

AMBIENT AWARENESS AND KNOWLEDGE ACQUISITION: USING SOCIAL MEDIA TO LEARN “WHO KNOWS WHAT” AND “WHO KNOWS WHOM”¹

Paul M. Leonardi

Technology Management Program, University of California, Santa Barbara, 1327 Phelps Hall–MC 5129,
Santa Barbara, CA 93106 U.S.A. {Leonardi@tmp.ucsb.edu}

The argument proffered in this paper is that use of enterprise social networking technologies can increase the accuracy of people’s metaknowledge (knowledge of “who knows what” and “who knows whom”) at work. The results of a quasi-natural field experiment in which only one of two matched-sample groups within a large financial services firm was given access to the enterprise social networking technology for six months revealed that by making people’s communications with specific partners visible to others in the organization, the technology enabled observers to become aware of the communications occurring amongst their coworkers and to make inferences about what and whom those coworkers knew based on the contents of the messages they sent and to whom they were sent. Consequently only individuals in the group that used the social networking technology for six months improved the accuracy of their metaknowledge (a 31% improvement in knowledge of who knows what and an 88% improvement in knowledge of who knows whom). There were no improvements in the other group over the same time period. Based on these findings, how technologically enabled “ambient awareness”—awareness of ambient communications occurring amongst others in the organization—can be an important antecedent for knowledge acquisition is discussed.

Keywords: Social networking sites, knowledge sharing, organizational learning, accuracy, technology use, communication, collaboration, transparency

Introduction

Social media technologies are beginning to proliferate across organizations as executives and managers attempt to leverage the power of the informal information economies of their companies. In a recent report, researchers from the McKinsey Global Institute predicted that use of social media within large companies could contribute as much as \$1.3 trillion in annual value to the U.S. economy (Chui et al. 2012). As the authors indicated, a full two-thirds of that potential is likely to come from improving collaboration within the organization. Given

such striking predictions, it is no surprise that organizations and information systems scholars have begun to theorize about how enterprise social media might aid organizational knowledge sharing (Jarrahi and Sawyer 2013; Kane et al. 2014; Majchrzak et al. 2013; Treem and Leonardi 2012). According to Leonardi et al. (2013, p. 2), enterprise social media allow workers to (1) communicate messages with specific coworkers or broadcast messages to everyone in the organization; (2) explicitly indicate or implicitly reveal particular coworkers as communication partners; (3) post, edit, and sort text and files linked to themselves or others; and (4) view the messages, connections, text, and files communicated, posted, edited, and sorted by anyone else in the organization at any time of their choosing. In contrast to most other technologies used for communication within organizations,

¹Arvind Malhotra was the accepting senior editor for this paper. Gerald Kane served as the associate editor.

enterprise social networking technologies provide a forum for public communication among employees (DiMicco et al. 2008; McAfee 2009). On most social media developed specifically for enterprise use, the communications that occur between two people in the organization are visible to all of those peoples' contacts, and if the appropriate settings are applied, by everyone in the organization.

The prevailing logic is that what makes social media unique technologies for organizational communication is that they provide affordances through which dyadic communication can be seen, stored, and added to by anyone in the organization, thereby making it possible for third-parties to learn vicariously from the communication occurring amongst their colleagues (Kane et al. 2014; Majchrzak et al. 2013; Treem and Leonardi 2012). A nascent theory of communication visibility emerging from these insights suggests that being able to observe the content of the messages people exchange with one another (what they say) and the directionality of those messages (to whom they say it) via social media reveals reliable indicators that third-party observers can use to improve their knowledge of "who knows what" and "who knows whom" (Ellison et al. 2015; Fulk and Yuan 2013; Leonardi 2014). Such knowledge of who knows what and who knows whom is often referred to as *metaknowledge* (Ren and Argote 2011). Research shows that when an individual's metaknowledge is distinguished by both correctness (he or she can correctly identify what and whom a coworker knows) and breadth (he or she can make such a correct identification not just of a few coworkers, but of many coworkers), metaknowledge it often linked to team performance on routine tasks (Ren et al. 2006), people's ability to recombine existing ideas into new innovations (Majchrzak et al. 2004), reduction in work duplication across the organization (Jackson and Klobas 2008), and many more positive benefits.

Although this emerging theory of communication visibility makes intuitive sense, it has yet to be empirically verified. We do not know, for example, whether users of enterprise social media will indeed develop an awareness of communications occurring amongst coworkers, whether they will use that awareness to make inferences about what and whom coworkers know, and whether those inferences will improve the correctness and breadth of their metaknowledge. Although there are reasons to suspect that these assumptions are accurate, such optimistic predictions have outpaced the collection of empirical data to support them.

To test these assumptions, I report the results of a quasi-natural field experiment in which only one of two matched-sample groups within a large financial services firm was given access to one kind of social media technology—an enterprise

social networking site—for six months. The results showed that by making people's communications with specific partners visible to others in the organization, the technology enabled observers to learn vicariously from the communications occurring amongst their coworkers and, consequently, improve the accuracy (increase both the correctness and breadth) of their metaknowledge (a 31% improvement in knowledge of who knows what and an 88% improvement in knowledge of who knows whom). I discuss how technologically enabled "ambient awareness"—awareness of ambient communications occurring amongst coworkers—can be an important antecedent for knowledge transfer.

Using Social Networking Technologies to Learn Who Knows What and Who Knows Whom

The introduction of social networking technologies into organizational contexts continues a long trend of making various aspects of people's work visible to a broader organizational audience. Table 1 provides an overview of such studies, indicating what the technology is, what activity use of that technology makes visible, what that visibility enables awareness of, and what consequence that awareness has for the way people work. Interestingly, one key work activity missing from Table 1 is people's communication. Workplace communication among individuals has been one aspect of the work environment that has long remained private. But as Treem and Leonardi (2012) show in their detailed review, the use of social networking technologies in the workplace are beginning to make routine communications occurring among coworkers even more visible to third parties than the many communication technologies that preceded them. For example, the communicative exchanges occurring between two people on an enterprise social networking technology often appear on the wall or newsfeed of a third party not at all involved in the communication (Jarrahi and Sawyer 2013). That people can articulate their social networks and tag documents and images produced by coworkers within social networking technologies gives outsiders further visibility into the communication partners of their peers (Hampton et al. 2011; Kane et al. 2014).

The little empirical research that has been done on the use of social networking technologies in formal organizations suggests that, unlike public social networking technologies such as Facebook where a user's online connections are strongly correlated with his or her off-line social networks (see, for example, Lampe et al. 2006), employees who use enterprise social networking technologies tend to maintain connections

Table 1. Visibility, Awareness, and Changes in Work Identified in Existing Literature

Technology	What Use of Technology Makes Visible	What Visibility Enables Awareness of	Consequence of Awareness for Work	Evidence from Literature
Workflow visualization software and automatic task notification e-mails	Task execution and workflow	Where other people are in a particular sequence of steps or activities	Improved Coordination	Dabbish et al. 2012; Dey and de Guzman 2006; Kinnaird et al. 2012
Persistent video streaming, context sensing software	Activity status	What other people are doing at a given moment	Appropriately timed requests, faster response times, decreased number errors	Dourish and Bellotti 1992; Dourish and Bly 1992; Heath and Luff 2000; Malhotra and Majchrzak 2014
Version control and digital trace software	Activity history	What changes people have made to documents/work in past	Enhanced scaffolding from past work and increased interoperability of design solutions	Begole et al. 1999; Robinson et al. 2000
Collaboration tools for coauthoring	What tasks people have conducted when	Individual and group progress on specific project	Faster time to completion and improved quality	Carroll et al. 2003; Carroll et al. 2009; Majchrzak et al. 2000
Eye tracking and interactional visual displays	Focus of attention	If people are following along or understanding current activity	Immediate corrections to misinterpretations, enhanced learning and common ground	Gergle et al. 2013; Gutwin and Greenberg 2002; Tan et al. 2004
Visual awareness displays and text monitoring software	Social presence	What other people are like and what their work habits and practices are	Improved interpersonal interaction and coworker availability	Birnholtz et al. 2012; Cadiz et al. 2002; Erickson and Kellogg 2000; Stuart et al. 2012
Mobile Devices with GPS Enabled Software	Location	Where people are currently working	Whether someone is involved in a current project and whether they are amenable to discussion	Dearman et al. 2005; Erickson 2010; Leonardi et al. 2010

with coworkers whom they do not know well and with whom they do not regularly interact offline (DiMicco et al. 2008). In short, by using an enterprise social networking technology in the workplace, individuals may gain visibility into the communications of coworkers that would otherwise be invisible to them. What aspects of communication do enterprise social networking technologies make visible to third-party observers? Research suggests that the social networking technologies enable communication visibility because they make the messages people exchange with their communication partners transparent and their network connections translucent.

