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THE INFLUENCE OF INTELLECTUAL CAPITAL ON THE TYPES OF INNOVATIVE CAPABILITIES

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We examined how aspects of intellectual capital influenced various innovative capabilities in organizations. In a longitudinal, multiple-informant study of 93 organizations, we found that human, organizational, and social capital and their interrelationships selectively influenced incremental and radical innovative capabilities. As anticipated, organizational capital positively influenced incremental innovative capability, while human capital interacted with social capital to positively influence radical innovative capability. Counter to our expectations, however, human capital by itself was negatively associated with radical innovative capability. Interestingly, social capital played a significant role in both types of innovation, as it positively influenced incremental and radical innovative capabilities.

It is widely accepted that an organization's capability to innovate is closely tied to its intellectual capital, or its ability to utilize its knowledge resources. Several studies have underscored how new products embody organizational knowledge (e.g., Stewart, 1997), described innovation as a knowledge management process (e.g., Madhavan & Grover, 1998), and characterized innovative companies as knowledge creating (e.g., Nonaka & Takeuchi, 1995). So close are the ties between research on knowledge and research on innovation, in fact, that in recent years scholars have seen a blurring of the boundaries between these areas. It is now quite common for studies examining innovation to use knowledge or intellectual capital as antecedents, and studies investigating knowledge and intellectual capital frequently use innovation as outcomes (e.g., Ahuja, 2000; Dougherty, 1992; Subramaniam & Venkatraman, 2001; Tsai & Ghoshal, 1998).

Although the basic link between organizational knowledge and innovation is on the whole persuasive, more remains to be understood about its precise nature. It is known, for instance, that organizations adopt different approaches for accumulating and utilizing their knowledge and that these approaches manifest themselves as distinct aspects of intellectual capital—namely, human, organizational, and social capital (Davenport & Prusak, 1998; Nahapiet & Ghoshal, 1998; Schultz, 1961). Research has also delineated the differences between incremental and radical innovative capabilities (Abernathy & Clark, 1985) and noted that they vary in the kinds of knowledge they draw upon (Cardinal, 2001). Yet the finer aspects of how organizational knowledge gets accumulated and utilized remain unconnected to the specific types of innovative capabilities organizations possess, with most studies only linking knowledge to very generic, broadly defined innovation outcomes (e.g., new product introductions, technology patents, sales generated from new products). This gap in understanding is of concern given that organizations invest significant resources to develop their intellectual capital, often with a strategic need to enhance select types of innovative capabilities (Tushman & O'Reilly, 1997).

Our study is an attempt to address this issue and therefore refine and extend comprehension of the knowledge-innovation link. To do so, we draw upon and synthesize insights from prior studies that have examined distinct aspects of intellectual capital (human, organizational, and social capital) and different types of innovative capabilities (incremental and radical) in an effort to develop new

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insights surrounding their intrinsic connections. More specifically, from studies on intellectual capital, we construe how human, organizational, and social capital enable organizations to either reinforce or transform their prevailing knowledge. Similarly, from studies on innovation, we infer how incremental and radical innovative capabilities require drawing upon knowledge in fundamentally different ways—incremental innovative capabilities requiring the reinforcing of prevailing knowledge, and radical innovative capabilities requiring the transforming of prevailing knowledge. Synthesizing these insights, we develop a research framework that conceptually delineates and can empirically test how different aspects of intellectual capital and their interrelationships selectively influence different types of innovative capabilities.

CONCEPTUAL BACKGROUND

Innovation is intrinsically about identifying and using opportunities to create new products, services, or work practices (Van de Ven, 1986). Knowledge helps organizations achieve these objectives, as opportunities get noticed and exploited because of asymmetries in knowledge across organizations (Hargadon & Sutton, 1997). Not surprisingly, the process of innovation is commonly equated with an ongoing pursuit of harnessing new and unique knowledge (Nonaka & Takeuchi, 1995).

A critical portion of the knowledge and skills required for innovation resides with and is used by individuals. The complexity of many modern innovations, however, necessitates a pooling and integration of multiple strands of this knowledge. As Van de Ven observed, "While the invention or conception of innovative ideas may be an individual activity, innovation (inventing and implementing new ideas) is a collective achievement" (1986: 591). Thus, organizations accumulate, codify, and store individual knowledge in manuals, databases, and patents for collective current and future use (Garud & Nayyar, 1994) and establish robust structures, systems, and processes (such as new product development teams and formal product-planning processes) to streamline individual inputs into steady streams of innovative outcomes (Cooper, 2001). Organizations also assimilate and integrate knowledge by facilitating its communication, sharing, and transfer among individuals and by encouraging interactions in groups and networks (Allen, 1977).

Aspects of Intellectual Capital: Conceptualization and Definitions

Several studies designating an organization's knowledge resources as its *intellectual capital* have underscored the notion that knowledge is utilized through different approaches in an organization. The authors of these studies consider *intellectual capital* to be *the sum of all knowledge firms utilize for competitive advantage* (Nahapiet & Ghoshal, 1998; Youndt, Subramaniam, & Snell, 2004). More importantly, it is the conceptualization of different aspects of intellectual capital that offers scholars a means to parsimoniously synthesize the approaches by which knowledge is accumulated and used in organizations. Previous research has identified three prominent aspects of intellectual capital: human, organizational, and social capital. *Human capital* is defined as the knowledge, skills, and abilities residing with and utilized by individuals (Schultz, 1961), whereas *organizational capital* is the institutionalized knowledge and codified experience residing within and utilized through databases, patents, manuals, structures, systems, and processes (Youndt et al., 2004). The third aspect, *social capital,* is defined as the knowledge embedded within, available through, and utilized by interactions among individuals and their networks of interrelationships (Nahapiet & Ghoshal, 1998).

