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AMBIGUITY AND THE PROCESS OF KNOWLEDGE TRANSFER IN STRATEGIC ALLIANCES

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This research examines the role played by the 'causally ambiguous' nature of knowledge in the process of knowledge transfer between strategic alliance partners. Based on a cross-sectional sample of 147 multinationals and a structural equation methodology, this study empirically investigates the simultaneous effects of knowledge ambiguity and its antecedents—tacitness, asset specificity, prior experience, complexity, partner protectiveness, cultural distance, and organizational distance—on technological knowledge transfer. In contrast to past research that generally assumed a direct relation between these explanatory variables and transfer outcomes, this study's findings highlight the critical role played by knowledge ambiguity as a full mediator of tacitness, prior experience, complexity, cultural distance, and organizational distance on knowledge transfer. These significant effects are further found to be moderated by the firm's level of collaborative know-how, its learning capacity, and the duration of the alliance. Copyright © 1999 John Wiley & Sons, Ltd.

'Knowledge has emerged as the most strategically-significant resource of the firm' (Grant, 1996a: 375). This assertion characterizes well the recent research impetus centered on the role of knowledge and knowledge-based resources in the firm and on competitiveness (see *SMJ* 1996 Special Issue on 'Knowledge and the Firm'; Nonaka, 1994). At the heart of the analysis of competitive advantage and its sustainability lies the issue of knowledge imitability (Spender and Grant, 1996). Accordingly, of all approaches to knowledge imitability between a knowledge holder and a knowledge seeker, strategic alliances constitute perhaps the most adequate, but nevertheless challenging vehicle for internalizing the other's competency. Not surprisingly, the growing interest in how organizations learn from their partners and develop new competencies through strategic alliances has led to the emergence of a distinct stream of research. This research explores how knowledge is managed in international joint ventures (Inkpen, 1997; Tiemessen *et al.*, 1997), how knowledge is transferred across partners (Appleyard, 1996; Choi and Lee, 1997; Dodgson, 1996; Mowery, Oxley, and Silverman, 1996), how knowledge is acquired from the parents by the joint venture itself (Lyles and Salk, 1996), and even how knowledge about collaborating *per se* develops over time and impacts collaborative outcomes (Doz, 1996; Powell, Koput, and Smith-Doerr, 1996; Simonin, 1997).

In conjunction with earlier research (Hamel, 1991; Hamel, Doz, and Prahalad, 1989; Kogut, 1988; Lyles, 1988; Pucik, 1988), these more recent studies confirm that the competitive nature of knowledge transfer and the process of organizational learning between partners pose fundamental challenges for both academics and practitioners alike. A number of theoretical perspectives related to the role of firm-specific

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knowledge in competitive strategy have started to contribute to our understanding of knowledge in strategic alliances. These theories include resource-based views of the firm, dynamic capabilities, knowledge-based views of the firm, management of technology, the economics of innovation and information, and organizational learning (Mowery *et al.*, 1996; Spender and Grant, 1996). Yet, the growing literature on this phenomenon is limited on two important fronts: theoretical vs. empirical and outcome vs. process.

First, unlike the profusion of conceptual work, there has been only limited empirical work on the role of knowledge in strategic alliances that goes beyond small-sample, in-depth studies of a few organizations. In fact, with respect to the overall collaborative phenomenon, Lewin acknowledges that 'although IJVs have been the subject of much "theorizing" they remain empirically under-researched (Mjoen and Tallman, 1997: 257).' Likewise, when looking at the more general, underlying theories, a common state of urgency and frustration seems to prevail. In relation to the resource-based view of the firm, Spender and Grant (1996: 8), for instance, acknowledge that 'there is a growing realization that the variables which are most theoretically interesting are those which are least identifiable and measurable.' Similarly, on organizational learning, Huber (1991) and Fiol (1994) report a clear need for hypothesis development and testing. In the same vein, Mowery *et al.* (1996) further complain that empirical research on the role of both knowledge within the firm and alliances within firm strategy has suffered from the widespread reliance on anecdotes and assertion, rather than statistical evidence. In response to these critical observations, this study constitutes an effort to depart from speculative grounds in favor of empirically based research that relies on a large cross-sectional sample and on a structural equation approach (LISREL) that allows the manipulation of latent (not directly observable) variables.

Second, as recognized by Crossan and Inkpen (1994: 271), 'while much of the MNC research has dealt with static theories of the firm and investigations of structural questions, very little research has delved into the process of knowledge transfer and the barriers to successful intraorganizational learning.' Likewise, Doz (1996) and Hagedoorn and Schakenraad (1994) recognize that much research attention has been directed to trends in alliance formation, determinants of cooperation, forms of collaborations, and alliance outcomes, in comparison to process-related questions (e.g., impact of interpartner learning on the evolution of a strategic alliance; economic effects of strategic alliances on parent companies). Even studies that focus on learning and knowledge transfer fall short of linking the intrinsic nature and dimensionalities of knowledge to transferability. Instead, these studies turn to the role of firm-specific variables such as strategic intent (Hamel, 1991), organizational capabilities (Lyles and Salk, 1996; Pucik, 1988), partner selection (Makino and Delios, 1996; Tiemessen *et al.*, 1997) or trust (Aulakh, Kotabe, and Sahay, 1996; Dodgson, 1996; Inkpen, 1997). For instance, Szulanski shows in his findings that knowledge-related barriers such as lack of absorptive capacity, causal ambiguity, and the arduousness of the relationship between the source and recipient of knowledge clearly dominate motivation-related barriers; he further acknowledges that such important constructs in explaining the difficulty of knowledge transfer 'have received scant systematic attention from researchers' (Szulanski, 1996: 37). Beyond the development of knowledge taxonomies (e.g., Kogut and Zander, 1993; Zander and Kogut, 1995), very few studies have empirically linked the properties of knowledge to its transfer across organizational boundaries. On tacitness, Hedlund and Zander (1993) go even as far as questioning why such a popular theoretical concept has received so little empirical attention. In contrast, this study approaches the process of knowledge transfer in strategic alliances by explicitly recognizing the central role played by the 'causally ambiguous' nature of knowledge (Reed and DeFillippi, 1990) and the need to account for the simultaneous effects of the characteristics of the knowledge transferred, the context, the source, and recipient of knowledge (see Szulanski, 1996; von Hippel, 1994).

To address these limitations and further our understanding of knowledge transfer processes in strategic alliances, this study will introduce and empirically investigate the antecedents of knowledge ambiguity: tacitness, asset specificity, complexity, experience, partner protectiveness, cultural distance, and organizational distance. Further, it will demonstrate the significant mediating effect of knowledge ambiguity on

knowledge transfer. Finally, the strength of the relationships between these explanatory variables, ambiguity, and knowledge transfer will be examined in light of the possible moderating effects of three important theoretical constructs: collaborative know-how, learning capacity, and the duration of the alliance entered.

THEORETICAL MODEL

Knowledge/causal ambiguity and knowledge transfer

Far from being readily or easily transferred from the originator to the user of a technology, knowledge faces barriers and is relatively immobile (Attewell, 1992). Such a view is shared by Tiemessen *et al.* (1997: 391), who warn that knowledge is not as mobile as it has often been assumed, and by Kogut and Zander (1992), who point to the 'inertness of knowledge.' Knowledge transfer depends on how easily that knowledge can be transported, interpreted, and absorbed (Hamel *et al.*, 1989). In this process, Hedlund and Zander (1993) emphasize the need to consider the more subtle aspects of knowledge, in particular its ambiguity, its resistance to clear communication, its embeddedness in context, and its idiosyncrasy. Likewise, Crossan and Inkpen (1995: 75) acknowledge that 'for joint-venture learning strategies to be viable, firms must overcome the ambiguity associated with their partner's skills.' All these studies are indicative of the existence of an important underlying latent construct, knowledge ambiguity, that needs to be explicitly recognized and integrated in the theory.

To that end, a fundamental starting point is offered by Reed and DeFillippi's (1990) observation that a strong barrier to imitation originates from the inability of competitors to comprehend the competencies that are sources of competitive advantages. These authors echo Lippman and Rumelt's (1982: 420) views on 'causal ambiguity' (i.e., the basic ambiguity concerning the nature of the causal connections between actions and results): 'Ambiguity as to what factors are responsible for superior (or inferior) performance acts as a powerful block on both imitation and factor mobility.' Yet, as eloquently stated by Barney (in Mosakowski, 1997: 414), 'Causal ambiguity has been a concept in the strategic management and organization theory literatures for some time. However, the full implications of this concept have largely been undeveloped.' Not until recently has research renewed interest in the construct and related issues. Mosakowski (1997), for instance, introduces a typology of causal ambiguity to examine its role in strategic decision-making. In a study of internal transfer of best practices, Szulanski (1996: 29) examines the concept of 'internal stickiness,' defined as 'the difficulty of transferring knowledge within the organization' after pointing out similar notions of 'difficult to imitate' in Foss, Knudsen, and Montgomery (1995), 'inert' in Porter (1994) or 'sticky information' in von Hippel (1994). Conceptually, the latter describes information stickinesss as 'information that is difficult to transfer, stickiness being reflected in the incremental cost of transferring the information.'

In the context of this study, *knowledge ambiguity*—or *ambiguity* for ease—refers to the same underlying notion of transferability (its ease or the lack thereof) of knowledge as construed under the previous appellations: ambiguity (Hedlund and Zander, 1993; Crossan and Inkpen, 1995), causal ambiguity (Reed and DeFillippi, 1990; Mosakowski, 1997), difficulty to imitate (Foss *et al.*, 1995), inertness of knowledge (Kogut and Zander, 1992; Porter, 1994), internal stickiness (Szulanski, 1996), sticky information (von Hippel, 1994), and transferability (Grant, 1996b). Importantly, as with causal ambiguity, it encapsulates a similar lack of understanding of the logical linkages between actions and outcomes, inputs and outputs, and causes and effects that are related to technological or process know-how. If causal ambiguity in skill and resource deployment that are sources of competitive advantages creates barriers to imitation (Reed and DeFillippi, 1990), by extension to the context of strategic alliances, it also lessens the propensity to learn from a partner. That is, when the degree of ambiguity associated with a partner's competence is high, chances of effectively repatriating and absorbing the competence are rather limited.

Hypothesis 1: Ambiguity is negatively related to knowledge transfer.

Multiple factors determine the level of ambiguity of a competence. As detailed in the next section, Reed and DeFillippi (1990) maintain that ambiguity is a unidimensional construct emerging from

the simultaneous effect of tacitness, specificity, and complexity. In comparison, Winter (1987) proposes a more comprehensive list of taxonomic dimensions of knowledge that impede transferability, a list at the heart of Kogut and Zander's (1993) and Zander and Kogut's (1995) studies of technology transfer in Swedish companies: tacit vs. explicit; not teachable vs. teachable; not articulated vs. articulated; not observable in use vs. observable in use; complex vs. simple; and element of a system vs. independent. In addition to knowledge characteristics, other attributes related to the context (e.g., fertile vs. barren organizational context; ease of communication; arduous nature of relationship), the source, and recipient of knowledge (e.g., lack of motivation; reliability of the source; absorptive capacity) have been identified as major sources of information stickiness or ambiguity (Szulanski, 1996; von Hippel, 1994).

