

The Strength-of-Weak-Ties Perspective on Creativity: A Comprehensive Examination and Extension

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Disentangling the effects of weak ties on creativity, the present study separated, both theoretically and empirically, the effects of the size and strength of actors' idea networks and examined their joint impact while simultaneously considering the separate, moderating role of network diversity. I hypothesized that idea networks of optimal size and weak strength were more likely to boost creativity when they afforded actors access to a wide range of different social circles. In addition, I examined whether the joint effects of network size, strength, and diversity on creativity were further qualified by the openness to experience personality dimension. As expected, results indicated that actors were most creative when they maintained idea networks of optimal size, weak strength, and high diversity and when they scored high on the openness dimension. The implications of these results are discussed.

Keywords: creativity, social network ties, personality

Over the past decade, research on creativity—defined here as the production of ideas that are original (i.e., that deviate radically from the status quo rather than incrementally) and useful (Amabile, 1996; George, 2007; Oldham & Cummings, 1996)—has proliferated (for a review, see Shalley, Zhou, & Oldham, 2004). In a reflection of the insight that the generation of creative ideas is often the result of the assemblage of novel combinations of different perspectives and approaches people are exposed to via social interactions (Allen, 1977), scholars have recently begun to identify the social network parameters that shape creativity at work (Burt, 2004; Cross & Cummings, 2004; Fleming, Mingo, & Chen, 2007; Obstfeld, 2005; Rodan & Galunic, 2004; Uzzi & Spiro, 2005).

Granovetter's (1973) strength-of-weak-ties theory, which illuminates the potential effects of social network ties on creativity, has gained particular prominence. According to this theory, networks saturated with "weak" ties, social relationships, which are typified by infrequent interaction, short history, and limited (emotional) closeness, are particularly valuable to the production of creative ideas because they allow for enhanced access and exposure to socially distant pockets of information—information that is likely to be novel and, therefore, likely to spur the combinatory process underlying the production of creative ideas (Brass, 1995; Perry-Smith & Shalley, 2003). Indeed, the creativity benefits that flow from large networks of predominantly weak ties have recently been documented. For instance, Perry-Smith (2006) found a positive link between the number of weak-tie acquaintances in scientists' networks and scientists' creativity. Similarly, Zhou, Shin, Brass, Choi, and Zhang (2009) showed that an increasing number of weak ties coincided with elevated levels of creativity in a sample of technology employees. However, their findings also

highlighted the diminishing returns that resulted from actors cultivating a growing number of weak ties, as this eventually produced lowered levels of creativity.

Although the insights obtained from this previous work are invaluable, this research also suffers from a number of ambiguities. First, the concept of weak ties confounds two different network parameters: the *number* of ties and the *strength* of these relationships. Thus, when one examines the effects of the strength (or lack thereof) of a set of relationships on creativity by counting the number of (weak) ties, it is not clear whether creativity benefits simply from a larger number of ties (promoting access and exposure to more pockets of information), from a lack of strength of these relationships (promoting access and exposure to socially distant pockets of information), or from both, as implicitly suggested by the strength-of-weak-ties perspective. To address this ambiguity, this study theoretically and empirically distinguished between the number of ties (i.e., network size) and their strength (i.e., network strength) and examined their individual and joint impact on creativity. Addressing this confusion is not only of theoretical importance but also of practical relevance, as the prescriptions for how networks should be structured will differ depending on which factor (or set of factors) is operative. Consistent with research suggesting that cultivating networks of increasing size has not only benefits but also costs (Mehra, Kilduff, & Brass, 2001; Zhou et al., 2009), I subscribe to the viewpoint that creativity requires the presence of an optimal number of ties, not a maximum number of ties resulting in an inverted *U*-shaped function (McFadyen & Cannella, 2004).

A second ambiguity in previous work stems from equating weak ties with access to diverse information. In formulating his theory, Granovetter (1973) argued that weak ties are particularly well suited for connecting people to others in different social circles. As such, they are ideal vehicles for access and exposure to very different thought worlds—perspectives and approaches that are not

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only new to the actor but that are fundamentally different from each other. Given that creative ideas are assumed to emerge at the confluence of these very different thought worlds (Mumford & Gustafson, 1988), the positive link between weak ties and creativity hinges upon the ability of such ties to deliver enhanced access to diverse pockets of information. However, not every weak tie connects to distinct social circles and provides entry to different thought worlds (Anderson, 2008; Burt, 1992). Thus, the strength-of-weak-ties perspective not only confounds the effects of network size and strength but also implicitly assumes that such ties link actors to different social circles—an assumption that may not always be valid.

Given that the strength of a set of relationships is conceptually independent from the diversity of information accessible via such ties, the present research directly examined the extent to which networks provide actors with exposure to different social worlds (e.g., colleagues in different parts of the organization, customers, competitors, suppliers) and considered this type of diversity as a moderator of the joint effects of network size and strength on creativity. Refining the strength-of-weak-ties perspective (Brass, 1995; Perry-Smith & Shalley, 2003), I hypothesized that the creativity benefits attributed to networks of optimal size and weak strength are more likely to materialize when these networks indeed connect actors to others in very different social worlds.

