

Relational Enhancement: How the Relational Dimension of Social Capital Unlocks the Value of Network-Bridging Ties

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Abstract

We propose and test a novel approach to the dilemma that the very network-bridging structure most likely to provide access to novel knowledge may be ill-suited for the cooperation needed to successfully transfer that knowledge. We theorize that the relational dimension of social capital (e.g., tie strength) can act as a substitute for the structural benefits of network closure, and so a network-bridging tie yields more value when it is also strong. We further investigate if it is emotional closeness, interaction frequency, or trust that underlies this “relational enhancement” effect. The results from analyzing a bounded network in a large consulting firm and egocentric networks in the engineering division of a large manufacturer provide support for the relational-enhancement effect of tie strength and further identify trust as the key mechanism allowing network actors to unlock the value embedded in their network-bridging ties.

Keywords

knowledge transfer, social capital, structural holes, tie strength, trust

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Imagine two work colleagues, Wyatt and Sam. Each of them provides you with what is, in essence, a kind of “bridge” into a different part of your organization, because the three of you travel in different circles and know hardly anyone in common. Your relationship with Wyatt is more of a weak bridge, though, in that you two don’t interact very frequently, don’t feel all that close, and haven’t necessarily developed a very trusting relationship. You get along ok with Wyatt, but it’s not like he would go out of his way for you. In contrast, your relationship with Sam is a strong bridge: you talk with Sam all the time, feel really close to him, and trust him a lot. So even though you and Sam don’t know anyone else in common, you both feel a strong bond. Now imagine you have a work problem that needs a fresh perspective, something that the rest of your work colleagues may have overlooked but that someone like Wyatt or Sam might be able to help you with. So you call them both, asking if they can spare an hour or two today to help you solve your work problem. Which one—Wyatt or Sam—is more likely to step up and help you?

Generating and making use of new knowledge can be a key source of competitive advantage for firms (Grant, 1996; Zander & Kogut, 1995) and for individual performance (Cross & Cummings, 2004; Mehra, Dixon, Brass, & Robertson, 2006), and hence the cultivation of effective work relationships—to develop and obtain this knowledge—is essential. Such relationships, in the aggregate, have been studied extensively in the literatures on social networks and social capital (for recent reviews, see Carpenter, Jiang, & Li, 2012; Phelps, Heidl, & Wadhwa, 2012). One of the main insights established by this research is that benefits accrue to network actors who broker between disconnected others and thereby generate or have access to novel insights (e.g., Burt, 1992; Rodan, 2010). Yet knowledge seekers can face a dilemma in that this network structure affords novelty (or, non-redundant knowledge) but often impedes knowledge transfer (Mors, 2010). Specifically, when relationships among actors are not surrounded by mutual third parties—that is, when they lack network closure (Coleman, 1990; Granovetter, 1985)—the willingness to cooperate may be diminished, which, in turn, may hinder the transfer and absorption of new knowledge (Burt, 2005). In a sense, the very network-bridging structure most likely to provide access to novel knowledge can be ill-suited for the cooperation needed to successfully transfer that knowledge (see Phelps et al., 2012; Reagans & McEvily, 2008, for recent reviews).

The early literature recognized brokerage and closure as two competing perspectives: The *brokerage view* emphasizes the benefits of accessing diverse and novel knowledge as well as the brokerage opportunities available to actors establishing network-bridging ties (Burt, 1992). In contrast, the *closure view* stresses the benefits of interacting with others in a dense network,

where close-knit connections are governed by social norms and reputation effects that encourage the willingness to cooperate and share information (Coleman, 1990). Following this perspective, prior studies took a contingency approach, recommending brokerage for certain situations, closure for others. For example, Moran (2005) found that network closure enhances managers' performance at more routine tasks but did not have a significant bearing on innovation tasks.

Oftentimes, the benefits of both novelty *and* cooperation would be helpful, however, like in our introductory vignette. In response, more recent studies have proposed so-called "hybrid" network positions (Baum, van Liere, & Rowley, 2007), in which a "group consists of people strongly connected to one another, with extensive bridge relations beyond the group" (Burt, 2005, p. 165), and which could reap the benefits of closure inside the group and the benefits of brokerage beyond the group (Reagans & McEvily, 2008; Walter, Lechner, & Kellermanns, 2007). Traditionally overlooked, however, has been the role that the characteristics of a *given* relationship (i.e., a dyad) can play in resolving this "cooperation conundrum," that is, the difficulty in getting enough cooperation to fully reap the benefits of network brokerage. As Moran (2005) has observed, "[u]nfortunately, dyad-specific qualities of social capital have been given much less empirical attention [and] have not been empirically disentangled from social capital's structural attributes" (p. 1132). We aim to address this gap in the literature by drawing on the notion that social capital—that is, the "sum of the actual and potential resources embedded within, available through, and derived from the network of relationships" (Nahapiet & Ghoshal, 1998, p. 243)—is more than just network structure. That is, we build on the conceptualization of social capital as having both a structural dimension (i.e., the pattern of network connections, such as network density or constraint) and a relational dimension (i.e., the nature of those connections, such as tie strength or trust; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998).¹ These dimensions are sometimes conflated but are actually distinct. For example, sometimes certain people but not others just "click" and get along well in a relationship, for no obvious reason related to network structure.

Thus, rather than assuming that the structural dimension is indicative of the relational dimension or vice versa, we disentangle the two dimensions—including how they interrelate—both theoretically and empirically. In particular, although the surrounding network structure can and does affect how people feel about each other (e.g., Paxton & Moody, 2003), not all significant features and benefits of a relationship derive from network structure. At the dyad level, the strength of a relationship, for example, can provide a willingness to cooperate independent of the surrounding network structure and thus

substitute for the cooperation benefits typically associated with network-level closure (Coleman, 1990; Granovetter, 1985).

Applying this insight to the cooperation conundrum outlined above, our study makes three main contributions. First, we propose that a network-bridging tie—that is, a tie that links two parties who have few or no third-party contacts in common—that is also a strong tie can provide *both* access to novel knowledge (by virtue of its structural bridging qualities) *and* the willingness to cooperate that is necessary for a successful transfer of that knowledge (by virtue of its relational qualities). We call these “relationally enhanced” network-bridging ties, and an example would be Sam (the strong bridge) from our introductory vignette. Thus, we provide evidence on ways in which the relational content of network bridges differs from that of more embedded ties. Second, we address the theoretical and empirical ambiguities (Krackhardt, 1992; Marsden & Campbell, 1984, 2012) surrounding the concept of tie strength by disentangling both conceptually and empirically the effects of the most important relational characteristics—emotional closeness, interaction frequency, and trust—to uncover the fundamental driver(s) of relational enhancement. And third, our study extends prior hybrid approaches to the cooperation conundrum. The main problem with network-level-only approaches is that they require extensive adjustments at the network level—either to the overall network structure (e.g., changing the pattern of ties among actors) or to the network’s composition (e.g., changing the types of actors in a network in terms of their stable traits, features, or resource endowments; Baum et al., 2007; Burt, 2005; Reagans & McEvily, 2008; Walter et al., 2007). In a sense, such network-level approaches are undersocialized (Granovetter, 1985), that is, they underestimate the constraints that a network structure imposes on an individual and thereby imply that an individual could easily make changes to the broader structure (such as adding or deleting ties among third parties) or to the network’s composition (such as embedding a new actor into an existing network). Such network-level adjustments, however, are likely to be time-consuming and difficult, if not impossible, for individuals to achieve on their own. Moreover, even *if* a network actor could assemble a group of people from different social circles, organizations, or backgrounds, they may not have the time or even *want* to forge a tight-knit group. In contrast to the collective action required by such hybrid approaches, our relational-enhancement approach can be implemented more unilaterally by an individual, for example, by building and maintaining a trusted tie. As a result, relationally enhanced network bridges may be just as valuable but not as rare or as difficult to achieve in practice.

Theory and Hypotheses

Network-Bridging Ties and Tie Strength

A *network-bridging tie* is a relationship that spans a structural hole in a network, that is, it is defined by the network structure surrounding the tie (Burt, 2005). While some prior studies have conceptualized “bridging” as links across a formal organizational boundary (e.g., Tortoriello & Krackhardt, 2010), across areas of expertise (Reagans & McEvily, 2003), or across demographic groups (Reagans & Zuckerman, 2001), we focus on bridging ties in the traditional, more fundamental sense, that is, as links across the informal network structure to contacts that are not connected to each other (Burt, 1992).

Moreover, a network-bridging tie, like any other tie between two actors, can be either weak or strong, with *tie strength* often being determined by the time spent together, emotional intensity, and intimacy characterizing the tie (Granovetter, 1973). At first glance, a strong network-bridging tie may seem like an oxymoron. After all, building on arguments from balance theory (Heider, 1958), early work on tie strength concluded that “except under unlikely conditions, *no strong tie is a bridge*” (Granovetter, 1973, p. 1364, emphasis in original). Only recently has the social network literature come to acknowledge the possibility of strong network-bridging ties. Burt (2005), for example, defines a bridging tie as “a (strong or weak) relationship for which there is no effective indirect connection through third parties” (p. 24). How do strong network-bridging ties come about? This can happen in any number of ways. For example, sometimes people whose relationship spans a structural hole simply “hit it off” by either finding things in common other than mutual contacts, such as similar attitudes, values, working style, outside interests, professional background, and so on, or by recognizing that they are complementary to each other (Dwyer, 2000), making reciprocal exchanges mutually beneficial. These things can forge a strong bond even without the benefit of knowing people in common.