At a basic level, the conceptual separation of these three aspects of intellectual capital is evident from how each aspect accumulates and distributes knowledge differently: either through (1) individuals, (2) organizational structures, processes, and systems, or (3) relationships and networks. Other key attributes, however, further highlight their inherent differences. For example, the distinction between human and organizational capital is most telling in Daft and Weick's observation: "Individuals come and go, but organizations preserve knowledge. . .over time" (1984: 285). That is, individual expertise and its associated human capital may or may not stay within organizations and can change depending on the hiring, mobility, and turnover of employees. Conversely, institutionalized knowledge and its associated organizational capital stay within organizations and do not change very easily (Walsh & Ungson, 1991). As for social capital's preservation, it tends to function more like organizational capital than human capital. Yes, social capital comprises a network of individuals who each have the option to leave their organization, but it is rare that this individual mobility completely destroys the viability of the overall network. Since social capital stems from norms for collaboration, interaction, and the sharing of ideas (Put-

nam, 1995), it tends to be largely preserved within organizations irrespective of changes in specific individual actors (Bourdieu, 1985).

Although social capital may be similar to organizational capital (and also unlike human capital) with regard to its institutionalization and preservation within organizations, it differs from organizational capital in terms of the flexibility by which knowledge is utilized. By its very nature, organizational capital is codified, and its creation, preservation, and enhancement occur through structured, repetitive activities (Nelson & Winter, 1982). Such codification is manifested in the various manuals, databases, and patents that organizations use to accumulate and retain knowledge. It also is reflected in an organization's time-honored structures and processes, or clearly mandated procedures and rules for retrieving, sharing, and utilizing knowledge. Information exchanges made as part of these established structures and processes thus tend to follow well-established and codified guidelines. Consequently, knowledge intrinsic to organizational capital tends to be bounded within set parameters and scripted to be accumulated and utilized in established ways (Brown & Duguid, 1991). In contrast, an inherent characteristic of knowledge associated with social capital is its evolution through interactions among individuals or groups who tend not to follow predetermined rules and procedures to access, share, or transact information. Knowledge is consequently not bounded within predetermined parameters, is unscripted, and is accumulated and utilized as a function of the shifting contours of relationships and interactions in a network (Burt, 1992). More fundamentally, social capital exemplifies flexible conduits for the sharing and exchange of knowledge and hence acts as a facilitator to strengthen how human and organizational capital are leveraged in organizations (Kostova & Roth, 2003).

A natural outcome of these various differences is that each of these aspects of intellectual capital requires unique kinds of investments (Youndt et al., 2004): human capital requiring the hiring, training, and retaining of employees; organizational capital requiring the establishment of knowledge storage devices and structured recurrent practices; and social capital requiring the development of norms that facilitate interactions, relationships, and collaboration. Despite these fundamental differences, however, the various aspects of intellectual capital are not always found in organizations in neat, separate packages. For example, individual knowledge (human capital) often becomes codified and institutionalized (organizational capital) and is transferred and leveraged in groups and networks (social capital). Thus, these different aspects of intellectual capital both individually and jointly deploy organizational knowledge.

Since innovations essentially draw upon such deployed knowledge, finding an association between various aspects of intellectual capital and an organization's generic capability to innovate would hardly be surprising. However, given that these aspects of intellectual capital accumulate and process knowledge differently, it is possible that each of them and their interrelationships may influence an organization's innovative capabilities in different ways. To better understand these influences,, we turn to the distinctions among different types of innovative capabilities.

Types of Innovative Capabilities: Conceptualization and Definitions

The most established classification of innovation distinguishes it as incremental or radical (Dewar & Dutton, 1986). Incremental innovations refine existing products, services, or technologies and reinforce the potential of established product/service designs and technologies (Ettlie, 1983). Accordingly, *incremental innovative capability* is defined as the capability to generate innovations that refine and reinforce existing products and services. Radical innovations, on the other hand, are major transformations of existing products, services, or technologies that often make the prevailing product/service designs and technologies obsolete (Chandy & Tellis, 2000). Thus, *radical innovative capability* is the capability to generate innovations that significantly transform existing products and services.

The underlying distinctions in incremental and radical innovative capabilities are further evident in how differently they draw upon organizational knowledge. As Gatignon, Tushman, Smith, and Anderson (2004: 1107) observed, incremental innovations involve "improving and exploiting an existing technological trajectory," whereas radical innovations "disrupt an existing technological trajectory." Similarly, Abernathy and Clark noted that incremental innovations "build on and reinforce the applicability of existing knowledge," while radical innovations "destroy the value of an existing knowledge base" (1985: 5). Thus, incremental innovative capabilities draw upon *reinforced* prevailing knowledge, with consequent innovations taking advantage of and improving upon prevailing knowledge, whereas radical innovative capabilities draw upon *transformed* prevailing knowledge, with innovations making prevailing technologies obsolete and "morphing" old knowledge into something significantly new.