In light of these studies, and as postulated by the conceptual model in Figure 1, seven factors are hypothesized to affect the level of knowledge ambiguity in alliances: tacitness, asset specificity, complexity, experience with the competence, partner protectiveness, cultural distance, and organizational distance between partners. While the individual importance of each of these variables has long been recognized in the literature, their simultaneous effects have yet to be examined and assessed empirically. Tacitness, in particular, has been the object of much research attention (e.g., Choi and Lee, 1997; Kogut and Zander, 1993; Senker and Faulkner, 1996; Zander and Kogut, 1995). Nevertheless, its distinct role and relative importance *vis-a-vis* other related theoretical constructs remain unascertained. In this respect, the formalization of the relationship between tacitness and ambiguity encapsulated in the hypothesized model constitutes a significant attempt to articulate more precisely the process of knowledge transfer across partners.

Antecedents of knowledge ambiguity in the process of knowledge transfer

Tacitness

Reed and DeFillippi (1990: 89) define tacitness as the implicit and noncodifiable accumulation of skills that results from learning by doing. Tacit knowledge, which can not be easily communicated and shared, is highly personal, deeply rooted in action and in an individual's involve-

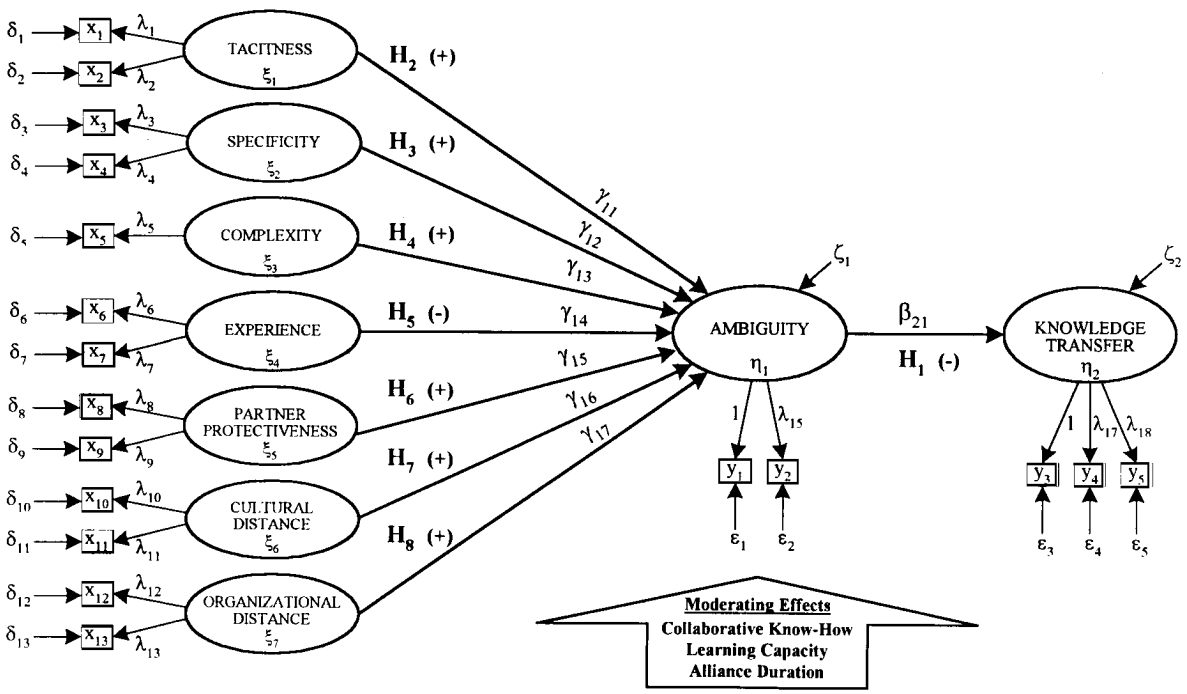

Figure 1. Conceptual model

ment within a specific context (Nonaka, 1994). The dichotomy between tacit and explicit knowledge, sometimes referred to as experiential (Johanson and Vahlne, 1977) vs. articulated (Senker and Faulkner, 1996) knowledge, has been well documented on the basis of whether knowledge can, or can not, be codified and transmitted in a formal, systematic language or representation (e.g., Choi and Lee, 1997; Kogut and Zander, 1993; Senker and Faulkner, 1996).

With respect to tacitness, Kogut (1988) argues that joint ventures displace markets essentially because of the necessity to replicate experiential knowledge that is difficult to grasp. Such a shift is not without problems and challenges. For instance, in the context of hybrid organizations, BoZys and Jemison (1987) acknowledge the impact of tacitness on the instability of cooperation by stating that technology transfer agreements whose purpose is the exchange of tacit knowledge and expertise tend to break down more often than those involving the exchange of formalizable technology. Tacitness as a source of destabilization or conflict in an alliance is a manifestation of the difficulty and frustration in learning. Nevertheless, when the level of tacitness associated with a technology is very high and unsuitable to imitation or licensing, close cooperation such as joint venturing may be the only way to learn particular R&D routines directly from the firm that has already mastered them (Pisano, 1988).

Tacitness is most often associated with the work of Polanyi (1967), who asserts that we can know more than we can tell. Three decades later, Grant (1996b: 114) admits that 'research into organizational learning and management of technology … has made only limited progress in addressing the fact that, if most of the knowledge relevant to production is tacit, then transfer of knowledge between organizational members is exceptionally difficult.' In response, the current study formally addresses the role of tacitness by postulating that through its impact on ambiguity the degree of tacitness of a particular competency or know-how influences transfer outcomes. Theoretical support is provided by Mody (1989), who simply equates the degree of tacitness of knowledge to the extent of its nontransferability, and by Reed and DeFillippi (1990), who identify this construct as a source of ambiguity that raises barriers to imitation. Based on the observations by Wagner and Sternberg (1985) that differences in tacit knowledge range from novice to expert, and by Schon (1983) that the skill-learning process occurs through a series of stages, Reed and DeFillippi further postulate that tacitness relates to ambiguity in a linear way. Finally, Zander and Kogut (1995: 85) establish empirically that, indeed, the degree to which manufacturing capabilities are codifiable and teachable (i.e., tacitness according to these authors) significantly influences the speed of their transfer. Overall, tacitness is expected to be a strong antecedent of knowledge ambiguity.

> *Hypothesis 2: Tacitness is positively related to ambiguity.*

Specificity

Specificity refers to Transaction Cost's asset specificity—i.e., durable investments that are undertaken in support of particular transactions (Williamson, 1985: 55); transaction-specific skills and assets that are utilized in production processes and provision of services for particular customers (Reed and DeFillippi, 1990: 89). The main issue concerns the discrepancy between the primary and secondary use or value of the asset; put in Williamson's (1990) terms, 'the ease with which an asset can be redeployed to alternative uses and by alternative users without loss of productive value.' The question is not how large fixed investments are, but rather how specialized the investments are (Englander, 1988).

Asset specificity is not only an important determinant of governance choice (see Klein, 1989; Anderson and Coughlan, 1987) that can be acquired over time by learning-by-doing. It is also a source of ambiguity. Based on Williamson's (1985) four types of asset specificity (site, physical asset, dedicated asset, and human asset), Reed and DeFillippi (1990) argue that the relationship between specificity and ambiguity is multifunctional:

> … the amount of ambiguity that can be derived from sites or physical assets will be limited. A competitor can simply observe site-embodied performance effects and, through technological deduction, can deduce the same for physical assets. However, dedicated assets (plants specifically designed for the production of goods and services for a specific customer) are protected by

> the security and exclusivity of the firm-customer relationship. That relationship between the firm and the customer produces ambiguity for rivals and creates a barrier to imitation.

In addition, Reed and DeFillippi postulate that human asset specificity is linearly and significantly related to ambiguity.

While vertical integration, hostages, and offsetting investments are well-established safeguards against opportunistic behavior when specific assets are involved, Kogut (1988) observes that joint ventures, as well, are a response to the existence of asset specificity. Nevertheless, collaboration does not constitute a foolproof safeguard against opportunism. In this respect, Dodgson (1996) stresses the importance of developing high levels of trust between partners for effective interfirm links, since the knowledge being exchanged may be not only tacit but also proprietorial (specific), a type of knowledge or competence that is not easily replicated or purchased and thus can provide important elements of a firm's defining competence and competitiveness. In the hypothesized model, asset specificity is mainly considered a source of ambiguity and a barrier to transferability, not an insurance against imitation or knowledge internalization.

Hypothesis 3: Specificity is positively related to ambiguity.

Complexity

Complexity refers to the number of interdependent technologies, routines, individuals, and resources linked to a particular knowledge or asset. As argued by Reed and DeFillippi (1990), more complex human or technological systems produce higher levels of ambiguity and, therefore, restrain imitation. The full information spectrum of a particular competence may span across numerous individuals and departments so that the totality of the knowledge can not be easily integrated or understood by many individuals. Such a view is shared by Mosakowski (1997: 422), who wonders

> Why would the complexity inherent in a nondecomposable system contribute to causal ambiguity? In addition to the causal ambiguity associated with each piece in the system—i.e., each subunit in a highly integrated firm—there may be causal ambiguity associated with the interdependencies linking them.

In some rapidly developing fields, knowledge may be inherently sophisticated and widely dispersed; this is well documented by Powell *et al.*'s (1996) examples of innovations in biotechnology involving numerous scientists across various biotech companies, pharmaceutical firms, research universities, and federal and nonprofit research laboratories. Alluding to more tactical and controlled ways, Roehl and Truitt (1987) further argue that ventures can be structured and modularized so that technology not intended to be transferred does not leak easily to the partner.

Complexity is expected to affect the comprehension of the totality of an asset and to impair its transferability. Kogut and Zander (1993), for instance, find that as technologies increase in their complexity, they are more likely to be transferred to wholly-owned subsidiaries than to a third party. More generally, Grant (1996a: 378) argues that a wider span of a knowledge to be integrated leads to more complex problems in creating and managing organizational capability; he cites Smith and Zeithaml's (1996) example:

> The difficulty experienced by the Bell operating companies in transferring the new capabilities developed in their overseas businesses back to their domestic operations can be attributed to the fact that many of these new capabilities (e.g., wireless communication, fiber-optics, marketing within competitive markets, and managing joint ventures) require integration across broad-spans of knowledge and expertise.