Finally, I extended the strength-of-weak-ties perspective by considering the moderating role of personality. Previous social network research has primarily focused on the effects of network parameters on a variety of outcomes and disregarded the role of personal factors in allowing actors to capture the informational value associated with certain network constellations. Only recently have scholars begun to acknowledge the potential interactive effects between network parameters and personal factors in jointly shaping different outcomes (e.g., Anderson, 2008; Zhou et al., 2009). Here, I examine, consistent with this recent work, how openness to experience—a personality dimension associated with the five-factor model (FFM; Costa & McCrae, 1992)—interacts with idea network size, strength, and diversity to jointly impact creativity.

The present research makes at least three valuable contributions to the extant literature. It theoretically and empirically separates the effects on creativity of the size and strength of actors' networks and examines their joint effects while simultaneously considering the separate, moderating role of network diversity. In doing so, this study brings greater conceptual clarity to the arguments of the strength-of-weak-ties perspective and provides a more appropriate and comprehensive test of these arguments, particularly with respect to creativity. In addition, the present study extends this perspective by identifying openness to experience as a critical personality factor determining the extent to which actors will be able to harness the benefits associated with diverse networks of optimal size and weak strength. Finally, by examining employees across different divisions of a large, global agricultural-processing firm, this study offers a more generalizable test of the strength-of-weak-ties perspective on creativity than does previous research, which has primarily focused on scientists and technology employees (e.g., McFadyen & Cannella, 2004; Perry-Smith, 2006; Zhou et al., 2009).

The current study focused on actors' "idea networks": networks of ties that provide access and exposure to novel insights and, as such, are instrumental in delivering the informational resources likely to spur the combinatory process underlying the production of creative ideas. I focused exclusively on direct idea ties because the kind of information likely to facilitate the production of creative ideas—information that is often fine-grained and complex—is more likely to be transmitted via direct than indirect channels (Hansen, 1999; McFadyen & Cannella, 2004).

Strength of Weak Ties and Creativity

In formulating his theory, Granovetter (1973) suggested that weak ties are more likely to connect actors to different social worlds and, as such, are ideal vehicles for access and exposure to perspectives and approaches that are not only new to the actor but also fundamentally different from each other. As ties grow stronger, individuals come to know each other better; as a consequence, the perspectives held by others may become more shared and redundant (Coleman, 1988). Because nonredundant information has been suggested to be the engine spurring the combinatory process underlying creativity, scholars have suggested that the development and maintenance of an increasing number of weak ties should coincide with elevated levels of creativity (Brass, 1995; Perry-Smith, 2006; Perry-Smith & Shalley, 2003). That is, the more pockets of novel, potentially diverse information can be accessed, the greater the probability for creativity. Reflecting the insight that cultivating an ever-increasing number of weak ties has not only benefits but also costs in draining actors' time and cognitive resources, thereby jeopardizing actors' engagement in the creative process and ability to take advantage of an increasing number of ties in the first place, recent work has suggested and demonstrated that it is an optimal number of (weak) ties, rather than a maximum number, that fosters creativity and the development of new insights (McFadyen & Cannella, 2004; Zhou et al., 2009).

Although appealing, the notion that an optimal number of weak ties fosters creativity is conceptually ambiguous, as it confounds two distinct features of actors' networks: the size and the strength. For example, it is conceivable that cultivating an optimal number of ties, irrespective of whether these ties allow actors to tap into socially distant or proximate pockets of information, is what propels creativity to higher levels. As each tie represents a channel providing access to information, increasing the number of idea contacts (up to some optimal level) should increase the breadth of information available (Anderson, 2008). The more information is available, in turn, the greater the number of potential creative combinations that can be derived and the greater the likelihood that creative ideas will emerge (Campbell, 1960; Mumford & Gustafson, 1988). Conversely, it may be possible that it is indeed the lack of strength of a set of relationships, irrespective of the number of ties in the network, that determines creativity. Even cultivating only a selected number of relationships to socially distant contacts may provide actors the necessary exposure to the type of novel information that is at the heart of the creative endeavor. Finally, it may be a combination of optimal network size and weak network strength, as implicitly suggested by the strength-of-weak-ties perspective, that provides the impetus for the generation of creative

ideas (Brass, 1995; Perry-Smith, 2006; Perry-Smith & Shalley, 2003).

To disentangle the effects on creativity of network size and strength, one must separate, conceptually and empirically, network size from network strength and consider their effects both individually and jointly. From a conceptual standpoint, cultivating idea networks of optimal size may gain actors exposure to the necessary breadth of information, and a lack of strength of these relationships ensures that actors primarily tap into socially distant and, as a likely result, novel pockets of information. From an empirical standpoint, rather than classifying ties as either strong or weak and then counting the number of ties that fall into either category, it may be preferable to separate the number of ties from strength by considering all ties in the network as an indicator of network size and the average strength across all ties as an indicator of network strength (Anderson, 2008; Morrison, 2002). If the arguments derived from the strength-of-weak-ties perspective are valid, quadratic network size and strength should combine multiplicatively to shape creativity in organizations. If either optimal size or weak network strength is sufficient to produce elevated levels of creativity, their respective main effects should emerge as significant predictors of creativity.

