual creativity, we followed earlier studies (e.g. Madjar et al., 2002; Perry-Smith, 2006; Zhou and Shalley, 2003) and used supervisor ratings of employee creativity. Five items from Zhou and George (2001) were rated on a scale from "strongly disagree" (1) to "strongly agree" (5). Sample items include: "this employee is a good source of creative ideas" and "this employee always comes up with new thoughts that might improve working condition here." The five item scores were averaged to form an individual creativity index (α= 0.89). Considering that some large departments were rated by the same supervisor, to reduce the effect of a particular supervisor department variables were controlled for and an analysis of variance among department supervisors was performed. The results suggest that there is no significant difference across supervisors in how they rated their employees' creativity ($F_{(12, 426)} = 1.45$, *ns*).

Control variables.

In testing my hypotheses, we added eight control variables in the regression models. In order to reduce the effect of demographic background the following variables were added to the models: age, education, job position, tenure, overseas experience, and previous job experience at other institutes and other departments. Age was measured by a five-point scale between 20 and 60. Education was coded as 1, "senior high school degree;" 2, "bachelor degree;" 3, "master's degree;" and 4, "Ph.D." There are four categories of positions at the institute. These positions were coded from one to four based on the degree of professionalism of each position. Tenure was measured on a six-point scale with ten-year intervals from "less than 5 years," "5 to 10 years," eventually up to "more than 25 years." Overseas experience was calculated by the total number of months an employee spent training or studying overseas. Previous job experience at other departments or institutes may also influence the informal social network. Therefore, we summed the number of departments or institutes at which a selected employee had working experience. Finally, in order to reduce the effect of differences between departments, we added 12 dummy variables to the models.

4. Results

Table 1 reports the Pearson's correlations among all variables. The correlations between network variables and knowledge diversity were significant and in the expected direction ($p \leqq 0.01$). In addition, the correlation between knowledge diversity and individual creativity was also

positively significant, which supports my hypothesis. Among the control variables, age, position and tenure have significantly positive correlations with knowledge diversity. Age, education, position and tenure also have positive correlations with individual creativity.

Table 2 summarizes the regression results for knowledge diversity and individual creativity. Model 1 in Table 2 provides the regression results for control variables that accounted for a minor percentage of the variance in knowledge diversity ($R^2 = 20.3\%, p < 0.01$). According to the results of Model 1, none of the control variables exhibit a significant effect on knowledge diversity, with the exception of the department dummy variables, which demonstrate a significant and negative impact.

For Hypothesis 1, we proposed that network centrality positively correlates with knowledge diversity. Consistent with Hypothesis 1, the results of Model 2 in Table 2 reveal that network centrality is significantly and positively correlated to knowledge diversity ($\beta = 0.436, p < 0.01$). The regression model accounts for 35% of the variance in knowledge diversity. Hence, Hypothesis 1 is supported. Regarding Hypotheses 2, we proposed that cluster ties negatively correlate with knowledge diversity. Consistent with Hypothesis 2, the results of Model 3 in Table 2 reveal that cluster ties are significantly and negatively correlated to knowledge diversity ($\beta = -0.289, p < 0.01$), which also accounts for 41.9% of the variance in knowledge diversity. Thus, the results support Hypothesis 2.

Finally, for Hypothesis 3, we proposed that knowledge diversity positively correlates with individual creativity. Consistent with Hypothesis 3, the results of Model 4 in Table 2 reveals that knowledge diversity is significantly and positively correlated to individual creativity ($\beta = 0.283, p < 0.01$). Hence, the results support Hypothesis 3.

Table 1
Descriptive Statistics and Correlations for Network Variables, Knowledge Diversity and Innovation Performance

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1. Age	2.7	1.0	1									
2. Education	2.99	0.6	.02	1								
3. Overseas Experience	0.56	1.50	.18**	.40**	1							
4. Position	2.46	0.63	.60**	.42**	.26**	1						
5. Tenure	3.42	1.51	.85**	-.00	.17**	.56**	1					
6. Other Institute	0.14	0.47	.16**	-.13**	-.00	-.01	.14**	1				
7. Other Department	0.51	0.93	.34**	-.07	.03	.13**	.21**	.22**	1			
8. Centrality	1.32	0.88	.21**	.20**	.07	.33**	.26**	.01	.01	1		
9. Cluster Ties	0.33	0.17	-.13**	-.09	-.08	-.14**	-.12*	.01	-.06	-.12*	1	
10. Knowledge Diversity	0.43	0.15	.11*	.02	.03	.14**	.11*	.08	-.03	.47**	-.30**	1
11. Individual Creativity	3.06	0.86	.10*	.19**	.04	.25**	.15**	.01	-.04	.81**	-.02	.31**

N=427; $^{*}P<0.05$; $^{**}P<0.01$; $^{***}P<0.001$;

Table 2
Regression Analysis Results

Dependent Variable	Knowledge Diversity Model 1	Knowledge Diversity Model 2	Knowledge Diversity Model 3	Creativity Model 4
Age	.01	.056	.032	-.165
Education	.00	-.078	-.067	.184**
Overseas Experience	-.016	.019	.00	-.065
Position	.119	.028	.021	.146*
Tenure	.025	-.087	-.085	.182
Other Institute	.054	.054	.060	.014
Other Department	.00	-.002	-.004	-.021
Dept. 1	-.129*	-.067	-.069	-.123*
Dept. 2	.021	.064	.042	-.057
Dept. 3	-.170*	-.108	-.182**	-.117
Dept. 4	-.138	-.081	-.060	-.001
Dept. 5	-.151*	-.055	-.096	-.116
Dept. 6	-.105	-.062	-.088	-.017
Dept. 7	-.082	.020	.076	-.156**
Dept. 8	-.043	-.021	-.061	-.083
Dept. 9	-.446**	-.341**	-.394**	-.061
Dept. 10	-.060	.038	-.025	-.189**
Dept. 11	-.108	-.024	-.090	-.128*
Dept. 12	-.209**	-.130**	-.165**	-.050
Centrality		.436**	.389**	
Cluster Ties			-.289**	
Knowledge Diversity				.283**
R^2	0.203	0.351	0.419	0.208
Adj. R^2	0.165	0.318	0.388	0.168
F ratio	5.259**	10.59**	13.402**	5.197**

N=427; * $P<0.05$; ** $P<0.01$; *** $P<0.001$.

