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THE EFFECTS OF EXECUTIVES' EXPERIENCES AND PERCEPTIONS ON THEIR ASSESSMENT OF POTENTIAL TECHNOLOGICAL ALLIANCES

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Researchers have only begun to provide explanations of how *top executives' experiences and perceptions influence organizational decisions. Drawing from a broad theoretical base, this study tests the contention that top executives' personal experiences (age, educational background, and work experience), their perceptions of their firms' attitudes toward technology and risk, and their perceptions regarding their firms' past success with collaborative technological development influence their cognitive assessments of potential technological alliances. Results from the study suggest that top executives with a technical education place more weight on the opportunities provided by the alliance than those with other types of education. Moreover, executives from firms that are perceived to emphasize technology and to have had success with technological alliances in the past tend to focus more on the opportunities provided by the alliance and less on the riskiness of the venture.* © 1998 John Wiley & Sons, Ltd

As competition becomes more global and the costs and complexity of technological development increase, firms are establishing networks of strategic alliances (Hagedoorn, 1993; Pennings and Harianto, 1992). As the firm's primary strategists, top executives (i.e., CEO, COO, vice presidents reporting directly to the CEO) as a group are ultimately responsible for the firm's cooperative strategies and for selecting alliance partners. The top executives of a firm can be expected to enact or construct a shared understanding of the situation that is used to determine which alliances are most beneficial to the firm (Daft and Weick, 1984; Walsh, 1995). Research suggests that the result of this enactment process is dependent on the cognitive orientations or mental understandings established in the minds of the individual executives involved (Hambrick and Mason, 1984; Melone, 1994; Miller, Kets de Vries, and Toulouse, 1982).

Unlike much of the strategic alliance research reported to date, this study does not focus on the underlying motivation for establishing alliances, on how they are structured (e.g., equity vs. nonequity) or on their success (e.g., Contractor and Lorange, 1988; Gulati, 1995; Harrigan, 1986; Hennart, 1988; Kogut, 1988). Nor does it consider the enactment process which takes place between executives in a firm as they evaluate cooperative partners or between firms as cooperative relationships emerge, evolve, and dissolve

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(e.g., Ring and Van de Ven, 1994). Rather, the theory presented and tested in this paper considers the cognitive orientations executives *use* when they individually assess technological alliance opportunities and *bring with them* when they talk with other executives about technological partnering. It considers *how* top executives' experiences and perceptions influence their attitudes toward technological alliance formation and the kinds of information they attend to when individually assessing potential technological alliance opportunities.

More specifically, behavioral decision theory is used to suggest that executives' cognitive orientations are reflected in (1) their age, educational background, and work experience; (2) their perceptions of their companies' emphasis on technology and risk; and (3) their perceptions of their companies' success in past technological collaborative efforts. Hypotheses are proposed which suggest that these executive experiences and perceptions directly and indirectly influence top executives' assessments of potential technological alliances (see Figure 1). Before developing and testing the theoretical arguments supporting this line of reasoning, the theoretical perspective adopted in the study will be noted and the definitions of a few terms will be clarified.

STATEMENT OF THEORETICAL PERSPECTIVE AND DEFINITIONAL CLARIFICATION

By adopting a cognitive processing perspective, this study seeks to provide insight on how top executives' cognitive orientations, as reflected in their experiences and perceptions, affect their personal assessments of technological alliance opportunities. It emphasizes the fact that although executives may try to assess potential technological alliances rationally, their ability to consider all the information they have is limited (Simon, 1957). Furthermore, how they interpret the information they notice is affected by the cognitive understandings they have established in their minds (Starbuck and Milliken, 1988; Walsh, 1988). Thus, the *individual* top executive, as a complex information-processing system, is the study's focus (March and Simon, 1958). The limited amount of research on alliances incorporating a cognitive perspective has not gone unnoticed. Indeed, Auster (1994), in her review of strategic perspectives on interorganizational linkages, called for research that incorporates cognitive and learning perspectives. The goal of this study is to respond to this gap in the literature.

Technology has been defined previously in

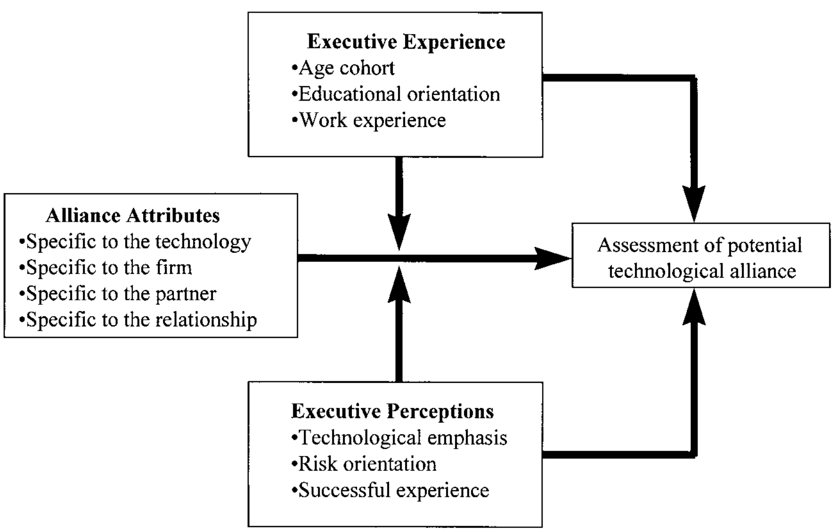

Figure 1. The effects of executives' experience and perceptions on their assessments of technological alliance opportunities

many ways (e.g., Cutler, 1989; Harris, Shaw, and Sommers, 1984). The definition proposed by Abetti (1989) has been used in this study. He defines technology as 'a body of knowledge, tools, and techniques, derived from both science and practical experience, that is used in the development, design, production, and application of products, processes, systems, and services' (Abetti, 1989: 37). Thus, technology not only entails new product innovations and new processes by which outputs are generated, but also includes scientific and practical know-how that comes with experience.