Prior research has found that stronger ties often lead to a greater exchange of useful knowledge. In particular, tie strength increases people’s motivation to be more easily available, treat each other well, and assist each other (Krackhardt, 1992). Tie strength also makes people more willing to share what they know and to listen to and absorb what the other person has to say (Levin & Cross, 2004; Levin, Walter, & Murnighan, 2011). Extending those arguments, we propose that tie strength will be especially useful for receiving value from a network-bridging tie, as tie strength can act as a substitute for the cooperation benefits usually associated with network closure. Unlike

weak network-bridging ties, which have only the potential to provide access to novel knowledge (Burt, 1992; Granovetter, 1973), strong network-bridging ties make both sides more willing to cooperate fully and engage in a productive knowledge exchange (Krackhardt, 1992). These valuable collaborations thereby allow people to make fuller use of the opportunity provided by the network-bridging tie. Thus, we would expect tie strength to enhance the value of a tie that bridges a structural hole, “unlocking” that tie’s potential by making meaningful exchanges between the two actors more likely. Conversely, for ties that do *not* bridge a structural hole, we would not expect tie strength to have a positive effect, as network closure in such cases already encourages the cooperation necessary for useful knowledge exchange (Coleman, 1990). Based on this line of reasoning, we propose:

Hypothesis 1 (H1): Tie strength will enhance the value of network bridging, such that the stronger the network-bridging tie, the more valuable network bridging will be.

Potential Mechanisms of Relational Enhancement

As an initial heuristic, thus far we have treated tie strength—and more generally, the relational dimension of social capital—as a single, unitary concept. As we describe below, however, this dimension actually contains multiple elements. Thus, to better understand how relational enhancement operates, it is important to pinpoint more precisely the relational characteristics that enable effective network bridging. This is important to the literature, as the dyadic concept of tie strength itself is in many ways an umbrella construct (Hirsch & Levin, 1999), containing multiple elements that may not always act in concert. Indeed, one early clue to this fact is that Granovetter (1973) originally defined tie strength not as a unitary concept but rather as “a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie” (p. 1361). Since then, subsequent scholars have conceptualized tie strength—representing the relational component of social capital—as emotional closeness (Moran, 2005; Seibert, Kraimer, & Liden, 2001), or as interaction frequency (Aral & Van Alstyne, 2011; Reagans & McEvily, 2008; Reagans & Zuckerman, 2001; Tortoriello & Krackhardt, 2010; Tortoriello, Reagans, & McEvily, 2012), or as trust or trustworthiness (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998), or as a combination of elements (Cross & Sproull, 2004; Lechner, Frankenberger, & Floyd, 2010; Levin & Cross, 2004; Moran, 2005; Reagans & McEvily, 2003).

In some instances, these multiple elements work in parallel—for example, when two people communicate frequently and also feel a close connection (e.g., Reagans & McEvily, 2003)—but this is not necessarily the case for a variety of relationships. In fact, several studies have demonstrated empirically that these different dyadic elements are conceptually and empirically distinct (Aral & Van Alstyne, 2011; Lechner et al., 2010) and, more importantly, may actually operate independently of one another (Marsden & Campbell, 1984). Burt (1997), for example, found that managers sorted relationships on two dimensions of strength—intimacy (from especially close to distant) and activity (from frequent to rare contact)—which led him to conclude, “Managers, like people in the general population, do not distinguish relations on a single dimension of strong versus weak. They distinguish on orthogonal dimensions of intimacy and activity” (Burt, 1997, p. 363). This finding that closeness and interaction frequency are orthogonal also resonates with more recent research that has found instances where these two elements diverge markedly—such as dormant ties where people still feel close even after many years of no communication (Levin et al., 2011; Walter, Levin, & Murnighan, 2014).

Similarly, while it has been used to conceptualize tie strength (e.g., Moran, 2005; Nahapiet & Ghoshal, 1998), trust is conceptually and empirically distinct from the other two elements. While closeness and frequency can each create trust (Levin & Cross, 2004; Tsai & Ghoshal, 1998), so can non-relationship factors like an observed pattern of trustworthy behavior (Whitener, Brodt, Korsgaard, & Werner, 1998), a third-party referral (Ferrin, Dirks, & Shah, 2006), a common background, similar demographics (Levin, Whitener, & Cross, 2006), a superordinate identity (Kane, 2010), a corporate culture of cooperation (Abrams, Cross, Lesser, & Levin, 2003), subliminal cues (Huang & Murnighan, 2010), or any number of other factors. In fact, the trust literature has identified dozens of “trust builders” (for an overview, see Levin, 2008), and trust has been shown to occur swiftly even among strangers in newly formed groups (Meyerson, Weick, & Kramer, 1996; Pérez-Nordtvedt, O’Brien, & Rasheed, 2013). In sum, sometimes people trust someone even if they do not know the other person very well (Levin & Cross, 2004) or at all (Meyerson et al., 1996), and conversely, sometimes trust is low among people who work together closely, either because severing an untrusted work tie is not always possible (Levin et al., 2006) or because some close contacts are also competitors—for example, for promotions, rewards, resources, attention—thereby creating ambivalence and rivalry even among people who feel close (Ingram & Zou, 2008). Thus, trusted ties can be high- or low-frequency ties and can also be close or distant ties.

We note that these three relational elements have the potential to be central to a productive knowledge exchange, in a variety of ways, to the extent that

they support actors' willingness to cooperate. In particular, feelings of emotional closeness can create a feeling of obligation to provide assistance or support to a close contact (Krackhardt, 1992). Frequent interactions can establish norms of reciprocity (Wills & DePaulo, 1991) as well as relationship-specific heuristics (Tortoriello & Krackhardt, 2010) that make knowledge exchanges more comfortable. And trust can lower competitive and motivational barriers (Krackhardt, 1992) and thereby make people more willing to share and listen. In sum, to better understand the precise dyadic mechanism that might duplicate the cooperation benefits of network closure and that could therefore enhance the value of a network-bridging tie, we aim to discover which basic concept—that is, closeness, frequency, and/or trust—is the critical element, as it could be any one of them. As Krackhardt (1992) has noted, disentangling these “quasi-independent elements . . . is not simply a question for the methodologically curious. It is an important part of the theory itself” (p. 216).

Close network-bridging ties. Emotional closeness measures the affect (Casciaro & Lobo, 2008) or personal familiarity (Moran, 2005) in a relationship. Krackhardt (1992), in particular, has emphasized the importance of this relational element by arguing that Granovetter's (1973) original theory on tie strength draws on balance theory (Heider, 1958) and that the underlying rationale for balance is psychological. For this reason, “[w]ithout positive affect, there is less motivation to maintain Heiderian balance, to share confidential information or refrain from malfesance” (Krackhardt, 1992, p. 219). Several studies have since concurred with this assessment and have suggested emotional intensity (McEvily & Zaheer, 1999) or closeness (Lechner et al., 2010; Sosa, 2011) as the main mechanism behind the benefits of strong ties. In particular, the level of emotional attachment or commitment to the relationship affects the motivation to provide assistance or support (Reagans & McEvily, 2003), that is, close contacts will generally feel more obligated to make the effort to carefully explain and listen to novel or complex ideas (Moran, 2005; Sosa, 2011).

Network-bridging ties, as noted above, lack the structural network properties that encourage a willingness to cooperate, to go out of one's way to help the other person. Such willingness, however, is often what emotional closeness contributes to a relationship, that is, the motivation for knowledge sources to share their insights, and for knowledge seekers to listen and assimilate the exchanged information (Casciaro & Lobo, 2008; Krackhardt, 1992). Thus, while this feeling of dyadic closeness may be unnecessary in an already-dense network, it should be particularly helpful in enhancing the value of a network-bridging tie:

Hypothesis 2 (H2): Emotional closeness will enhance the value of network bridging, such that the closer the network-bridging tie, the more valuable network bridging will be.

High-frequency network-bridging ties. There are two main reasons to expect frequent interactions to enhance the value of network-bridging ties. The first reason is that more frequent interaction is likely to be positively related to the number of requests that each person has made of the other, that is, a shared history of reciprocity (Wills & DePaulo, 1991). After all, even within an organization, work interactions often involve back-and-forth exchanges of resources, knowledge, and assistance over time (Cross & Sproull, 2004), and so it stands to reason that more frequent interactions will likely involve more such exchanges. Given that the norm of reciprocity is fairly universal (Gouldner, 1960), this shared history of exchange is likely to create dyadic obligations that can be cashed in, which, in turn, would increase the other person's willingness to cooperate and help.

The second reason is that more frequent prior interactions among individuals likely lead to more efficient and effective communication through, for example, the development of a common language and other relationship-specific heuristics that facilitate cooperation (Tortoriello & Krackhardt, 2010). By making exchanges more efficient and effective—that is, less burdensome—frequent interactions likely make people feel more comfortable and thus more willing to cooperate. Similarly, research suggests that mere exposure to something can increase attraction (Zajonc, 1968), and this familiarity principle is particularly true for interpersonal interactions, in part because it makes people feel more comfortable (Reis, Maniaci, Caprariello, Eastwick, & Finkel, 2011). Thus, greater interaction frequency may, by itself, make people more comfortable with each other and hence more inclined toward cooperation.

These reasons suggest that frequent interactions may establish a higher willingness to reciprocate and cooperate, and thereby allow knowledge seekers to unlock the value of the opportunity provided by a network-bridging tie. We therefore propose:

Hypothesis 3 (H3): Interaction frequency will enhance the value of network bridging, such that the more frequent the interactions for the network-bridging tie, the more valuable network bridging will be.