Message Transparency

The things a person says to someone else in routine communication—facts about work assignments, questions about

problems, reports of items learned in meetings—provide explicit cues about what that person knows (Campbell et al. 2003). When a person is exposed to a coworker's communications she can pull from those communications bits of information that reveal a broader set of topics on which that coworker is knowledgeable. If she is exposed to the contents of many of her coworkers' communications, she can begin to develop an accurate perception of who knows what within the organization.

But people are normally unaware of the content of the vast majority of messages exchanged within the organization (Ackerman 1998). For example, an employee may know that two of his or her team members communicate regularly with one another, but that employee is unlikely to know what their messages say. Sometimes people are intentionally excluded from others' communications because they are private, but more often organizational norms or the limits of conventional

technologies make the contents of communication opaque. Most messages communicated face-to-face, over the telephone, or via e-mail or instant messaging, are shared between a sender and specified receiver(s), but are not audible or visible to others in the organizations. Short of shouting or taking the time to add the address everyone in the organization to the carbon copy line in an e-mail, there are few economical (and nonirritating) ways to assure that anyone who may benefit from the message, but who is not directly participating in it, will become aware of its contents (Cabrera and Cabrera 2002).

Messages that are exchanged within an enterprise social networking technology overcome these challenges because they are made transparent to third-party observers in a way that messages exchanged in face-to-face contexts or through traditional technologies like the telephone, e-mail, instant messaging, and text messaging are not. All directed messages exchanged through use of an enterprise social networking technology are, or can be, made public so that others can see them and view their contents—even people the communicators may not know (Majchrzak et al. 2013; McAfee 2009). In other words social networking technologies afford workers the ability to see the content of the messages exchanged among their coworkers. The ability to see not only that others are communicating, but also to read what they are saying to each other may help individuals learn what those others do and do not know. If learning does occur through such exposure, it is likely to happen vicariously, as individuals are both actively and passively allocating their attention to the communications they see occurring amongst others. Therefore, I propose

Hypothesis 1: Exposure to the content of coworkers' messages on an enterprise social networking technology is positively related to improved accuracy of an observer's knowledge about who knows what in the organization.

Network Translucence

Knowing who coworkers' frequent communication partners are can help an individual to develop a cognitive social structure that accurately represents the actual communication patterns in the organization (Borgatti and Cross 2003). But it is difficult to know with whom others communicate. People see coworkers sitting at their desks talking on the phone or sending e-mails, but they cannot see with whom those coworkers are talking or to whom they are writing. Thus, short of actually seeing two people conversing, hearing reports that two people talked, or inferring communication partners based on team assignments, there are often few easy and accurate

ways for workers to learn who knows whom (Cross et al. 2003).

One of the most discussed aspects of social networking technologies is that they afford people the ability to make their communication networks public and viewable to others. Boyd and Ellison (2007, p. 211) have suggested that "what makes social network sites unique is not that they allow individuals to meet strangers, but rather that they enable users to articulate and make visible their social networks." Similarly, Hampton et al. (2011, p. 1046) observe that on social networking technologies "not only are networks persistent over time, but they are increasingly pervasive and visible across what were once clearly articulated and bounded cliques." And research shows that making inferences about people's communication partners based on digital trace data can be quite accurate (Quintane and Kleinbaum 2011). For these reasons, I suggest that enterprise social networking technologies make one's social networks translucent. That is, like an obscured glass enables someone to see an object's shape without discerning what that object is, users of enterprise social networking technologies can see that a person has a tie with someone else, but they most likely cannot know the strength or nature of the tie. As Donath (2007, p. 238) observes,

The list of connections on a [social networking technology] profile does not differentiate between close friends known in person for years and people known only through cursory glances at their profiles. The significance of these "unnuanced" links is thus ambiguous.

Consequently, although social networks provide a view of one's networks, that view is not entirely clear.

There are multiple indicators available on an enterprise social networking technology with which to learn with whom someone communicates. Most enterprise sites, like their public counterparts, provide lists of "contacts" or "connections" that individuals have approved. People who casually view another's profile page can see these lists of self-reported communication partners. Also, the communications that occur between people on the enterprise social networking technology are marked in such a way that the casual observer can see that two individuals have exchanged messages in the past. From these visible indicators of past and present communication partners, observers may be able to learn vicariously, as they are both actively and passively allocating their attention to the communications they see occurring amongst others who typically talk to one another within the organization. Consequently, I propose

Hypothesis 2: Exposure to indicators about the people with whom coworkers communicate on an enterprise social networking technology is positively related to improved accuracy of an observer's knowledge about who knows whom in the organization.

Hypothesis 3: Individuals who are exposed to coworkers' communications on an enterprise social networking technology will experience greater improvements in the accuracy of their metaknowledge (both who knows what and who knows whom) than individuals who do not use an enterprise social networking technology.

Implications of Social Networking Technology Use for Overall Accuracy of Metaknowledge

Communication becomes visible when enterprise social networking technologies afford the ability to make people's messages transparent and their networks translucent. If individuals can improve the accuracy of knowing who knows what by learning vicariously (through either or both active and passive attention allocation) to the content of messages they can see exchanged amongst their coworkers and improve the accuracy of knowing who knows whom by observing who the senders and receivers of those messages are, it stands to reason that use of an enterprise social networking technology would improve the overall accuracy of their metaknowledge as compared to people who only had the opportunity to develop metaknowledge through direct communications with or direct observation of others working (i.e., they did not use an enterprise social networking technology at work).

The effects of vicarious learning occurring through enterprise social networking technology use, when compared to a baseline of only learning via direct experiential communication with others, is likely to arise because an individual's metaknowledge is typically confined to the people with whom he or she talks regularly (Hollingshead 1998; Liang-Rulke and Rau 2000). Consequently, metaknowledge developed via experiential learning through direct communication with colleagues is likely to be confined to a small number of individuals, reducing the overall accuracy of one's metaknowledge as it concerns individuals from across the organization (Ren et al. 2006). Because enterprise social networking technologies enable people to observe the communications of any number of people occurring across the organization, not just those occurring in close physical proximity, among work team members, or among contacts in small social cliques (Hampton et al. 2011; Treem and Leonardi 2012), the vicarious learning about what and whom others know that is gained through observation of transparent messages and translucent networks may allow an individual to develop more accurate metaknowledge than he or she could simply via experiential learning through direct communication with a smaller number of people in the organization. Consequently, I propose the following:

Methods

Research Setting and Design

The data for this study were collected through a quasi-natural field experiment (Shadish et al. 2002) at a large financial services firm headquartered in the Midwestern United States. American Financial (a pseudonym) is a direct banking and payment services company with over 15,000 employees. In late 2010, the Director of Communication began working with the external software vendor, Jive, to customize an enterprise social networking technology for internal communication among employees. The social networking technology, which was called "A-Life" (short for "American Financial Life"), looked nearly identical to publically available social networking technologies, such as MySpace and Facebook. It contained profile pages, news feeds, and algorithms for suggesting new contacts. The default settings for the site, which American Financial left unchanged, allowed anyone who used it to view anyone else's profile and to see communications occurring between any other users on the site. Only 4 percent of respondents changed the default setting to make their messages private during the course of this study. Unlike public social networking technologies, it also contained a shared document repository where items could be tagged and linked to a user's profile page or news feed, and the system used employment data to create a list of a user's work group members and display that list on his or her profile page.