Network Diversity as a Critical Contingency

Implicit in the strength-of-weak-ties theory is the assumption that weak ties provide exposure to perspectives and approaches that are not only different from the actor's own but that are also fundamentally different from each other. Indeed, as the generation of creative ideas is typically the result of the coming together of very different thought worlds, including those that are inconsistent with the actor's own cognitive framework (Mumford & Gustafson, 1988), the ability of networks of optimal size and weak strength to stimulate creativity is dependent upon the ability of such networks to deliver enhanced access and exposure to diverse pockets of information. However, as highlighted by previous research, networks of optimal size and weak strength by no means guarantee entry into different social worlds (Burt, 1992; Zhou et al., 2009). Information delivered via such networks may be novel to the focal actor but may lack the necessary diversity to foster the production of highly creative ideas. Indeed, studying the information-gathering behavior of 53 managers in response to an e-commerce assignment, Anderson (2008) found no relation between the average tie strength of managers' networks and the diversity of information the managers were able to locate via their networks.

Given that the diversity of information accessible via networks appears to be independent from the strength of a set of relationships, a proper test of the arguments outlined in the strength-of-weak-ties theory requires the simultaneous consideration of all three network parameters. Consequently, the current study directly examined the extent to which actors' networks provide access and exposure to different thought worlds. According to previous research, differences in cognitive perspectives and approaches tend to be greater across different units of an organization or across organizations than within such domains (Perry-Smith & Shalley, 2003). Thus, access to fundamentally different pockets of information should be maximized when networks connect individuals to colleagues

in different parts of an organization or to acquaintances in other organizations (e.g., competitors, suppliers, customers). Only when actors cultivate networks of optimal size and weak strength that simultaneously link them to contacts in very different social worlds are they likely to be exposed to fundamentally different perspectives and approaches allowing for the generation of highly creative ideas. In contrast, in circumstances in which networks of optimal size and weak strength provide entry to new but similar thought worlds, differences in cognitive structures among network contacts may be relatively small. Such lesser differences may reduce the amount of diverse information available to actors and, ultimately, the amount of creativity that may be involved in their ideas. Thus, idea-network diversity in terms of contacts' affiliation may function as an important moderator of the joint quadratic relation among network size, strength, and creativity: Creativity should be higher in response to moderate idea network size and weak strength when network diversity is high. Thus,

Hypothesis 1: Idea network diversity will moderate the joint quadratic relation among idea network size, strength, and creativity such that creativity will be higher in response to moderate idea network size and weak strength when network diversity is high.

Individual Differences in Openness to Experience

Thus far, it has been suggested that actors who cultivate idea networks of optimal size and weak strength are more likely to be creative when their networks connect them to others in different social worlds. The production of creative ideas, however, requires that actors be able to take advantage of the informational benefits flowing from their networks. To derive creative ideas, individuals have to be able to integrate and synthesize the new information into their existing conceptual frameworks (Rodan & Galunic, 2004; Utterback, 1971). This should be especially challenging when actors interact with a diverse set of network members, because the perspectives and approaches acquired via such contacts tend not only to be fundamentally different from the actor's existing cognitive structures but also to be different from each other, requiring substantial integrative work on the part of the individual. This suggests that the extent to which actors develop creative ideas in response to moderate idea network size, weak strength, and high diversity may be regulated by the degree to which they are able to integrate and reconcile different perspectives and approaches (Mumford & Gustafson, 1988).

Openness to experience captures such an integrative quality (Feist, 1998). According to McCrae and Costa (1997), open individuals are characterized not only by a need to seek out new and varied experiences but also by a particularly permeable structure of consciousness allowing for better integration and combination of new and unrelated information (Baer & Oldham, 2006). These characteristics should enhance actors' ability to take advantage of the informational benefits associated with diverse networks of moderate size and weak strength. Thus, it can be hypothesized that creativity should be highest when actors maintain diverse networks of moderate size and weak strength and when they simultaneously score high on the openness to experience personality dimension.

No study has examined the complex interplay between actors' personality and these social network features on creativity. However, Anderson (2008) showed that need for cognition, a personality variable conceptually related to openness to experience, played an important role in allowing individuals to capture the informational benefits associated with their social networks. In addition, Zhou et al. (2009) showed that an optimal number of weak ties related to elevated levels of creativity only when actors placed little importance on conformity, a personal value likely to coincide with reduced levels of openness. Thus,

Hypothesis 2: Openness to experience will moderate the joint quadratic relation among idea network size, strength, diversity, and creativity such that the creativity of actors' ideas will be higher in response to moderate idea network size, weak strength, and high diversity when actors score high on the openness dimension.

Method

Research Setting and Participants

Hypotheses were tested in a sample of employees from a large, global agricultural-processing firm. Employees from different divisions, including Accounting, Finance, Processing, R&D, and Sales, and from different hierarchical levels (e.g., nonsupervisory employees, supervisors) were approached for participation. Information on actors' idea networks and personality was assessed via web-based surveys from participating employees. Information on creativity was obtained via supervisor rating, to avoid problems of common source variance. In total, 531 employees and 111 supervisors were identified.