Trusted network-bridging ties. Separate from closeness and frequency, the trust literature offers a third potential mechanism for relational enhancement. Specifically, the belief that the other person cares about and will look out for

you—sometimes referred to as relational trust² (Levin et al., 2011)—is particularly well suited to the goals of relational enhancement and appears to go to the heart of the cooperation conundrum. That is, if network-bridging ties are less likely to produce a willingness to engage, listen, learn, and share due to the lack of network closure, then trusting each other to do those things might be just what the tie needs to help overcome this conundrum.

Along these lines, prior research has found that trust acts as a governance mechanism that facilitates knowledge exchange by lowering competitive and motivational barriers (Krackhardt, 1992), thereby enhancing the value of such exchanges (Alexopoulos & Buckley, 2013; Levin & Cross, 2004; Levin et al., 2011; Tsai & Ghoshal, 1998; Walter et al., 2014), especially when these exchanges encompass high-quality information (Uzzi, 1996). In addition, given the fact that trust is usually reciprocated (Ferrin, Bligh, & Kohles, 2007; Ferrin et al., 2006), a trusted tie can help reduce a knowledge provider's concerns about knowledge appropriation and misuse; thus, network actors should be more willing to share sensitive or proprietary details when trust is high (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). Trust may thus make “the difference between a short and possibly guarded hallway conversation about a new idea and active and open brainstorming and tweaking of a new initiative” (Moran, 2005, p. 1136). Following this line of reasoning, we suggest that trust will increase the willingness to cooperate and engage, thereby amplifying the value of a network-bridging tie:

Hypothesis 4 (H4): Trust will enhance the value of network bridging, such that the more trusted the network-bridging tie, the more valuable network bridging will be.

Method

We tested these hypotheses in two separate samples. The first is a bounded network in a consulting firm and helps us test our theoretical intuition about the overall phenomenon of strong network-bridging ties (i.e., relational enhancement) as a valuable phenomenon (H1). It is, essentially, a “proof of concept” sample for the overall notion of relational enhancement. The second sample is an egocentric network (in the engineering division of a large manufacturer) that tests our follow-up hypotheses about the potential mechanisms (H2-H4) underlying the relational-enhancement effect. Unfortunately, for methodological reasons, we were unable to test the three underlying elements in the bounded-network sample, as that would have meant burdening respondents with up to 90 additional network questions in that sample (i.e., three items per contact person), so we draw on a second sample where we can

Table 1. Samples Comparison.

	Sample 1 (proof of concept)	Sample 2 (main sample)
Purpose	Demonstrate overall phenomenon	Identify theoretical mechanism(s)
Dependent variable	Distal	Proximate
Network survey type	Bounded	Egocentric
Hypotheses	H1	H2-H4

Note. H = hypothesis.

examine these issues in a more fine-grained way. For an overview of and comparison between the two samples, see Table 1.

Sample 1 Overview

To test our first hypothesis, we surveyed all 607 employees in a division—with offices in 10 U.S. cities—of a general management consulting firm. We chose this site for our data gathering because management consultants, as part of the growing class of knowledge workers (Davenport, 2003), critically depend on their abilities to access and manage intra-firm knowledge transfers in successfully completing consulting projects (Cross & Cummings, 2004). Individual participation in the survey was voluntary and strictly confidential (though not anonymous). We pre-tested and revised our survey based on feedback from a pilot group of 20 employees across teams and physical locations. We then emailed a unique link to the web-based survey to each employee, with non-respondents receiving up to three email reminders over a period of several weeks. The emailed survey used a standard, broad-based name generator/interpreter methodology, asking the respondent to list any individuals important in his or her professional network ($N = 5,787$ ties; $M = 11.7$ per respondent; $SD = 6.0$; $min = 0$; $max = 30$). We used two network prompts to be sure to capture important ties to people throughout the division and not just in the respondent’s work unit (see the appendix for details). Respondents could list up to 30 people in all, with type-ahead functionality, that is, when they entered part of a name, it brought up the list of people in the division whose names started with those letters. Respondents then replied to several questions about each of the people selected.

After we dropped non-respondents from our analyses, the network prompts allowed us to generate and analyze the bounded network among the 494 respondents (response rate = 81.4%). Respondents were 85.4% White, 70.2% male, were either at the level of senior associate (66%) or higher, and 75.6%

had worked 5+ years at the firm. Respondents did not differ significantly from the division as a whole in terms of race/ethnicity ($t = 0.26, p = .793$), organizational tenure ($t = 0.36, p = .721$), or gender ($t = 0.91, p = .363$).

Sample 1 Measures

Outcome (dependent) variable. In the context of a consulting firm, one of the main ways a tie can be valuable is in helping to generate revenue from clients. Respondents thus indicated the extent to which, based on their interactions with each person, they had been able to improve and/or generate revenue in a client-sale scenario where collaboration was required (see the appendix for all items). The survey instructions prior to this question prompted respondents to focus on the past year as the time frame. A large subsample of responses was verified against the firm's customer relationship management system and found to be in accord. This scale originally went from 1 to 7, but we combined Option 1 (no interactions related to a client sale and no potential to do so) and Option 2 (no such interactions but respondent saw potential to do so), as this distinction was not relevant to our theory and to aid in interpreting this measure. This change also allowed us to have a more objective outcome variable, thereby increasing the validity of a single-item measure like this (Wanous & Reichers, 1996). Thus, the final *revenue production* scale went from 2 to 7, where 2 = no client-sale interactions, 3 = client-sale interactions that did not result in a sale, 4 = interactions that generated a sale of less than US\$1 million (M), 5 = sale of US\$1 M-US\$5 M, 6 = sale of US\$5 M-US\$25 M, 7 = sale of US\$25+ M. These revenue bands were set after reviewing past sales as well as testing the bands and the overall scale with a group of partners, vice presidents, and senior associates for face validity. In a robustness test, we further collapsed the bottom categories to create a 3 to 7 scale (US\$0 revenue for whatever reason, less than US\$1 M, US\$1 M-US\$5 M, US\$5 M-US\$25 M, US\$25+ M), with identical results.

Predictor (independent) variables. There are many ways to measure an umbrella construct (Hirsch & Levin, 1999) like tie strength, and so we are especially precise in Sample 2 in measuring multiple relational elements rather than relying on just one such measure. As a first approximation of the phenomenon, however, and in line with prior research (Aral & Van Alstyne, 2011; Granovetter, 1973; Reagans & Zuckerman, 2001), in Sample 1 we operationalized *tie strength* broadly as the amount of time spent per week by the respondent preparing for and in interaction with each person on core work-related topics. We used a 6-point scale ranging from 1 hr or less per week to

16+ hr per week. We also chose this measure as prior research has shown that people can recall it with considerable accuracy (Tortoriello et al., 2012).

We measured *network bridging* following Burt's (1992) contact-specific constraint:

$$c_{ij} = \left(p_{ij} + \sum_q p_{iq} p_{qj} \right)^2, \quad \text{for } q \neq i, j, \quad (1)$$

where p_{ij} is the proportion of i 's relations invested in j , p_{iq} is the proportion of i 's relations invested in q , and p_{qj} is the proportion of q 's relations invested in j . We reverse-coded this measure to indicate the extent to which the tie between i and j is network bridging. As we had bounded-network data, we used the constraint procedure in UCINET 6.347 (Borgatti, Everett, & Freeman, 2002) that considers all of the connections in the network, even people not directly tied to the respondent. Before creating the interaction term to test for the hypothesized moderation effect (H1), we mean-centered the independent-variable matrices (per Krackhardt & Kilduff, 1999).

Control variables. To rule out the alternative explanation that our results might be due to homophily, that is, people's affinity for similar others (McPherson, Smith-Lovin, & Cook, 2001), we controlled for *same race/ethnicity*, *same gender*, and *same tenure*. We also controlled for *same location*, as people are more likely to interact and collaborate with each other if they work out of the same office (Allen, 1970). To control for the cognitive dimension of social capital (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998), we included a variable indicating if two people were in the *same community of practice*, of which there were 18 in this division, for example, research, analytics, and so on. To make sure, we were capturing the effects of informal structure, we also controlled for bridges across formal organization structure, with a variable for *same account*, as all employees were in one of six accounts (e.g., health care, insurance).

Sample 1 Reliability Issues

To reduce the length of the overall survey, we relied on single-item measures for our variables. Although single-item measures are not ideal, they are typical for network research (e.g., Borgatti & Cross, 2003; Seibert et al., 2001), including outcome variables at the dyadic level of analysis (e.g., Sosa, 2011). A review by Marsden (1990) suggested they are largely reliable when the appropriate procedures are followed to help respondents accurately report on

their contacts. Accordingly, each item was as specific as possible—including examples (Ferrin et al., 2006)—to enhance recall. We also asked respondents to assess *typical* interactions, which prior research has found respondents can recall with high accuracy (Freeman, Romney, & Freeman, 1987).

Another possible concern is that tie strength and revenue production are estimated by the same respondent, with a potential for common methods bias (see Reinholt, Pedersen, & Foss, 2011; Sosa, 2011, for recent empirical studies discussing this issue). In designing our study, we considered using other data sources for measuring a tie's value, such as project outcomes, supervisor ratings, or the perceptions of the other person, but we concluded that these data sources would be either too far removed, uninformed, or biased to be of much use. In line with prior work (e.g., Levin & Cross, 2004; Sosa, 2011), we concluded that third parties, such as supervisors, are rarely in a position to know the details of dyadic interactions, let alone their usefulness, and therefore relied on our respondents' understanding of the usefulness of a given tie.