In late 2011, the IT team responsible for implementation of A-Life selected 20 groups, at random, from across the company to participate in a pilot study to assure the new technology was working properly before it was rolled-out across the entire company. One of these randomly selected groups was a management leadership program in the company's Marketing Division. The leadership program consisted of employees from various departments within the Marketing Division. Employees were selected into the program after a competitive admissions process during their first year of employment and remained members of the program throughout their tenure at the company. Membership in the program provided employees with regular access to company executives, extensive professional development classes, and

regularly scheduled workshops and speaker events designed specifically for the program. In short, the leadership program was a community of practice within the Marketing Division. At the time of this study, there were 44 members in the program.

The ability to attribute changes in the accuracy of metaknowledge to the vicarious learning occurring through the use of A-Life, however, required more than a simple pre/post research design. To do so, it was necessary to demonstrate that accuracy of metaknowledge did not increase naturally due simply to the passage of time. To refute this alternative hypothesis, I was fortunate enough to be allowed to test whether changes in accuracy of metaknowledge also occurred in a similar management leadership program group in the Operations Division over the same time period. The Marketing and Operations groups represented a matched sample in that the two leadership program groups had nearly identical demographic profiles with regard to age, gender, ethnicity, tenure at the company, hierarchical level, and job performance ratings. The Operations groups had 50 employees.

In December of 2011, a survey was administered to each member of Marketing and Operations. In addition to demographic information, data were collected on what respondents believed to be areas in which they were most knowledgeable, what areas they believed each of their coworkers in their respective leadership program were knowledgeable about, who they considered to be a friend at work, who they believed were their coworkers' work-related friends, who they sought advice from about work-related matters, who they believed their coworkers' sought advice from, and with whom they had worked on a project team at some point at American Financial. The survey had a very high response and completion rate of 93 percent (41/44) in Marketing and 90 percent (45/50) in Operations. A-Life was implemented in Marketing only in early January 2012.

At the end of June 2012, six months after A-Life was implemented in Marketing, but before Operations began to use the technology, a second survey was conducted with both groups. Questions from the first survey were repeated verbatim. Several additional questions about A-Life use that emerged from the second round of interviews were asked of Marketing. Due to the longitudinal design of the study, only individuals who completed the first survey were invited to respond to the second survey. In the second round, completed surveys were returned by 85 percent (35/41) of respondents in Marketing and 91 percent (41/45) of respondents in Operations. To avoid approximating for missing data, which can affect the validity of the accuracy scores used as dependent variables in

this study, only respondents who completed both survey 1 and 2 were included in the analyses presented in this paper.²

Dependent Variables

Accuracy of Who Knows What: The first dependent variable in this study is accuracy at identifying who has what knowledge. Accuracy was defined as being constituted by both correctness and breadth. Each respondent was asked to provide three self-generated pieces of task-related knowledge about which they considered themselves an expert. Respondents were then given a list of each other person who worked in their division (Marketing or Operations) and asked to indicate, for each of those people, three pieces of task-related knowledge about which they had expertise. Two independent raters then took the answers provided by each respondent about what types of task-related knowledge others in their division possessed and looked to see whether these perceptions matched with self-reports provided by their coworkers. Each time there was a match the rater assigned the perceiver a point. Respondents who earned the most points were the most accurate in identifying where knowledge was located. Cohen's Kappa for inter-rater reliability was .83. Discrepancies were resolved by selecting the score provided by the more conservative rater. The indicator of *accuracy of knowledge about who knows what* was an average of the two rater's scores, which ranged from 0 to 26.

Accuracy of Who Knows Whom: The second dependent variable in this study is accuracy (correctness and breadth) at identifying the network of advice relations within one's division. Following prior studies, the advice network was chosen for this analysis because, as the instrumental, workflow-based network of the organization, the advice network serves as the primary conduit linking people who can provide help in accomplishing key work tasks (Blau 1955; Constant et al. 1996). To perform this analysis, I adopted a cognitive social structure approach (Krackhardt 1987, 1990). Cognitive accuracy requires the measure of two sets of network relations. First, one must identify an actual network (who actually communicates with whom) against which accuracy can be measured. Second, one must assess each individual's cognitive representation of the actual network. Accuracy is determined by measuring how well the individual's cognitive map approximates the actual network of communicative relations (Krackhardt 1990). Following the work of Casciaro

²Consequently, the remainder of individuals in Marketing ($n = 9$) and Operations ($n = 9$) were excluded as option choices for respondents when calculating the dependent variables described below.

(1998), the individual cognition of work-related advice was measured through a questionnaire in matrix format. In the advice network, each person k was asked whether he or she thought that person i in his or her division (Marketing or Operations) sought task-related advice from person j who was also in the same division. When the answer was positive, person k placed a check in the cell of the advice network matrix that corresponded to a relation going from i to j . This process was repeated such that each respondent in Marketing evaluated his own advice seeking relations, as well as those of his 43 coworkers, while each respondent in Operations evaluated the advice seeking relations of his 49 coworkers in addition to his own. To determine the actual network of advice seeking relations, I adopted the locally aggregated structure (LAS) approach (Krackhardt 1987). Each respondent's cognition of the network was taken from the set of responses he or she selected on the network questionnaire. Calculation of a Pearson correlation coefficient between the original elements in the actual and cognitive social structure was used to generate a normalized accuracy score for each respondent's perception of the advice network within his or her division.³ The indicator of *accuracy of knowledge about who knows whom* is the resulting score, which ranged from 0 to 1.

Independent Variables

Exposure to Content of Others' Messages: During the second round of surveys (after Marketing had been using A-Life for nearly six months) respondents in Marketing were asked four questions about whether they used the social networking technology to learn who knew what: (1) they happened to notice the things other people said in a message to a coworker, (2) they noticed the titles of documents other people posted in A-Life, (3) they spent time carefully reading the messages exchanged among others, and (4) they read documents others posted in detail. To gauge how frequently they conducted these practices, respondents were asked to rate their level of agreement (on a five-point scale, where a response of 1 meant "not at all" and 5 meant "very strongly agree") with a statement saying that they conducted each of these four practices frequently. A correlation analysis indicated that responses to the statements "I frequently spend time carefully reading the messages exchanged between my coworkers on A-Life" and "I frequently read the documents others post on A-Life in detail" were strongly correlated.

Responses to the statements "I frequently notice the things other people say to one another when they exchange messages on A-Life" and "I frequently notice the titles of documents other people post in A-Life" were also strongly correlated. A confirmatory factor analysis was run to determine if findings 1 and 2 tapped the same underlying construct while 3 and 4 tapped into a different construct. Cronbach's alpha between statements 1 and 2 was .93 and it was .86 for statements 3 and 4 and the first principle component explains 83.6 percent of the variance. Thus I use two indicators for the *exposure to content of others' messages*, which is made possible by the fact that social networking technologies afford message transparency. The first indicator, which is the mean of the responses of the first two statements, reflects a practice of *monitoring content* of other people's messages and the full documents they post. The second indicator, which is the mean of the responses of the second two statements, reflects simple *awareness of content* of others' messages and document titles.

Exposure to Indicators of Others' Communication Partners: During the second round of surveys in Marketing, respondents were also asked if they used A-Life to learn who knows whom in the following ways: (1) they spent time reviewing the list of people's connections on their profile page, (2) they read through people's communications with others to find mentions of people in the organization that the person who was communicating might know, (3) they happened to notice the names of coworkers' communication partners while they were doing something else on the site, and (4) they noticed who was listed on a person's profile page as a work group member. As was done with the communication transparency responses, respondents rated their agreement on a five-point scale. A correlation analysis indicated that responses to the statements "I frequently spend time reviewing the list of connections appearing on other people's profile pages in A-Life" and "I frequently read others communications on A-Life for names of people they might know" were strongly correlated. Responses to the statements "I frequently notice the names of people's communication partners when I am on A-Life" and "I frequently notice who is listed as a person's work group members on A-Life" were also strongly correlated. Cronbach's alpha between statements 1 and 2 was .88 and it was .84 for statements 3 and 4 and the first principle component explains 79.2 percent of the variance. Consequently, I use two indicators for *exposure to others' communication partners*, which was made possible by the fact that social networking technologies afford network translucence. The first indicator, which is the mean of the responses of the first two statements, reflects a practice of *monitoring connections* and mentions of third parties. The second indicator, which is the mean of the responses of the second two state-

³For more details on this statistic, also known as S_{14} see Krackhardt (1990, p. 350). The procedures used to calculate the LAS and accuracy scores can be found in Version 6 of UCINET (Borgatti et al. 2002).

ments, reflects simple *awareness of connections*; that is, awareness of their communication partners and work group members.