Out of the 531 employees invited to participate, a total of 238 completed all sections of the survey for a response rate of 45%. Of those sampled, 151 were male and 94% were White. The mean age was 40.58 years ($SD = 11.52$), and average company tenure was 8.16 years ($SD = 7.95$).¹ Out of the 111 supervisors invited to participate in the study, 98 provided employee ratings for a response rate of 88%. Of those sampled, 86 were male and 92% were White. The mean age was 46.55 years ($SD = 8.57$), and average company tenure was 14.39 years ($SD = 9.10$). The final sample size dropped to 216 because I was unable to obtain the necessary ratings for 22 employees. The ratings for the final sample were provided by 86 supervisors (median number of employees rated = 2).

Measures

I used an egocentric network approach to capture actors' idea networks (e.g., Smith, Collins, & Clark, 2005). Employees first responded to a name generator question (e.g., Rodan & Galunic, 2004): "People may discuss work-related matters with others inside their organization, such as colleagues and supervisors, and with others outside of their organization, such as family members, customers, suppliers, and competitors. These discussions may result in people getting, intended or unintended, new information or insights about work-related problems or issues they face. Thinking back over the past year, please write down the names, nicknames, or initials of all people inside or outside [organization] who have provided you with new information or insights about work-related

problems or issues." On the basis of discussions with representatives from the participating divisions, the number of contacts participants could list was limited to 25.

After listing their contacts, participants responded to a set of name interpreter questions for each contact. To derive an indicator of network strength, I had employees respond to three items assessing closeness, duration, and frequency (Granovetter, 1973): "How close are you with each person?" (1 = *acquaintance*, 2 = *distant colleague*, 3 = *friendly colleague*, 4 = *close colleague*, 5 = *very close colleague*); "How many years has each relationship been in existence?" (1 = *less than one year*, 2 = *1 to 3 years*, 3 = *4 to 6 years*, 4 = *7 to 9 years*, 5 = *10 or more years*); "On average, how frequently do you communicate with each person?" (1 = *once a year or less*, 2 = *several times a year*, 3 = *once a month*, 4 = *several times a month*, 5 = *several times a week*, 6 = *daily*; Perry-Smith, 2006). To obtain a measure of diversity, I asked participants to indicate the affiliation of each contact using 11 categories in cases of internal contacts (1 = *Processing*, 2 = *Marketing*, 3 = *Sales*, 4 = *R&D*, 5 = *IT*, 6 = *Human Resources*, 7 = *Legal*, 8 = *Finance*, 9 = *Accounting*, 10 = *Audit*, 11 = *Credit*) and eight categories for contacts located outside the organization (12 = *family*, 13 = *suppliers*, 14 = *customers*, 15 = *competitors*, 16 = *alliance partners*, 17 = *governmental agencies*, 18 = *trade associations*, 19 = *board of directors*) (Smith et al., 2005).

Idea network size. This measure, also known as degree centrality (Kilduff & Tsai, 2003), was measured via the number of contacts listed in response to the name generator question.

Idea network strength. To construct an index of network strength, I averaged responses to the three items assessing closeness, duration, and frequency across all contacts in an actor's network and then averaged these scores (standardized) across items (e.g., Morrison, 2002). The correlations between the items were as follows: closeness and duration ($r = .31$, $p < .01$), closeness and frequency ($r = .40$, $p < .01$), and duration and frequency ($r = .08$, $p > .05$). Given that these items represent formative indicators of strength, the lack of sufficient convergence and internal reliability ($\alpha = .47$) is negligible (see Anderson, 2008; Diamantopoulos & Winklhofer, 2001).

Idea network diversity. To establish a measure of idea network diversity, I calculated Blau's (1977) index of heterogeneity based on the affiliations assigned to each contact: Heterogeneity = $1 - \sum p_i^2$, where p_i is the proportion of contacts in the i th category (e.g., Processing, Marketing).

Openness to experience. This was measured with 14 items from the International Personality Item Pool (IPIP; Goldberg, 1999). Sample items include "I avoid philosophical discussions" (reverse scored) and "I love to read challenging material." Items

¹ Characteristics of employee respondents and nonrespondents were generally similar. There were no significant differences in terms of age, $t(488) = 0.02$, $p > .05$; gender, $\chi^2(1) = 0.89$, $p > .05$; or race, $\chi^2(1) = 0.28$, $p > .05$. However, there were significant differences in terms of company tenure, $t(523) = 2.81$, $p < .01$. The average tenure of respondents ($M = 8.16$ years) was significantly lower than the average tenure of nonrespondents ($M = 10.17$ years), suggesting that shorter tenured individuals may have been overrepresented.