In testing for any "common methods variance" that might result from our approach, we were reassured, first, that the web-based nature of our survey instrument made it more difficult for respondents to use previous answers to fill in retrieval gaps (because each network question had its own webpage), a feature which helps reduce common methods bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Second, our outcome variable is relatively objective and straightforward (Wanous & Reichers, 1996). Third, the complex formula for our network-bridging variable makes it extremely hard for respondents to introduce a systematic bias (cf. Doty & Glick, 1998). Fourth, moderator effects, as in our study, are less vulnerable to common methods bias, as noted by Brockner, Siegel, Daly, Tyler, and Martin (1997) and others, "because it shows that respondents did not unthinkingly rate all items as either high or low" (Levin & Cross, 2004, p. 1482). Indeed, recent empirical research suggests that, contrary to popular beliefs among scholars, the use of a common method does not necessarily lead to inflated or otherwise biased parameter estimates (Lance, Dawson, Birkelbach, & Hoffman, 2010). Thus, any potential bias resulting from our approach is likely to be minor and unlikely to affect our results.

Sample 1 Analysis Technique

Because bounded-network data contain interdependent relationships among actors, we used UCINET 6.347's (Borgatti et al., 2002) multiple-regression quadratic assignment procedure (MRQAP) with Double-Dekker Semi-Partialling, which is robust against autocorrelation in the rows and columns of relational data (Dekker, Krackhardt, & Snijders, 2007) and which allows

us to effectively compute correlations between network and non-network data (Carpenter et al., 2012). We used UCINET's standard mean-replacement procedure for missing cells, which yields unbiased MRQAP results for those ties that were rated (D. Dekker, personal communication, December 21, 2011). We also performed two additional tests to assess the robustness of this procedure. First, we replaced any missing cells with the lowest value possible for that variable (D. Dekker, personal communication, December 21, 2011), with the same results. Second, we tested a fixed-effects model (S. P. Borgatti, personal communication, December 18, 2011), that is, an ordinary least squares (OLS) regression with dummy variables for respondents and contacts, again with the same results.

Sample 2 Overview

To test H2 to H4 on the potential mechanism(s) responsible for the proposed "relational enhancement" effect, we approached a large U.S. engineering firm, one of the top three global producers in its primary product category. Engineers are knowledge workers (Davenport, 2003) and thus represent an appropriate population in which to study the effects of work-related social networks on knowledge transfer. The firm's senior engineering manager agreed to have a web survey distributed to all 303 members of his staff who were believed to have worked on a particular project. This project required numerous areas of engineering expertise, ran for more than 5 years, and spanned research and development, prototype design and testing, and manufacturing. Individual participation in the survey was voluntary and strictly confidential (though not anonymous). We pre-tested and revised our survey based on feedback from 15 engineers working at a firm providing engineering services on a contract basis to the target firm. Some of these engineers were former employees of the target firm. We further validated our measures of closeness and trust in a separate robustness sample, as described in more detail below. We emailed a password and link to the web-based survey to the 303 people at the target firm, with non-respondents receiving at least three email reminders over a 2-month period. Of the 303, a total of 34 indicated they were ineligible to participate, for example, they had not worked on the focal project.³ Of the remaining 269, we received data from 62 (response rate = 23%). While this may seem low, it is actually fairly typical for social network-related surveys of this type and length (e.g., Seibert et al., 2001, reported a response rate of 28%). More importantly, whereas response rates are of substantial concern for bounded-network studies, where the accuracy of network-level measures depends on having data from most, if not all, network members, our focus here is on

respondents' egocentric networks. These, by definition, do not require information on the network structure beyond a respondent's direct ties (Burt, 1992). A listwise deletion of missing values further reduced the usable sample to a total of 408 dyadic knowledge-seeking relationships, assessed by 41 engineers. This is consistent with other social network studies that typically study a small number of network actors in connection with knowledge transfer (e.g., 41 network actors in Hansen, 1999; 24 in Tsai, 2002; and 15 in Tsai & Ghoshal, 1998), although those were interdivisional ties, whereas we examine interpersonal ties.

Respondents were 87.8% male, an average of 44.8 years old, and had an average tenure of 5.1 years in their current job and 17.2 years at the company. All respondents had attended at least some college, and nearly two thirds (64%) had a graduate degree. On average, respondents had worked on 11.4 previous projects in the same technical area as their part of the focal project, which consumed 52.5% of their time. Average project involvement was 29.7 months. To see if there was a systematic difference between respondents and non-respondents, we compared their gender, which was the only demographic variable made available to us for both groups, and found no significant difference ($t = 0.17, p = .862$). In addition, within the group of 62 initial respondents, we detected no significant differences between those who provided partial versus full data, for example, in terms of gender ($t = 0.23, p = .820$), how long they had been working on the focal project ($t = 0.71, p = .484$), how much of their time the project took ($t = 1.03, p = .310$), and how many people they had consulted ($t = 0.19, p = .847$).

At the start of the survey, we asked respondents, "Within the [focal project] effort, think of a major task or project that holds significance for your career." We then told respondents to "answer the rest of the questions as they pertain specifically to your involvement with the selected project or task, a part of the larger [focal project] effort." By focusing on a specific task, we aimed to ground the responses in a more concrete set of experiences (Levin & Cross, 2004; Levin et al., 2011), thereby reducing any recall or other biases (Marsden, 1990, 1993).

Using standard egocentric network survey techniques (Burt, 1992), we created respondents' egocentric advice networks by asking them to list by name—or by a more anonymous shorthand, such as initials—up to 20 people either inside or outside the firm whom they had consulted as part of their work on their task or project; that is, people "who may have tried to provide information, advice on a technical issue, or advice on an organizational issue like budgeting, deliverables, etc." To reduce selection bias, respondents were asked to include all sources they consulted, "whether or not they were useful in this particular instance." We then asked a series of questions about all these

knowledge providers. On average, our respondents consulted with 10.0 people, 85.3% of whom were in the surveyed company and 74.4% on the same project.

Sample 2 Measures

Outcome (dependent) variable. In the engineering setting, because there were numerous components that went into the larger project, an individual engineer did not have a sense of his or her own contribution to profitability but rather project completion hinging on problem solving and, hence, knowledge acquisition. For our dependent variable, we therefore focused on a proximal measure of value, the *receipt of useful knowledge* (Alexopoulos & Buckley, 2013; Levin & Cross, 2004), as this is one of the main ways that a tie can be valuable in an engineering context (Appleyard, 1996; Argote & Ingram, 2000). Specifically, we asked respondents to indicate how much each knowledge source had contributed to the respondent's project performance in terms of providing answers to their questions or solutions to their problems on the focal task/project (Cross & Sproull, 2004). We thus relied on a similar approach to that of Ferrin et al. (2006) in using descriptions to increase the specificity and reliability of a single-item measure that is an outcome variable (see the appendix for all items).

Predictor (independent) variables. We measured *closeness* using Burt's (1992) approach and language (0 = distant, 1 = in-between, 2 = especially close, reverse-coded as 2, 1, 0). For *frequency of interaction*, we measured how often a respondent communicated with a focal contact, using the same scale as Levin and Cross (2004), with a focus on communication since the start of the focal project. (This measure does not include the respondent's preparation time, as our conceptual focus here is on the interactions themselves.) For *trust*, we used the first item from the Mayer and Davis (1999) scale for the benevolence dimension of trustworthiness, that is, the respondent's perception that the other person cared about the respondent's welfare.

To alleviate the potential concern that respondents might have been unable to distinguish between closeness and trust, we *validated* these 2 items on a separate robustness sample of Amazon's Mechanical Turk respondents (Mason & Suri, 2012), which prior research has shown to be representative and reliable (Buhrmester, Kwang, & Gosling, 2011; Paolacci, Chandler, & Ipeirotis, 2010). Specifically, we asked 175 respondents in the United States and Canada to list up to 20 work ties, regardless of how regularly they communicated with them. We then selected one of these ties at random and asked 10 questions about that tie: The closeness item and the trust item used in our

Sample 2 network survey; the remaining 4 items from the Mayer and Davis (1999) 5-item benevolence trustworthiness scale; and 4 additional closeness items ([This person] and I have a close relationship; . . . have a strong relationship; . . . have an emotional bond; I feel emotionally close to [this person]). (For the 4 additional closeness items, we considered using items for so-called “affect based” trust [McAllister, 1995]—which is similar to what we and other network theorists call emotional closeness—but most of these items include a heavy emphasis on knowledge sharing, for example, “We have a sharing relationship. We can both freely share our ideas, feelings, and hopes” [McAllister, 1995, p. 37], which we felt would overlap too much with our outcome measures.) Principal axis factoring with direct oblimin rotation of our 10 items indicated two factors (eigenvalues of 6.6, 1.4, 0.6, 0.4, 0.3, 0.2, 0.2, 0.1, 0.1, 0.1; both Cronbach’s α s > .93), with all expected factor loadings above .67 ($M = .83$) and no cross-loadings above .26. (Confirmatory factor analysis yielded the same result, with the two-factor solution fitting significantly better than just one factor, $\chi^2_{\text{difference}}(6) = 539.98, p < .001$.) Thus, we were able to distinguish between these two constructs very clearly (and cleanly). Moreover, both items used in our Sample 2 network survey were highly correlated with their respective 5-item scales in the Mechanical Turk sample: $r = .83$ ($p < .001$) for closeness; $r = .90$ ($p < .001$) for trust. Thus, we are reassured that—consistent with our theory—closeness and trust are not only empirically differentiable and distinct but can be measured reliably using the items in our network survey.