For this study, technological alliance is defined as *any activity where two or more partners contribute differential resources and technological know-how to agreed complementary aims* (Dodgson, 1993). This definition does not include one-way transfers of know-how, such as licensing, marketing agreements, or simple one-time only contracts. Rather, technological alliances, as defined here, are continuing arrangements where partners share their expertise and output. These alliances represent a spectrum of interorganizational cooperative arrangements with a variety of governance mechanisms (Borys and Jemison, 1989; Hagedoorn, 1990, 1993; Oliver, 1990; Ring and Van de Ven, 1992). Firms may or may not have legal contracts, and may or may not have provided equity funding for a separate entity (e.g., joint venture). What is common to all of these relationships is the commitment of two or more companies to develop technology cooperatively, thus strengthening their ability to keep pace with technological advancements in the marketplace.

When top executives decide to investigate potential technological alliances, they must collect information that will allow them to evaluate and compare various options. The important *alliance attributes* for which information is sought may be related to the technology around which the alliance is to be structured, potential partner characteristics, characteristics of the firm considering an alliance, and attributes of the proposed relationship (Lambe and Spekman, 1997; Mohr and Spekman, 1994; Tyler and Steensma, 1995). The information obtained can then be assessed by executives individually and incorporated into the management team's decision process.

Some of the information processed by executives as they individually assess potential technological alliances can be categorized as information related to organizational opportunities and information related to organizational threats (Dutton and Jackson, 1987). Moreover, research suggests that there is a threat bias; that is, executives are more sensitive to information that is associated with threats than to information associated with opportunities (Jackson and Dutton, 1988). In addition, an organization's image and identity guide and activate its executives' interpretations of information and their motivations for action (Dutton and Dukerich, 1991). It will be argued here that executives' personal experiences and perceptions of their firms influence the extent to which they focus on both opportunity and threat-based information while assessing potential technological alliances. More specifically, it will be proposed that the concepts of *strategic intent* and organizational *stretch* are related to opportunity-based information executives attend to when evaluating alliances, while two types of perceived risk represent threat-based information (Das and Teng, 1996; Hamel and Prahalad, 1989).

According to Hamel and Prahalad (1989: 67) traditional strategy 'focuses on the degree of fit between existing resources and current opportunities' while 'strategic intent creates an extreme misfit between resources and [organizational] ambitions,' and 'challenges the organization to close the gap by systematically building new advantages' aligned with tomorrow's opportunities. Thus, strategic intent implies a sizable 'stretch' for an organization seeking to attain clear ambitious goals. Efforts of firms to 'stretch' and take advantage of future opportunities are reflected in their commitment to a technology policy that supports firm strategy (Zahra and Covin, 1993), their commitment to learn from alliance partners (Hamel, 1991; Kogut, 1988), and their sensitivity to the possibility of broad corporate applications of technology and its potential to expose the firm to related markets (Prahalad and Hamel, 1990; Tyler and Steensma, 1995; see Table 1).

Two types of perceived risk associated with interfirm alliances may be considered threatening to executives assessing technological alliance opportunities: relational risk and performance risk (Das and Teng, 1996, 1997; Ring and Van de Ven, 1994). According to a great deal of research, alliances as a structural form are inherently risky and unstable due to the dual control nature of the relationship, the intrinsic incentive to cheat,

Table 1. Examples of opportunity- and threat-based information related to assessment of potential technological alliances

Opportunity-based information related to strategic intent
Significance of this technology to current strategy
Potential for broad corporate application of the technology
Potential to learn from the cooperative relationship
Potential for increased exposure to related markets
Threat-based information related to relational risk
Number of potential partners with similar joint development capabilities
Favorability of potential partner's cooperative history
Compatibility of operating and management styles
Your company's information regarding the technology relative to the potential partner
Threat-based information related to performance risk
Total expected cost to develop the technology
Ability to patent protect the technology
Potential for decreasing development risk
Availability of technological substitutes

and the uncertainty about the partner and its changing goals (Parkhe, 1993; Inkpen and Beamish, 1997). Therefore, some of the risk perceived by executives assessing potential technological partners is associated with the risk of partnering or *relational risk* (Das and Teng, 1996, 1997). A second type of risk is associated with the technology itself and its commercial success. This risk may result from the unpredictable nature of R&D activities, the high costs associated with development, questionable market acceptance, and the uncertain appropriability of the technology (Chakravarthy, 1985; Pisano, 1990). This type of risk has been labeled *performance risk* because these risks exist even if alliance partners cooperate fully. Performance risk embraces all kinds of hazards except those related to cooperation (Das and Teng, 1996).

Examples of alliance attributes that top executives may associate with relational risk are the compatibility of management styles (i.e., can we work together?), the number of potential cooperative partners (i.e., what are my alternatives if this partner acts opportunistically?), and the favorability of a potential partner's cooperative history (Dodgson, 1993; Kogut, 1988, Pisano, 1990). Factors that executives may associate with performance risk are the potential for decreasing development risk by cooperating, the total expected cost for developing the technology, the ability to patent protect the technology once developed, and the availability of technological substitutes (Barney, 1991; Reed and DeFillippi, 1990; Tyler and Steensma, 1995).