These distinctions in how different types of innovative capabilities draw upon knowledge that is either reinforced or transformed provide an a priori basis for systematically linking them to the various aspects of intellectual capital and their interrelationships. At the heart of this basis is the premise that the various aspects of intellectual capital and their interrelationships, by accumulating and mediating knowledge differently, enable organizations to draw upon knowledge in distinct ways. The nature of this link, however, needs to be further delineated and empirically verified, an effort that is the focus of our current research.

RESEARCH FRAMEWORK

The underlying rationale for our framework is that inherent differences in the key attributes of human, organizational, and social capital cause each of them to have a particular reinforcing or transforming influence on knowledge. However, these influences are not always isolated, given that human, organizational, and social capital are often intertwined in organizations. Thus, their interrelationships also play an important role in shaping these influences. Accordingly, we rooted our research framework in the premise that *human, organizational, and social capital—either independently or through their interrelationships—reinforce or transform knowledge to selectively influence incremental and radical innovative capabilities.*

Reinforcing Prevailing Knowledge for Incremental Innovative Capabilities

An organization's preserved knowledge influences its propensity to reinforce its knowledge. Preserved knowledge tends to be used in structured, recurrent activities and is generally perceived to be more reliable and robust than other knowledge (Katila, 2002). Consequently, it biases an organization's problem-solving activities to focus on what has previously proved useful (Lyles & Mitroff, 1980) and on areas closely related to preexisting knowledge (Martin & Mitchell, 1998). For instance, the domains of knowledge in which organizations pursue fresh patenting activities are known to closely follow and converge on the domains of knowledge of their existing patents (Stuart & Podolny, 1996). Moreover, when organizations harness their preserved knowledge through structured recurrent activities, they deepen their knowledge and further legitimize its perceived value (Katila & Ahuja, 2002). Eventually, such processes create a path-dependent trajectory of reinforced knowledge (Cohen & Levinthal, 1990; Daneels, 2002).

Such institutionalization of an organization's means to preserve knowledge and the mechanisms to use it recurrently is most evident in its organizational capital. The hallmarks of organizational capital include reliance on manuals, databases, patents, and licenses to codify and preserve knowledge, along with establishment of structures, processes, and routines that encourage repeated use of this knowledge (Hansen, Nohria, & Tierney, 1999). Thus, we expect organizational capital to enhance the reinforcing of prevailing knowledge and thereby influence an organization's incremental innovative capabilities.

Hypothesis 1. The greater the organizational capital in organizations, the higher their incremental innovative capability.

By and large, established processes and routines leveraging an organization's preserved knowledge tend to run on their own, often steering knowledge evolution in directions that the organization may find it difficult to rein in or change (Nelson & Winter, 1982). However, the strength of an organization's preserved knowledge and the intrinsic worth of the trajectory it takes can be expected to improve with the quality of the interactions, relationships, and collaborations among groups of individuals who operate with this preserved knowledge. Groups play a substantial role in deploying knowledge within organizations (Nonaka, 1994), and the quality of group work and teams most likely not only improves how an organization's codified knowledge in patents, databases, and licenses is leveraged, but also improves how these knowledge sources are updated and reinforced. Similarly, structured processes, such as new product development projects that harness and reinforce organizational knowledge, clearly benefit from rich exchanges of information and collaboration among a project's team members (Subramaniam & Venkatraman, 2001).

An organization's social capital enhances the quality of group work and the richness of information exchange among team members. Social capital is epitomized in how it facilitates interactions and the exchange of ideas. Thus, social capital most likely assists in the iterative process of knowledge reinforcement by enabling groups not only to efficiently draw upon prevailing knowledge, but also to refine the evolving body of this knowledge. Hence, we expect social capital to augment organizational capital's role in reinforcing knowledge and thereby strengthen organizational capital's influence on incremental innovative capabilities.

Hypothesis 2. The greater the social capital in organizations, the stronger the influence of organizational capital on incremental innovative capability.

Transforming Prevailing Knowledge for Radical Innovative Capabilities

An organization's access and exposure to a variety of new and alternate knowledge domains influence its propensity to transform knowledge. Rather than relying on preserved knowledge for problem solving, knowledge transformation requires questioning prevailing norms and looking for fundamentally different solutions to existing problems (Tushman & Anderson, 1986). Access and exposure to diverse knowledge domains enlightens organizations about new ways by which existing problems can be solved (Rosenkopf & Nerkar, 2001). As different technologies often stem from sciences with unique premises and often have vastly differing logics for their inner workings, the more an organization gets exposed to the premises behind new knowledge domains, the less unilaterally valid and attractive its preserved knowledge appears (Ahuja & Lampert, 2001). Organizations consequently begin to question the premises behind prevailing knowledge and broaden their repertoires of problem-solving approaches, thereby increasing their likelihood of transforming prevailing knowledge.