To compute the degree to which a given tie was *network bridging*, we generated an adjacency matrix for each respondent’s egocentric advice network, and similar to our measure in the first sample, calculated the reverse-coded contact-specific constraint, but this time we were able to use valued (i.e., interval-scale) data for the strength of the ties among the respondent’s direct contacts (Burt, 1992). Given our egocentric data, we used UCINET 6.347’s (Borgatti et al., 2002) ego network model, in which ties beyond direct contacts have no effect on constraint, consistent with Burt (2007). Before creating the interaction terms to test for the moderation effects, we mean-centered the independent variables.

Control variables. We controlled for several factors that might confound our results. Because demographic similarity (i.e., homophily) is often correlated with perceptions of trust, helpfulness, and performance (Ferrin et al., 2006), we included *same age* (± 5 years), *same gender*, and *same race/ethnicity* as control variables. To account for respondents selecting relationships based on happenstance or convenience, we also controlled for *physical proximity* between the respondent and knowledge source, using an item from Levin and

Cross (2004), as well as for *communication in person*, that is, mostly face-to-face versus mostly via other communication modes like phone or email. To control for bridges across formal organizational boundaries (Burt, 2005; Reagans & McEvily, 2003; Tortoriello & Krackhardt, 2010), we included whether a contact was on the *same project* or in the *same company* as the respondent. In addition, we included the *perceived competence* or ability of the contact (as perceived by the respondent) using an item adapted from one of Butler's (1991) competence measures. We controlled, too, for *relationship length*, as this may affect the quality of a tie and of the knowledge being transferred; we used the logarithm of the number of months since the respondent had first met each contact (Levin et al., 2006). Finally, to control for the cognitive dimension of social capital, we used a measure adapted from items used by Levin et al. (2006) and Tsai and Ghoshal (1998) for the extent to which respondents felt they had a *shared perspective* with each contact.

Sample 2 Reliability Issues

The need to reduce survey length—which for Sample 2 was approximately 50 minutes, including questions requested by the company—led us to follow prior research on social networks (e.g., Borgatti & Cross, 2003; Seibert et al., 2001) and rely on single-item measures for our variables. As in Sample 1, we used specific items and examples (Ferrin et al., 2006) and focused respondents on typical interactions (Freeman et al., 1987), to enhance accuracy and recall.

In testing for any common method variance in Sample 2, we were reassured by Harman's one-factor test. Specifically, a principal components factor analysis of all the interval-scale variables used in our regression models produced two factors—not just one—with eigenvalues higher than 1.0, with the largest eigenvalue accounting for only 34.2% of the total variance, well below the 50% rule-of-thumb cutoff (Podsakoff & Organ, 1986). In addition, in Sample 2 we followed the same bias-reducing procedures mentioned for Sample 1 above, such as having a separate webpage for each network question to prevent the use of prior answers to fill in retrieval gaps (Podsakoff et al., 2003), relying on but not revealing to respondents the complex formula for network bridging (cf. Doty & Glick, 1998), and hypothesizing moderator (not main) effects (Lance et al., 2010). Thus, common method bias is again likely to be minimal.

Sample 2 Analysis Techniques

We used hierarchical linear modeling (HLM) to test H2 to H4 (Bryk & Raudenbush, 1992). HLM is ideally suited for nested, egocentric network

data (Cross & Sproull, 2004)—in our case, knowledge-seeking, dyadic relationships (“Level 1”) nested within respondents (“Level 2”)—as HLM does not rest on the assumption of independent observations, as traditional OLS regression does (Hofmann, Griffin, & Gavin, 2000). In contrast to OLS, HLM allows the researcher to tease apart the variance explained by characteristics of the individual respondents versus the variance explained by each dyadic tie by formally representing each level of analysis with its own sub-model (cf. Hofmann, 1997). As is standard practice with Likert-type scales, we specified our models for a normal (i.e., continuous) distribution of the outcome variable. As a robustness test, we also specified HLM models with an ordinal outcome variable with seven categories (see Mors, 2010; Sosa, 2011, for recent examples), with identical results. We tested all three potential moderator effects simultaneously.

Results

Table 2 provides the descriptives for our first sample’s variables; Table 3, the results of our MRQAP analysis for H1. Interestingly, 28% of the ties in this sample were strong network-bridging ties, that is, above average for both tie strength and for network bridging. This suggests that, at least in this sample’s setting, many network-bridging ties are *not* necessarily very weak ties, and thus the kinds of bridges that we are interested in investigating are not so rare after all.

As shown in Table 3’s Model 2, the interaction term for Network bridging \times Tie strength was positive and significant ($p = .003$)—that is, tie strength enhanced the value of network bridging—thus supporting H1. To illustrate this effect, we plotted these results in Figure 1, following Preacher, Curran, and Bauer’s (2006) recommendation to use the lower and upper observed values of the moderator. As predicted, we see a positive slope associated with strong ties.

Table 4 provides the descriptives for our Sample 2’s variables; Table 5, the results of our HLM analysis for H2 to H4. Consistent with prior research showing that closeness, interaction frequency, and trust are conceptually distinct, these three relational factors were only moderately correlated in Table 4 ($r_s = .28$ to $.43$), suggesting that—as in our Mechanical Turk robustness sample—our respondents were able to distinguish among these variables. On one hand, we find relatively small negative correlations between network bridging and the three relational factors ($r_s = -.10$ to $-.29$), suggesting that—going back to our introductory vignette—people’s networks contain slightly more Wyatts (weak bridges) than Sams (strong bridges). However, we also find that a non-trivial percentage of ties in this sample were above average

Table 2. Means, Standard Deviations, and QAP Correlations (Sample 1).

Variable	M	SD	1	2	3	4	5	6	7	8	9
1. Revenue production	4.54	1.84									
2. Same race/ethnicity	0.77	0.42	.07								
3. Same gender	0.61	0.49	-.01	.02							
4. Same location	0.60	0.49	-.01	.01	-.01						
5. Same tenure	0.40	0.49	.07	.02	.01	.02					
6. Same community of practice	0.42	0.49	.01	-.03	.01	.04	.05				
7. Same account	0.69	0.46	.13	.00	-.03	.00	-.04	-.07			
8. Tie strength	1.75	1.14	.30**	.03	.00	.04	.02	.09	.27**		
9. Network bridging	0.99	0.02	.02	.01	-.02	.02	.01	-.11	-.01	-.04	
10. Network bridging x Tie strength	0.00	0.02	-.01	.02	.01	-.03	-.01	-.03	.00	-.07	-.51**

Note. Based on Quadratic Assignment Procedure (QAP) correlation method. Number of permutations performed = 10,000.

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

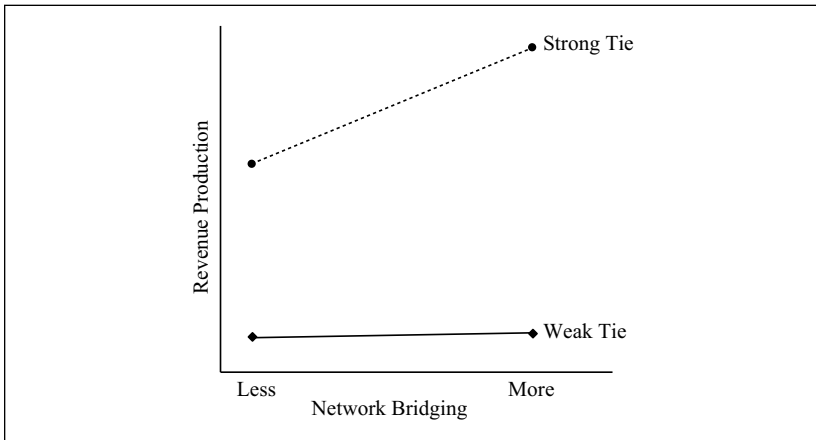
Table 3. MRQAP Regression Results for Revenue Production (Sample 1).

	Model 1	Model 2
Same race/ethnicity	1.41***	1.41***
Same gender	-2.50	-2.50
Same location	-1.65	-1.65
Same tenure	0.24	-0.25
Same community of practice	0.26***	0.28***
Same account	1.24***	1.23***
Tie strength ^a	0.36***	0.37***
Network bridging ^a	2.43***	4.70***
H1: Network bridging × Tie strength		5.04**
R ²	.606	.609

Note. Unstandardized coefficients shown, based on a Double-Dekker Semi-Partialling regression model using multiple-regression quadratic assignment procedure (MRQAP). Number of permutations performed = 10,000. H = hypothesis.

^aVariable was grand-mean centered.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

**Figure 1.** Moderator effect for Sample 1.

Note. Based on output from Table 3's Model 2.

both for network bridging and for one of the relational factors, that is, 6% were “especially close” network-bridging ties (and another 57% were “in-between” (in terms of closeness) network bridges); 49% of ties were

Table 4. Means, Standard Deviations, and Correlations (Sample 2).