Other Explanatory Variables

A number of additional possible explanatory variables were included in the analysis. People who have been in the organization for some time may have more accurate metaknowledge through simple exposure to others (Blau 1955). *Tenure* was measured by the number of months of employment at American Financial. Also, people who are higher-up in the hierarchy may have a broader view of who has worked on what and with whom, and consequently more accurate metaknowledge (Heald et al. 1998). *Hierarchical Level* was measured by assigning one of eight possible hierarchical levels within American Financial that respondents in Marketing or Operations could attain.

People who sit in close proximity to others may learn who knows what and who knows whom through chance hallway encounters or by overhearing or seeing coworkers in conversation with others (Palazzolo et al. 2006). To control for this possibility, a variable was created that measured *Number of Proximate Coworkers*. To create this variable, I followed Allen's (1977) influential work on the relationship between proximity and the likelihood of communicating with one's coworkers, or overhearing their communications by employing 30 meters as a cut-off point for proximate individuals. Using a scaled seating chart diagram provided by the company, I calculated the number of coworkers (from that person's division) who sat within a 30-meter radius of the focal individual. Each individual received a score indicating the number of their coworkers within this radius, representing people whom they were likely to see and/or overhear in conversation.

Individuals may also learn who and what others know if they have worked together with them on teams (Ren and Argote, 2011). The *Number of Team Members* variable represents that number of other individuals in a person's division who currently work or have worked with that person on a project team. The term *project team* was a specific term used at American Financial that referred to a departmental team assignment. To construct the number of team members variable, respondents were presented with a roster of everyone in their division and asked to indicate those individuals with whom they were currently working or had worked on a project team in the past. Each respondent's response was compared to the responses of the people they selected and only those who selected each other were considered to have worked together on a team.

Individuals may learn what and whom others know because they are friends at work and, consequently, share information or gossip about coworkers and the tasks they conduct (Krackhardt 1990). *Friendship Network Centrality* was assessed by asking respondents to look at a list of coworkers from their division and place checks next to the names of people they considered to be personal friends. The friendship data were arranged into a square matrix for each division with cell entries of 0 or 1. Because friendships are reciprocal relationships, a friendship relation should only be counted if both parties agree that they are friends (Kilduff 1992). For this reason, the matrix was symmetrized using the rule that if both members of a pair nominated the other, the pair was considered to be a friendship pair. Using this symmetrized matrix, normalized degree centrality scores were calculated for each individual in the network. The degree centrality score gauges the quantity and strength of direct ties that a member has with others in the network (Freeman 1979).

Another way in which people may learn what and who others know is by being sought often for advice about work-related issues (Blau 1955). Thus, to calculate *Advice Network Centrality*, matrices for Marketing and Operations were created using the LAS procedure described above in the formulation of the accuracy of the cognitive advice network variable. Unlike the matrices for the friendship network, the advice network matrices were not symmetrized. As Carley and Krackhardt (1996) argue, asymmetric ties in advice networks should be considered as structural characteristics of social interaction, not as errors to be corrected. Further, studies of advice seeking have demonstrated that advice relations are rarely asymmetrical (Constant et al. 1996; Cross et al. 2001). For these reasons, in-degree was used as a measure of degree centrality in the advice network. An actor's in-degree centrality is defined as the number of ties converging on him or her; a person's in-degree score is the number of people who go to that person for advice (Casciaro 1998). Centrality scores were normalized for comparison.

Analysis

The effects of the affordances provided by the social networking technology for message transparency and network translucence on change in accuracy of knowing who knows what and who knows whom from Time 1 to Time 2 (calculated simply by subtracting Time 1 accuracy scores from Time 2 accuracy scores) were assessed by OLS regression for Marketing only. The overall effects of enterprise social networking technology use on individuals' accuracy of knowledge about who knows what and accuracy of knowledge about who knows whom were tested in several ways. A paired-samples t-test was conducted for both the treatment

(Marketing) and control (Operations) conditions to ascertain whether the mean accuracy scores in both groups did or did not improve between the periods before (Time 1) and after (Time 2) the enterprise social networking technology was implemented. The second test assessed the effect of enterprise social networking technology use on that change through a differences-in-differences estimation (Cameron and Trivedi 2005). This differences-in-differences estimation was conducted on the observations of the 76 individuals in Marketing and Operations to test for the effects of enterprise social networking technology use on change in accuracy of metaknowledge from Time 1 to Time 2. Change in *Accuracy of Knowledge About Who Knows What* and *Accuracy of Knowledge About Who Knows Whom* were calculated by subtracting the values obtained for each variable at Time 1 from the values obtained at Time 2. Change in *Friendship Centrality* and *Advice Centrality* were also calculated by subtracting the values obtained for each variable at Time 1 from the values obtained at Time 2. A dummy variable was created to represent whether the respondents worked in Marketing or Operations.

Results

The effects of message transparency and network translucence on change in metaknowledge in Marketing from Time 1 to Time 2 are presented in Table 2. Overall, exposure to the content of others' messages (enabled by message transparency) explains change in accuracy of knowledge about who knows what but not change in accuracy of knowledge about who knows whom, while exposure to indicators of others' communication partners (enabled by network translucence) explains change in accuracy of knowledge about who knows what but not accuracy of knowledge about who knows whom. Interestingly, only the second indicator of each construct—the indicator suggesting a developed *awareness* of the contents of others' messages or who their communication partners were—is significant in the hypothesized change in its respective dependent variable. In other words, respondents improved the accuracy of their cognitive knowledge structures if they happened to notice what others were saying in their messages, but few people actually monitored others' communications in enough depth to develop knowledge about what they knew. This finding supports hypotheses 1 and 2.

Hypothesis 3 was explored in multiple ways. Table 3 summarizes the results of the differences-in-differences estimation, which tested whether the treatment condition (enterprise social networking technology use) predicted change in accuracy of metaknowledge. As the results in Table 3 show, the only predictor of change in accuracy from Time 1 to Time 2

was the treatment condition. In other words, the analysis indicates that the mean value of accuracy of metaknowledge (both cognitive knowledge structure and cognitive social structure) within Marketing at Time 2 differed significantly from the expected mean value at Time 2 based on the trend in Operations across the two time periods.

A paired-samples t-test was conducted to evaluate whether this change in accuracy scores for metaknowledge in Marketing represented a statistically significant improvement from Time 1 to Time 2. The results are displayed in Figure 1 for ease of interpretation. In Marketing, there was a significant increase in cognitive knowledge structure accuracy scores from Time 1 ($M = 8.26$, $SD = 6.03$) to Time 2 ($M = 10.85$, $SD = 6.03$), $t(34) = 4.65$, $p < .001$ (two-tailed); the mean increase in accuracy of knowledge about who knows what scores was 2.59 with a 95 percent confidence interval ranging from 1.46 to 3.73, ($\eta^2 = .24$). This represents a 31 percent improvement in Marketing employees' knowledge of who knows what. There was also a statistically significant increase in accuracy of knowledge of who knows whom scores from Time 1 ($M = .17$, $SD = .19$) to Time 2 ($M = .32$, $SD = .22$), $t(34) = 8.20$, $p < .001$ (two-tailed); the mean increase in cognitive social structure accuracy scores was .15 with a 95 percent confidence interval ranging from .11 to .18, ($\eta^2 = .49$). This represents an 88 percent improvement in Marketing employees' knowledge of who knows whom. By contrast, Operations employees, who did not use the enterprise social networking site, experienced no significant increase in either accuracy of knowledge about who knows what scores from Time 1 ($M = 6.17$, $SD = 5.77$) to Time 2 ($M = 6.24$, $SD = 5.46$), $t(40) = 1.29$, $p = .21$ (two-tailed) or in accuracy of knowledge about who knows whom scores from Time 1 ($M = .19$, $SD = .24$) to Time 2 ($M = .20$, $SD = .17$), $t(40) = .35$, $p = .73$ (two-tailed). Because the only change that occurred in Marketing during the duration of this study was the introduction of the social networking site, we can conclude that the significant increase in mean values for Marketing is attributable to social networking site use. These findings provide strong support for hypothesis 3.