Table 1
Means, Standard Deviations, and Intercorrelations of All Variables

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Accounting	0.12		—												
2. Finance	0.13		-.14*	—											
3. Processing	0.25		-.21**	-.23**	—										
4. R&D	0.25		-.21**	-.23**	-.34**	—									
5. Sales	0.15		-.15*	-.16*	-.24**	-.24**	—								
6. Education	4.49	2.44	-.04	-.27**	-.14*	.35**	-.01	—							
7. Position	0.79	0.72	.03	.02	.14*	-.28**	.23**	.01	—						
8. Professional activity	0.88	0.85	-.10	-.04	-.33**	.23**	-.08	.26**	-.10	—					
9. Job tenure	4.47	4.82	-.04	.14*	.10	.00	-.16*	-.20**	.10	-.01	—				
10. Idea network size	11.47	7.59	-.12	-.18**	.07	.07	.18**	-.03	.09	.00	.10	—			
11. Idea network strength	0.00	0.71	.04	.20**	.09	-.20**	-.05	-.17*	.09	-.12	.18**	-.25**	—		
12. Idea network diversity	0.42	0.26	.00	.03	-.25**	-.02	.23**	.03	.17*	.17*	.05	.48**	-.20**	—	
13. Openness to experience	5.15	0.74	-.07	-.15*	-.03	.01	.21**	.21**	.21**	.12	-.09	.02	-.04	.18*	—
14. Creativity	2.88	1.38	-.10	-.02	-.10	.23**	.06	.27**	.16*	.20**	-.05	.23**	-.10	.18*	.24**

* $p < .05$. ** $p < .01$.

were rated on a scale that ranged from 1 (*strongly disagree*) to 7 = (*strongly agree*) and were then averaged ($\alpha = .85$).

Creativity. This was measured with three items derived from those developed by Subramaniam and Youndt (2005): “Ideas that imply substantial departures from existing product and service lines”; “Breakthrough ideas—not minor changes to existing products/services”; and “Ideas that make existing knowledge about current products/services obsolete.” Supervisors indicated the extent to which each of the three statements was characteristic of their employees using a scale ranging from 1 (*not at all characteristic*) to 7 = (*extremely characteristic*). The three items were then averaged to create a scale ($\alpha = .93$).²

Control variables. Given the potential to confound the hypothesized relations (e.g., Ibarra, 1993; Mumford & Gustafson, 1988; Unsworth, Wall, & Carter, 2005), the following were included as control variables: divisional membership, education (years of post high school education), position (1 = *nonsupervisory/individual contributor*, 2 = *supervisor/coordinator and/or technical expert*, 3 = *manager/director*, 4 = *senior management*), job tenure (years on the job), and professional activity (0 = *no activity*, 1 = *I belong to a professional society or attend the meetings of a professional society*, 2 = *I belong to a professional society and attend its meetings*).

Results

Descriptive statistics and correlations are shown in Table 1. The average network size was 11.47 contacts ($SD = 7.59$). On average, 39% of these ties crossed divisional and/or organizational boundaries ($SD = .28$). This result provided some support for the notion that actors’ idea ties were nonredundant (i.e., that they represented contacts that themselves are unlikely to be connected).

In Hypothesis 1, I proposed that idea network diversity would moderate the joint quadratic relation among network size, strength, and creativity such that creativity would be higher in response to moderate size and weak strength when network diversity was high. Consistent with Hypothesis 1, the $\text{Size}^2 \times \text{Strength} \times \text{Diversity}$ interaction term was statistically significant ($\beta = -.43$, $p \leq .05$; see Table 2). In addition, as shown in Figure 1 (Aiken & West, 1991), the relation between idea network size and creativity indeed

followed an inverted *U*-shaped function when networks were of low strength and high diversity. As shown in this figure, under conditions of moderate network size, actors with networks of low strength and high diversity exhibited higher levels of creativity than did those in the other conditions.

In Hypothesis 2, I proposed that openness to experience would qualify the joint quadratic relation among idea network size, strength, diversity, and creativity such that creativity would be higher in response to moderate idea network size, weak strength, and high diversity when actors scored high on the openness dimension. Consistent with Hypothesis 2, the $\text{Size}^2 \times \text{Strength} \times \text{Diversity} \times \text{Openness}$ interaction term was statistically significant ($\beta = .67$, $p < .01$). In addition, as shown in Figure 2, the relation between idea network size and creativity followed an inverted *U*-shaped function for actors scoring high on openness to experience and simultaneously maintaining networks of low strength and high diversity. Under conditions of moderate network size, highly open actors with networks of low strength and high diversity

² I established concept unidimensionality and discriminant validity (vis-à-vis incremental ideas and overall performance) via confirmatory factor analysis. To this end, I submitted the three creativity items along with three items assessing incremental ideas (Subramaniam & Youndt, 2005) and three items measuring overall performance (Hackman & Oldham, 1976) to the confirmatory factor analysis. This hypothesized three-factor model was then tested against a two-factor model (collapsing creativity and incremental ideas) and a one-factor model (Anderson & Gerbing, 1988). Model fit was determined by inspecting the chi-square ratio (i.e., chi-square divided by degrees of freedom), the comparative fit index (CFI) (Bentler, 1990), as well as the root mean square error of approximation (RMSEA) (Steiger & Lind, 1980). Following convention, I took a chi-square ratio of two (or less) as a guideline for acceptable model fit. For the CFI and the RMSEA I considered values of .95 (or larger) and .06 (or smaller), respectively, to indicate acceptable model fit (Hu & Bentler, 1999). Results revealed that the hypothesized three-factor solution fit the data well, $\chi^2(24) = 43.37$, $p < .01$, $\chi^2/df = 1.81$, CFI = .99, RMSEA = .06, and significantly better, $\Delta\chi^2(2) = 342.11$, $p < .01$, and $\Delta\chi^2(3) = 576.64$, $p < .01$, than the two-factor solution, $\chi^2(26) = 385.48$, $p < .01$, $\chi^2/df = 14.83$, CFI = .76, RMSEA = .25, or the one-factor solution, $\chi^2(27) = 620.01$, $p < .01$, $\chi^2/df = 22.96$, CFI = .60, RMSEA = .32. These results suggest that creativity is distinct from both incremental ideas and general performance.