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Receipt of useful knowledge	5.86	1.22																	
2. Same age	0.38	0.49	.10																
3. Same gender	0.85	0.36	-.06	.04															
4. Same race/ethnicity	0.86	0.35	.15**	-.03	-.01														
5. Physical proximity	4.19	1.90	.25**	.11*	-.03	-.12*													
6. On same project	0.75	0.43	.08	.05	.12*	.04	.13*												
7. In same company	0.85	0.36	.15**	.08	-.02	.06	.28**	.09											
8. Perceived competence	6.20	1.22	.57**	.12*	-.07	.13*	.16**	.01	.06										
9. Communication in person	0.73	0.45	.29**	.10	-.05	.05	.59**	-.06	.21**	.15**									
10. Relationship length	1.61	0.47	-.06	.02	-.03	.00	.09	-.10	.18**	.04	.00								
11. Shared perspective	5.18	1.24	.59**	.05	-.06	.27**	.14*	-.01	.13*	.46**	.20**	.07							
12. Closeness	1.99	0.49	.35**	.11*	-.13*	-.03	.25**	-.02	.15**	.26**	.22**	.25**	.43**						
13. Frequency of interaction	4.82	1.86	.28**	.00	.05	.01	.28**	.18**	.01	.15**	.26**	.02	.26**	.28**					
14. Trust	4.74	1.21	.41**	.01	-.10	.06	.18**	-.10	.18**	.17**	.19**	.06	.53**	.43**	.30**				
15. Network bridging	0.95	0.10	-.15**	.04	.16**	.03	-.13*	.11*	-.12*	-.05	.00	-.14**	-.22**	-.29**	-.10	-.13*			
16. Network bridging x Closeness	-0.01	0.05	.01	.07	.14*	.10	-.10	.08	-.02	.04	-.03	.00	.03	-.04	.03	-.08	.50**		
17. Network bridging x Frequency	-0.02	0.13	-.04	.04	-.01	-.05	.03	.04	-.06	-.03	.01	-.03	.01	.05	.11*	-.02	.35**	.18**	
18. Network bridging x Trust	-0.02	0.11	.06	.02	.08	.07	-.15**	-.03	.00	-.02	-.11*	-.06	.01	-.10	-.02	-.02	.14*	.61**	.18**

Note. N = 346.

*p < .05. **p < .01, two-tailed tests.

Table 5. HLM Regression Results for Receipt of Useful Knowledge (Sample 2).

	Model 1		Model 2	
Same age	0.06	(0.07)	0.06	(0.07)
Same gender	0.16	(0.17)	0.16	(0.18)
Same race/ethnicity	-0.03	(0.20)	-0.04	(0.18)
Physical proximity	0.00	(0.04)	0.01	(0.04)
On same project	0.26**	(0.09)	0.29***	(0.09)
In same company	0.04	(0.14)	0.01	(0.13)
Perceived competence	0.51***	(0.12)	0.51***	(0.11)
Communication in person	0.27†	(0.16)	0.29†	(0.16)
Relationship length	-0.16	(0.13)	-0.18	(0.14)
Shared perspective	0.24*	(0.10)	0.24*	(0.10)
Closeness	0.37*	(0.16)	0.42**	(0.15)
Frequency of interaction	0.06†	(0.03)	0.06†	(0.03)
Trust	0.06	(0.06)	0.05	(0.06)
Network bridging	-0.14	(0.46)	0.23	(0.52)
H2: Network bridging × Closeness			-0.78	(1.07)
H3: Network bridging × Frequency			-0.37	(0.31)
H4: Network bridging × Trust			1.37*	(0.60)
$\Delta\chi^2$ (Δdf)	222.71***	(14)	19.839***	(3)
Level 1 pseudo- R^2 =	.703		.712	

Note. Unstandardized coefficients shown, with robust standard errors in parentheses, based on a random coefficient regression model using hierarchical linear modeling (HLM). $N = 346$ observations. All variables grand-mean centered. $\Delta\chi^2$ refers to the Satorra–Bentler scaled χ^2 difference test (Satorra, 2000); Δdf is change in degrees of freedom. Variance explained calculated as pseudo- $R^2 = 1 - (\text{Level-1 restricted error} + \text{Level-2 restricted error}) / (\text{Level-1 unrestricted error} + \text{Level-2 unrestricted error})$ (Snijders & Bosker, 2012). H = hypothesis.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

high-frequency network bridges; and 44% were trusted network bridges. Thus, as in Sample 1, relationally enhanced network-bridging ties were not as rare as one might have expected.

As shown in Table 5's Model 2, we can detect no support for H2, that is, the interaction term for Network bridging × Closeness is not statistically significant ($p = .472$). H3 is also not supported, as the interaction term for Network bridging × Frequency in Table 5's Model 2 is not statistically significant ($p = .221$). H4, however, is supported: The interaction term for Network bridging × Trust is statistically significant ($p = .022$), that is, the higher the trust, the greater the impact of network bridging on the receipt of

useful knowledge. To illustrate this moderator effect visually, we draw a figure of two simple slopes (see Figure 2): the effect of network bridging on receipt of useful knowledge when trust is high versus low. We again followed Preacher et al.'s (2006) recommendation to use the lower and upper observed values of the moderator (in this case, trust).

We checked for multicollinearity in Sample 2, to rule this out as an alternative explanation. Although there is no direct diagnostic test for multicollinearity in HLM, we tested for this potential problem using OLS regression. The result was that all variance inflation factors (VIFs) were below 2.8, well below the standard cutoff of 10; similarly, none of the correlations among our predictor variables in Table 4 approached the danger level of .80 or .90 indicated by Meyers, Gamst, and Guarino (2012). Moreover, if we remove the other two interaction terms, Network bridging \times Trust remains statistically significant ($p < .001$).

In choosing our outcome variable for Sample 2, we focused on the receipt of specific answers or solutions, as these are the most commonly sought and transmitted via network bridges and, hence, are most relevant to the theory and literature on structural holes and network bridging (Burt, 1992). Nevertheless, in a robustness check, we also examined the receipt of useful knowledge more generally (Cross, Borgatti, & Parker, 2001). That is, using the same 1 to 7 scale as our main outcome measure, we checked the impact of the three potential moderators on a five-item variable ($\alpha = .86$) that comprised all 5 types of actionable knowledge identified by Cross and Sproull (2004): specific answers or solutions (same item as in our main analysis), referrals, problem-solving assistance, validation, and legitimation.⁴ Once again, consistent with H4, trust was the only relational mechanism to enhance the value of a network-bridging tie ($p = .032$). Interestingly, closeness again did not enhance the value of network bridging ($p = .617$), but frequency actually seemed to worsen the benefits of network bridging ($p = .010$)—perhaps because frequent interactions can sometimes lead to knowledge saturation, that is, to hearing the same things over and over (Aral & Van Alstyne, 2011; Levin et al., 2011), and this saturation in turn may undermine the benefits of certain types of knowledge. In any event, we are reassured that our central finding—that trust enhances the value of network-bridging ties—is supported both for the receipt of useful knowledge in the form of solutions as well as more generally.

To assess the robustness of our findings further, we also tested eight additional control variables at the respondent (i.e., "Level 2") level of analysis: (a) the number of previous projects in the same technical area that the respondent was involved in (a proxy for the respondent's level of experience), (b) percentage of a respondent's workday spent on the task/project,

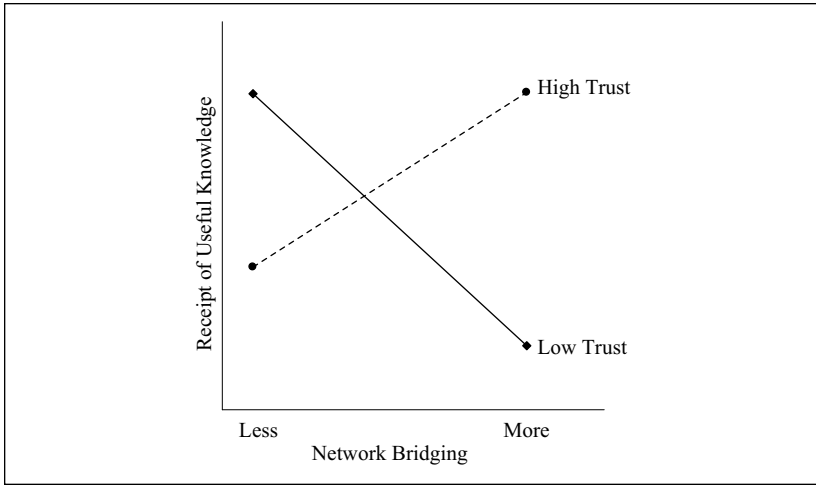


Figure 2. Moderator effect for Sample 2.

Note. Based on output from Table 5's Model 2.

(c) education (with dummy variables corresponding to some college, bachelor's, master's, and doctorate), (d) tenure at the company, (e) tenure in current job, (f) gender, (g) age, and (h) network density (i.e., the number of ties among the respondent's contacts, divided by the maximum possible number of such ties). The latter variable was included to take into account any effects of information volume (i.e., the quantity of information available to the knowledge seeker) in our results (Koka & Prescott, 2002). When we added these eight controls to all our models (not shown due to space considerations), our hypothesized results were unchanged. Thus, our results were robust to several alternative explanations, with statistically significant results over and above both dyad- and respondent-level controls.

Discussion

Our findings from two separate samples provide strong empirical support for our argument that the relational dimension of social capital enhances the value of network-bridging relationships. Our results also identify the mechanism for this relational solution to the "cooperation conundrum." That is, we find that it is trust that enhances the value received via network-bridging ties, even controlling for other possible dyadic mechanisms, such as emotional closeness or interaction frequency, which did not enhance the value of network-bridging ties in our study. Interestingly, we found that when a particular

tie's trust was low (i.e., the other person was actually distrusted), then our respondents benefited from network closure, that is, from having densely interconnected contacts, which prior research has shown creates feelings of obligation and a fear of negative consequences for misbehavior (Coleman, 1990). Indeed, it appears that trust is most helpful precisely when there is a lack of densely interconnected contacts to encourage and enforce social norms. These results thus provide support for our argument that structural norms of cooperation encouraged by dense connections among surrounding ties (i.e., network closure) versus trust at the dyadic level may act as substitutes; both allow network actors to reap the benefits of being embedded in relationships.