The propensity for access and exposure to diverse knowledge domains is most likely seen in an organization's human capital. The hallmarks of human capital are creative, bright, skilled employees, with expertise in their roles and functions, who constitute the predominant source for new ideas and knowledge in an organization (Snell & Dean, 1992). It is in these individuals that organizations not only find the greatest repertoires and diversity of skills (Hayek, 1945), but also the most flexibility in acquiring new skills (March, 1991). Furthermore, it is these bright and skilled employees who are most likely to question prevailing norms in organizations (Tushman & Anderson, 1986). Accordingly, individuals and their associated human capital are crucial for exposing an organization to technology boundaries that increase its capacity to absorb and deploy knowledge domains (Hill & Rothaermel, 2003). Therefore, we expect human capital to enhance the transformation of prevailing knowledge and thereby influence an organization's radical innovative capabilities.

Hypothesis 3. The greater the human capital in organizations, the higher their radical innovative capability.

Individuals and their associated human capital may encourage the questioning of prevailing norms and originate new ways of thinking, but their unique ideas often need to be tied to one another for radical breakthroughs to occur. Hargadon and Sutton (1997) described the process of combining previously unconnected ideas as "brokering," suggesting that making unconventional connections between disparate understandings is as important in developing radical innovations as is having diverse ideas. Moreover, even when individuals come up with breakthrough ideas, their contributions most likely need to gain recognition, dissemination, and currency for their impact to be maximized. A variety of studies have highlighted how social networks assist the acceptance of individuals' radical ideas within broad organizational or industry settings. Research on "product champions," for example, has emphasized the significance of networking and lobbying within organizations for facilitating the acceptance and implementation of radical innovations (Schön, 1963). Similarly, research on "dominant designs" has suggested how relationships and networks developed across organizations are critical to industry-wide acceptance of new standards arising from revolutionary ideas (Tushman & Murmann, 1998). Through strong ties with suppliers and distributors, for instance, organizations can influence the adoption of radical technologies, increase the installed base of their innovations, and augment the penetration and establishment of new standards (Schilling, 1998).

Ties and links that encourage the sharing of information and know-how among a wide range of individuals are key attributes of social capital. Such attributes further facilitate human capital's role in transforming prevailing knowledge. While human capital provides organizations with a platform for diverse ideas and thoughts, social capital can help connect them to make unforeseen and unusual combinations for radical breakthroughs. Moreover, social capital also encourages collaboration both within and across organizations. In doing so, it can help individuals not only establish legitimacy for their revolutionary ideas within organizations, but also enable organizations to orchestrate widespread adoption of radical breakthroughs.

Hypothesis 4. The greater the social capital in organizations, the stronger the influence of human capital on radical innovative capability.

METHODS

We collected data for this longitudinal study through a combination of questionnaires and sec-

ondary sources. Different key informants were used for obtaining survey information for the independent (intellectual capital) and dependent variables (innovative capabilities). Data for all except one of the control variables were collected through secondary sources.

Sample

We included a broad group of organizations and industries to maximize variation of the variables as well as to increase the generalizability of the findings. However, we included only public, single-business-unit organizations with more than 100 employees because (1) intellectual capital, innovative capabilities, and competitive strategies may differ across autonomous business units in multidivisional organizations; (2) the study required comprehensive organization-level performance data for control purposes; and (3) organizations with more than 100 full-time employees are more likely to have somewhat formalized R&D and innovation systems. We selected 919 organizations meeting these criteria from the *U.S. Directory of Corporate Affiliations*.

As this was a longitudinal study, data collection occurred in two different time periods. In 1998, a questionnaire assessing the organizations' human, organizational, and social capital was mailed directly to the two highest-ranking executives (usually the CEO and president) and the vice president of human resources in each of the 919 organizations. Executives from 208 of the organizations returned usable questionnaires, a number representing a response rate of 23 percent. Approximately three years later we mailed another questionnaire to the vice president/director of marketing and vice president/director of R&D of the same 208 organizations to assess their incremental and radical innovative capabilities. Ninety-three executives responded to this second wave of data collection, for a 44 percent response rate. These 93 organizations represented 54 four-digit SIC codes, had an average of 3,929 employees, and had mean annual revenues of $689 million. An analysis of respondents and nonrespondents showed no differences in industry membership, number of employees, and revenues.

Measures

As our study spanned many industries, we crafted generalizable, multi-item scales (using a seven-point Likert format) for each of our constructs, tapping core conceptual attributes developed by prior research. We pilot-tested all measures with executive MBA students (33 for the independent variables and 35 for the dependent variables) to ensure the clarity of the questions and to ascertain whether or not the scales were capturing the desired information; we then refined and modified the scales on the basis of the pilot-test feedback.

Intellectual capital. The five items assessing *human capital* were based on the original discussions surrounding human capital (Schultz, 1961) as well as on contemporary strategic human resource management studies (Snell & Dean, 1992), and they reflected the overall skill, expertise, and knowledge levels of an organization's employees. Likewise, *organizational capital* was measured with a four-item scale assessing an organization's ability to appropriate and store knowledge in physical organization-level repositories such as databases, manuals, and patents (Davenport & Prusak, 1998) as well as in structures, processes, cultures, and ways of doing business (Walsh & Ungson, 1991). And lastly, the five items measuring *social capital* drew upon the core ideas of the social structure literature (Burt, 1992) as well as on the more specific knowledge management literature (Gupta & Govindarajan, 2000); these items assessed an organization's overall ability to share and leverage knowledge among and between networks of employees, customers, suppliers, and alliance partners. The Appendix gives the texts of our 14 items.