The diffused nature of the asset among employees or business units parallels and reinforces the effect of protectiveness on ambiguity. Contrary to protectiveness, which captures a conscientious and intended state of information filtering, complexity corresponds to an inherent characteristic of the asset or its deployment by the partner.

Hypothesis 4: Complexity is positively related to ambiguity.

Experience

As pointed out by von Hippel, information stickiness goes beyond attributes of the information itself (e.g., tacitness, complexity, and specificity);

it also involves attributes of and choices made by both information seekers and providers. In particular, 'Information stickiness can also be high because organizations must typically have or acquire related information and skills to be able to use the knowledge that may be transferred to them- (von Hippel, 1994); that is, firms must have prior experience with the knowledge domain. Support for this relation ranges from Cohen and Levinthal's (1990: 128) argument that a firm's absorptive capacity is 'largely a function of the firm's prior related knowledge' to Szulanski's (1996: 36) empirical verification that indeed the lack of absorptive capacity, which is 'a function of the recipient's knowledge endowment prior to the transfer' (i.e., experience), is one of the most important origins of stickiness.

For a knowledge seeker, prior experience with a given asset or knowledge base predetermines the level of familiarity and comfort with both information content and context, and thus favors the transferability of knowledge. Cumulative experience with a technology, in particular, is a critical factor in understanding new technologies (Zander and Kogut, 1995). In a cooperative context, related technological experience by the partner seeking a technology, for instance, counteracts the effect of the intrinsic tacitness of the technology upon its understanding and transferability (Pisano, 1988: 58–59):

> Experienced firms are more likely to possess the relevant tacit know-how to fill in the gaps left by codified descriptions. For a firm that has had no experience with the particular technology, these codified descriptions may provide only vague clues about what has been tried and what might be tried next. They lack the experience to interpret these descriptions within a heuristic frame that would suggest how to proceed.

Significant differentials in base-knowledge and skills between partners have been shown to impede learning (Baughn *et al.*, 1997; Crossan and Inkpen, 1995). In short, to use Hamel's (1991: 97) terms: 'If the skills gap between partners is too great, learning becomes almost impossible.' Similar observations at the individual level are articulated by Grant (1996b: 116) under the notion of 'commonality of specialized knowledge' as it relates to knowledge integration within the firm:

> There is something of a paradox in this. The benefit of knowledge integration is in meshing the different specialized knowledge of different individuals—if two people have identical knowledge there is no gain from integration—yet, if the individuals have entirely separate knowledge bases, then integration cannot occur beyond the most primitive level.

In other words, learning is limited by the degree of experience of the knowledge seeker. In the context of knowledge transfer between strategic alliances partners, the implication is thus straightforward: the greater (lower) the level of prior experience of the knowledge seeker with the underlying knowledge domain, the less (more) ambiguous the knowledge to be transferred.

Hypothesis 5: Experience is negatively related to ambiguity.

Partner protectiveness

In addition to the firm's existing stock of related knowledge (i.e., experience) von Hippel (1994) argues that other attributes related to the information seeker and provider (as opposed to the information itself) influence information stickiness; for instance: specialized personnel such as technological gatekeepers, specialized organizational structures such as transfer groups, or the pricing of access to proprietary information. These attributes are all explicit indicators of the degree of protectiveness desired by the information transmitter *vis-a-vis* its knowledge base. In the context of strategic alliances, some partners can also manage to be less transparent or open than others (Hamel, 1991). This transparency or permeability of the organizational membrane between partners (Doz, Hamel, and Prahalad, 1986) can be achieved through active means, including the adoption of strict policies or the deployment of shielding mechanisms aimed at protecting key competencies (Inkpen and Beamish, 1997). For instance, through the astute partitioning of tasks and the physical separation of experts, proprietary technology can be 'walled off' (Baughn *et al.*, 1997). In addition, gatekeepers can be assigned to filter information access and disclosure across organizational boundaries.

As argued by Pisano (1988), the ability to learn through joint ventures does not simply rests on the firm's internal absorptive capabilities; it

also depends on the willingness of external sources to fully cooperate (i.e., minimize protectiveness). In fact, Winter (1987) further affirms that the transfer of tacit knowledge demands teaching. This means that the level of partner protectiveness should be at its lowest. In the case of intrafirm knowledge transfer, Szulanski (1996: 31) also identifies the lack of motivation of the source of knowledge (i.e., protectiveness) as a likely source of internal stickiness. This may be due to the fear of losing ownership, to a position of privilege or superiority, to inadequate rewards or simply to the unwillingness to devote time and resources towards that end. Similar lack of enthusiasm and incentive to cooperate too closely because of the risk of revealing too much to a competitor in-the-making can be pervasive and can turn to paranoia. This phenomenon is evidenced by Tatsuno's (1986: 17) narration of the early cooperative problems of Japan MITI's VLSI project, when researchers from rival companies were brought together for the first time:

> But company rivalries created serious barriers to the free flow of information. The mutual distrust was so great that some engineers installed locks on their doors. Although the Association held monthly seminars to exchange information, this arrangement was too formal. Finally Nebashi resorted to taking small groups of scientists out for drinks in the evening to break the ice. After a while, the barriers began to dissolve.

When disruptive to the operation or chronic, protectiveness will contribute to the escalation of cross-cultural and other conflicts between partners, which have also been postulated to impede knowledge transfer (Lyles and Salk, 1996).

Hypothesis 6: Protectiveness is positively related to ambiguity.

Cultural distance

The possibly damaging effects of cultural distance on the various facets of collaboration, ranging from cross-cultural negotiations to joint venture performance and failures, have been well documented (see Mjoen and Tallman, 1997; Parkhe, 1991). In international strategic alliances, cultural differences produce additional difficulties and challenges for managers, who must allocate more time on communication, design of compatible work routines, and development of common managerial approaches (Olk, 1997). In fact, according to Meschi (1997), most of the problems encountered in international joint ventures can be traced back to cultural factors, be they national or organizational. From the alliance's inception onward, the partner's national and organizational cultures have the potential to affect in depth all aspects of a collaboration, including the process of knowledge management (Tiemessen *et al.*, 1997). This view is also shared by Lyles and Salk (1996), who report that not only conflicts but also cultural misunderstandings rooted in cultural differences can minimize flows of information and learning. Similarly, commenting on their findings that for U.S. firms international alliances result in lower levels of knowledge transfer than domestic alliances, Mowery *et al.* (1996) point to distance and cultural differences between partners as key obstacles to interfirm knowledge transfer.

In some cases, a problem of cultural asymmetry (Hamel, 1991) rather than cultural distance leads to an unbalanced situation between partners in their aptitude for decoding and interpreting information. For instance, foreign partners may be fluent enough in English to understand most key documents, charts, and specs while their American counterparts, with the exception of a few specialists, may totally lack the language ability to recognize and understand similar information. That is, cultural distance or asymmetry not only creates difficulties for identifying market opportunities and figuring out market mechanisms, it also raises barriers for communicating with partners and for understanding the nature of their competitive advantage. At the heart of these difficulties, language proficiency and alignment between partners dictate the boundaries of communication and knowledge flows. Grant (1996b: 116), for instance, maintains that 'the lack of a common language among workers in many U.S. plants and other polyglot organizations is a significant barrier to the introduction of integration-intensive manufacturing techniques.' The bottom line, as expressed by Pucik (1988), is that a lack of cross-cultural skills, exposure, and understanding for a partner will impair both the ability to learn and to exercise control in alliances.

Hypothesis 7: Cultural distance is positively related to ambiguity.

Organizational distance

Differences between partners go beyond differences of nationalities; they also include differences in organizational culture (Tyebjee, 1988). As the counterpart to the variable cultural distance, organizational distance represents the degree of dissimilarity between the partners' business practices, institutional heritage, and organizational culture. While much of past research on this construct has focused on the role of management asymmetry—i.e., dominant parent vs. shared management—on the alliance's success or failure (see Doz, 1988; Harrigan, 1988; Killing, 1982), there is also evidence that organizational distance impacts knowledge transfers. For instance, in their study of knowledge transfer from the parents to the joint venture, Lyles and Salk (1996) find that the two-parent shared management joint ventures exhibit the highest levels of knowledge acquisition; however, they caution that conflicts and misunderstandings may quickly erase these gains. Baughn *et al.* (1997) further warn that significant differences in firm size translate into power differentials between partners that likely leave smaller firms striving to keep simultaneously their technology proprietary and the alliance going.

In light of Mosakowski's (1997: 422) observation that 'perhaps the most frequently mentioned type of "causally ambiguous resource" is organizational culture,' one can easily conceive how the juxtaposition of two different organizational cultures in an alliance may well result in increased levels of ambiguity for each partner. In fact, Szulanski (1996) shows this. Arguing that knowledge transfer builds on numerous individual exchanges whose success depends on the ease of communication and 'intimacy' between the source and recipient of knowledge, he finds that an arduous (i.e., laborious and distant) relationship creates additional hardship in internal knowledge transfer. Mirroring the effect of cultural distance, organizational distance amplifies ambiguity. In other words, as hypothesized by Choi and Lee (1997), the greater the difference between the partners in terms of corporate, national (Hypothesis 7), organizational, and professional culture, the greater the difficulty of transferring knowledge through cooperative interorganizational relationships.

Hypothesis 8: Organizational distance is positively related to ambiguity.

Moderating effects of collaborative know-how, learning capacity, and alliance duration

The previously hypothesized relationships between knowledge transfer, ambiguity, and its antecedents are likely to be moderated by three important variables: collaborative know-how, learning capacity, and alliance duration. First, experience at collaborating is essential to manage a diverse portfolio of collaborative ties as well as to accumulate the capability to benefit from the resulting interdependencies (Powell *et al.*, 1996). In fact, ignorance and lack of collaborative experience are often blamed as the main source of alliance problems and failures (Lei and Slocum, 1992). Furthermore, as empirically shown by Simonin (1997), past experience leads to the emergence of a distinct form of collaborative know-how that helps achieve greater benefits in subsequent alliances. In a significant way, this collaborative know-how affects the ability of firms to understand and adopt proper procedures for information gathering, interpretation, and diffusion. In this context, Pisano (1988: 68) maintains that firms traditionally involved in the purchase of technology from outside sources will develop appropriate routines to deal with this activity based on the accumulation of operating experience. Such understanding of collaborative mechanisms and transfer processes favors knowledge absorption by eliminating many of the unnecessary tasks and disruptive noise of cooperation.