BEHAVIORAL DECISION THEORY

According to behavioral decision theory, executives develop their own cognitive representations of reality called schema or mental understandings which are stored and then used as templates to explain and interpret events (Hastie, 1981; March and Simon, 1958). These mental structures control the encoding and reconstruction of information stored in memory. They also allow executives to select the information that is most relevant in a given situation and process that information quickly and efficiently (Oldfield and Zangwill, 1942; Starbuck and Milliken, 1988). This ability to attend to information selectively is important because more information is typically available for processing than individuals are cognitively capable of considering. Due to these 'bounds' or limitations of the human condition, individuals must learn to amplify relevant information and attenuate irrelevant information in order to create understanding (Simon, 1957).

While filtering is a necessary part of the human perceptual process, it can lead to differences in perception between people, and sometimes within the same person at different points in time (Schoemaker, 1990). Starbuck and Milliken (1988) have delineated two types of perceptual filtering that may vary the perceptions of decision-makers: *noticing* and *sensemaking*. Differences in *noticing* may lead to perceptual differences as the decision-maker focuses less attention on certain stimuli while other stimuli dominate his or her attention. Perceptual differences due to *sensemaking* occur as the decision-maker frames the context of the decision, predicts possible outcomes, and forms causal attributions. Thus, during the perceptual process, the potential exists for the executive's cognitive models or understandings to influence not only what information is noticed, but also the meaning attributed to that information.

In order to 'come to conclusions' regarding the attractiveness of technological alliance opportunities, executives must evaluate the available information and draw conclusions about their potential (Russo and Schoemaker, 1989). According to behavioral decision theory and cognitive research, the information that executives attend to and the weightings they give to various pieces of information will be influenced by the cognitive or mental understandings they have developed over time.

EFFECTS OF EXECUTIVES' EXPERIENCES ON THEIR ASSESSMENTS

Building on the premises of cognitive and behavioral research, strategy researchers argue that observable executive characteristics serve as indicators of the mental models executives use during strategic decision making (e.g., Hambrick and Mason, 1984). Furthermore, research suggests that these observable executive characteristics are significantly related to what information is noticed and how it is weighted when top executives evaluate the desirability of strategic alternatives (Hitt and Tyler, 1991; Melone, 1994).

Age

Child (1974) proposed that older executives are more committed to the status quo than are younger executives. It appears that, over time, the mental models executives use during strategic decision making become solidified through use (Hambrick, Geletkanycz, and Fredrickson, 1993). Age is highly correlated with total work experience, organizational tenure, and industry tenure. This correlation makes it extremely difficult to determine whether the relationship between age and the strategic choices of executives is due to cohort history, organizational experiences, industry-specific experiences, or seasonal phases, which are distinct patterns of executive attention and behavior that emerge over time. All of these factors may affect the cognitive development of mental understandings (Hambrick and Fukutomi, 1991; Hambrick *et al*., 1993; Hitt and Tyler, 1991; MacCrimmon and Wehrung, 1990). In any event, executive experience, as represented by age, can be argued to influence the mental understandings executives use to process information during strategic decision making.

Hambrick and Mason (1984) maintained that firms with younger managers would be more inclined to pursue risky strategies than would firms with older managers. These authors also suggested that younger managers are more likely than older managers to seek growth through more novel and innovative strategies in an effort to seize perceived opportunities. Support for their beliefs was found in a study of more than 500 top executives by MacCrimmon and Wehrung (1990). In their study, the most mature executives were also the most risk averse (maturity was a combination of age, seniority, and number of dependents). In addition, Grimm and Smith (1991) found that top executives from firms that changed their strategies were younger than top executives from firms that did not change their strategies.

Technological alliances provide firms with a relatively novel and innovative strategy for growth in an effort to seize perceived opportunities. They are also inherently risky and unstable, due to the control nature of the relationship, the incentive to cheat, and the uncertainty regarding partners' goals (i.e., high relational risk) (Parkhe, 1993; Inkpen and Beamish, 1997). Although alliances may help to limit performance risk associated with technology development such as the sharing of costs and development risk, technological development in general is typically considered risky since there is no assurance the technology will be developed or that a market for the technology will materialize. Because technological strategic alliances are typically considered a fast and innovative route to firm growth and are perceived as risky relative to other methods of growth, such as acquiring technology already developed, it is argued that older executives will be more conservative in their assessments of potential technological alliances than younger executives.

Hypothesis 1: The older an executive is, the less attractive potential technological alliances will be to the executive.

Education

Education may be considered indicative of one's knowledge and skill base (Hambrick and Mason, 1984). As noted by Hitt and Tyler (1991), an executive who has one type of formal education can be expected to have developed different problem-solving skills and mental models with which to evaluate situations than an executive with a different type of formal education. For example, Heilmeier (1993), CEO of Bellcore and the Industrial Research Medalist for 1993, noted the importance attributed to the technical training of CEOs in the 1990s. He argued that the role of top executives has changed from that of 'operator' to that of 'designer' and emphasized the need for executives to understand not only the technology that drives their business today, but also the technology that will change their business in the future. His arguments suggest that top executives with a more complete understanding of the technological base of a company will be better able to position the firm proactively to compete more effectively in the future than executives without an understanding of the firm's technology.

It can be argued that executives with formal educational training in science and engineering will have a more complete understanding of the technological base of the company, will be better able to envision how technology might be developed through cooperation, and will be more committed to technological development than executives with formal training in nontechnical areas such as business or liberal arts. Moreover, the technically trained executives should be more capable of structuring a technological cooperative relationship in a way that would be more advantageous to the technological needs of the firm. On the other hand, executives without a technical education can be expected to be aware of the fact that they are less capable of assessing technological alliance alternatives than their colleagues with a technical education and, therefore, should be more conservative in their assessments. Because they are more likely to know what information to look for, will notice more, can interpret the information they receive with greater ease (Finkelstein and Hambrick, 1996), and are more capable of structuring a technological alliance relationship, top executives with a technical education can be expected to be more confident of the firm's ability to gain from such a relationship and to be more optimistic in their assessment of technological alliance opportunities than executives with other educational backgrounds.