Discussion

These findings suggest that enterprise social networking technologies can help individuals to more accurately identify who knows what and who knows whom within the workplace. The development of such accurate metaknowledge (metaknowledge that is both correct and covers a breadth of coworkers) is an important antecedent to effective knowledge transfer and collaboration (Jackson and Klobas 2008; Majchrzak et al. 2004; Ren et al. 2006). Consequently, this

Table 2. Examples of Knowledge Mentioned and Identified by Respondents

Knowledge Mentioned by Person Evaluating	Knowledge Attested by Person Being Evaluated
Extracting Data from Datacenter	Data extraction
Competitive market analysis	Competitive analysis
Contracts for purchasing	Purchasing contract analysis
Creating banner adds	Developing Banner adds
Promotional branding	Branding for promotional cards
Using social media for marketing	Social Media Marketing strategy
Doing customer contests	Promotional contests for cardmembers
Streamlining call center calls	Call routing optimization in the field ("field" is lingo for "call center")
Knowing what to pay vendors	Fair market value determination for contracts
Writing macros in excel	Spreadsheet programming

Table 3. Effects of Enterprise Social networking Technology Affordances on Individuals' Improvement in Accuracy of Metaknowledge from Time 1 to Time 2 in Marketing (N = 35)

Variable	Change in Accuracy of Knowledge About "Who Knows What"	Change in Accuracy of Knowledge About "Who Knows Whom"
<i>Exposure to Others' Messages (enabled by Message Transparency)</i>		
Monitoring Content of Coworkers' Messages	-.530 (.427)	-.060 (.044)
Awareness of Content Coworkers' Messages	.846*** (.214)	.034 (.022)
<i>Exposure to Indicators of Others' Connections (enabled by Network Translucence)</i>		
Monitoring Coworkers' Connections	.307 (.390)	-.024 (.041)
Awareness of Coworkers' Connections	.243 (.227)	.301*** (.072)
R ²	.402	.425
Adjusted R ²	.322	.348
F	5.034**	5.533**

*p < .05; **p < .01; ***p < .001. Standard errors are in parentheses.

study provides some initial empirical support for the speculation offered by industry analysts (Chui et al. 2012) and organizational and information systems theorists (Jarrahi and Sawyer 2013; Kane et al. 2014; Majchrzak et al. 2013; Treem and Leonardi 2012) that enterprise social media may play a key role in helping companies to more effectively share knowledge among their workers.

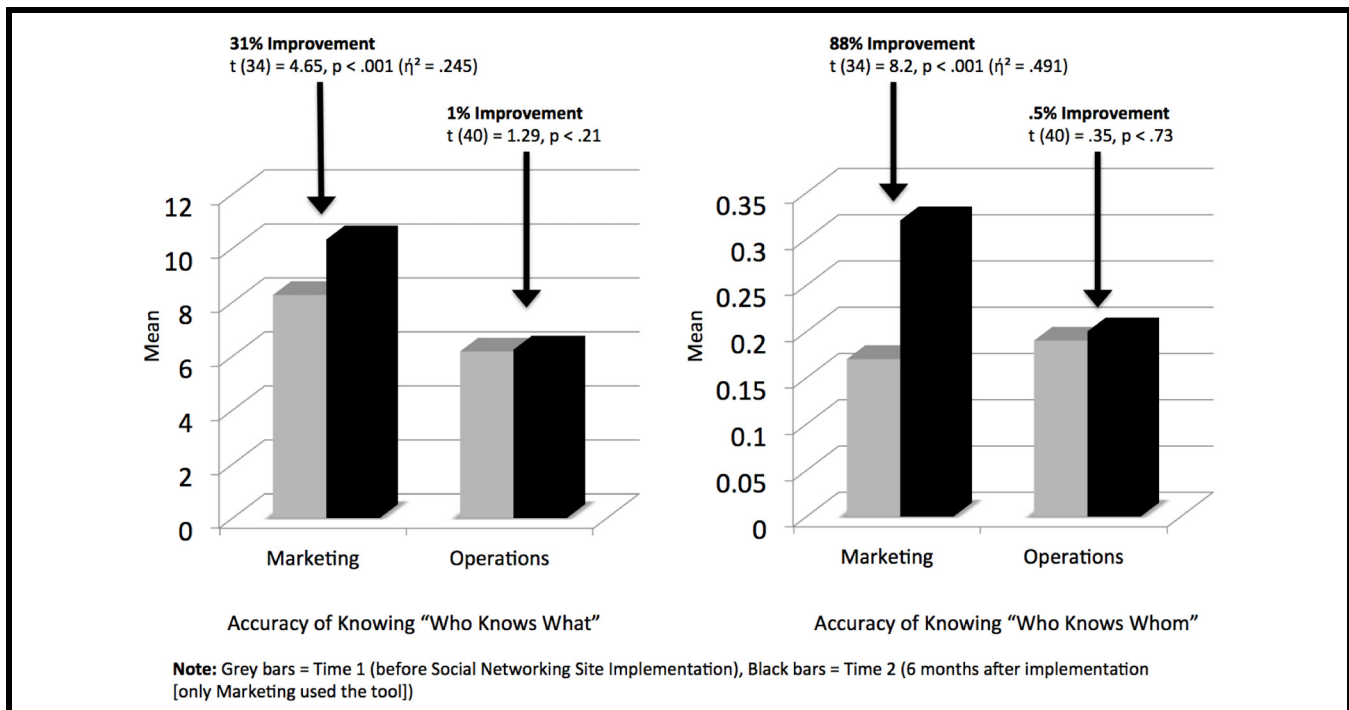
Specifically, the data showed that people developed accurate knowledge about who knows what as they became exposed to the contents of the messages their coworkers shared with one another on the social networking site. The content of those messages provided cues from which observers could make accurate inferences about what kind of knowledge their coworkers held. Exposure to indicators about whom their

coworkers communicated with (e.g., seeing that two people sent messages to each other through the site) improved observers' accuracy of knowledge about who knows whom. Interestingly, only the second indicator of each construct tested in hypotheses 1 and 2—the indicator suggesting a developed *awareness* of the contents of others' messages or who their communication partners were—was a significant predictor in the improvement of metaknowledge over time. In other words, respondents appeared to improve the accuracy of their knowledge of who knows what if they happened to notice what others were saying in their messages, but few people actually monitored others' communications in enough depth to develop knowledge about what they knew. Also, respondents improved the accuracy of their knowledge about who knows whom when they happened to notice who was

Table 4. Differences-in-Differences Estimation of Effects of Treatment (Enterprise Social Networking Technology Use) on Individuals' Improvement in Accuracy of Metaknowledge from Time 1 to Time 2 (N = 76)

Dependent Variable	Change in Accuracy of Knowledge About "Who Knows What"	Change in Accuracy of Knowledge About "Who Knows Whom"
Treatment Condition	2.616*** (.550)	.495** (.140)
Tenure	.001 (.007)	.002 (.001)
Hierarchical Level	.271 (.116)	.013 (.022)
Number of Proximate Coworkers	-.101 (.053)	-.004 (.007)
Number of Team Members	-.046 (.086)	-.016 (.011)
Change in Friendship Network Centrality	-3.860 (3.139)	-.164 (.386)
Change in Advice Network Centrality	-1.029 (2.991)	.782 (.397)
R ²	.428	.266
Adjusted R ²	.369	.183
F	7.267***	3.211**

*p < .05; **p < .01; ***p < .001. Standard errors are in parentheses.

**Figure 1. Change in Accuracy (Correctness and Breadth) of Metaknowledge Over Time Due to Social Networking Site Use**

communicating with whom or made inferences about communication partners when they saw a list of work group members. But respondents did not seem to spend time on the social networking site actively monitoring other people's connections or scouring their communications for names of people they said they talked to.