Second, strategic alliances are formed for many different reasons as partners entertain various, sometimes hidden, often asymmetric if not conflicting objectives. On this basis, the extent of knowledge transfer is closely linked to the goals of each partner. Both voluntary and involuntary transfers of knowledge are possible (Winter, 1987), depending partly on the degree of protectiveness of the knowledge holder and on the intent (or lack thereof) of the knowledge seeker. That latter intent is best manifested by the presence of appropriate resources allocation aimed at knowledge transfer. Under conditions of low intent, limited resources deployment will typically prevail. These dedicated resources shape the firm's overall learning capacity. In turn, the importance of learning capacity in the propensity to transfer knowledge across corporate boundaries has been well established. For instance, based on his findings pertaining to the study of the transfer

of best practices within organizations, Szulanski (1996) recommends that instead of using only incentive systems to mitigate internal stickiness (i.e., the difficulty of transferring knowledge within the organization), scarce resources and managerial attention should be devoted to developing the learning capacities of organizational units. Likewise, Hamel (1991) introduces the notion of 'receptivity' as the capacity of organizations to learn from their partners—a fundamental tenet in the process of learning, together with intent (the desire to learn) and transparency (the opportunity to learn). Central to such an organizational capability, the appropriateness of resource deployment, both human and support assets, shapes the learning outcomes (Hamel *et al.*, 1989; Pucik, 1988). For instance, limited staffing may result in a constant struggle to solve immediate problems, leaving no leeway for learning; low quality of staff assigned to alliances or dependence on the partner for staffing will cripple any future learning attempt; inappropriate information processing and communication capabilities between the alliance and the parent are also likely to prevent both the acquisition and diffusion of new insights. In their study of the reciprocal flow of knowledge (from the parents to the joint venture), Lyles and Salk (1996) observe that, indeed, the capacity to learn (measured by the joint venture flexibility, creativity, and knowledge about employees) significantly influences the level of knowledge acquisition. Based on the previous evidence, it is pertinent to examine the relations hypothesized in Figure 1 under conditions of low vs. high learning capacity.

Finally, the duration of the alliance is also expected to moderate the relationships hypothesized in the model. As an alliance sustains itself over the years, cultural (national) distances tend to decrease (Meschi, 1997), trust intensifies (Gulati, 1995), attachment between partners develops (Inkpen and Beamish, 1997), and the partners become more familiar with each other's expertise and idiosyncrasies. Thus, one could well expect different dynamics with respect to knowledge transfer in comparison to the early stage of collaboration. The case of 'younger' (more recent) strategic alliances should be contrasted to the one of 'older' (more established) alliances. Rather than explicitly formulating detailed hypotheses on the nature and direction of these moderating effects, an exploratory approach is advocated.

METHODS

Sample

The population for this study consists of large and medium-size U.S. companies. Selection criteria for compiling the sample—sales greater than $50 million and a workforce of more than 500 employees—drew from available, published information in the Corptech directory. Based on the reported concentration of strategic alliances in specific industries (Hergert and Morris, 1988; Hladik, 1985; Terpstra and Simonin, 1993) and similar to Aulakh *et al.*'s (1996) and Parkhe's (1993) rationale for selecting *Fortune* 500 U.S. industrial firms and particular industries to build their data base on strategic alliances, this study targeted large and medium-size companies operating in high-technology sectors to avoid surveying small firms with a high likelihood of no international alliances. Nevertheless, eliminating small firms from the population to be surveyed did not preclude respondents from selecting the case of an alliance with a small firm when responding to the survey.

Accordingly, a sample of 1000 public and privately owned U.S. companies was randomly drawn from the Corptech directory. From the directory, key executives were identified as potential respondents by their name, address, and function for each selected company, based on their areas of responsibility. This screening process, similar to that of Parkhe's (1993), was designed to target respondents most likely to be knowledgeable about international alliances. The strategic nature of the survey's content, the focus on cross-corporate boundaries issues such as transfer of technological know-how, and the probing of past corporate experience with collaborations necessitated the choice of top executives, whose understanding and field of action pertain to the overall organization. These top executives were the most able to observe and to determine the impact of a specific alliance on the rest of the organization's activities. Furthermore, these executives were best qualified to direct the questionnaire to other individuals in the organization who may have been even more competent on the subject (see Aulakh *et al.*, 1996).

Instrument and measures

The questionnaire design, implementation, and the conduct of the survey followed the Total Design

Method (TDM) approach (Dillman, 1978). Similar to Geringer (1988) and Parkhe (1993), the format and content of the questionnaire were initially developed from a thorough literature review, and pretested using doctoral students, faculty, and business contacts familiar with the issue of interfirm collaboration. In particular, capitalizing on their active interest and involvement with collaborative issues, a group of business executives ($n = 12$) previously enrolled in an executive seminar on international strategic alliances at a prominent business school participated in a pretest phase by completing an advanced version of the questionnaire and by offering criticisms and suggestions for improving it.

The questionnaire itself prompted the respondents to focus on a current (at least 1 year old) or past but recent (terminated less than 3 years ago) international strategic alliance with which they were the most familiar. This approach was in line with other researchers' attempts to build detailed data bases on the collaborative phenomenon (e.g., Schrader, 1989). Respondents were invited to focus on the technological expertise of their partner and on the technological aspects of the alliance activities. In addition to general facts and descriptive information about the alliance under scrutiny, the questionnaire included specific questions related to the partner, the collaborative objectives of each party, the degree of collaborative experience, and issues of knowledge transfer pertaining to technology or process know-how. Most of the items in the questionnaire followed 7-point Likert-type scales.

In addition to the structural model, Figure 1 encapsulates the measurement model. Table 1 reports the means and standard deviations for all the measures as well as the correlation matrix used as input in LISREL. The latent variables in the model are measured by multiple indicators. All measures were assessed via a 7-point interval scale ranging from 'strongly disagree' to 'strongly agree.' These scales were reverse-coded where appropriate. The wording of these measurement items in the questionnaire is given in the Appendix.

To investigate the moderating effects of collaborative know-how, learning capacity, and alliance duration, a multiple-group analysis is advocated that requires the sample to be divided into a high and low group along each of these variables (median split). This split-half of the sample is performed one variable at the time, resulting in three sets of two groups in total. Collaborative know-how was measured in the questionnaire by a 20-item additive index derived from previous research on strategic alliances. Likewise, learning capacity was assessed by a two-item scale aimed at measuring resource deployment. Finally, the duration of the alliance was computed from the date of inception of the alliance as reported in the questionnaire.

Respondents and alliances profiles

From the 192 companies that participated in the study, 147 completed, usable questionnaires were collected, yielding a response rate not atypical for this kind of research. The level of participation was even more gratifying when considering the profile of the respondents, the sensitive nature of many questions, and the detailed nature of the questionnaire. The majority of the respondents were top executives (i.e., Presidents, CEOs, Vice-Presidents, Directors, or General Managers) in some of America's largest corporations. On average, these respondents had been personally involved with the alliance under scrutiny for a period of five years, suggesting an appropriate level of awareness and expert knowledge with the collaborative phenomenon. Over 50 percent of the companies included in the study had a sales volume greater than $350 million and a workforce larger than 2500 employees.

The possibility of nonresponse bias was checked by comparing the characteristics of the respondents to those of the original population sample. The calculated t-statistics for the number of employees ($t = -0.19$, $p < 0.85$), employee growth ($t = 1.01$, $p < 0.31$), sales volume ($t = 0.11$, $p < 0.91$), exports as a percentage of sales ($t = 0.28$, $p < 0.78$), and age of the company ($t = 1.63$, $p < 0.10$) are all statistically insignificant, suggesting that there are no significant differences between the respondent and nonrespondent groups. Furthermore, since all measures were collected in the same survey instrument, the possibility of common method bias was tested using Harman's one-factor test (see Scott and Bruce, 1994; Konrad and Linnehan, 1995). A principal components factor analysis on the questionnaire measurement items yielded seven factors with eigenvalues greater than 1.0 that accounted for 77 percent of the total variance. Since several factors, as opposed to one single factor, were

Table 1. Means, standard errors, and cross-correlations[a,b]

Variables	Measures	Means	S.D.	Y_1	Y_2	Y_3	Y_4	Y_5	x_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
Technology/process know-how easily transferable	Y_1	3.71	1.80	1.00																	
Clear associations between causes and effects, I/O	Y_2	3.46	1.52	0.66	1.00																
Has learned a great deal about technology held by partner	Y_3	4.14	1.49	–0.19	–0.40	1.00															
Has greatly reduced initial technological dependence	Y_4	3.64	1.72	–0.22	–0.21	0.37	1.00														
Technology is assimilated and contributed to other projects	Y_5	3.10	1.79	0.01	–0.15	0.53	0.39	1.00													
Easily codifiable—in writing instructions	X_1	4.30	1.82	0.24	0.22	–0.23	–0.07	0.05	1.00												
Partners technology know-how more explicit than tacit	X_2	3.37	1.68	0.42	0.41	–0.29	–0.19	–0.09	0.43	1.00											
Invested significantly in specialized equipment/facilities	X_3	4.68	1.91	0.01	–0.12	0.16	–0.07	0.18	–0.18	–0.01	1.00										
Partner invested significantly in skilled human resources	X_4	4.59	1.82	0.05	–0.06	0.18	–0.06	0.26	–0.12	0.05	0.80	1.00									
The product of many independent techniques/…	X_5	3.85	1.75	0.31	0.26	–0.11	–0.06	0.08	0.24	0.15	–0.04	–0.01	1.00								
High level of expertise with partners' technology	X_6	3.70	1.64	–0.46	–0.35	0.08	0.19	0.08	–0.16	–0.24	0.07	0.07	–0.05	1.00							
High level of experience with partners' technology	X_7	4.53	2.75	–0.42	–0.33	0.13	0.18	0.14	–0.15	–0.22	0.04	0.04	–0.11	0.87	1.00						
Intentional procedures/policies to restrict information flow	X_8	4.73	1.80	0.09	0.11	0.20	–0.01	0.24	–0.04	0.09	0.38	0.42	0.20	–0.10	–0.07	1.00					
Partner is protective of its technology/process know-how	X_9	4.80	1.89	0.16	0.12	0.07	0.02	0.24	–0.06	0.07	0.26	0.28	0.18	0.05	0.05	0.62	1.00				
National culture of partner differs greatly	X_{10}	3.56	2.18	0.12	0.15	–0.10	0.00	–0.05	0.09	0.17	0.05	0.00	–0.03	0.00	0.03	–0.06	0.01	1.00			
Language differences are major obstacles	X_{11}	4.01	1.93	0.13	0.14	–0.07	–0.10	–0.15	–0.04	0.14	0.05	0.06	0.03	–0.02	–0.01	0.03	0.06	0.76	1.00		
Similarity of business practices	X_{12}	5.17	1.64	–0.23	–0.21	0.05	0.23	–0.06	0.03	–0.03	–0.06	–0.10	–0.10	0.05	0.09	0.03	–0.07	0.24	0.27	1.00	
Similarity of corporate culture and management style	X_{13}	4.69	1.66	–0.24	–0.25	0.10	0.12	–0.02	0.05	0.03	–0.03	–0.03	–0.13	0.10	0.12	0.03	–0.02	0.20	0.22	0.79	1.00

[a]Based on $n = 147$.
[b]Correlations above 0.14 are significant at $p < 0.05$; correlations above 0.18 are significant at $p < 0.01$.

identified and since the first factor did not account for the majority of the variance (only 19.6%), a substantial amount of common method variance does not appear to be present (Podsakoff and Organ, 1986).