Hypothesis 2a: Executives with a technical educational background (i.e., engineering, chemistry) will assess potential technological alliances more favorably than executives with other educational backgrounds.

Not only can it be expected that executives with a formal technological education will be more favorable toward cooperative opportunities than those with a different educational background, but they can also be expected to evaluate information differently. Hitt and Tyler (1991) argued that an executive's educational background (i.e., liberal arts, chemistry, engineering, etc.) is related to what information they focus on and use during evaluations of strategic alternatives. They found that education type moderated the weighting of information executives used when asked to evaluate a number of potential acquisitions.

Heilmeier (1993) suggested that technical training fosters in individuals a long-term commitment to a deeper understanding of relevant technologies and prepares an executive to predict, comprehend, and anticipate long-term change (i.e., opportunities). Moreover, Finkelstein and Hambrick (1996) argued that executives with an in-depth understanding of advanced technology notice a greater proportion of the technological information. They also require fewer pieces of information to form an opinion about a technological trend than executives without this in-depth understanding. Furthermore, there is speculation that executives with only a formal management education are more likely to pursue short-term performance goals at the expense of innovation and long-term asset building than executives with other educational backgrounds (Hambrick and Mason, 1984). Hambrick and Mason (1984) argue that business schools are not effective at developing risk-taking tendencies, but rather teach future managers risk avoidance. In contrast, those who are technically trained may not have been socialized in this short-term, risk-averse orientation. In summary, those executives with a technical education may be more inclined to focus on the opportunities provided by alliances in terms of stretch and competency development and less inclined to focus on relational and performance risk when evaluating potential technological alliances, as compared to those without a technical education.

Hypothesis 2b: Executives' educational back-

grounds will influence the weighting of alliance attributes when assessing potential technological alliances. More specifically, executives with formal technical education (engineering, sciences) are expected to place more weight on opportunities and less weight on threats than those executives who lack a formal technical education.

Functional background

An early study by Dearborn and Simon (1958) reported evidence that executives define problems largely in terms of the goals and tasks in their respective functional areas. While a number of studies have not found support for Dearborn and Simon's original, somewhat simplistic contentions, there is support for a more complex relationship between functional work experience and strategic decision-making processes (e.g., Hitt and Tyler, 1991; Melone, 1994). For example, Walsh (1988) found that the belief structures (mental understandings) managers brought to bear on problems were not particularly simplistic or narrowly functional. However, he did report some support for hypotheses which argued that managers were likely to identify problems that were from the same functional domain as the content of their belief structures, and that managers were likely to seek additional information from the same functional domain as the content of their belief structures. In a study of the effects of functional background on executives' selective perceptions, Waller, Huber, and Glick (1995) found that functional work experience had no influence on which changes top executives perceived in their organization's environment but did influence the changes they perceived related to organizational effectiveness.

An organization's strategy partly determines the types of functional expertise that will be central to a firm's success (Hitt, Ireland, and Palia, 1982). Moreover, a firm's relative emphasis on technology will likely influence the functional expertise considered important to success (Datta and Guthrie, 1994). For example, executives with backgrounds in R&D or engineering are arguably consistent with 'progress, invention, and improvement' (Wiersema and Bantel, 1992: 100). The managerial skills of these executives can be expected to be particularly important to strategy formulation and implementation in high-technology organizations, which must have substantial technical wherewithal to remain competitive (Hambrick, Black, and Fredrickson, 1992).

Govindarajan (1989) reported that functional experience in R&D was positively related to the successful implementation of a differentiation strategy while functional experience in manufacturing was positively related to the successful implementation of a low-cost strategy. This led McGee, Dowling, and Megginson (1995) to argue that new high-technology ventures whose management team's functional experience fit with the venture's choice of competitive strategy would be more successful in cooperative strategies than ventures that lacked the functional experience–strategy fit. In their study of new venture management teams, they found that cooperative arrangements were most beneficial to those new ventures whose management teams were relatively well versed in the technical aspects of their business. It appeared to them that only firms with technologically adept managers saw benefits from collaboration. These arguments suggest the following hypothesis:

Hypothesis 3a: Executives with technical work experience (i.e., R&D, engineering) will assess potential technological alliances more favorably than executives with other work experience.

In a study of the influence of experience-based expertise on decision processes, Melone (1994) found that vice-presidents of corporate development (VPCDs) tended to be more optimistic in their evaluations of acquisition candidates than did chief financial officers (CFOs). Moreover, VPCDs were likely to take a more balanced view of strategic and financial matters in forming their overall ratings while CFOs tended to place the predominant emphasis on financial matters. Hitt and Tyler (1991) also found that the information executives notice and use when asked to evaluate acquisition candidates is influenced by their functional experience. In other words, top executives with dissimilar functional backgrounds weighted the information they used in evaluating potential acquisitions differently.

Similar to the arguments regarding the influence of technical education, top executives with technical work experience can be expected to weight the information they consider when assessing potential technological alliances differently from executives without technical work experience. These executives can be expected to be more sensitive to opportunities associated with technological alliances (e.g., the importance of the technology for the firm's strategy, learning opportunities) and less concerned about threats related to relational and performance risk than executives without technical work experience.

Hypothesis 3b: Executives' work experience will influence the weighting of alliance attributes when assessing potential technological alliances. Specifically, executives with technical work experience (engineering, R&D) are expected to place more weight on opportunities and less weight on threats than those executives who lack technical work experience.