One potential drawback to using dyadic trust as a substitute for network closure is that closure—unlike trust alone—is more likely to create cooperative norms that are enforced by third parties (Granovetter, 1992). For example, if a potential knowledge source refuses to help a knowledge seeker, news of this would likely spread within a tight-knit group and could lead to the source's ostracism, thereby limiting the source's own ability to receive future support from fellow group members (Reagans & McEvily, 2003). Such third-party monitoring and reputational effects might also serve to reduce trust violations within the group, such as stealing someone else's ideas. With a trusted network-bridging tie, however, knowledge seekers do not have such recourse, as by definition the two sides have few or no third parties in common. Nevertheless, even without this network-based constraint, relational trust (i.e., a confidence that the other person cares about you) is likely to allay most fears of uncooperative or untrustworthy behavior.

Our findings for trusted network-bridging ties are, in some sense, an extension of earlier work on the benefits of trusted weak ties (Levin & Cross, 2004), that is, of knowledge-exchange partners who do not know each other well but who nonetheless trust each other. Levin and Cross (2004), however, do not account for network structure, relying solely on tie strength as a proxy for structure. They also follow a somewhat different logic. Specifically, they suggest that tie strength and trust can be seen independently, where high trust offers relational benefits and weak ties offer structural benefits, but they did not propose a moderator effect between these two factors. In our study, we find a moderator effect such that high trust enables actors to reap the benefits of a network-bridging tie.

Our research is also unique in distinguishing—both conceptually and also empirically—between the relational elements of emotional closeness versus trust. While there is ample theoretical precedent for each of our three interaction hypotheses, we did not find a significant impact of emotional closeness in enhancing the value of network-bridging ties. That is, a network-bridging

tie does not necessarily need to be especially close for people to be willing to engage in a productive knowledge exchange; rather, they just need to be concerned about each other's welfare. There are two possible explanations for this result. First, prior research has shown that the knowledge benefits of closeness are in fact often due to trust (Levin & Cross, 2004; Levin et al., 2011). That is, cooperation in a work context derives not so much from *personal* feelings about the other person (i.e., closeness), but rather from a willingness to engage fully in a knowledge exchange, a willingness that derives primarily from perceptions that the other person will act benevolently in a work context toward you and thereby establish a trusting, cooperative knowledge exchange. Second, prior research has found that people can have complicated, ambivalent feelings toward someone with whom they feel close (Oglenksy, 2008)—for example, they might feel mostly positive but also simultaneously feel, at least sometimes, trapped, resentful, or annoyed. In contrast to the ambivalence associated with closeness, trust is a “purer” form of relational enhancement, that is, it captures that quality of the relationship that is most relevant for extracting value from a network bridge, namely, a belief that the other person has your best interests at heart, thereby making people willing to listen and share knowledge with each other.

Similarly, in distinguishing between trust versus interaction frequency, we find in Sample 2 that there need not necessarily be frequent communications across a network bridge for people to be willing to engage in a productive knowledge exchange. This result suggests that—over and above the effects of trust—merely communicating more frequently may not be sufficient to establish the cooperative attitude necessary to take full advantage of a network-bridging tie. This makes sense if one considers that not all communication is necessarily positive and cooperative, particularly in an organizational setting, where workflow or other considerations often require employees to interact, and particularly for boundary-spanning or bridging ties, which may suffer from intergroup conflict (Labianca, Brass, & Gray, 1998). Moreover, frequent interaction might even lead to knowledge saturation (Aral & Van Alstyne, 2011), thereby undermining the benefits of brokerage and leading to the transfer of less novel knowledge (Levin et al., 2011; Walter et al., 2014). In sum, our results point to trust—even without much emotional closeness or interaction frequency—as the key relational mechanism for enhancing the value of a network-bridging tie.

More generally, our findings can also shed some light on ambiguous prior results for tie strength. For example, some studies have reported an overall advantage for stronger relationships (Aral & Van Alstyne, 2011; Krackhardt, 1992; Reagans & McEvily, 2003, 2008; Seibert et al., 2001; Tortoriello & Krackhardt, 2010); others, for weaker relationships (e.g., Granovetter, 1973;

Wright Brown & Konrad, 2001); and still others, contingent effects (Cross & Sproull, 2004; Hansen, 1999; Hu & Randel, 2014; Lechner et al., 2010; Levin & Cross, 2004; Moran, 2005). We suspect that this lack of consistent findings may be due in part to the fact that tie strength is a kind of umbrella construct (Hirsch & Levin, 1999), where researchers have used different relational elements to stand for the whole. Indeed, we have been guilty of this ourselves. For example, we measured tie strength using a variation of interaction frequency as an initial proxy in our “proof of concept” in Sample 1. However, for our subsequent, in-depth examination of the relational-enhancement phenomenon in Sample 2, we disaggregated tie strength (and relational enhancement more generally) into several distinctly measured constructs: interaction frequency, emotional closeness, and trust. This approach allowed us in Sample 2 to identify the specific underlying mechanism(s) responsible for the relational-enhancement effect. Researchers might therefore carefully select a measurement approach that is congruent with the theoretical logic of their hypotheses, or ideally include and compare several approaches to disentangle the unique impact of these dyadic characteristics.

By examining dyadic ties, our study follows Moran (2005) and others in their call for more attention in the social capital literature not just to the overall network structure but also to the actual relationship between two actors, that is, to the nature of the “line” that connects two nodes in a social network diagram. In contrast to prior work such as Moran’s (2005), however, we present empirical evidence not just for independent effects of these structural and relational dimensions of social capital, but an example of how these two dimensions *interrelate*. Moreover, our study on informal network structure extends prior work that has focused on ties that bridge across formal organizational boundaries (Burt, 2005; Reagans & McEvily, 2003; Tortoriello & Krackhardt, 2010). As we controlled for a number of such formal organizational boundaries in our study (e.g., project, firm), our results suggest that relationally enhanced network-bridging ties are valuable, even over and above the impact of formal structures.

Our study also contributes to the literature on the cooperation conundrum, that is, on how actors can reap the benefits of brokerage. While prior research has suggested a number of potential resolutions that could accommodate the benefits of both closure and brokerage, these suggestions are difficult, if not impossible, for people to implement unilaterally, as they would require extensive changes to either network structure or composition. In contrast to these network-level-only options, however, we propose and find empirical support for an alternative hybrid option—relationally enhanced network-bridging ties—which focuses on dyadic ties. Our approach may thus be much easier for practitioners to implement, as it does not require much investment in

ongoing maintenance (e.g., building trust need not be time-consuming; Abrams et al., 2003) nor does it require any additional actions by third parties (e.g., one's contacts do not need to coalesce around the network-bridging tie). From a practical standpoint, we also suspect that trusted network-bridging ties can be cultivated, just as trust in general can be cultivated (Abrams et al., 2003), making such ties less rare but just as valuable.

All studies have limitations, and ours is no exception. First, although we establish in our study that the three relational elements of closeness, frequency, and trust are conceptually and empirically distinct and determine which one is most closely associated with the relational-enhancement effect, we do not address a potential causal ordering among these elements. Moreover, our samples are cross-sectional, which can limit causal inferences. Future research in the form of a longitudinal or experimental study may thus want to examine, for example, if and when interaction frequency might eventually lead to trust. Second, the level of explained variance in our study was not overly large. However, the methodological literatures for both MRQAP (Sample 1) and HLM (Sample 2) have each cautioned against interpreting the size of explained variance. For example, Dekker, Krackhardt, and Franses (2002) and Kase (2014) have recommended against interpreting the size of an MRQAP equation's R^2 . Similarly, Snijders and Bosker (1994) warned that explained-variance measures like the pseudo- R^2 used in HLM do not necessarily behave as one might expect, due to the nature of multi-level variance components. In fact,

the addition of an explanatory variable to a HLM can simultaneously increase some of the variance components and decrease others. This means that examining the individual components of variance separately by way of a traditional R^2 can lead to surprising outcomes like negative values or values that decrease when a new regressor is added to the model. (Recchia, 2010, p. 3)

Still, future research might want to replicate our results and/or further probe the explained variance of our theoretical framework to corroborate the practical significance of trusted network-bridging ties. Third, our two samples were from different industries (one in manufacturing; the other, service), so we selected outcome variables that were most relevant for each context; however, future research might benefit from using multiple measures of value in a single sample. Fourth, another limitation of our study's Sample 2, besides issues of sample size and representativeness, is that we measured network bridging using egocentric, not bounded, network data. As a result, it is possible that what looks like a network-bridging tie in that sample is in fact linked indirectly to the respondent's other contacts via people not in the respondent's egocentric network. Although much of the prior research on network-bridging

ties relies on egocentric network data (e.g., Burt, 1992)—supported by evidence that bridging/brokerage benefits are concentrated mainly in the immediate network around a person (Burt, 2007)—future researchers may want to examine the issue of trust in a bounded network as well.

In sum, our study provides support for the idea that the relational dimension of social capital can enhance the value of network-bridging ties. That is, whereas network-bridging ties can provide access to novel and non-redundant knowledge, a relationally enhanced tie—or, more precisely, a tie with high levels of trust—enables network actors to actually realize the potential of network bridging. By focusing on the structural and relational dimensions of social capital—conceptualized at the dyadic level of analysis—we offer a systematic way to understand how and why interpersonal, network-bridging relationships can provide cooperation and value.