Innovative capability. Our measures for the two types of innovative capabilities were based on the discussions provided by Tushman and Anderson (1986) and Henderson and Clark (1990). *Incremental innovative capability* was measured with a three-item scale assessing an organization's capability to reinforce and extend its current expertise and product/service lines. Similarly, *radical innovative capability* was measured with a three-item scale assessing an organization's capability to make current product/service lines obsolete. (See the Appendix).

Organizational environment controls. Numerous organizational factors beyond intellectual capital may influence innovative capabilities. For example, large organizations may be more likely to develop innovative capabilities owing to their extensive resource bases (Henderson & Cockburn, 1994); however, smaller organizations may be more innovative owing to their flexibility (Cohen, 1995). Thus, we controlled for any extraneous effects of organization size. *Size* was measured as the natural logarithmic transformation of the number of full-time employees, which was obtained from the *Directory of Corporate Affiliations*. We also accounted for R&D spending in our analysis, as innovation is the intended outcome of most R&D

efforts (Cohen, 1995). *R&D spending* was calculated as an organization's yearly R&D expenditures divided by its annual sales. Data on R&D spending were obtained from two databases, Disclosure and Bloomberg. Additionally, we controlled for whether the innovations in question were product- or service-based, as certain innovations may lend themselves more to products than services, or vice versa. We measured *product-* or *service-based* innovation by asking respondents[1] to focus their responses on either product innovations or service innovations, depending on in which area most of their companies' innovations had occurred during the last five years. Then we entered this categorical variable (0 = "product," 1 = "service") in our analyses. Lastly, we controlled for prior performance, as associated slack resources in organizations could influence their innovative capabilities (Hill & Rothaermel, 2003). We chose to utilize two financial returns, return on equity (ROE) and return on assets (ROA), because they represent resources available for reinvestment in a firm. More specifically, we calculated our performance variable by averaging an organization's 1998 and 1999 ROE and ROA. As have prior researchers (e.g., Skaggs & Youndt, 2004), we averaged performance over the two time periods to help guard against random fluctuations and anomalies in the data, and combined ROE and ROA into one measure because they were highly correlated. Both ROE and ROA were obtained through Disclosure.

Industry environment controls. The nature of the industries organizations compete in is known to influence their innovative capabilities. Following suggestions in Dess, Ireland, and Hitt (1990), we controlled for industry effects by including industry *munificence, dynamism,* and *complexity* in our analysis. Following Boyd (1990), we measured industry *munificence,* or resource abundance, as the regression slope coefficient divided by mean sales value found when regressing time against industry sales for the past five years. *Dynamism,* or volatility, was assessed with the same regression model and was measured as the standard error of the regression slope coefficient divided by the mean sales value. And lastly, *complexity,* or heterogeneity in the environment, was assessed with the MINL formula of sales concentration (Schmalensee, 1977). Data for industry measures were obtained from the *U.S. Industrial Outlook, StatUSA,* the *Census of Manufacturers*, and *Moody's Industrials*.

[1] The respondents were vice presidents/directors of marketing and R&D and were the same individuals who provided information on innovative capabilities. This was the only control variable for which information came from our survey; information for all the other control variables came from secondary sources.

Measurement Properties

Using LISREL 8.54, we conducted confirmatory factor analysis (CFA) of the three aspects of intellectual capital and the two types of innovative capabilities. Overall, the CFA results suggested that the intellectual capital model provided a moderate fit for the data and that the innovative capability model provided a good fit for the data. More specifically, both models had chi-squares less than three times their degrees of freedom (*intellectual capital,* 133.54/48 = 2.78; *innovative capabilities,* 16.29/8 = 2.04). Additionally, the CFA fit indexes exceeded the levels suggested by Bentler and Bonnett (1980) (*intellectual capital:* comparative fit index [CFI] = .91, incremental fit index [IFI] = .92, goodness-of-fit index [GFI] = .87; *innovative capabilities:* CFI = .97, IFI = .97, GFI = .95). Moreover, since the standardized "loadings" of all the measurement items on their respective constructs were significant ($p < .05$) and none of the confidence intervals of the phi values contained a value of one, we concluded that the constructs exhibited convergent and discriminant validity (Montoya-Weiss, Massey, & Song, 2001). We assessed construct reliability by calculating Cronbach's alpha coefficients for each of the intellectual capital and innovative capability constructs. All of the scales were above the suggested value of .70. Thus, we concluded the measures utilized in the study were valid and internally consistent.

RESULTS

To test our hypotheses, we used moderated regression analysis. Following Venkatraman (1989), we centered ($\bar{x} = 0$) the intellectual capital variables when performing our moderated regression analysis to minimize the effects of any multicollinearity among the variables comprising our interaction terms. Table 2 summarizes our results.