5. Discussion and Conclusion

In an effort to understand the social network view of creativity, this study hypothesizes and examines the influence of social network parameters and knowledge diversity on individual creativity. we proposed that network centrality positively correlates with individual's knowledge diversity, whereas cluster ties negatively correlate with individual's knowledge diversity. In addition, for individual creativity, we also proposed that knowledge diversity positively correlates with individual creativity. Overall, these hypotheses are supported by the results of the empirical tests.

Theoretical implications

The findings of this study offer a richer understanding of social relationships with regard to individual creativity. Unlike previous research that focuses on the relationship between network parameters and individual creativity, this study finds a process role for knowledge diversity between social network parameters and individual creativity. When social network researchers

demonstrated that social contact is a critical factor for employees to create new ideas (Brass, 1984; Ibarra, 1993; Cross et al., 2001), they did not consider a context factor like knowledge diversity. In other words, this research demonstrates that knowledge diversity plays an important intervening role: social ties are associated with knowledge diversity, which in turn influences individual creativity. While previous studies (Perry-Smith, 2006) were unable to find a connection with domain-relevant knowledge, this research fills an important gap within the literature's understanding of the cognitive creativity-generating process.

Secondly, as the results reported here demonstrate, network relations have different resource implications, depending on an individual's network position. The current findings suggest that network centrality facilitates an individual's knowledge diversity. Here, knowledge diversity acts as a source for resources, which may contribute to an individual's capability for solving problems or even coming up with new ideas. Previous researchers have demonstrated the positive relationship between network centrality and valued resources. However, there is little previous evidence on what value network resources provide. This current study not only confirms the relevance of social ties but also confirms the importance of network resources. Thus, these findings support the static portion of Perry-Smith and Shalley's (2003) social network perspective on creativity.

Perhaps the most important implication of this study for existing research, however, is the concept of cluster ties. Most previous studies on network structure focus on direct ties and their impact on individual behavior. They explain how direct ties are a powerful factor influencing individual behaviors and outcomes. However, few researchers pay attention to the way these direct ties are connected. Relatively to direct ties, the impact of cluster ties on individual behavior has earned little attention. Thus, this study offers an important contribution by not only devising the concept of cluster ties, but also explaining their influence on knowledge diversity and individual creativity. Specifically, the current study finds that the cluster tie is negatively associated with the degree of knowledge diversity, and this has extended our understanding of the differences in social structures and their impact on individual behaviors and outcomes.

In summary, this study contributes to several streams of research. First, it adds to the literature on social networks and individual creativity by demonstrating the concept of knowledge diversity, and explaining the link between knowledge diversity and social ties and individual creativity. Secondly, above all, this study diverges from the findings of previous studies regarding the influence of network centrality on individual creativity. Lastly, it also finds the negative impact of cluster ties on knowledge diversity. These results suggest that individual creativity research should be applied to more social network approaches.

Limitations and future research

Although this research makes several important contributions, there are still several important limitations. The first concerns the validity of the individual creativity measures. Although common method variance was not an issue because the social network and creativity ratings data had different sources, a leniency bias may have been present in the team leaders' ratings on individual creativity. The informal network structure may correlate to the team leaders' assessment of individual performance, rather than to actual creativity.

Secondly, there are limitations to the cross-sectional model. More people in a network may seek out creative individuals than uncreative ones, so creativity may lead to certain individuals occupying more central network positions. A longitudinal design should be used in the future to understand directionality.

Third, another limitation for this research is that only one organization was tested, and these findings may be associated with the peculiarities of this particular sample. For example, creativity was both encouraged and required as part of the job in this setting. Creativity is important in a wide variety of jobs and organizations (Shalley, Gilson & Blum, 2000), but not necessarily as explicitly important as in this case study. We would expect the results to be similar in a variety of settings, since the theoretical ideas apply to creativity broadly, but differences in the extent to which creativity is required should be explored.

Managerial implications

Social networks have been used to explain and understand a variety of organizational behavior phenomena, such as commitment and satisfaction (Krackhardt & Porter 1986), job-related rewards (Granovetter, 1973; Burt, 1992, 1997; Bian, 1997), influence and power (Brass, 1984), individual creativity (Perry-Smith and Shalley, 2003), and knowledge flow (Hansen, 2002; Cross et al., 2003). Moreover, social ties are regarded as valuable resources for solving problems, especially for those who work in knowledge-intensive industries. Social ties can serve as a resource for individuals to come up with new ideas or innovations. The findings of this study suggest that individual creativity can be enhanced by adding more knowledge diversity. The results strongly suggest that individuals should invest more energy in building social networks. However, the current study also suggests that cluster ties lead to less diverse knowledge pools, and redundant connections may reduce the contribution of social ties on an individual's knowledge base. Thus, individuals should cultivate social networks within which there are weaker connections among network members.

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