In terms of structural form, 40 percent of the strategic alliances represented in the study were equity-based alliances vs. 60 percent that were purely nonequity-based. At the functional level, about half of the alliances were organized on a joint research or joint product development project basis. The overwhelming majority of these projects were concentrated in high-technology sectors: aerospace (7.6%), automotive (4.2%), chemicals and pharmaceuticals (22.2%), computing equipment and software (18.6%), electronics and medical equipment (11.1%), industrial equipment (11.8%), and semiconductors and telecommunications (13.2%). By industry, the applications ranged from the development of jet engines to training and simulation systems for aircrafts, polymer compounds to anticancer drugs, microprocessor and memory devices to semiconductor fabrication equipment, ultrasound products to diagnostic systems, metalworking tools to gas turbine engines, computer peripherals to connectivity software and communication systems. For these alliances, two-fifths of the partners were identified by the respondent as being a strong to very strong competitor as opposed to a weak or noncompetitor. At the time of the survey, 12 of the reported alliances had been terminated (six the year of the survey, six others the year before) after averaging a 7-year lifespan. The other, active alliances were, on average, 6 years old.

Model and analysis

LISREL's VIII maximum likelihood program (Joreskog and Sorbom, 1996) was used to test the theoretical model postulated in Figure 1. Through its flexible interplay between theory and data, this structural equation model approach bridges theoretical and empirical knowledge for a better understanding of the real world (Fornell, 1982). Such analysis allows for modeling based on both latent (unobservable) variables and manifest (observable) variables, a property well suited for the hypothesized model where most of the represented constructs are abstractions of unobservable phenomena. Furthermore, structural equation modeling takes into account errors in measurement, variables with multiple indicators, and multiple-group comparisons.

RESULTS

With respect to the quality of the measurement model for the full sample, the constructs display satisfactory levels of reliability as indicated by composite reliabilities ranging from 0.79 to 0.99 and shared variance coefficients ranging from 0.67 to 0.96 (computed from the LISREL loading estimates following Fornell and Larcker's (1981) formula). Convergent validity—the extent to which maximally different attempts to measure a same concept agree—can be judged by looking at both the significance of the factor loadings and the shared variance. The amount of variance shared or captured by a construct should be greater than the amount of measurement error (shared variance >0.50). All the multi-item constructs meet this criteria with each loading (λ) being significantly related to its underlying factor (t-values greater than 4.67) in support of convergent validity (not reported in tables). Likewise, a series of chi-square difference tests on the factor correlations showed that discriminant validity—the degree to which a construct differs from others—is achieved among all constructs (Anderson and Gerbing, 1988). In particular, discriminant validity was established between the two latent variables *tacitness* and *ambiguity* by constraining the estimated correlation parameter between them to 1.0 and then performing a chi-square difference test on the values obtained for the constrained (χ^2 = 212.75, d.f. = 101) and unconstrained models (χ^2 = 176.02, d.f. = 100) (see Anderson and Gerbing, 1988). The resulting significant difference in chi-square ($\Delta\chi^2$ = 36.73, Δd.f. = 1) indicates that the two constructs are not perfectly correlated and that discriminant validity is achieved (Bagozzi and Phillips, 1982). That is, from a measurement model point of view, the constructs *tacitness* and *ambiguity* represent two distinct constructs, not one. Of further interest, discriminant validity is also achieved between *cultural distance* and *organizational distance* ($\Delta\chi^2$ = 36.36, Δd.f. = 1).

Turning to the structural model itself, Table 2 reports the parameter estimates and goodness-of-fit indicators of the structural equation system. Although the overall chi-square is significant (χ^2

= 186.72; 107 d.f.; $p < 0.00$), as might be expected with this statistic's sensitivity to sample size (Bagozzi and Yi, 1988; Bentler, 1990), the ratio of χ^2 to degrees of freedom (1.74, less than 3) corresponds to a satisfactory fit (Carmines and McIver, 1981), while the other fit indices (NNFI = 0.90; NFI = 0.85; CFI = 0.93) and the low standardized root mean square residual (RMR = 0.07) are all within acceptable ranges and show that a substantial amount of variance is accounted for by the model (Bagozzi and Yi, 1988). Hence, the model is a reasonable representation of the data.

Looking at the parameter estimates, a first, notable result consists of the significant negative effect of *ambiguity* on *knowledge transfer* in support of Hypothesis 1 ($\beta_{21} = -0.357$, $t = -3.511$). That is, fundamentally, greater (smaller) levels of ambiguity associated with a technological capability lead to smaller (greater) knowledge transfer outcomes for an alliance partner, an empirical verification of Reed and DeFillippi's (1990) theoretical postulate that causal ambiguity constitutes a key barrier to imitation. With the exception of *specificity* and partner *protectiveness*, all the other postulated antecedents display a significant effect on *ambiguity*: *tacitness* ($\gamma_{11} = 0.342$, $t = 3.908$), *complexity* ($\gamma_{13} = 0.168$, $t = 2.553$), *experience* ($\gamma_{14} = -0.283$, $t = -4.031$), *cultural* ($\gamma_{16} = 0.176$, $t = 2.511$) and *organizational distance* ($\gamma_{17} = 0.274$, $t = 3.953$) in support of Hypotheses 2, 4, 5, 7, and 8 respectively. That is, the greater (smaller) the degree of tacitness, complexity, cultural distance, organizational distance, and the smaller (greater) the level of prior experience, then, the greater (smaller) the level of ambiguity. Although not formally hypothesized, a next pertinent question concerns the relative magnitude of these identified effects on ambiguity. In other words, are all these significant effects equal or does any one of these antecedents impact ambiguity to a significantly greater extent? To test such a hypothesis under LISREL, a chi-square difference test is performed between a model where the estimates are free and a model where these estimates are constrained to be equal. Such a test reveals that statistically all the significant antecedents contribute equally to ambiguity. Overall, a substantial amount of variance is explained in the endogenous variables *knowledge transfer* ($R^2 = 0.14$) and *ambiguity* ($R^2 = 0.64$) by the model.

To further understand the role of ambiguity in the process of knowledge transfer and examine the appropriateness of the hypothesized model, an important competing theoretical model must be tested, one that allows all the antecedents of *ambiguity* to relate not only to *ambiguity*, but also to *knowledge transfer* directly (saturated model). When comparing this unconstrained model with the hypothesized theoretical model, the resulting difference in chi-square is nonsignificant ($\Delta\chi^2 = 12.91$, Δd.f. = 7; n.s.), indicating that the more parsimonious model (the one with greater degrees of freedom; i.e., with fewer paths) is preferred (Hoskisson, Johnson, and Moesel, 1994); in this case, the hypothesized model. Importantly, this result supports a model with no direct relationship between the antecedents of *ambiguity* and *knowl-*

Table 2. Structural parameter estimates and goodness-of-fit indices (full sample)

Hypotheses	Paths		Estimate	*t*-Value
H1	Ambiguity → Knowledge transfer	β_{21}	–0.357	–3.511*
H2	Tacitness → Ambiguity	γ_{11}	0.342	3.908*
H3	Specificity → Ambiguity	γ_{12}	–0.045	–0.634
H4	Complexity → Ambiguity	γ_{13}	0.168	2.553*
H5	Experience → Ambiguity	γ_{14}	–0.283	–4.031*
H6	Protectiveness → Ambiguity	γ_{15}	0.023	0.335
H7	Cultural distance → Ambiguity	γ_{16}	0.176	2.511*
H8	Organizational distance → Ambiguity	γ_{17}	0.274	3.953*

NFI = 0.851	Standardized RMR = 0.071
NNFI = 0.897	χ^2 (107 d.f.) = 186.72
CFI = 0.928	p-value < 0.001 $n = 147$

*Significant at the $p < 0.01$ level

edge transfer (all the corresponding direct paths are statistically nonsignificant, while the previously established significant paths in the hypothesized model remain significant). Altogether, these results underline the role and pertinence of ambiguity as a mediating variable between *tacitness, complexity, experience, cultural distance, organizational distance,*and *knowledge transfer.*

While these first results shed some important light on the process of technological knowledge transfer between alliance partners, further refinement is desirable through the investigation of the possible moderating effects of collaborative know-how, learning capacity, and alliance duration. Indeed, Table 3 reveals that the previous results differ somewhat across groups of significantly different levels of collaborative know-how (as measured by the 20-item know-how index which ranges from 0 to 140: mean = 110.03 for the 'high' group vs. mean = 79.28 for the 'low' group). Whereas the results in the low collaborative know-how group are identical to the general results—significant effect of *ambiguity* on *knowledge transfer* ($\beta_{21}^{low} = -0.341$, $t = -2.512$) and of *tacitness* ($\gamma_{11}^{low} = 0.382$, $t = 2.654$), *complexity* ($\gamma_{13}^{low} = 0.309$, $t = 2.242$), *experience* ($\gamma_{14}^{low} = -0.236$, $t= -2.735$), *cultural* ($\gamma_{16}^{low} = 0.158$, $t = 2.177$) and *organizational distance* ($\gamma_{17}^{low} = 0.449$, $t = 3.728$) on *ambiguity*—they do differ noticeably for the high group. For the latter group, the results show that *ambiguity* still impacts *knowledge transfer* significantly ($\beta_{21}^{high} = -0.266$, $t = -2.365$) as do *tacitness* ($\gamma_{11}^{high} = 0.591$, $t = 4.196$) and *experience* ($\gamma_{14}^{high} = -0.247$, $t = -2.734$) impact *ambiguity*. On the other hand, the effects of *complexity*, *cultural distance,* and *organizational distance* on *ambiguity* are now nonsignificant. That is, companies with greater levels of collaborative know-how are better able to cope with the barriers created by the complex nature of a technological capability spread across various organizational units and areas of expertise, and better able to overcome cultural and organizational differences with their partner. Furthermore, using LISREL it is possible to answer another pertinent question: are the paths that are significant in both groups equal in strength? A corresponding series of chi-square difference tests reveals that, indeed, paths that are significant in both groups do not differ in magnitude across groups (e.g., the effect of *experience* on *ambiguity* is the same for companies with low and high levels of collaborative know-how: $\gamma_{14}^{high} = \gamma_{14}^{low}$).