Control Variables

As anticipated, several of our control variables exhibited significantly different effects across the innovative capability variables. Industry dynamism was positively related to radical innovative capability ($\beta = .42$, $p < .001$), implying that industries characterized by volatile sales tend to comprise organizations with high degrees of radical innovative capability. Incremental innovative ca-

TABLE 1
Correlations[a]

	Variables	1	2	3	4	5	6	7	8	9	10	11	12
1.	Product/service												
2.	Size	.03											
3.	R&D spending	−.13	−.27										
4.	Prior performance	−.13	−.13	.01									
5.	Complexity	−.14	.04	−.03	.17								
6.	Dynamism	−.00	.13	.13	−.27	−.15							
7.	Munificence	−.19	.08	.16	.06	.16	.04						
8.	Human capital	.22	−.15	.06	.17	.15	.02	.16	(.72)				
9.	Social capital	.16	.07	−.12	.08	.42	.04	.25	.44	(.71)			
10.	Organizational capital	−.14	−.26	.27	.19	−.02	−.06	.20	.14	.03	(.85)		
11.	Radical innovative capital	−.34	.06	.22	−.01	−.01	.38	.08	−.09	.15	.29	(.71)	
12.	Incremental innovative capital	.09	.05	−.02	−.05	−.21	−.04	.12	.24	.43	.23	.31	(.85)

[a] $n = 93$. Correlations greater than .20 are significant at $p < .05$. Alpha coefficients are on the diagonal in parentheses.

pability, on the other hand, exhibited a significant, negative relationship with industry complexity (β = -.69, $p < .001$), suggesting that organizations operating in industries with a high sales concentration among a few firms (low industry complexity) tend to possess incremental innovative capabilities. Supporting Dewar and Dutton's findings (1986), we also found R&D spending ($\beta = .24$, $p < .05$) to be significantly related to radical innovative capability.

Independent Variables

With regard to our hypotheses based on the rationale that intellectual capital reinforces prevailing knowledge for incremental innovative capabilities, we found organizational capital to be significantly related to incremental innovative capability ($\beta = .25$, $p < .05$), thereby providing support for Hypothesis 1. However, the social capital by organizational capital (Hypothesis 2) interaction was not significantly related to incremental innovative capability.

With regard to our hypotheses based on the rationale that intellectual capital transforms prevailing knowledge for radical innovative capabilities, we found human capital exhibited a significant, *negative* relationship with radical innovative capability (β = -.27, $p < .05$). Interestingly, this result is diametrically opposite to what we predicted in Hypothesis 3. As expected, however, the human capital by social capital interaction exhibited a significant, positive relationship with radical innovative capability ($\beta = .30$, $p < .01$), thus supporting Hypothesis 4. Figure 1 shows a plot of this interaction effect.

In addition to these results, a few nonhypothesized results are worth mentioning. Social capital was significantly and positively related to both incremental ($\beta = .84$, $p < .001$) and radical ($\beta = .54$, $p < .001$) innovative capabilities. These findings reveal a different facet of social capital; it is not simply a moderator, as we had hypothesized, but also appears to have its own direct influence on both the incremental and radical innovative capabilities of organizations.

DISCUSSION

Overall, our findings provide strong support for the premise that different aspects of an organization's intellectual capital and their interrelationships selectively influence its capabilities for incremental and radical innovations. We found organizational capital to positively influence incremental innovative capability. Thus, institutionalized knowledge accumulated in and utilized through an organization's patents, databases, structures, systems, and processes seems to help it reinforce its prevailing knowledge and, consequently, augments its incremental innovative capabilities. We did not, however, find social capital to further enhance organizational capital's influence on incremental innovative capabilities. So it appears that broad ties and interrelationships among individuals and groups within and across organizations may not significantly add to the effectiveness of the flows of information and interactions that already occur within the confines of an organization's structured and codified procedures and rules. Therefore, we can surmise that these institutionalized procedures for accumulating and utilizing knowledge seem to have a focused strength of their own and a well-charted trajectory for reinforcing

TABLE 2
Results of Regression Analysis for Intellectual Capital and Innovative Capability[a]

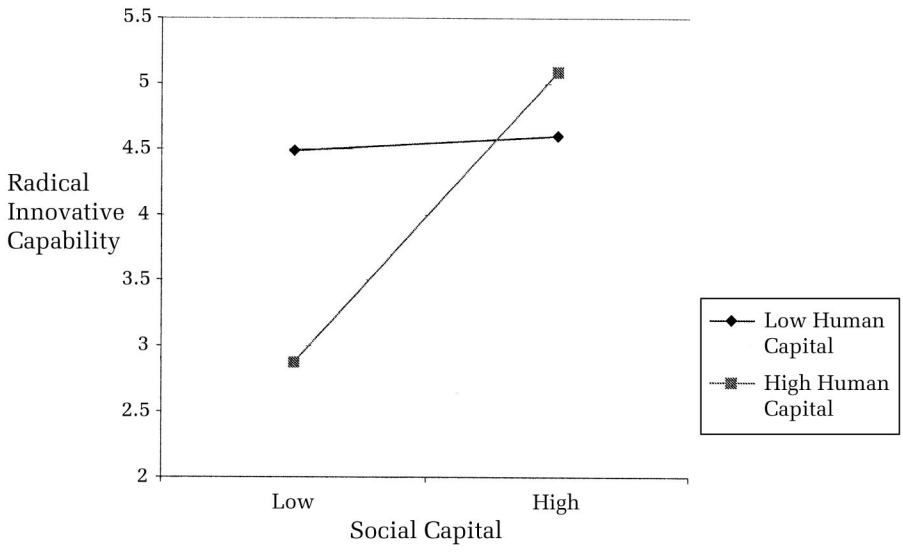
Variables	Reinforcing/Incremental			Transforming/Radical		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Control						
Product/service–based	.13	−.15	−.15	−.12	.22	−.18
Size	.04	.12	.14	.01	.03	.01
R&D spending	−.10	.13	.12	.14	.24*	.24*
Prior performance[b]	−.09	−.11	−.11	.06	.07	.15
Industry complexity	−.18	.68***	−.69***	.04	−.17	−.23
Industry dynamism	−.14	−.14	−.13	.35***	.37***	.42***
Industry munificence	.05	−.08	−.09	.07	−.09	−.15
Intellectual capital						
Human capital		.09	.10		−.25*	−.27*
Social capital		.84***	.84***		.50***	.54***
Organizational capital		.24*	.25*		.19	.19
Intellectual capital interactions						
Organizational capital × social capital			.06			
Human capital × social capital						.30**
ΔR^2		.37	.00		.15	.06
ΔP		16.05***	.36		5.31**	7.28**
R^2	.11	.48	.49	.20	.35	.42
F	1.26	6.27***	5.68***	2.47*	3.64**	4.28**