As Table 1 illustrates, numerous research studies have shown how features of particular information technologies can be used in ways that make aspects of work visible to others, but that this visibility alone is not what drives changes in the way people work. Instead, the visibility of a specific aspect of work leads to a certain kind of awareness amongst others for whom one's work has become visible and it is this awareness that prompts change. Consequently, the benefits of visibility, and the awareness that it enables, accrue to third parties who are not themselves conducting the work activity made visible. This study makes a contribution to the emerging line of work on the relationship between technology-enabled work visibility and awareness in organizations by adding an understanding about communication visibility and awareness to the growing body of scholarship in this area. As the findings showed, daily communication among organizational members, including project updates, requests for help, recommendations, summaries of past projects, and the like, contain a great deal of useful information that is not only valuable to the individuals involved directly in the communication, but is also of value to third parties outside of the communication. And, individuals who are able to see this communication, by virtue of using social networking technologies in the workplace, can use it to make accurate inferences about who knows what and whom. The development of accurate metaknowledge is an extremely important antecedent for knowledge sharing (Choi et al. 2010; Ren and Argote 2011).

Interestingly, the findings presented in Table 2 showed that passively developed awareness of the contents of other people's messages and the names of their communication partners was associated with accuracy of metaknowledge while active monitoring of the contents of those messages and lists of workplace connections was not. One reason for this difference may have been that respondents were twice as likely to report that they noticed multiple inputs in their passive exposure to the message contents and communication partners of their coworkers than they were to report reading or reviewing documents in ways that were focused at learning something specific. Informants most often went on the social networking sites with the goal of sending messages to their coworkers, not to read the messages other coworkers were sending to each other. But because the technology was configured in a way so as to push people's communications on to their newsfeeds, employees were consistently exposed to the communications of others. The data suggest that putting

oneself in a position to simply become aware of what other people say and to whom they say it may be more efficient than monitoring because it requires less focused attention and reserves limited cognitive resources. As Weick et al. (1999, p. 90) suggest,

awareness is more than simply an issue of "the way in which scarce attention is allocated" (March 1994: 10). [It] is as much about the quality of attention as it is about the conservation of attention.

Consequently, these findings point to the importance of being aware of ambient communications occurring in the workplace. Like ambient noise (e.g., any sound other than the sound being monitored) or ambient lighting (e.g., background light that shines, dully, on the object of interest), ambient communications are those communications that occur around employees, but with which they are not directly involved. I use the term *ambient awareness* to refer to the awareness that an individual has about the communications occurring among those around them. As the data reported herein suggest, ambient awareness can be enabled in important ways through the use of social networking technologies. Even though an individual may not use social networking sites to actively monitor the content of others' messages and the connections they have with others, simple exposure to them through use of a social networking site can produce sufficient awareness of them so as to translate into improved accuracy of metaknowledge.

If the ambient awareness enabled by enterprise social networking sites can help people to develop more accurate metaknowledge than they would otherwise develop through traditional mechanisms, they are likely to do so only very slowly. It would be unlikely that a routine communication between two coworkers occurring on an enterprise social networking site would contain a concise description of someone's knowledge that would be useful at some other time by a casual observer. Instead, it is more probable that routine communications seen by third-party observers contain some dribs of information that can only be turned into metaknowledge when they are assembled with other drabs of information from different observed communications. As Gioia and Mehra (1996, p. 1229) observe about learning through observation, people's cognition is "modified in intricate ways of out awareness via assimilation of subtle cues over time." Consequently, the findings of this study suggest that individuals need not pay close attention to individual communications occurring amongst their coworkers to develop accurate metaknowledge. Instead, passive exposure to ambient communications occurring between others, over time, can provide the material out of which a person can assemble an understanding about what and whom others know. And,

because enterprise social networking sites enable people to become aware of ambient communications occurring across the organization, not just those occurring in close physical proximity, among work team members, or among contacts in small social cliques, they may afford users the ability to increase the accuracy of their knowledge of what and whom a wide variety of coworkers from across the organization know.

A situation in which individuals develop accurate meta-knowledge through exposure to ambient communications may help to overcome the persistent problem of a source's motivation to share his or her knowledge consistently identified in theories of knowledge sharing (Kankanhalli et al. 2005; Wasko and Faraj 2005) because it requires little work on the part of sources. Use of an enterprise social networking technology requires minimal effort on the part of knowledge sources. The only change that sources would have to make to assist others to develop knowledge about what and whom they know would be to shift their communicative activity from private channels like the phone, e-mail, or instant messaging to an enterprise social networking technology where their communications are visible to others in the organization.

But even if awareness of ambient communications leads to accurate metaknowledge, no one will have a perfect understanding of who knows what or who knows whom for all possible problems they may encounter in the future. Consequently, a major drawback of using enterprise social networking technology to become aware of ambient communications concerns the volume of communications occurring through the technology. One might expect a curvilinear relationship between communication volume and ability to develop accurate metaknowledge because too few communications in the system means there is insufficient information from which to build knowledge about who knows what and who knows whom while too much information elicits problems of attention and focus. It is unclear what the thresholds are for the appropriate volume of communication within an enterprise social networking technology to allow for the development of accurate metaknowledge. At the time of the second survey, employees in Marketing had communicated a total of 651 messages through A-Life, an average of 18.6 messages per person. By any metric, this is a relatively small number of communications per person over a six-month period. Yet, the results suggest that even a minimal number of communications such as this was sufficient to enable substantial increases in accuracy of metaknowledge.

If communications through the enterprise social networking technology stagnate, however, one would expect smaller increases in accuracy of metaknowledge over time. Too many communications in the system may create a market for attention (Hansen and Haas 2001) in which individuals who

can no longer simply notice people's communication content or partners because there are too many people and messages become demotivated and do not use the system. In other words, their attention is distributed across too much content to learn vicariously from any of it. Or, with too many communications in the system, individuals may begin to attend only to those occurring between people they deem relevant for their work and thus artificially limit the reach across the organization provided by the enterprise social networking technology and reinforce accurate metaknowledge within small workgroups only.

Directions for Future Research

In addition to needing empirical data to answer the questions posed above about whether ambient awareness could help resolve the search-transfer problem in knowledge sharing and what effects attention allocation processes in a technology crowded with content might have on the ability to develop metaknowledge, the findings of this study point to a number of additional directions for research on the use of social media for knowledge sharing. Although this study focused on whether or not individuals could use an enterprise social networking technology to develop metaknowledge, it stopped short of examining how individuals approach others to ask for knowledge, or how transfer or knowledge actually occurs. One might imagine that ambient awareness could have effects on both processes. For example, awareness of the kinds of tasks coworkers are conducting or information about their personal preferences might make it easier to approach knowledge sources to ask them for needed knowledge. In other words, ambient awareness may provide the social lubrication to get knowledge moving. If people develop more awareness of what and whom their coworkers know, they may be able to strengthen their relationships with them, thus improving tie strength to help in the transfer of tacit knowledge.

Future research should explore whether ambient awareness increases social lubrication and makes it easier for people to ask for knowledge and whether or not learning about coworkers through social networking sites can actually help increase tie strength. Another area for future research is related to knowledge transfer. Are social networking sites useful for the actual process of transferring knowledge, or do individuals simply develop metaknowledge through them and ask for knowledge in another setting (e.g., via e-mail or face-to-face)? This is an open empirical question. One might expect that because social media are platforms upon which communication can occur, rather than simple channels that carry communication, they may provide the contextual richness to create a joint space of practice that is important for

actual knowledge transfer. For example, one key feature of practice is that it provides context for action, such that individuals understand other's motives and behaviors. By being able to read a chain of communications occurring between coworkers, following documents coworkers posted, and monitoring responses and reactions to the content produced by others, employees in both firms were able to develop contextual understanding about how a particular issue arose or how the knowledge that was produced was linked to other activities or initiatives within the firm. This type of contextualization is a key way in which knowing happens in practice. Consequently, future research should explore whether the visible nature of third-party communication creates a rich context for mediated knowledge transfer.