EFFECTS OF EXECUTIVES' PERCEPTIONS ON THEIR ASSESSMENTS

Executives' perceptions of their companies' context may also directly and indirectly influence their assessments of potential technological strategic alliances. Perceptions of their companies' emphasis on technology, risk orientation, and success with other technological alliances can be expected to influence the information top executives notice, how they frame their assessments, and the conclusions they draw (Dutton and Dukerich, 1991; Russo and Schoemaker, 1989; Starbuck and Milliken, 1988).

Technological emphasis

Technology procurement, a significant aspect of the firm's overall technology strategy, requires careful integration of the various methods that can be used to acquire technology. Some firms will invest primarily in internal R&D, others will invest in contracted R&D and joint ventures, while still others may use a combination of acquisitions and licensing arrangements. Ford (1988) argued that those firms with a high standing in an area of technology, relative to industry competition, will find it more appropriate to develop internally any new technology related to their core area, as opposed to using other methods of procurement, such as technological alliances or acquisitions. Pisano (1990) found that companies tend to internalize R&D and avoid technological alliances in areas that constitute a high percentage of their sales and where they have extensive experience. Moreover, it has been argued that when a firm's strategy is highly dependent on a given technology, executives may not collaborate for fear of losing control over vital intellectual capital (Harrigan, 1986).

The literature reviewed suggests that executives who perceive their firm (1) to be dependent on core technologies, (2) to have extensive expertise in a technological area, and (3) to have a potential to lose control over vital intellectual capital will be less motivated to participate in technological alliance opportunities than executives who do not have these perceptions. Unsurprisingly, all three of these conditions can be associated with relational risk—the risk that partners may act opportunistically. Arguably, the more executives perceive their firms to emphasize technology the more they can be expected to be concerned about their firms' dependency on specific core technologies, their capabilities to develop technology internally, and their potential for losing control over vital technological capital through strategic alliances. Executives with these perceptions can be expected to be less concerned about the risks associated with developing the new technology because they have established internal development capabilities. Thus, in firms where technology is emphasized relational risk appears to take precedence over performance risk (Das and Teng, 1996).

In contrast, executives from firms that place less emphasis on technology can be expected to be more concerned about performance risk than relational risk. These executives can be expected to recognize that their firms have fewer internal technological capabilities than potential partners. Thus, they will be less concerned about opportunistic partner behavior and more concerned about limiting the risks associated with developing the new technology than executives from firms that place more emphasis on technology. This should make them more favorably disposed to alliances as a method of technological development than executives from firms that emphasize technology. These arguments suggest the following hypothesis:

Hypothesis 4a: The greater an executive's *perception that his/her firm emphasizes technology, the less attractive potential technological alliances will be to the executive.*

Not only can top executives in firms that are perceived to emphasize technology be expected to judge technological alliance opportunities less favorably, they can also be expected to focus on different alliance attributes during the evaluation process. From the arguments above, executives from firms that are perceived to emphasize technology may be more aware of, and more concerned about, the opportunities a given alliance provides than executives from firms that are perceived to emphasize technology less (Hamel, 1991; Kogut, 1988). In addition, these executives may be particularly concerned with the relational risk and less focused on performance risk than executives from firms that place less emphasis on technology (Prahalad and Hamel, 1990).

Hypothesis 4b: Executives' perceptions of their firms' emphasis on technology will influence their weighting of alliance attributes when assessing potential technological alliances. Specifically, executives who perceive their firms to emphasize technology are expected to place more weight on the opportunities and threats associated with relational risk, and place less weight on threats associated with performance risk than executives who perceive their firms to place less emphasis on technology.

Risk orientation

Chiles and McMackin (1996) have suggested that the often-ignored behavioral assumption of risk neutrality, inherent in transaction costs economics, be relaxed in future research. They urge researchers to acknowledge the variable risk preferences of firms and the unstated view of subjective economic costs. Sitkin and Pablo (1992) integrated diverse theoretical streams of research on risk taking into a comprehensive model which suggested that individual, organizational, and problem characteristics affect risk behavior through the mediating mechanism of risk perceptions. One of the organizational characteristics they believe influences an individual's risk perceptions is an organization's tendency to prefer certainty vs. uncertainty and risk avoidance vs. risk seeking (Douglas and Wildavsky, 1982). Pfeffer and Salancik (1978) argued that social information processing is a primary mechanism by which organizations and organizational members influence the beliefs and perceptions of other organizational members. Through socialization, organizational members come to accept an organizational perspective that influences their mental models. They then apply these models during the perceptual process and begin to view their world through the lens of their organization's culture (Ginsberg, 1990; Sitkin and Pablo, 1992).

Executives from firms perceived to be risk seeking can be expected to be less concerned about relational and performance risk than executives from firms perceived to be risk averse. This risk seeking propensity, however, can be expected to have little direct influence on executives' overall assessments of technological alliance opportunities. A risk-seeking attitude toward relational risk (less concern about potential opportunism) would make the assessment more favorable while a risk-seeking attitude toward performance risk (less concern about sharing development risks) would make the assessment less favorable; that is, the two types of risk influence overall assessments in the opposite direction. Alternatively, a risk-averse stance toward relational risk would decrease the attractiveness of alliances. Simultaneously, the attractiveness of alliances would increase due to their ability to limit performance risk. Thus, executives' perceptions of their companies' attitudes toward risk taking is not expected to directly affect their assessment of technological alliance opportunities.

However, Sitkin and Weingart (1995) tested a portion of the Sitkin and Pablo (1992) model and found some support for the contention that risk propensity moderated the relationship between how the problem was framed and risky decision-making behavior through its influence on risk perceptions. Baird and Thomas (1985) hypothesized that organizational variables impinge on the strategist, whose resultant risk estimates are seen as interacting with the nature of the strategic problem. Sitkin and Pablo (1992) argued that employees in organizations where risk seeking or risk aversion are clearly favored will perceive situational risks automatically and unthinkingly. This would result in preprocessing and biasing of information related to the decision at hand. In organizational cultures where the risk orientation was more moderate, Sitkin and Pablo

(1992) predicted that decision-makers would more carefully and slowly sort through the data, resulting in a more accurate perception of situational risk.