[a] Standardized regression coefficients are shown.
[b] Measured as ROE plus ROA.
* $p < .05$
** $p < .01$
*** $p < .001$

knowledge that is not influenced appreciably by social capital. This finding resonates with the observations of Christensen and Overdorf, who noted that at "firms such as McKinsey & Company, the processes and values have become so powerful that it almost doesn't matter which people get assigned to which project teams" (2000: 71).

Contrary to our expectations, human capital had

FIGURE 1
Hypothesized Human and Social Capital Interaction Plot



a negative influence on radical innovative capability. This is an intriguing result suggesting that individual expertise on its own is not conducive to radical innovation. In fact, having fiercely independent experts reluctant to share their ideas with their colleagues may be counterproductive for organizations. Interestingly, however, we found that the interaction of human and social capital positively influenced radical innovative capability, indicating that the importance of human capital is strongly tied to social capital. That is, unless individual knowledge is networked, shared, and channeled through relationships, it provides little benefit to organizations in terms of innovative capabilities. It is instructive to note parallel conclusions from research on executive pay. Finding weak main effects of human capital on executive remuneration, this research suggests that individuals who cannot network and leverage their positions in their organizations (i.e., use their social capital) are unlikely to be rewarded (Carpenter & Wade, 2002). Similarly, Groysberg, Nanda, and Nohria (2004) found that the performance of "star" analysts invariably plummeted when they moved across companies and, presumably, lost their social networks. Thus, it seems that the social component of individuals is likely an intrinsic aspect of their human capital (Gratton & Ghoshal, 2003). Hence, in today's more network-based organizations and economy, it may be appropriate to move beyond traditional definitions of human capital that revolve primarily around educational/functional skills to include competencies surrounding interpersonal interactions and networking.

Although we did not hypothesize it, we also found social capital to positively influence both incremental and radical innovative capabilities. These findings surrounding social capital underscore the significance of interrelationships, partnerships, and collaborative networks to an organization's innovation versatility. They also validate some recent anecdotal evidence provided by O'Reilly and Tushman (2004) on "ambidexterous" organizations, or organizations that can simultaneously pursue incremental and discontinuous innovations. Taking an in-depth look at two companies' successful efforts to be ambidexterous, O'Reilly and Tushman found that conscious efforts to build strong social networks were an important underlying factor. More broadly, the versatility that we found in social capital's influence on innovative capabilities parallels findings in other recent studies that social capital is a very important organizational resource. For example, social capital has been found to influence a wide range of organizational outcomes, such as success in strategic alliances (Koka & Prescott, 2002), attraction of venture capital (Florin, Lubatkin, & Schulze, 2003), and career success (Gabbay & Zuckerman, 1998), to name a few.

Implications

Taken together, these findings have two important implications that not only enhance and refine conceptualizations of the knowledge-innovation link, but also offer useful and specific guidelines for management practice. First, it appears that the value of human capital in organizations is inextricably tied to social capital. To effectively leverage investments in human capital, it may be imperative for organizations to invest in the development of social capital to provide the necessary conduits for their core knowledge workers to network and share their expertise. Organizations that neglect the social side of individual skills and inputs and do not create synergies between their human and social capital are unlikely to realize the potential of their employees to enhance organizational innovative capabilities. Thus, an organization's efforts at hiring, training, work design, and other human resource management activities may need to focus not only on shoring up their employees' functional or specific technological skills/expertise, but also on developing their abilities to network, collaborate, and share information and knowledge.

Two, social capital appears to be the bedrock of innovative capabilities. Given that innovation is fundamentally a collaborative effort, social capital assumes a central role in generating both incremental and radical innovations. Thus, communication, fluid diffusion of information, and the sharing and assimilating of knowledge are vital elements of innovative capabilities, irrespective of their type. Investments in social capital, therefore, may be fundamental for developing a range of innovative capabilities and gaining the flexibility to selectively use these capabilities to meet market or competitive exigencies. Accordingly, social capital may be the key not only for creating ambidexterous organizations (Tushman & O'Reilly, 1997), but also for developing "dynamic capabilities" that enable organizations to shift their competitive focus and achieve new forms of competitive advantage (Blyler & Coff, 2003; Teece, Pisano, & Shuen, 1997).