Finally, the findings of this study raise a number of important questions about the politics of knowledge. If people's communications with others provide sufficient cues for their coworkers to infer the areas in which they are knowledgeable, will employees want to be open about their communications? Individuals may wish to be seen as knowledgeable in areas about which they do not communicate often and may therefore decide to be selective about what they present, withholding some information about areas in which they hold knowledge, or exaggerating their proficiency in other areas. The visible nature of communication means that opportunities for self-monitoring may increase because an individual can see what others are saying about him or her on the site. Future research should closely examine the dynamics of self-disclosure, censure, honesty, and deception in communication on social networking sites within organizations.

Conclusion

The key conclusion of this study is that the awareness of ambient communication enabled by the use of an enterprise social networking technology can help people to improve the accuracy of their metaknowledge. The data suggest that social technologies may be useful for knowledge sharing and collaboration within organizations not because they change what or with whom people communicate, but because they simply make the communications that people are already having visible to others throughout the organization. Such visibility allows observers access to cues through which they can infer one's knowledge. And as the results of this study have shown, those inferences can be quite accurate.

Acknowledgments

The author wishes to thank Senior Editor Arvind Malhotra, the associate editor, and three anonymous reviewers for comments that

have improved this manuscript, as well as Jeffrey Treem, Casey Pierce, and Stephanie Dailey who helped with data collection. Janet Fulk and Luke Rhee also offered valuable comments that helped improve this manuscript. Generous funding for this study was provided by two grants from the National Science Foundation (SES-1331492) and (ACI-1322103).

References

- Ackerman, M. 1998. "Augmenting Organizational Memory: A Field Study of Answer Garden," *ACM Transactions on Information Systems* (16:2), pp. 203-224.
- Allen, T. J. 1977. *Managing the Flow of Technology*, Cambridge, MA: MIT Press.
- Begole, J., Rosson, M. B., and Shaffer, C. A. 1999. "Flexible Collaboration Transparency: Supporting Worker Independence in Replicated Application-Sharing Systems," *ACM Transactions on Computer-Human Interaction* (6:2), pp. 95-132.
- Birnholtz, J., Dixon, G., and Hancock, J. 2012. "Distance, Ambiguity and Appropriation: Structures Affording Impression Management in a Collocated Organization," *Computers in Human Behavior* (28:3), pp. 1028-1035.
- Blau, P. M. 1955. *Dynamics of Bureaucracy*, Chicago: University of Chicago Press.
- Borgatti, S. P., and Cross, R. 2003. "A Relational View of Information Seeking and Learning in Social Networks," *Management Science* (49:4), pp. 432-445.
- Borgatti, S. P., Everett, M. G., and Freeman, L. C. 2002. *UCINET for Windows: Software for Social Network Analysis*, Harvard, MA: Analytic Technologies.
- Boyd, D. N., and Ellison, N. B. 2007. "Social Network Sites: Definition, History, and Scholarship," *Journal of Computer-Mediated Communication* (13), pp. 210-230.
- Cabrera, A., and Cabrera, E. F. 2002. "Knowledge-Sharing Dilemmas," *Organization Studies* (23), pp. 687-710.
- Cadiz, J. J., Venolia, G., Jancke, G., and Gupta, A. 2002. "Designing and Deploying an Information Awareness Interface," in *Proceedings of the ACM Conference on Computer-Supported Cooperative Work*, New York: ACM Press, pp. 315-323.
- Cameron, A. C., and Trivedi, P. K. 2005. *Microeconometrics: Methods and Applications*, New York: Cambridge University Press.
- Campbell, C. S., Maglio, P. P., Cozzi, A., and Dom, B. 2003. "Expertise Identification Using E-mail Communications," in *Proceedings of the 12th International Conference on Information and Knowledge Management*, New Orleans, November 3-8, pp. 528-531.
- Carley, K. M., and Krackhardt, D. 1996. "Cognitive Inconsistencies and Non-Symmetric Friendship," *Social Networks* (18), pp. 1-27.
- Carroll, J. M., Neale, D. C., Isenhour, P. L., Rosson, M. B., and McCrickard, D. S. 2003. "Notification and Awareness: Synchronizing

- ronizing Task-Oriented Collaborative Activity,” *International Journal of Human-Computer Studies* (58), pp. 605-632.
- Carroll, J. M., Rosson, M. B., Farooq, U., and Xiao, L. 2009. “Beyond Being Aware,” *Information and Organization* (19), pp. 162-185.
- Casciaro, T. 1998. “Seeing Things Clearly: Social Structure, Personality, and Accuracy in Social Network Perception,” *Social Networks* (20), pp. 331-351.
- Choi, S. Y., Lee, H., and Yoo, Y. 2010. “The Impact of Information Technology and Transactive Memory Systems on Knowledge Sharing, Application, and Team Performance: A Field Study,” *MIS Quarterly* (34:4), pp. 855-870.
- Chui, M., Manika, J., Bughin, J., Dobbs, R., Roxburgh, C., Sarrazin, H., Sands, G., and Westergren, M. 2012. “The Social Economy: Unlocking Value and Productivity Through Social Technologies,” McKinsey Global Institute.
- Constant, D., Sproull, L., and Kiesler, S. 1996. “The Kindness of Strangers: The Usefulness of Electronic Weak Ties for Technical Advice,” *Organization Science* (7:2), pp. 119-135.
- Cross, R., Borgatti, S. P., and Parker, A. 2001. “Beyond Answers: Dimensions of the Advice Network,” *Social Networks* (23:1), pp. 215-235.
- Cross, R., Borgatti, S. P., and Parker, G. 2003. “Making Invisible Work Visible: Using Social Network Analysis to Support Strategic Collaboration,” *California Management Review* (44:2), pp. 25-46.
- Dabbish, L., Stuart, C., Tsay, J., and Herbsleb, J. 2012. “Social Coding in GitHub: Transparency and Collaboration in an Open Software Repository,” in *Proceedings of the ACM Conference on Computer-Supported Cooperative Work*, New York: ACM Press, pp. 1277-1286.
- Dearman, D., Hawkey, K., and Inkpen, K. M. 2005. “Effect of Location-Awareness on Rendezvous Behaviour,” in *CHI’05 Extended Abstracts on Human Factors in Computing Systems*, New York: ACM Press, pp. 1929-1932.
- Dey, A. K., and de Guzman, E. 2006. “From Awareness to Connectedness: The Design and Deployment of Presence Displays,” in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, R. Grinter, T. Rodden, P. Aoki, E. Cutrell, R. Jeffries, and G. Olson (eds.), New York: ACM Press, pp. 899-908.
- DiMicco, J., Millen, D. R., Geyer, W., Dugan, C., Brownholtz, B., and Muller, M. 2008. “Motivations for Social Networking at Work,” in *Proceedings of the 2008 ACM Conference on Computer-Supported Cooperative Work*, New York: ACM Press, pp. 711-720.
- Donath, J. 2007. “Signals in Social Supernet,” *Journal of Computer-Mediated Communication* (13:1), pp. 231-251.
- Dourish, P., and Bellotti, V. 1992. “Awareness and Coordination in Shared Workspaces,” in *Proceedings of the Conference on Computer-Supported Cooperative Work*, J. Turner and R. E. Kraut (eds.), New York: ACM Press, pp. 107-114.
- Dourish, P., and Bly, S. 1992. “Portholes: Supporting Awareness in a Distributed Work Group,” *Proceedings of CHI’92*, pp. 599-607.
- Ellison, N. B., Gibbs, J. L., and Weber, M. S. 2015. “The Use of Enterprise Social Network Sites for Knowledge Sharing in Distributed Organizations: The Role of Organizational Affordances,” *American Behavioral Scientist January* (59), pp. 103-123.
- Erickson, I. 2010. “Geography and Community: New Forms of Interaction Among People and Places,” *American Behavioral Scientist* (53:8), pp. 1194-1207.
- Erickson, T., and Kellogg, W. 2000. “Social Translucence: An Approach to Designing Systems that Support Social Processes,” *ACM Transactions on Computer-Human Interaction* (7), pp. 59-83.
- Freeman, L. C. 1979. “Centrality in Networks 1: Conceptual Clarifications,” *Social Networks* (1), pp. 215-239.
- Fulk, J., and Yuan, Y. C. 2013. “The Adoption and Usage of Social Networking Tools to Support Knowledge Sharing in Contemporary Organizations,” *Journal of Computer-Mediated Communication* (19), pp. 20-37.
- Gergle, D., Kraut, R. E., and Fussell, S. R. 2013. “Using Visual Information for Grounding and Awareness in Collaborative Tasks,” *Human-Computer Interaction* (28:1), pp. 1-39.
- Gioia, D. A., and Mehra, A. 1996. “Sensemaking in Organizations,” *Academy of Management Review* (21:4), pp. 1226-1230.
- Gutwin, C., and Greenberg, S. 2002. “A Descriptive Framework of Workspace Awareness for Real-Time Groupware,” *Computer Supported Cooperative Work* (11), pp. 411-446.
- Hampton, K. N., Lee, C.-J., and Her, E. J. 2011. “How New Media Affords Network Diversity: Direct and Mediated Access to Social Capital Through Participation in Local Social Settings,” *New Media & Society* (13:7), pp. 1031-1049.
- Hansen, M. T., and Haas, M. R. 2001. “Competing for Attention in Knowledge Markets: Electronic Document Dissemination in a Management Consulting Company,” *Administrative Science Quarterly* (46:1), pp. 1-28.
- Heald, M. R., Contractor, N., Koehly, L. M., and Wasserman, S. 1998. “Formal and Emergent Predictors of Coworkers’ Perceptual Congruence on an Organization’s Social Structure,” *Human Communication Research* (24:4), pp. 536-563.
- Heath, C., and Luff, P. 2000. *Technology in Action*, Cambridge, UK: Cambridge University Press.
- Hollingshead, A. B. 1998. “Retrieval Processes in Transactive Memory Systems,” *Journal of Personality and Social Psychology* (74:3), pp. 659-671.
- Jackson, P., and Klobas, J. 2008. “Transactive Memory Systems in Organizations: Implications for Knowledge Directories,” *Decision Support Systems* (44:2), pp. 409-424.
- Jarrah, M. H., and Sawyer, S. 2013. “Social Technologies, Informal Knowledge Practices, and the Enterprise,” *Journal of Organizational Computing and Electronic Commerce* (23:1), pp. 110-137.
- Kane, G. C., Alavi, M., Labianca, G., and Borgatti, S. P. 2014. “What’s Different about Social Media Networks? A Framework and Research Agenda,” *MIS Quarterly* (38:1), pp. 274-304.
- Kankanhalli, A., Tan, B. C. Y., and Wei, K.-K. 2005. “Contributing Knowledge to Electronic Repositories: An Empirical Investigation,” *MIS Quarterly* (29), pp. 113-143.
- Kilduff, M. 1992. “The Friendship Network as a Decision-Making Resource: Dispositional Moderators of Social Influences on Organizational Choice,” *Journal of Personality and Social Psychology* (62:1), pp. 168-180.