These arguments suggest that a firm's perceived risk propensity will influence how executives weight those attributes when asked to assess technological alliance opportunities. For example, executives from companies that are perceived to be risk seeking can be expected to be less concerned about compatible management styles, the partners' cooperative history (i.e., relational risk), the ability to patent protect the technology, and the availability of technological substitutes (i.e., performance risk) than executives from companies that are risk averse.

Hypothesis 5: Executives' perception of their firms' attitude toward risk taking will influence their weighting of alliance attributes when assessing potential technological alliances. Specifically, executives who perceive their firms to be risk seeking are expected to place less weight on threats as compared to executives who perceive their firms to be risk averse.

Technological alliance experience and success

Technological alliance experience can lead to learning. Research and theory suggest that a learning curve exists whereby the first technology transfer attempt a company is involved in will be the most difficult and costly (Teece, 1976). Initially, the process required to transfer technology is not well understood. Over time, however, firms move down a learning curve by developing and codifying methods and procedures. Because most technology alliances require the transfer of technology, either between the partners or from the partners to a joint venture which is established, it is reasonable to assume that a learning curve also exists for the establishment and success of technological alliances.

At the individual level, past experience with technological alliances can be expected to affect the mental models used to judge technological alliance opportunities (Hambrick and Mason, 1984). If executives and the companies they work for do not have previous experience with joint technological development, they can be expected to be apprehensive of the potential pitfalls associated with joint R&D and to have very incomplete mental models to apply in alliance assessments. Support for this contention was found by Bolton (1993) in interviews with top executives involved in 14 U.S. collaborative organizations. These interviews suggested that senior executives are initially reluctant to engage in collaboration with rival firms because of the danger of leaking proprietary technical information. However, the more experience executives had with technological alliances, the more comfortable they became with these types of associations.

Link, Tassey, and Zmud (1983) found that a firm's previous success in R&D is likely to lead to future internal innovative efforts. These same arguments could be applied to the propensity to pursue technological alliances. The success of previous or current technological alliances can influence future alliance behavior and lead to an increase in the probability of alliance success (Lyles, 1988). In the words of Dierickx and Cool, 'historical success translates into favorable initial asset stock positions which in turn facilitate further asset accumulation' (1989: 1507). These organizational assets may be tangible or intangible resources or cooperative capabilities embedded in organizational routines and systems within the firm (Barney, 1991; Tyler, 1997). This asset accumulation should make executives more optimistic when evaluating potential technological alliance opportunities.

Hypothesis 6a: The greater an executive's perception that his/her firm has been successful with technological alliances in the past, the more attractive potential technological alliances will be to the executive.

Perceived success or failure with prior alliances can also be expected to influence how executives evaluate incoming information associated with technological alliance opportunities (Bateman and Zeithaml, 1989). Negative experience in a prior alliance may cause an executive to focus on particular attributes of these alliances. For example, when an alliance was not successful because of differences in the partners' management style, an executive may weight that attribute more heavily in future assessments than an executive who has not experienced poor results due to this factor. Likewise, when alliance activity has been deemed to be successful in the past, an executive may be more likely to key in on the opportunities (e.g., learning, exposure to related markets) in future assessments of potential alliances. Indeed, Brockhoff (1992) found that low levels of perceived success in R&D cooperative relationships were related to a relatively high frequency of citing transaction costs as a disadvantage of the relationship. Therefore, executives from firms that have not had success with their prior alliances may focus more on the transaction costs associated with potential technological alliances than executives from firms that have been successful with prior alliances.

These arguments suggest that executives who perceive their firm as having been successful in previous technological alliances can be expected to focus more on the opportunities potential technological alliances provide than executives who perceive their company to have been less successful. In addition, executives from firms that have been more successful with technological alliances in the past are less likely to focus on relational and performance risk than executives from firms that have not had positive past experiences (Hladik, 1988).

> *Hypothesis 6b: Executives' perceptions of their firms' success with previous technological alliances will influence their weighting of alliance attributes when assessing potential technological alliances. Specifically, executives who perceive their firms to have been successful in previous technological alliances are expected to place more weight on opportunities and less weight on threats than those executives who perceive their firms to have been less successful in technological alliances.*

A summary of the hypotheses proposed is reported in Table 2.

METHODS

Sample

A survey instrument was used to collect the data required for the study. The sampling frame consisted of top executives (i.e., CEO, COO, vice presidents reporting directly to the CEO) who graduated from either a large Midwestern university or a smaller, prestigious engineering school. Many high-technology firms are small and private while most sampling frames are biased toward large publicly traded firms. The sampling frame established by combining executives with degrees from these two very different types of institutions included top executives employed by public and private companies that varied in size and industry affiliation. It also provided a higher level of variance in the type of degree awarded than would have been possible if the sample had been drawn from a single source. A random sample of 130 executives was selected from a list of 1076 graduates from the Midwestern university holding top executive titles in companies in industries where technological development is particularly relevant (manufacturing, utilities, and software industries; 2-digit SIC codes 20–39, 49, and 73). These same criteria were also utilized in selecting the population of executives graduating from the engineering school. A random sample was not taken from this population because only 105 executives met these criteria.

To further verify their appropriateness, each executive was contacted by phone and asked if decisions regarding the pursuit of collaborative technology development would be within his or her decision-making authority. Of the 235 executives contacted, 168 met this criterion and were mailed the survey instrument. One hundred and one surveys were returned, for an overall response rate of 60 percent. Seven responses were found to have missing data required for testing the hypotheses. In addition, responses on three surveys suggested that the firms in which the executives were currently employed were not within the appropriate industries. This left a preliminary usable sample of 91.