Table 2
Results of Regression Analysis of Creativity on Idea Network Parameters, Openness to Experience, and Their Interactions

Variable	Creativity
Controls	
Accounting	0.16
Finance	0.13
Processing	0.33***
R&D	0.46**
Sales	0.18
Education	0.14
Position	0.17*
Professional activity	0.23**
Job tenure	-0.05
Linear main effects	
Network size	0.23*
Network strength	-0.16
Network diversity	0.20
Openness to experience	0.00
Linear two-way interactions	
Network Size × Network Strength	-0.20
Network Size × Network Diversity	0.02
Network Size × Openness to Experience	0.11
Network Strength × Network Diversity	0.37*
Network Strength × Openness to Experience	-0.20
Network Diversity × Openness to Experience	0.28*
Linear three-way interactions	
Network Size × Network Strength × Network Diversity	0.12
Network Size × Network Strength × Openness to Experience	-0.11
Network Size × Network Diversity × Openness to Experience	0.02
Network Strength × Network Diversity × Openness to Experience	-0.32
Linear four-way interaction	
Network Size × Network Strength × Network Diversity × Openness to Experience	0.15
Quadratic main effect	
Network size ²	0.01
Quadratic two-way interactions	
Network Size ² × Network Strength	-0.03
Network Size ² × Network Diversity	-0.27
Network Size ² × Openness to Experience	0.25
Quadratic three-way interactions	
Network Size ² × Network Strength × Network Diversity	-0.43*
Network Size ² × Network Strength × Openness to Experience	0.20
Network Size ² × Network Diversity × Openness to Experience	-0.24
Quadratic four-way interaction	
Network Size ² × Network Strength × Network Diversity × Openness to Experience	0.67***
R ²	0.45
F	3.57***

Note. Entries refer to standardized regression coefficients at the last step.
* $p \leq .05$. ** $p < .01$.

exhibited higher levels of creativity than did those in the other conditions.³

Discussion

The results of the present study support not only the more nuanced approach to examining the arguments of the strength-of-

weak-ties perspective with respect to creativity (Brass, 1995; Perry-Smith, 2006; Perry-Smith & Shalley, 2003; Zhou et al., 2009) but also the proposed refinement and extension of this perspective. Although results confirmed, as implicitly suggested by the strength-of-weak-ties theory but never explicitly hypothesized or tested, that creativity flourished when actors developed and maintained (idea) networks of both increasing size (up to some optimal level) and weak strength, this inverted *U*-shaped pattern emerged only when (a) networks simultaneously connected actors to colleagues in all different parts of the organization or to acquaintances in other organizations, providing access and exposure to a wide range of fundamentally different pockets of information; and (b) actors scored high on the openness to experience personality dimension, allowing for the absorption and synthesis of these diverse sets of information. Thus, neither optimal network size nor weak network strength is sufficient to guarantee access to the type of information likely to spur the combinatory process underlying the production of creative ideas. In fact, idea networks have to exhibit both features and simultaneously provide exposure to a wide range of different thought worlds if creativity is to flourish—and this potential is more likely to be realized when individuals possess the personality characteristics that allow them to take advantage of the informational benefits associated with their idea networks.

The results of this study refine and extend the strength-of-weak-ties perspective on creativity by highlighting (a) the importance for scholars to consider network diversity, particularly diversity with respect to contacts' organizational affiliation, as a contingency factor that is independent of the effects of both network size and strength and (b) the critical role of openness to experience in allowing actors to capture the informational value of certain network constellations. Thus, the present findings underscore the need for network scholars to consider various networks parameters separately and in concert and to extend their theorizing beyond these variables to incorporate personal factors as well.

The notion that individual differences are key to unlocking the benefits of certain network constellations is consistent with recent work by Zhou et al. (2009), who showed that an optimal number of weak ties related to creativity only when actors scored low on the personal value of conformity. In fact, when conformity was high, the number of weak ties was unrelated to creativity. Similarly, the results of the present study demonstrate that idea networks of optimal size and weak strength, even when they reach into different social circles, do not foster creativity unless actors

³ Although most supervisors rated only two employees in terms of their creativity, problems associated with nonindependence of observations can still arise. To address this issue, I reran all analyses adjusting standard errors for correlations of error terms due to clustering within supervisors. Results from these analyses were virtually identical to those presented in Table 2 and are available upon request. In addition, I estimated the level of nonindependence at the division level (the employee-to-supervisor ratio was too small for me to estimate the effects of nonindependence at the supervisor level) by calculating the relevant intraclass correlation (ICC). Following Bliese (2000), I calculated ICC(1) values based on a one-way random effects analysis of variance in which division membership served as the independent variable and creativity served as the dependent variable. Results indicate that nonindependence due to division membership was not a serious problem in this study (ICC = .06).