- Kinnaird, P., Dabbish, L., and Kiesler, S. 2012. "Workflow Transparency in a Microtask Marketplace," in *Proceedings of GROUP'12*, ACM Press: New York, pp. 281-284.
- Krackhardt, D. 1987. "Cognitive Social Structures," *Social Networks* (9), pp. 109-134.
- Krackhardt, D. 1990. "Assessing the Political Landscape: Structure, Cognition, and Power in Organizations," *Administrative Science Quarterly* (35:2), pp. 342-369.
- Lampe, C., Ellison, N., and Steinfield, C. 2006. "A Face (book) in the Crowd: Social Searching vs. Social Browsing," in *Proceedings of the Annual Conference on Computer-Supported Cooperative Work*, New York: ACM Press, pp. 167-170.
- Leonardi, P. M. 2014. "Social Media, Knowledge Sharing, and Innovation," *Information Systems Research* (25:4), pp. 796-816.
- Leonardi, P. M., Huysman, M., and Steinfield, C. 2013. "Enterprise Social Media: Definition, History, and Prospects for the Study of Social Technologies in Organizations," *Journal of Computer-Mediated Communication* (19:1), pp. 1-19.
- Leonardi, P. M., Treem, J. W., and Jackson, M. H. 2010. "The Connectivity Paradox: Using Technology to Both Decrease and Increase Perceptions of Distance in Distributed Work Arrangements," *Journal of Applied Communication Research* (38:1), pp. 85-105.
- Liang-Rulke, D., and Rau, D. 2000. "Investigating the Encoding Process of Transactive Memory Development in Group Training," *Group & Organization Management* (25:4), pp. 373-396.
- Majchrzak, A., Cooper, L. P., and Neece, O. E. 2004. "Knowledge Reuse for Innovation," *Management Science* (50:2), pp. 174-188.
- Majchrzak, A., Faraj, S., Kane, G. C., and Azad, B. 2013. "The Contradictory Influence of Social Media Affordances on Online Communal Knowledge Sharing," *Journal of Computer Mediated Communication* (19:1), pp. 38-55.
- Majchrzak, A., Rice, R. E., Malhotra, A., King, N., and Ba, S. L. 2000. "Technology Adaptation: The Case of a Computer-Supported Inter-organizational Virtual Team," *MIS Quarterly* (24:4), pp. 569-600.
- Malhotra, A., and Majchrzak, A. 2014. "Enhancing Performance of Geographically Distributed Teams Through Targeted Use of Information and Communication Technologies," *Human Relations* (67:4), pp. 389-411.
- March, J. G. 1994. *A Primer on Decision Making: How Decisions Happen*, New York: Free Press.
- McAfee, A. 2009. *Enterprise 2.0: New Collaborative Tools for Your Organization's Toughest Challenges*, Boston: Harvard Business School Press.
- Palazzolo, E. T., Serb, D. A., She, Y. C., Su, C. K., and Contractor, N. S. 2006. "Coevolution of Communication and Knowledge Networks in Transactive Memory Systems: Using Computational Models for Theoretical Development," *Communication Theory* (16), pp. 223-250.
- Quintane, E., and Kleinbaum, A. M. 2011. "Matter Over Mind? E-mail Data and the Measurement of Social Networks," *Connections* (31:1), pp. 22-46.
- Ren, Y., and Argote, L. 2011. "Transactive Memory Systems 1985-2010: An Integrative Framework of Key Dimensions, Antecedents, and Consequences," *Academy of Management Annals* (5:1), pp. 189-229.
- Ren, Y., Carley, K. M., and Argote, L. 2006. "The Contingent Effects of Transactive Memory: When Is it More Beneficial to Know What Others Know?," *Management Science* (52:5), pp. 671-682.
- Robinson, M., Kovalainen, M., and Auramäki, E. 2000. "Diary as Dialogue in Papermill Process Control," *Communications of the ACM* (43:1), pp. 65-70.
- Shadish, W. R., Cook, T. D., and Campbell, D. T. 2002. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*, Boston: Houghton Mifflin.
- Stuart, C., Dabbish, L., Kiesler, S., Kinnaird, P., and Kang, R. 2012. "Social Transparency in Networked Information Exchange: A Theoretical Framework," in *Proceedings of the ACM Conference on Computer-Supported Cooperative Work*, New York: ACM Press, pp. 451-460.
- Tan, D., Gergle, D., Scupelli, P., and Pausch, R. 2004. "Physically Large Displays Improve Path Integration in 3D Virtual Navigation Tasks," in *Proceedings of CHI 2004*, New York: ACM Press, pp. 439-446.
- Treem, J. W., and Leonardi, P. M. 2012. "Social Media Use in Organizations: Exploring the Affordances of Visibility, Editability, Persistence, and Association," *Communication Yearbook* (36), pp. 143-189.
- Wasko, M. M., and Faraj, S. 2005. "Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice," *MIS Quarterly* (29:1), pp. 35-57.
- Weick, K. E., Sutcliffe, K. M., and Obstfeld, D. 1999. "Organizing for High Reliability: Processes of Collective Mindfulness," in *Research in Organizational Behavior*, B. M. Staw and R. I. Sutton (eds.), Greenwich, CT: JAI Press, pp. 91-123.

About the Author

Paul M. Leonardi is the Duca Family Professor of Technology Management at the University of California, Santa Barbara. His research and teaching focus on helping companies to create and share knowledge more effectively. He is interested in how implementing new technologies and harnessing the power of informal social networks can help companies take advantage of their knowledge assets to create innovative products and services.