The average age of the 101 respondents was 49, and the ages ranged from 34 to 69. The respondents had an average of 26 years of work experience. Thirty-four percent held the position of CEO or president, 8 percent were senior vice presidents, while another 41 percent were vice presidents. Seventy-one percent had previous experience selecting technology partners. Furthermore, 49 percent of the executives had technical academic degrees (engineering or physical sciences), while 39 percent had undergraduate business training. Forty-three percent held an MBA degree. Twenty-six percent indicated that their work experience was primarily technical (engineering or R&D). Within the usable sample

Table 2. Hypothesized relationships

Independent variables	Hypothesis	Proposed relationship
Executive experience		
Age	1	–
Technical education	2a	+
Technical education	2b	M
Technical work experience	3a	+
Technical work experience	3b	M
Executive perceptions		
Technological emphasis	4a	–
Technological emphasis	4b	M
Risk seeking orientation	5	M
Successful collaborative experience	6a	+
Successful collaborative experience	6b	M

(N = 91), 16 industries were represented, and the annual firm sales averaged $728 million.

A comparison of the positions held by respondents and nonrespondents suggested no significant differences. Moreover, 61 percent of the instruments sent to executives associated with the large Midwestern university were returned, while the engineering school executive alumni provided a 58 percent response rate. This suggests little response bias due to school affiliation. Only one industry sector revealed a difference in terms of respondents and nonrespondents. The electrical equipment sector (3600) made up 14 percent of the respondents and only 7 percent of the non-respondents.

Instrument

The survey instrument was made up of two parts. One part contained a policy-capturing exercise which included 30 scenarios of potential technological collaborative relationships described through 17 criteria (discussed below). In addition to the policy-capturing exercise, each respondent was asked to complete a survey consisting of a number of scales and questions soliciting descriptive data on the firm and the individual respondent. Thus, the packet of materials consisted of three sets of scaled questions, a page of demographics, and the policy-capturing exercise. These five items were randomly ordered before the survey was stapled and mailed to participants. This precaution was taken to control for potential order effects.

Decision models

The policy-capturing exercise was created to capture the decision models being applied by the executives while assessing potential technological collaborative opportunities within the context of their organization. Policy-capturing techniques are believed to tap the underlying cognitive processes of the respondent more objectively than other methods and are thought to reduce social desirability biases (Schwab, Rynes, and Aldag, 1987). The external validity of this approach has been further established through post hoc interviews that indicated that policy-capturing models accurately represent decision-making behavior (Hitt and Middlemist, 1979).[1]

Initially, the authors reviewed the literature on technical collaborative relationships and selected a set of primary considerations that are thought to influence the attractiveness of these relationships. To verify the rationale and wording of the factors, interviews were conducted with five top executives and five academics who either were involved in making similar decisions and/or had

[1] This methodology has been broadly utilized in previous organizational research to model decision processes (e.g., Hitt and Middlemist, 1979; Hitt and Tyler, 1991; Tyler and Steensma, 1995) and is similar to a repeated-measures design. This technique allows for the assessment of actual ‘theories in use’ as opposed to ‘espoused theories in action’ (Argyris and Schon, 1974). Policy capturing requires the subjects to evaluate a series of scenarios within the context of their organization. Using regression, the executive decisions made regarding each scenario can be aggregated and quantified into a decision model identifying influential criteria.

published in this area. This led to a set of factors that were pilot tested. Subsequent revisions from the pilot test led to 17 factors. Twelve of the 17 factors can be categorized as factors associated with strategic intent (stretch), relational risk, and performance risk (compare Table 1 and the Appendix). The sequence in which these factors were listed in the actual scenarios was randomly determined. This order, however, was consistent for all 30 scenarios.

The 30 different scenarios were developed by randomly assigning each of the 17 criteria a number on a scale ranging from one (low) to five (high). This random assignment creates diverse collaborative opportunities while limiting collinearity. The highest correlation was $r = 0.55$, and 96 percent of the pairwise *r*s were below 0.40. This suggests that the criteria are sufficiently independent and free of collinearity. A sample of one of the scenarios used in the study is provided in the Appendix.

Dependent variable

Each respondent was asked to evaluate the same set of 30 different scenarios. The dependent variable for each scenario was the executive's rating on two items, each on a 7-point Likert scale. Executives were asked about the attractiveness of the proposed relationship and the probability that they would pursue such a relationship. These items were combined to create the dependent variable, 'assessment of the opportunity' (alpha = 0.95). The resulting returns of 91 surveys equated into a sample size of 2730 observations. The assumption that each case represents an independent observation has previously been accepted in the strategy literature (e.g., Hitt and Middlemist, 1979; Hitt and Tyler, 1991; Tyler and Steensma, 1995).

Executive characteristics

Attributes of each respondent were obtained through a series of survey questions. The respondents were asked to report their age, undergraduate and graduate degrees, and primary work experience. 'Age' was a continuous 2-digit number reported by each participant. 'Technical education' was constructed as a dichotomous variable (0 = no, 1 = yes). Participants were assigned a value of 1 if the executive had either an engineering or a physical science degree; otherwise this variable was 0. The respondents were also asked to indicate their primary work experience. Those executives who indicated engineering or R&D as their primary work experience were categorized as having principally technical work experience. For these respondents, work experience was coded as 1. Executives who reported a primary work experience other than these two (e.g., marketing, production, finance, general management) were coded as 0.