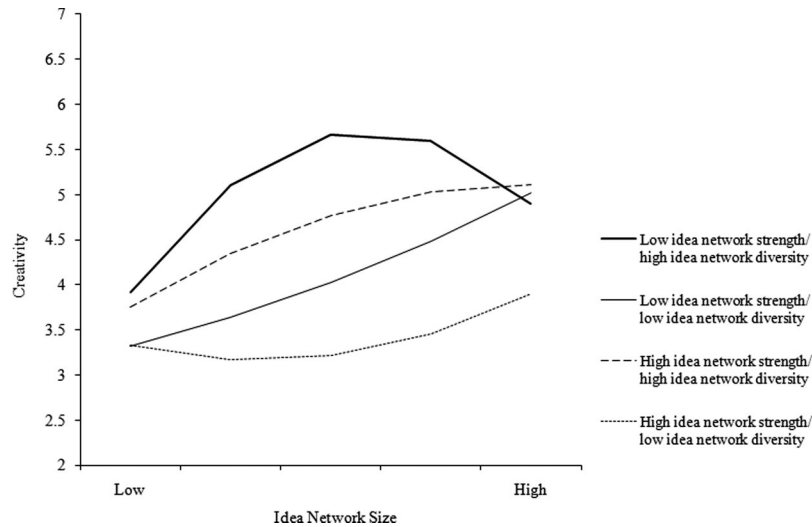


Figure 1. Quadratic interaction of idea network size, idea network strength, and idea network diversity on creativity.

are able to take advantage of the opportunities afforded by their networks. Although previous research has called for enriching social network theory by considering the possibility that certain personality dimensions may allow actors to differently capture the value of their social networks (Mehra et al., 2001), little work has actually identified the relevant dimensions (for an exception, see Anderson, 2008). Instead, most research has considered personality as a correlate of network structure (e.g., Burt, Jannotta, & Mahoney; 1998; Oh & Kilduff, 2008). The present results contribute to the extant literature by suggesting that openness to experience is one personality dimension critical if idea networks of optimal size, weak strength, and high diversity are to result in elevated levels of creativity. Thus, researchers should consider personality and other individual factors, such as cognitive ability, as moderators of the link between various network parameters and creativity.

Although no such relation was hypothesized, no support was found for a simple, quadratic relation between network size and creativity as documented in previous, related work (McFadyen & Cannella, 2004; Zhou et al., 2009). One explanation for this may be found in the samples used in these earlier efforts. McFadyen and Cannella examined the relation between the number of coauthors and knowledge creation in a sample of biomedical scientists; Zhou et al. (2009) studied the link between the number of weak ties and creativity in a sample of employees from a high-technology company. Given these samples, it is safe to assume that both knowledge creation (e.g., publishing high-impact research articles) and the development of creative ideas fell within individuals' job descriptions. In contrast, although encouraged, creativity was not part of the formal job descriptions of most employees sampled in the present study.

As a result of knowledge creation and creativity being formally required, social relationships and collaborations are likely to be established with the intent of assembling novel, distinct information sets by including coauthors, colleagues, and acquaintances from various (academic) departments or institutions in an effort to

maximize the potential for creativity. Thus, measures of the number of (weak) ties in these studies may have partially confounded the effects not only of size and strength but also of diversity. In addition, because McFadyen and Cannella (2004) sampled scientists and research has shown that openness to experience is one of the FFM dimensions distinguishing scientists from nonscientists (Feist, 1998), the McFadyen and Cannella sample likely included individuals scoring high on this dimension. Given this logic, it is not surprising that an inverted *U*-shaped relation between network size and creativity emerged only once the multiplicative effects of size, strength, diversity, and openness were considered simultaneously. Due to the differences in creativity—externally driven in previous work versus more proactive in the present study—my results contribute to the extant literature by identifying the factors likely to encourage creativity in settings in which it may not be explicitly required. Thus, the current study adds to the burgeoning discussion on the different factors contributing to various types of creativity in the workplace (Unsworth, 2001).

Despite these contributions, the current study has some drawbacks. First, given the complex set of predictions and the inherent difficulty associated with reliably detecting higher order interactions, particularly in field studies (McClelland & Judd, 1993; Zhou, 2003), both the three-way and the four-way interaction results need to be replicated in future research. Researchers may also want to explore some of the nonhypothesized relations observed in this study. For example, results revealed a general positive trend between idea network size and creativity for actors who scored high on the openness to experience personality dimension but who had cultivated networks that either lacked sufficient diversity or were too strong. Although creativity was comparatively lower under these conditions, it appears that increasing network size may be able to compensate, at least to some extent, for a lack of diversity or excessive strength. Future research should examine the complex interplay between various network parameters in more detail.