As another likely moderator of the previously established relations, learning capacity in the form of resource deployment shows results very similar to the effect of collaborative know-how. Table 4 shows that, again, for the 'low' capacity to learn group (as measured by the two-item index: Mean = 1.98 for the 'low' group vs. Mean = 4.55 for

Table 3. Structural parameter estimates and goodness-of-fit indices for two-group comparison on collaborative know-how

Paths/hypotheses			Collaborative know-how High ($n_1 = 75$)			Collaborative know-how Low ($n_2 = 72$)	
				Estimate	*t*-Value	Estimate	*t*-Value
Ambiguity	→	Knowledge transfer	β_{21}	–0.266	–2.365*	–0.341	–2.512*
Tactiness	→	Ambiguity	γ_{11}	0.591	4.196*	0.382	2.654*
Specificity	→	Ambiguity	γ_{12}	0.049	0.459	0.005	0.046
Complexity	→	Ambiguity	γ_{13}	0.143	1.602	0.309	2.242*
Experience	→	Ambiguity	γ_{14}	–0.247	–2.734*	–0.236	–2.735*
Protectiveness	→	Ambiguity	γ_{15}	–0.038	–0.339	–0.105	–0.682
Cultural distance	→	Ambiguity	γ_{16}	0.117	0.969	0.158	2.177*
Organizational distance	→	Ambiguity	γ_{17}	0.225	1.872	0.449	3.728*
			NFI = 0.802		Standardized RMR = 0.077		
			NNFI = 0.897		χ^2 (214 d.f.) = 301.42		
			CFI = 0.928		*p*-value < 0.00		

*Significant at the $p < 0.05$ level

Table 4. Structural parameter estimates and goodness-of-fit indices for two-group comparison on learning capacity

Paths/hypotheses				Learning capacity High (n_1 = 75)		Learning capacity Low (n_2 = 72)	
				Estimate	*t*-Value	Estimate	*t*-Value
Ambiguity	→	Knowledge transfer	β_{21}	–0.433	–2.388*	–0.559	–3.848*
Tactiness	→	Ambiguity	γ_{11}	0.481	3.088*	1.557	2.586*
Specificity	→	Ambiguity	γ_{12}	–0.003	–0.029	–0.113	–1.013
Complexity	→	Ambiguity	γ_{13}	–0.020	–0.022	0.270	2.394*
Experience	→	Ambiguity	γ_{14}	–0.019	0.347	–0.235	–2.389*
Protectiveness	→	Ambiguity	γ_{15}	0.023	0.305	–0.134	–1.120
Cultural distance	→	Ambiguity	γ_{16}	0.002	0.023	0.185	2.627*
Organizational distance	→	Ambiguity	γ_{17}	0.265	2.098*	0.300	2.813*
				NFI = 0.796	Standardized RMR = 0.082		
				NNFI = 0.903	χ^2 (214 d.f.) = 288.90		
				CFI = 0.932	*p*-value < 0.00		

*Significant at the $p < 0.05$ level

the 'high' group) the results are identical to the general results with a significant effect of *ambiguity* on *knowledge transfer* ($\beta_{21}^{low} = -0.559$, $t = -3.848$) and of *tacitness* ($\gamma_{11}^{low} = 1.557$, $t = 2.586$), *complexity* ($\gamma_{13}^{low} = 0.270$, $t = 2.394$), *experience* ($\gamma_{14}^{low} = -0.235$, $t = -2.389$), *cultural* ($\gamma_{16}^{low} = 0.185$, $t = 2.627$) and *organizational distance* ($\gamma_{17}^{low} = 0.300$, $t = 2.813$) on *ambiguity*. Again, looking at the high capacity to learn group, the results differ substantially: *ambiguity* still impacts *knowledge transfer* significantly ($\beta_{21}^{high} = -0.433$, $t = -2.388$), but only *tacitness* ($\gamma_{11}^{high} = 0.481$, $t = 3.088$) and *organizational distance* ($\gamma_{17}^{high} = 0.265$, $t = 2.098$) now significantly impact *ambiguity*. That is, both *complexity* ($\gamma_{13}^{high} = -0.020$, $t = -0.022$) and *cultural distance* ($\gamma_{16}^{high} = 0.002$, $t = 0.265$) are once again nonsignificant and *experience* has also dropped out of the picture (in lieu of *organizational distance* for the previous moderator in Table 3). Further analysis through chi-square difference tests ($\Delta\chi^2 = 6.24$, Δd.f. = 1; sig.) reveals that among the paths that are significant in both groups the effect of *tacitness* on *ambiguity* is greater in the low learning capacity group than in the high group ($\gamma_{11}^{low} > \gamma_{11}^{high}$). In other words, the deployment of proper resources and organizational capabilities (learning capacity) aimed at the transfer of technological knowledge held by a partner significantly attenuates the effects of tacitness on the ambiguity linked to the asset in question.

Finally, when looking at the role of alliance duration, Table 5 reveals that, again, the effects of *ambiguity* on *knowledge transfer* and of *tacitness* on *ambiguity* are significant and of equal magnitude in both groups (on average, about a 2-year lifespan for the 'younger' alliances group vs. a more than 7-year lifespan for the 'older' alliances group). Consistent with the previous results, neither *protectiveness* nor *specificity* exercises any influence on *ambiguity*. A more contrasting picture exists for the other antecedents of ambiguity: while both *experience* ($\gamma_{14}^{young} = -0.434$, $t = -3.927$) and *complexity* ($\gamma_{13}^{young} = 0.279$, $t = 2.780$) are significant for the group composed of more recent alliances, their effects are nonsignificant in the group of more mature alliances. That is, for companies involved in younger (as opposed to older) strategic alliances, existing familiarity and experience with the partner's technological knowledge as well as the complex nature of that knowledge will play a significant role in raising the barriers to transferability. Vice versa, *organizational distance*, which is nonsignificant for the more recent alliances, becomes significant ($\gamma_{17}^{old} = 0.348$, $t = 2.551$) for the longer-established alliances.

DISCUSSION AND FUTURE RESEARCH

Through a structural equation modeling approach, this study has focused on the process of techno-

Table 5. Structural parameter estimates and goodness-of-fit indices for two-group comparison on alliance duration

Paths/hypotheses				Alliance duration Older (n_1 = 85)		Alliance duration Younger (n_2 = 62)	
				Estimate	*t*-Value	Estimate	*t*-Value
Ambiguity	→	Knowledge transfer	β_{21}	–0.466	–3.370*	–0.316	–2.166*
Tactiness	→	Ambiguity	γ_{11}	0.714	2.679*	1.048	2.344*
Specificity	→	Ambiguity	γ_{12}	–0.058	–0.516	0.124	0.012
Complexity	→	Ambiguity	γ_{13}	0.091	0.815	0.279	2.780*
Experience	→	Ambiguity	γ_{14}	–0.070	–0.516	–0.434	–3.927*
Protectiveness	→	Ambiguity	γ_{15}	0.153	1.612	–0.082	–1.214
Cultural distance	→	Ambiguity	γ_{16}	0.169	1.838	0.075	0.726
Organizational distance	→	Ambiguity	γ_{17}	0.348	2.551*	0.031	–0.357*
				NFI = 0.763		Standardized RMR = 0.107	
				NNFI = 0.841		χ^2 (214 d.f.) = 338.96	
				CFI = 0.889		*p*-value < 0.00	

*Significant at the $p < 0.05$ level

logical knowledge transfer between strategic alliance partners by proposing and testing a comprehensive model that explicitly articulates the role of various key variables that in past research received attention only partially and independently of one another. Rather than focusing on any one specific relation, it is the simultaneity of all the hypothesized relationships as challenged against competing models that confers integrity and relevance to the model. The following discussion of the results, shortcomings, and future research directions—as summarized in Table 6—will: (1) recap the main findings by highlighting the consistently critical role of knowledge ambiguity and tacitness; (2) attempt to understand the failed relationship for specificity and partner protectiveness; (3) discuss the possible presence of learning curves; and finally (4) contrast the moderating effects of learning capacity with those of collaborative know-how.

Ambiguity and tacitness at the core of knowledge transfer

The overall results point to the critical role played by knowledge ambiguity as a full mediator of tacitness, experience, complexity, and cultural and organizational distance on knowledge transfer. In particular, the significant effect of ambiguity on knowledge transfer is found consistently across the main analysis and the various group analyses. These findings do not only coincide with Lippman and Rumelt's (1982) observations that ambiguity acts as a powerful block on both imitation and factor mobility, or offer some empirical support to Reed and DeFilippi's (1990: 96) proposition that 'barriers to imitation are dependent upon the ambiguity in a firm's competency-based advantage.' They also provide some new light on the multidimensional process of knowledge transfer across corporate boundaries. While previous research may have argued for or demonstrated the negative effects of tacitness or cultural distance, for instance, on knowledge transfer, it generally assumed the form of a direct effect between these variables. In contrast, the current study shows that these relations are indirect by virtue of the mediating role of ambiguity. In turn, it underlines the theoretical importance of ambiguity and—coinciding with a resurgence of interest (Mosakowski, 1997; Szulanski, 1996)—the need to formally account for this construct in future research.

Across the various analyses, the consistently significant effect of tacitness on ambiguity constitutes another important result of this study, one in line with Zander and Kogut's (1995: 85) findings that 'the more codifiable and teachable a capability is, the higher the "risk" of rapid transfer.' As such, the seminal work of Polanyi (1967) remains timely and fundamental to understanding the flow of knowledge transfer between partners of strategic alliances. This result also points to the desirability of implementing knowledge codi-

Table 6. Overview of the findings

Main findings	Managerial implications	Research implications
Ambiguity is a full mediator of the effects of *tacitness, complexity, experience*, and *cultural* and *organizational distance* on *knowledge transfer*	To learn, share, or protect a knowledge asset, be cognizant of the role of ambiguity and of its multidimensional nature	The construct *ambiguity* needs to be formally recognized and integrated in future research
	Try to decompose the 'gestalt' of ambiguity into its individual components and gauge their respective effects	There is a need for cross-validatation by replicating the general approach of this study with other types of competencies
The effect of *tacitness* on *ambiguity* is consistently significant across analyses	To facilitate teaching and active knowledge sharing, it is important to implement programs aimed at knowledge codification whenever possible	The process of codification, itself, warrants further research attention. Much remains to be learned about the mechanics and limits of articulating knowledge, the value of data-basing corporate knowledge, and the challenges of designing and managing a corporate knowledge system
	Learning from past experience and by doing is critical. To this end, proper resource commitment is necessary, particularly with respect to staffing decisions	
	Strategic intent is no substitute for resource commitment	
	Corporate mindset needs to switch from being cost-driven to investment-driven	
Specificity is not significant	All technology-based competencies are vulnerable to imitation; nothing is off limits	The construct's lack of effect needs to be further investigated for other types of competencies
Partner protectiveness is not significant	Partner protectiveness may not always be detectable or observable. In its finest form, it may be fully camouflaged	Consider the case of failed alliances; unreliable or not knowledgeable partners
	In doubt or as a proactive measure, probe your partner's true self by articulating specific requests from time to time	Consider multiple informants to assess the partner's behavior at various hierarchical and functional levels of the collaborative exchange