Limitations

We recognize several limitations of this study. Our net sample size was relatively small, given the number of variables in our research models. Although a larger sample would have given more

power to our results, the difficulty of collecting executive-level primary data—particularly through a two-part longitudinal study—imposed limits on size. Another limitation was that our measures of the different aspects of intellectual capital and the types of innovative capabilities were perceptual, based on key informants. We relied on perceptual measures because it was difficult to obtain relevant objective measures capturing the variations in intellectual capital and innovative capabilities across multiple industries with the kind of precision we required. Moreover, we measured the various aspects of intellectual capital from the vantage point of key informants because our objective was to assess the degree of each of these aspects of intellectual capital for an organization as a whole.

It is possible, however, to measure intellectual capital at different levels in an organization using different measurement approaches. For example, in a more focused study researchers could collect individual-level data and aggregate them to assess an organization's human capital or use network analysis of relationship matrixes to assess social capital. However, it was impractical to get such information from hundreds of firms in many different industries and achieve the generalizability across contexts that our present inquiry provides.

We also recognize that the links between intellectual capital and innovative capabilities are complex and contingent upon several multifaceted organizational actions and attributes. For example, organizations may undertake specific strategic directives while hiring individuals who are intended to either reinforce or transform existing organizational practices. Such directives can influence the way human capital influences incremental and radical innovative capabilities. The scope of our research, however, did not take into account the possible influences of such directives. Similarly, the level at which individuals (human capital) are positioned in an organization's hierarchy (for instance, top versus middle managers) may also produce different influences on innovative capabilities. Such contingencies point to additional areas that need to be probed with respect to the knowledge-innovation link. So, although we have tried to parsimoniously examine the core aspects of this link by focusing on a select set of essential variables, we acknowledge that we have addressed only one part of a very complex question. Nonetheless, by synthesizing two distinct literature streams (intellectual capital and innovation), we have initialized efforts to understand the multifaceted knowledge-innovation link.

Future Research Directions

By taking a first step toward understanding the broad patterns in the interrelationships between various aspects of intellectual capital and different types of innovative capabilities, this study provides a road map for more focused studies' examination of these interrelationships. One such approach would be to focus more closely on the link between social capital and innovative capability in an effort to understand why social capital influences both types of innovative capabilities. For example, Tsai and Ghoshal's (1998) classification of structural, relational, and cognitive dimensions of social capital could be used to examine whether the "ambidexterous" impact of social capital is due to the multipronged influence of these subdimensions. Similarly, Adler and Kwon's (2002) insights on various contingencies governing the value of social capital could be used to further refine understanding of the impact of social capital on innovative capabilities. One such contingency that Adler and Kwon (2002) suggested involves the nature of a task, which may determine whether weak or strong social ties are more valuable. A question this line of reasoning opens up is whether weak or strong or social ties add differential value depending on whether the task at hand is generating incremental or radical innovations.

Another area into which this study can be extended is examination of how certain precipitating events exogenous to organizations can galvanize their intellectual capital to generate different types of innovations. How would events, such as personal crises (e.g., the unexpected departure of a strong CEO), firm-level crises (e.g., disruptive innovations), or simple serendipitous events (such as a breakthrough discovery), change the dynamics between different aspects of intellectual capital and innovative capabilities? Would human capital still provide the platform for diverse and vibrant ideas? Would organizational capital continue to reinforce prevailing capabilities? Would social capital become an even more versatile, powerful driver of innovation? These are some possible points of departure for further synthesis of the knowledge and innovation literature streams.

To conclude, our study provides an empirically grounded framework simultaneously linking various aspects of intellectual capital and their interrelationships to different types of innovative capabilities. This framework shows how organizations need to distinctively utilize their varied knowledge resources to achieve different types of capabilities for innovation. It also provides a structure for fu-

ture research probing of more specific questions regarding the knowledge-innovation link.

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APPENDIX

Intellectual Capital and Innovative Capabilities Questionnaire Items

The following items had this stem and response format: "To what extent do you agree with the following items describing your organization's intellectual capital? (1 = strongly disagree; 7 = strongly agree)."

Human Capital

Our employees are highly skilled.

Our employees are widely considered the best in our industry.

Our employees are creative and bright.

Our employees are experts in their particular jobs and functions.

Our employees develop new ideas and knowledge.

Social Capital

Our employees are skilled at collaborating with each other to diagnose and solve problems.

Our employees share information and learn from one another.

Our employees interact and exchange ideas with people from different areas of the company.

Our employees partner with customers, suppliers, alliance partners, etc., to develop solutions.

Our employees apply knowledge from one area of the company to problems and opportunities that arise in another.

Organizational Capital

Our organization uses patents and licenses as a way to store knowledge.

Much of our organization's knowledge is contained in manuals, databases, etc.

Our organization's culture (stories, rituals) contains valuable ideas, ways of doing business, etc.

Our organization embeds much of its knowledge and information in structures, systems, and processes.

The following items had this stem and response scale: "How would you rate your organization's *capability* to generate the following types of innovations in the products/services you have introduced in the last five years? (1 = weaker than competition; 4 = similar to competition; 7 = stronger than competition)."

Incremental Innovative Capability

Innovations that reinforce your prevailing product/service lines.

Innovations that reinforce your existing expertise in prevailing products/services.

Innovations that reinforce how you currently compete.

Radical Innovative Capability

Innovations that make your prevailing product/service lines obsolete.

Innovations that fundamentally change your prevailing products/services.

Innovations that make your existing expertise in prevailing products/services obsolete.

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