Appendix

Survey Items

Sample 1

Outcome variable

Revenue production. Please indicate the extent to which you are able to improve and/or generate revenue based on your interactions with each person below. (1 = We have not interacted in a client-sale scenario and I do not see the potential to do so, 2 = We have not interacted in a client-sale scenario but I do see the potential to do so, 3 = We have interacted in a client-sale scenario where collaboration did not result in a sale, 4 = We have interacted in a client-sale scenario where collaboration was required to generate a sale under US\$1 M, 5 = We have interacted in a client-sale scenario where collaboration was required to generate a sale of US\$1 M to US\$5 M, 6 = We have interacted in a client-sale scenario where collaboration was required to generate a sale of US\$5 M to US\$25 M, 7 = We have interacted in a client-sale scenario where collaboration was required to generate a sale of US\$25+ M). [Response Options 1 and 2 were combined, that is, Option 1 was recoded as a 2 so that the scale goes from 2 to 7]

Predictor and control variables

Same race/ethnicity. (1 = Black/African American, 2 = Hispanic or Latino, 3 = two or more races, 4 = White, 5 = Asian) [recoded as 1 = same race/ethnicity; 0 = different race/ethnicity]

Same gender. (1 = female, 2 = male) [recoded as 1 = same gender; 0 = different gender]

Same location. 10 U.S. cities listed [variable coded as 1 = same location; 0 = different location]

Same tenure. (1 = less than 1 year, 2 = 1-3 years, 3 = 3-5 years, 4 = 5-10 years, 5 = 10+ years) [recoded as 1 = same tenure cohort; 0 = different tenure cohort]

Same community of practice. [each employee is assigned to 1 of 18 communities of practice, for example, research, analytics, hardware technology; variable coded as 1 = same community of practice; 0 = different community of practice]

Same account. [each employee is assigned to one of six accounts, for example, health care, insurance, manufacturing; variable coded as 1 = same account; 0 = different account]

Tie strength. Please indicate the amount of time you spend in a typical week preparing for and in interaction with the people listed below. Please try to estimate just the time you spend preparing for and in interactions with this person on core work-related topics and not other initiatives. (1 = 1 hr per week or less, 2 = 2-4 hrs per week, 3 = 4-8 hrs per week, 4 = 8-12 hrs per week, 5 = 12-16 hrs per week, 6 = 16 + hrs per week)

Network bridging. Please identify people who are important in your professional network and are (*in [your primary unit] within [the division]*) (*outside of [your primary unit] but inside [the division]*). Please consider the most influential people that provide you with information or resources to do your job, help you think about complex problems posed by your work or provide developmental advice or personal support helpful in your day-to-day working life. These may or may not be people you communicate with on a regular basis and can be located at your site or others but should be the people you consider to be your most important relationships (*within [your primary unit] in [the division]*) (*outside of [your primary unit] but inside [the division]*). [Both lists—that is, for inside and outside the employee's primary unit—were combined to create the overall network for inside the division; variable calculated as contact-specific constraint (reverse-coded), as described in "Method" section.]

Sample 2

Outcome variable

Receipt of useful knowledge. Sometimes when we consult with people, we benefit from their ability to provide specific answers to our question or solutions to our problems. To what extent did this person's *specific answers or input* contribute to your performance on [name of task/project]? (1 = very negative, 2 = negative, 3 = somewhat negative, 4 = neither positive/negative, 5 = somewhat positive, 6 = positive, 7 = very positive, NA = did not receive anything like this from this person on this task/project [recoded as missing value])

Predictor and control variables

Same age. Relative to yours, what is this person's age? (1 = younger than me by more than 5 years; 2 = my age plus or minus 5 years; 3 = older than me by more than 5 years; 4 = don't know) [recoded as 1 = same age \pm 5 years; 0 = different age].

Same gender. What is this person's gender? (1 = male; 2 = female) [recoded as 1 = same gender as respondent; 0 = different gender].

Same race/ethnicity. Do you consider this person to be the same race/ethnicity as you? (1 = yes; 2 = no) [recoded as 0 = no].

Physical proximity. Please indicate each person's physical proximity to you during your work on [name of task/project]. (1 = worked immediately next to me, 2 = same floor and same hallway, 3 = same floor but different hallway, 4 = different floor, 5 = different building, 6 = different city, 7 = different country) [item reverse-coded].

On same project. At the time you consulted this person, was the person working on [name of task/project you selected]? (yes, no, don't know) [recoded as 1 = same task/project; 0 = different task/project]

In same company. Where does this person work? (1 = [your company], 2 = university, 3 = government agency, 4 = customer, 5 = supplier, 6 = [affiliated firm 1], 7 = [affiliated firm 2], 8 = somewhere else) [recoded as 1 = same company; 0 = someplace else]

Perceived competence. This person is very capable at the work he or she performs. (1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neutral; 5 = somewhat agree; 6 = agree; 7 = strongly agree).

Communication in person. During [name of task/project], what is the main way you have communicated with this person? (1 = in person; 2 = on-line (such as via the Internet or an intranet); 3 = by telephone; 4 = other) [recoded as 1 = in person; 0 = all others].

Relationship length. How long have you known each person? [logarithm of the number of months].

Shared perspective. This person and I share the same perspective, in that we think in a similar way, have similar goals and objectives, and understand each other's language/jargon when we communicate. (1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neutral; 5 = somewhat agree; 6 = agree; 7 = strongly agree).

Closeness. This next section deals with the relationship between you and the sources of information you listed in the first part of the questionnaire. It will also ask you to consider their relationships with each other. To start with you, how well do you know each of your sources? Please rate each relationship on the following scale. 1 = especially close—in the sense that this person and I are one of each other's closest personal contacts; 2 = relationships that are somewhere between "especially close" and "distant."; 3 = distant—in the sense that this person and I are total strangers or do not enjoy each other's company. [reverse-coded scale as 2, 1, 0]

Frequency of interaction. How often have you communicated with each person since starting on [name of task/project]? (1 = daily; 2 = twice a week; 3 = once a week; 4 = twice a month; 5 = once a month; 6 = once every 2nd month; 7 = once every 3 months or less) [item reverse-coded].

Trust. This person is very concerned about my welfare. (1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neutral; 5 = somewhat agree; 6 = agree; 7 = strongly agree).

Network bridging. For the calculation of contact-specific constraint (reverse-coded), we asked respondents about the closeness of their direct ties (see above for closeness) and indirect ties: "Please continue to use this scale to rate how well this person knows the others. 1 = especially close—in the sense that they are one of each other's closest personal contacts; 2 = relationships that are somewhere between "especially close" and "distant."; 3 = distant—in the sense that they are total strangers or do not enjoy one another's company." [reverse-coded scale as 2, 1, 0; variable calculated as described in "Method" section]

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Notes

1. Some frameworks of social capital include a third, cognitive dimension (i.e., the common understanding between connected actors, such as shared goals or ways of thinking; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). However, Tsai and Ghoshal (1998) found that this dimension tends to have an impact on resource exchange and combination only *via* the relational dimension, and not directly. Thus, while we control for shared cognition in our empirical models, we do not hypothesize that it enhances people's willingness to cooperate, as such willingness is more of a relational issue.
2. For simplicity, we refer to this as trust. More precisely, the construct of trust is typically defined as a willingness to be vulnerable, where this willingness is based on positive expectations of others, that is, on perceptions of people's trustworthiness (Whitener et al., 1998). These trustworthiness perceptions, in turn, have been categorized in terms of several factors, such as ability, integrity, and benevolence (Mayer & Davis, 1999). For our purposes, however, only one of these (benevolence) relates to cooperation and relational enhancement, and so this is our focus. That is, a contact perceived as having high ability is not necessarily more willing to cooperate or otherwise engage in a knowledge exchange. Likewise, perceived integrity is also not necessarily relevant to cooperation. For example, as Levin (2008) noted, "a boxing opponent may have high integrity ('I always play by the rules.') but low benevolence ('I'm going to hurt you.')" (p. 1574). As this example illustrates, integrity does *not* necessarily mean that a contact will be cooperative, that is, it does not address the cooperation conundrum that is the focus of our study. Moreover, both ability and integrity are mainly characteristics of the other person (Levin, Whitener, & Cross, 2006), whereas our focus is on the cooperation conundrum, which is that certain *relationships*—not certain people in general—tend to be less cooperative. Thus, we concentrate on the relational aspect of trust.

3. This is a conservative estimate, as we suspect strongly that more employees were ineligible to participate than just the 34 who took the time to write back to us. That is, there were probably more such employees who simply chose to ignore our survey rather than let us know that it did not apply to them—a fact which would have increased our stated response rate (by lowering the denominator of eligible employees). However, we were unable to confirm a more precise list of names with the company, so this remains a potential limitation. It is doubtful that any ineligible employee would have completed the survey, given the survey instructions repeatedly emphasized the focal project.
4. These measures were adapted from Cross and Sproull (2004): (a) *referrals* (“Sometimes when we consult with people, we benefit from their ability to point us to relevant sources of information, such as other people, paper archives, or databases. To what extent did this person’s *guidance in identifying relevant information sources* contribute to your performance on [name of task/project]?”); (b) *problem-solving assistance* (“Sometimes when we consult with people, we benefit from their helping us think through a problem (even when they may not have specific information that solves our original problem). These interactions may help us consider important dimensions of a problem and/or anticipate issues likely to appear in the future. To what extent did this kind of *problem-solving assistance* from this person contribute to your performance on [name of task/project]?”); (c) *validation* (“Sometimes when we consult with people, we benefit from their validation of our plans or solutions. These interactions bolster confidence in a plan or solution and improve our willingness and ability to express ideas persuasively to others. To what extent did this person’s *validation* contribute to your performance on [name of task/project]?”); and (d) *legitimation* (“Sometimes when we consult with people, we benefit from being able to say we have spoken with that person about our plans or solutions. The individual may be in a position of formal authority or a perceived expert and so indicating that we have consulted with such a person lends credibility to our plans or solutions. To what extent did *your ability to reference this person’s support of your ideas* contribute to your performance on [name of task/project]?”).

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