Moderating effects of alliance duration: The effects of *ambiguity* and *tacitness* are lasting For older alliances, the effects of *prior experience* and *complexity* on *ambiguity* disappear For youger alliances, the effects of *cultural* and *organizational* distance disappear	Resource allocation is not a one-time deal. Needs must be continuously reassesssed to match the evolution of a technological asset and the possible reinvestment by partners in causally ambiguous competencies. The 'unsticking' of information may have limits in the context of a strategic alliance. Further knowledge development may require the use of alternate channels and organizational arrangements Learning curves pertaining to the partner's technological knowledge can be achieved Caution: conditions and perceptions at the start of an alliance may not be representative of the reality that settles in later	Longitudinal studies are needed to trace more precisely the evolution of cultural awareness and to explain more accurately the dynamics of partners' adaptation over the life of the alliance.
Moderating effects of learning capacity: Under conditions of greater resource deployment, the effect of *tacitness* on *ambiguity* is smaller and the effects of *complexity, prior experience*, and *cultural distance* disappear	Proper resource allocation accelerates learning curves: a firm may be able to compensate for its lack of prior experience and for the complex nature of a technological asset by deploying greater resources to learn International knowledge transfers are not doomed due to inherent cross-cultural barriers; appropriate resource deployment can alleviate the difficulties caused by cultural distance, language in particular	Beyond absorptive capacity (as captured by resource deployment), other facets of the construct *learning capacity* warrant investigation (e.g., retentive capacity, Not-Invented-Here syndrome, individual knowledge integration, unlearning propensity) The exact nature of the relationship between learning capacity and cultural distance calls for further scrutiny
Moderating effects of collaborative know-how: Under conditions of greater *collaborative know-how*, the effects of *complexity* and *cultural* and *organizational distance* on *ambiguity* disappear	Collaborative know-how is a source of cooperative advantage; it enhances the ability to cope with new, unfamiliar situations When lacking collaborative know-how, a firm will benefit from hiring talents familiar with the partner's culture and from conducting training programs to circumvent the effects of cultural and organizational distance	As a significant moderating variable, the importance of past collaborative experience and know-how needs to be further acknowledged and modeled for future research undertakings

fication programs whenever possible, particularly when active knowledge sharing is a requisite or agreed-upon objective of the alliance. To facilitate the intended transfer, the knowledge holder should be responsible for the codification effort. Far from being obvious, the task is nevertheless feasible and a positive outcome is attainable, as evidenced by the rise of programs targeting the codification of corporate knowledge (see Davenport and Prusak, 1998). In support, Ben Barnes, general manager of IBM Worldwide Global Business Intelligence Solutions, even argues that one can standardize best practices, tools, lesson learned, and customer reference sites and have all this information shared globally (Moran, 1997). Still, much remains to be learned about the mechanics and limits of articulating knowledge, the value of data-basing corporate knowledge, and the challenges of designing and managing an efficient corporate knowledge system. This entire area as well as the process of codification itself warrant further research attention.

When technological knowledge is not or cannot be codified in a meaningful way like a formula of a complex chemical compound or a blueprint in a patent disclosure, learning from experience and learning by doing in the presence of knowledgeable partners become a *sine qua non* for circumventing ambiguity and favoring knowledge transfer. Such requirement is resource-intensive and calls for the articulation of a clear strategic vision at first (Hamel, 1991), one that explicitly recognizes and targets the partner's technological advantage. More importantly, this vision must translate into proper resource commitment. Far too often, rhetoric prevails over collaborative engagement and corners are cut. In particular, the adequate deployment of human resources is critical (Nonaka, 1994; Pucik, 1988). For instance, expatriation of experts who are greatly valued at home may be necessary so that they can gain first-hand experience with the partner's technology through the partner's own team of engineers or scientists. These 'star' expatriates may be the only ones able to efficiently make sense of their direct contacts with the foreign counterparts, to observe with a purpose, to ask the right questions, or learn from others' mistakes. The bottom line, then, is for companies to switch their mindset from one focused on costs to one based on investment. After all, as argued by Elizabeth Lank, program director, knowledge management of ICL (Houlder, 1997): 'Managing knowledge is expensive but the cost of not managing knowledge is enormous.'

On the lack of significance of specificity and partner protectiveness

Overall, the results of this study support Reed and DeFilippi's (1990) propositions linking causal ambiguity to barriers to imitation as well as tacitness and complexity to ambiguity. The significance of the latter relation between complexity and ambiguity (from an outcome perspective) sheds some new and contrasting light on the results of Zander and Kogut (1995), who found that neither the complexity nor system dependence nature of manufacturing capabilities had a significant effect on the speed of their transfer or imitation (from a diffusion rate/speed perspective). Yet, one of the propositions articulated by Reed and DeFilippi (1990) was not verified empirically: the effect of asset specificity on ambiguity was found nonsignificant across the board. That is, in light of other knowledge and alliance characteristics, the degree to which a technological asset is specialized has no real impact on its transferability. It means, as one could further argue, that regardless of how specialized and dedicated the assets surrounding a particular technology or process know-how, it is vulnerable to imitation. Nothing is off limits. Still, for companies seeking to internalize their partner's competency, corporate executives should not take such an outcome for granted. The process must be managed, since various degrees of efficiency can be observed depending on level of commitment and resource deployment (Hamel, 1991; Inkpen, 1997). Likewise, some caution is in order before generalizing such a result since, of all the various and diverse organizational capabilities and competencies that serve as sources of competitive advantage, the current study has considered only technological knowledge.

The other postulated relation that consistently fell short of significance concerns the effect of partner protectiveness on ambiguity. Two factors may well have contributed to the absence of a significant effect. First, partner protectiveness may not always be detectable or observable. In its finest form, it may be totally transparent to the knowledge seeker, even more so at the level of high-ranking executives, the majority of this

study's respondents. In fact, Baughn *et al.* (1997) report for their study that critical issues of learning potential by a partner and of regulating the outflow of skills were often more apparent to middle managers and engineers involved in the alliance's day-to-day activities than to senior executives. Thus, methodologically, this study's single informant approach may have contributed to only a partial view of the construct. In this respect, future research will benefit from the use of multiple informants to assess the partner's behavior from the perspective of observers at various hierarchical and functional levels of involvement with the alliance. Since protectiveness may be difficult to notice, it is wise for managers to regularly probe a partner's disposition by articulating specific requests that force the issue. Only then can an unequivocal opinion be formed and corrective steps adopted if necessary.

Second, the lack of significance of partner protectiveness may well be rooted in the close interplay between protectiveness and opportunism, and consequently between collaborative viability and failure. Lorange (1997), on the one hand, argues from his 'black-box strategy'—a strategy resting on flexible and dynamic contractual protection, latent retaliatory power, and hands-on managerial involvement—that full cooperation can be achieved while core competencies are protected in a strategic alliance. Yet, in a strong form, protectiveness is likely to lead to irreparable conflicts between partners and, in turn, to an early termination of the alliance. *De facto*, since most of the alliances under study were still active, acute cases of protectiveness associated with failed or failing alliances may not have been detectable. This stipulation is similar to the study limitation acknowledged by Lyles and Salk (1996): by not having data on failed joint ventures, assessing the link between lack of knowledge acquisition and failure is not possible. Likewise for the current study, a more accurate role of protectiveness on ambiguity could be assessed only by considering failed alliances as well. In this spirit, further research is needed to examine the relationship between knowledge ambiguity and conflicts, not only when the conflicts are grounded in a competitive desire to safeguard an important competency, but also when the source of knowledge is not perceived as being knowledgeable or reliable (Szulanski, 1996).

Time dimension and learning curves

Turning to the moderating effects of alliance duration on the postulated model, the two-group comparison between 'younger' and 'more established' alliances provides some partial support as well as some surprising results with respect to the existence of learning curves. First, both the significant effects of tacitness on ambiguity and of ambiguity on knowledge transfer are constant across groups, irrespective of the age of the alliance. These results are consistent with Mosakowski's (1997: 437) conclusion that 'I do not expect causal ambiguity to disappear completely.' They suggest that there are some limitations and possible boundaries to the 'unsticking' of information (see von Hippel, 1994), knowledge conversion from tacit to explicit (Nonaka, 1994), or to the decay in barriers to imitation possibly through reinvestment in causally ambiguous competency characteristics (Reed and DeFilippi, 1990). Managers should, therefore, approach the issue of resource allocation not as a one-time deal but rather on a continuous basis to match the evolution of a technology and the partner's actions. Moreover, strategic alliances are no panacea when it comes to knowledge transfers; when ceiling effects are reached in the unsticking of information, further development of a technological base will require the courting of new partners, if not the use of alternate channels and organizational arrangements.

Second, the results reveal some moderating effects of alliance duration that are consistent with a learning curve at the alliance level: the significant effects of prior experience and complexity on ambiguity disappear as alliances sustain themselves over time. Again, these two variables being directly linked to a technological dimension, one can recognize in these results the presence of more typical learning curves associated with manufacturing or production. The more surprising results pertain to the apparent lack or even reversal of learning curve associated with the softer, nontechnological dimensions, namely cultural and organizational distance. Intuitively, or in light of Meschi's (1997: 218) findings and conclusions that 'all cultural differences in an international joint venture, regardless of their nature or intensity, will ultimately recede over time,' one may have expected a significant effect of both cultural and organizational distance

on ambiguity for the 'younger' alliances and possibly a drop of significance for the 'older' alliances. Instead, a quasi-reversal was observed: no significant effect of these variables on ambiguity in the group of 'younger' alliances but a significant effect for organizational distance and borderline significant (t = 1.838) for cultural distance in the group of 'older' alliances.

A plausible explanation for this peculiar finding may well lie in the necessity to switch from a monotonic view to a more cyclical representation of the world. For instance, for the sake of comparison, one may want to recall the sinusoidal shape of the more familiar curve of expatriates' cultural shock. In a first so-called 'honeymoon' stage, expatriates tend to feed on the exoticism of their new assignment and enjoy the many novel facets of their context and duties. In the following stage (high stress, low well-being) the expatriate suffers from a hard reality-check created by the cross-cultural differences that are no longer perceived as a source of enjoyment but rather as a source of constant struggle to function in a foreign environment. At this point an early repatriation (failure) may occur, or in a third stage, the expatriate is able to regain and sustain typical 'pre-honeymoon' levels of well-being and stress. In the context of strategic alliances, it is not unreasonable to expect that a similar cultural-shock and adjustment curve could manifest itself organization-wide for the relationship between partners (stage 1—initial euphoria and interest in partner's differences; 2—frustration; and 3—irreconcilable differences leading to alliance termination or a readjustment to cope with these differences). Similarly, it could occur with knowledge transferability (stage 1—transfer fulfillment due to effects of newness of the partner's competencies and built-in diversity; 2—frustration with the inability to go beyond the obvious or to fully comprehend; and 3—giving up on knowledge transfer or adjustments to bypass the effects of miscommunication or other cross-cultural barriers). Under this perspective, the previous findings are more sensible, as the study's grouping of alliances based on duration may well coincide with the first two identified stages: the 'younger' alliance group (2-year lifespan average) with stage 1 ('honeymoon' period) and the 'older' group (7-year average) with stage 2 (frustration). Irrespective of the validity of the previous interpretation, the only certainty about this finding rests on the necessity for future research to trace more closely and accurately the evolution of cultural awareness and adaptation of partners over the course of the alliance. While the study reveals the existence of a shift, it does not explain how this change occurs over time. More of a 'frame by frame' as opposed to a multiple-group approach is needed to capture the evolution of the process and changes of the underlying conditions over the alliance's life, very much in the spirit of Doz's (1996) longitudinal methodology. As a result, greater accuracy could be expected in reconciling apparently divergent results across studies; for example, Lyles and Salk (1996) did not find significant main effects between cultural misunderstandings/cultural differences and levels of knowledge acquisition in Hungarian joint ventures.