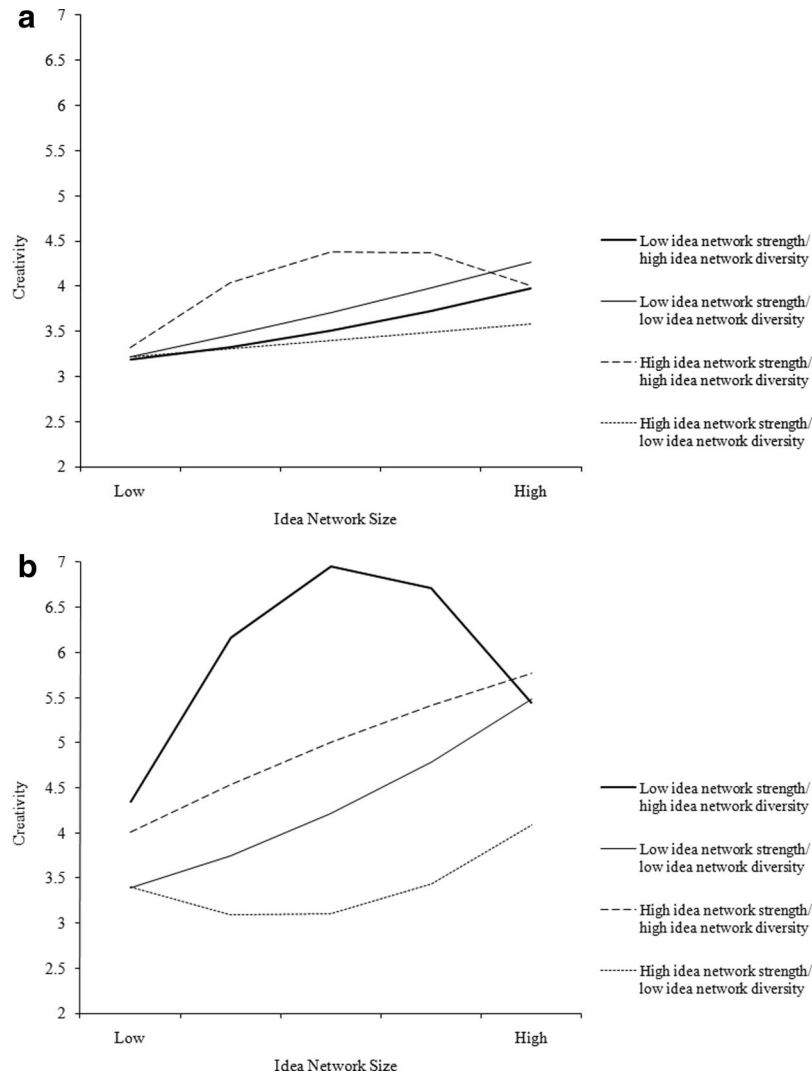


Figure 2. a: Quadratic interaction of idea network size, idea network strength, idea network diversity, and openness to experience on creativity: Openness to experience low. b: Quadratic interaction of idea network size, idea network strength, idea network diversity, and openness to experience on creativity: Openness to experience high.

Although using an egocentric network approach allowed me to study different divisions of a large organization, a second limitation stems from my inability to validate the existence of the reported relationships. However, previous research suggests that people are able to accurately report typical social relationships, although they may not be able to recall certain interactions in a limited period of time (Hansen, 1999; Marsden, 1990). Given that the network generator question inquired about exchanges that occurred over the course of an entire year, there is reason to believe that actors reported typical interactions rather than unique ones. Hence, threats to reliability and validity may not be of great concern in this study.

Finally, I measured network size as actual rather than effective network size. In contrast to actual size, effective network size adjusts the number of reported ties for the level of interconnectivity present in an actor's network (Burt, 1992). Naturally,

because people who are themselves connected are more likely to offer information that is redundant, using actual rather than effective network size may overestimate the level of nonredundant information available to actors via their direct ties. However, given that, on average, almost 40% of the ties reported by actors in this study crossed divisional and/or organizational boundaries and that even ties to contacts within an actor's division cannot necessarily be considered redundant, given the size of some of the divisions, use of actual network size may not have greatly biased my results.

The results of this study suggest that organizations attempting to boost the production of creative ideas may want to focus their selection efforts on recruiting and hiring open individuals. This approach in and of itself, however, is unlikely to promote creativity unless paired with efforts that encourage such employees to actively cultivate relationships that reach across numerous departmental or organizational divides, as this is likely to provide them

with the kind of perspectives and approaches needed for developing more groundbreaking contributions. One way to stimulate the exchange of ideas across divisions is for managers to promote the occurrence of serendipitous meetings between people from different parts of the company, for example, at conferences, off sites, or training programs (Kleinbaum & Tushman, 2008). To stimulate interactions with customers or other external parties, managers may want to introduce targets and metrics requiring a boost in the proportion of innovations incorporating external ideas or introduce incentives that reward business units that generate profits via external relationships (Roth & Sneader, 2006). However, caution needs to be exercised, as maintaining an increasing number of such ties (beyond an optimal level) or engaging in too frequent interaction with such contacts may eventually drain actors' resources or result in too strong relationships ultimately undermining creativity. The current study suggests that developing a dozen or so ties (optimal number of ties is around the midpoint; i.e., 11.47) to acquaintances and distant colleagues all across the organization and beyond with whom the focal actor communicates on a monthly (or less frequent) basis may be a healthy place to start in crafting one's idea network.

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Correction to Correction to Ilies et al. (2009)

In the Correction to Ilies et al. (2009; *Journal of Applied Psychology*, Vol. 95, No. 2, 404) the volume number of the original article was incorrectly identified. It should have been identified as Vol. 94.

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