On the moderating effects of learning capacity and collaborative know-how

The criticality of proper resource commitment, previously acknowledged in discussing tacitness, is further supported by the results of the multiple-group analysis centered on the role of learning capacity. It was shown that as companies deploy greater resources dedicated to facilitating knowledge transfer from their alliances, smaller effects of tacitness on ambiguity occur in conjunction with a drop in the effect of complexity, cultural distance, and prior experience on ambiguity. In a sense, proper resource allocation may speed up existing learning curves: the significance of some specific barriers to knowledge transferability (complexity of the partner's technological capability, impediments rooted in cross-cultural differences) is eradicated, as is the countervailing effect of prior experience with the technological domain (substitution effect of experience by learning capacity). Of particular interest, the notion of being able to bypass the inhibiting effects of cultural distance through adequate resource deployment constitutes a remarkable finding in that it suggests that there is nothing fatalistic or irremediably wired about cross-cultural knowledge transfers, a possibly contentious position that calls for further research. In comparison, organizational distance (significant across groups) is not affected by the level of learning capacity. This result could be understood in light of Meschi's (1997: 219) findings and

cautious observations that in the context of international joint ventures the effects of national distance tend to decrease over time considerably more than those of organizational distance—in other words, that 'organizational culture seems to be far more durable than national culture.' Correspondingly, the impact of learning capacity may well give rise to a similar differential effect between cultural and organizational distance. While the current study has focused on the resource deployment side of learning capacity—that is, the absorptive capacity viewpoint (Szulanski, 1996), other facets of that complex organizational capability remain to be examined, for instance: articulated goals (Lyles and Salk, 1996); retentive capacity (Szulanski, 1996); Not-Invented-Here syndrome (Inkpen, 1997; Szulanski, 1996); individual knowledge integration (Grant, 1996a, 1996b; Nonaka, 1994); the ability of the firm to unlearn (Hamel, 1991), to double- rather than just single-loop learn (Schon, 1983), or to balance exploitation with exploration (Levinthal and March, 1993).

When examining the analogous effects of collaborative know-how on the process of knowledge transfer, it was observed that under conditions of greater collaborative know-how the effects of complexity and cultural and organizational distance on ambiguity disappear, while prior experience remains significant. That is, similar results to those of learning capacity are obtained, with one noticeable exception: a switch of significance between experience (now significant) and organizational distance (now nonsignificant) for the 'high' group. Whereas greater levels of collaborative know-how lead to a situation where organizational distance stops impacting ambiguity significantly, such levels cannot substitute for the role of prior technological experience. In sum, learning capacity, which is intrinsically technology-specific, moderates the effect of prior technology experience, but does not impact the effects of organizational distance and vice versa for collaborative know-how, which by nature is less technology dependent and more organizationally oriented. As illustrated by the greater cross-cultural and organizational challenges of firms that have more limited collaborative know-how, these results suggest the presence of some underlying learning curve or effects at the organization level. As firms multiply their collaborative endeavors, expert know-how on partnering should develop (Powell *et al.*, 1996; Simonin, 1997) and result in greater abilities to cope with new, unfamiliar situations. Although cross-cultural barriers may be more prominent for less experienced companies, it is wise for all managers to expect their effect to last a long time, if not in terms of transparency, at least in terms of their contribution to management conflicts. When lacking collaborative know-how, a firm will benefit from implementing clever cultural sensitivity programs and from hiring talents well versed in the partner's culture to circumvent the impact of both cultural and organizational distance. Given its significant moderating effect, the role of past collaborative experience and know-how needs to be further addressed and explicitly modeled in future research undertaking.

CONCLUSION

The aim of this study was to advance our understanding of the process of knowledge transfer in strategic alliances. It revealed that both knowledge-specific variables (i.e., tacitness and complexity) and partner-specific variables (i.e., prior experience, cultural distance, and organizational distance) impacted this process. The study further established the critical role played by the construct *knowledge ambiguity* by showing that it fully mediates the effects of these variables on knowledge transfer. Despite its limitations of a single informant and the possibility of common method problems, this research constitutes a detailed, empirical attempt to answer the call for statistical evidence (Fiol, 1994; Huber, 1991; Mowery *et al.*, 1996) that has typically been lacking in the research on the learning organization. While the study has focused on technological knowledge, much could be learned from replicating this type of large sample-based, process-oriented, latent variable modeling with other categories of know-how. One example would be marketing know-how, for which Hamel (1991) conjectures that market intelligence tends to flow more easily than knowledge of leading-edge manufacturing know-how, in contrast to Tiemessen *et al.* (1997), who argue that partners contributing market knowledge to a strategic alliance have proprietary knowledge of relationships with suppliers, employees, and government that is often ill codified and difficult to transmit.

To clarify such issues and broaden our understanding of this phenomenon, much in-depth empirical work remains to be conducted before a general theory can emerge.

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APPENDIX: Questionnaire Items

Ambiguity ($\alpha = 0.079$)

		Strongly disagree						Strongly agree
Y_1.	The technology/process know-how held by your partner is easily transferable back to your company.	1	2	3	4	5	6	7
Y_2.	The association between causes and effects, inputs and outputs, and actions and outcomes related to the technology/process know-how held by your partner is clear.	1	2	3	4	5	6	7

Knowledge transfer ($\alpha = 0.070$)

		Strongly disagree						Strongly agree
Y_3.	Your company has learned a great deal about the technology/process know-how held by your partner.	1	2	3	4	5	6	7
Y_4.	Your company has greatly reduced its initial technological reliance or dependence upon the partner since the beginning of the alliance.	1	2	3	4	5	6	7
Y_5.	The technology/process know-how held by your partner has been assimilated by your company and has contributed to other projects developed by your company.	1	2	3	4	5	6	7

Tactiness ($\alpha = 0.72$)

		Strongly disagree						Strongly agree
X_1.	Your partner's technology/process know-how is easily codifiabile (in blueprints, instructions, formulas, etc.).	1	2	3	4	5	6	7
X_2.	Your partner's technology/process know-how is more explicit than tacit.	1	2	3	4	5	6	7

Specificity ($\alpha = 0.89$)

		Strongly disagree						Strongly agree
X_3.	To develop its technology/process know-how, your partner had to invest significantly in specialized equipment and facilities.	1	2	3	4	5	6	7
X_4.	To develop its technology/process know-how, your partner had to invest significantly in skilled human resources.	1	2	3	4	5	6	7

Complexity

		Strongly disagree						Strongly agree
X_5.	Your partner's technology/process know-how is the product of many interdependent techniques, routines, individuals, and resources.	1	2	3	4	5	6	7

Experience ($\alpha = 0.93$)

		Strongly disagree						Strongly agree
X_6.	Independently from the alliance, your company has a high level of expertise with your partner's technology/process know-how.	1	2	3	4	5	6	7
X_7.	Independently from the alliance, your company has a high level of experience with your partner's technology/process know-how.	1	2	3	4	5	6	7

Partner protectiveness ($\alpha = 0.77$)

		Strongly disagree						Strongly agree
X_8.	Your partner has intentional procedures, routines, and policies to restrict the sharing of relevant information concerning its technology/process know-how.	1	2	3	4	5	6	7
X_9.	Your partner is very protective of its technology/process know-how.	1	2	3	4	5	6	7

Cultural distance ($\alpha = 0.86$)

		Strongly disagree						Strongly agree
X_{10}.	The national culture of your partner greatly differs from yours.	1	2	3	4	5	6	7
X_{11}.	Language differences are a major obstacle in communicating with, and understanding your partner.	1	2	3	4	5	6	7

Organizational distance ($\alpha = 0.85$)

		Strongly disagree						Strongly agree
X_{12}.	The business practices and operational mechanisms of your partner are very similar to yours.	1	2	3	4	5	6	7
X_{13}.	The corporate culture and management style of your partner is very similar to yours.	1	2	3	4	5	6	7

Collaborative know-how ($\alpha = 0.92$)

In order to be successful in its collaborations, your firm needs collaborative know-how (i.e., experience and expertise in interfirm cooperation). Please rate your company's know-how in the following areas:

		No know-how						Extensive know-how
a.	Partner identification	1	2	3	4	5	6	7
b.	Partner selection	1	2	3	4	5	6	7
c.	Negotiations	1	2	3	4	5	6	7
d.	Legal aspects	1	2	3	4	5	6	7
e.	Understanding strategic implications of collaborating	1	2	3	4	5	6	7
f.	Technological assessment	1	2	3	4	5	6	7
g.	Estimating asset values and future cash flows	1	2	3	4	5	6	7
h.	Tax aspects	1	2	3	4	5	6	7
i.	Closing the deal	1	2	3	4	5	6	7
j.	Staffing (recruiting, training, rewarding, rotating)	1	2	3	4	5	6	7
k.	Managing alliance–parent company relations	1	2	3	4	5	6	7
l.	Building trust with the partner	1	2	3	4	5	6	7
m.	Conflict resolutions	1	2	3	4	5	6	7
n.	Renegotiating initial agreements with partner	1	2	3	4	5	6	7
o.	Logistics and resource transfer	1	2	3	4	5	6	7
p.	Cross-cultural training.	1	2	3	4	5	6	7
q.	Knowledge/skills acquisition	1	2	3	4	5	6	7
r.	Knowledge/skills safeguarding	1	2	3	4	5	6	7
s.	Profit or capital repatriation	1	2	3	4	5	6	7
t.	Existing from the alliance	1	2	3	4	5	6	7

Learning capacity ($\alpha = 0.81$)

		Strongly disagree						Strongly agree
a.	Your company has committed a lot of personnel to this alliance.	1	2	3	4	5	6	7
b.	Your company has committed a lot of physical, financial, organizational, and logistical resources to support the seeking, diffusion and sharing of information originating from this alliance.	1	2	3	4	5	6	7

Alliance duration

a. Year in which the alliance was formed: _____