Perceived company characteristics

Technology emphasis

The firm's emphasis on technology was measured using a 3-item 5-point Likert scale (low to high). Each respondent was asked: 'How significant is technology to the company's strategy?'; 'Is technological development a primary focus of the company?'; and 'How much emphasis does your company place on developing new technological skills?' The coefficient alpha for this scale was 0.91.

Risk orientation

To capture the firm's risk orientation, two previously utilized scales were combined: Khandwalla's (1976) 6-item scale and a 2-item scale derived from Miller *et al*. (1982). All eight items used a 5-point Likert scale format. After data collection, one item from Khandwalla's scale was found to be deficient and subsequently dropped, leaving a 7-item scale (coefficient alpha = 0.86). The scale was constructed so that the higher the score on the 7-question scale, the greater the firm's propensity for risk taking.

Successful collaborative experience

A firm's overall successful collaborative experience is a function of both the number of these relationships that it had been involved in and the success of these relationships. Thus, this measure is comprised of two components: experience and success. First, respondents were asked to indicate how many collaborative technological relationships their firm had been involved in and the number it was currently participating in. The responses to these two questions were added to form the measure of total collaborative experience (Experience). In order to establish the past *success* of collaboration for each executive's firm, a 2-item scale was constructed. Each respondent was asked to rate the overall success of previous collaborative technology development activities on a 5-point scale. They were also asked to estimate the percentage of such relationships that had been successful. This percentage was recoded on a 5-point scale (1 = 0–20%, 2 = 21–40%, 3 = 41–60%, 4 = 61–80%, 5 = 81–100%), which was then added to the overall success rating to generate a 2-item scale of collaborative success (Success). The alpha for these two items was 0.83. This measure of success was multiplied by the firm's total collaborative experience (Experience $\times$ Success) in order to capture the firm's level of positive experience with technological collaboration as accurately as possible.

Control variables

Industry, firm size, performance, and individual experience selecting collaborative partners were controlled for in the analysis. During initial telephone screening, executives were asked to provide information regarding their firm's primary industry. This was further verified using the CD/Corporate data base whenever possible. This information was used to assign 2-digit SIC codes to each respondent's profile. The natural log of annual sales, in millions, and its squared term were used to control for size effects (Damanpour, 1992; Ettlie, 1983). The firm's overall performance was estimated using a 5-item Likert scale (1 = very low, 7 = very high) derived from Khandwalla (1976). The respective items addressed profitability, growth rate, employee morale, financial strength, and public image (alpha = 0.78). Finally, a dummy variable, indicating whether the executive had experience selecting technology partners, was included as a control variable.

Pilot study

The survey instrument was piloted with executives involved in an executive development program and with part-time executive MBAs. Following data analysis, individual and group-level results were provided to the participants. The executives were debriefed in order to assess the interpretation of the policy-capturing criteria and survey scales. Any discrepancies in interpretation were subsequently addressed in the final instrument by altering the wording of the criteria or questions in the final questionnaire.

RESULTS

Prior to testing any of the hypotheses, each executive's individual model for assessing the attractiveness of potential technological alliances was determined by using stepwise regression to analyze his or her response to the 30 scenarios. Each of the 17 criteria were entered as independent variables in an attempt to explain the variance of the executive's assessment of opportunities. Stepwise regression accepts into the model only those variables that are statistically significant at $p > 0.05$. The explained variance for each individual model represents the respondent's internal consistency when evaluating the 30 collaborative opportunities. The complexity of the individual models ranged from no significant criteria to eight independent criteria entering into an individual's model.

In conformity with previous work that has employed this policy-capturing technique (e.g., Hitt and Middlemist, 1979; Keats, 1991; Tyler and Steensma, 1995), those respondents who failed to generate individual models that explained a minimum level of variance ($R^2 < 0.40$) were viewed as giving inconsistent responses. It is suspected that these individuals may not have viewed each scenario as independent of the others, or they may not have given adequate time to the exercise. In essence, an analysis of the individual models provides a check with regard to the internal reliability of each subject. Using the 0.40 cutoff, 21 individual models failed to meet this minimum standard; their data were not included in any further analyses. Observations from the remaining 70 respondents were aggregated, providing a total sample of 2100 observations (70×30). Table 3 reports the means, standard deviations, and Pearson product–moment matrix of the dependent, control, and independent variables (except for the alliance attributes) for these 70 executives.

Hierarchical regression was used to test the direct effects of the independent variables. Hierarchical moderated regression models were uti-

Table 3. Intercorrelation matrix for evaluation of the opportunity, control, and independent variables

	Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.	Assessment of the opportunity	7.16	3.46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2.	Food products	0.01	0.12	−0.01	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3.	Apparel and fabrics	0.01	0.12	−0.02	−0.01	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4.	Paper and allied products	0.01	0.12	0.05	−0.01	−0.01	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5.	Chemical and allied products	0.16	0.36	−0.01	−0.05	−0.05	−0.05	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6.	Petroleum refining	0.06	0.23	−0.02	−0.03	−0.03	−0.03	−0.11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7.	Rubber and plastics	0.04	0.20	0.01	−0.02	−0.03	−0.03	−0.09	−0.05	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8.	Fabricated metal products	0.04	0.20	0.02	−0.02	−0.03	−0.03	−0.09	−0.05	−0.04	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9.	Industrial and comp. equip.	0.09	0.28	−0.05	−0.04	−0.04	−0.04	−0.13	−0.07	−0.06	−0.06	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10.	Electronic equip.	0.16	0.36	−0.02	−0.05	−0.05	−0.05	−0.18	−0.11	−0.09	−0.09	−0.13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11.	Transportation equipment	0.11	0.32	−0.05	−0.04	−0.04	−0.04	−0.15	−0.09	−0.08	−0.08	−0.11	−0.16	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12.	Measuring instruments	0.06	0.23	0.00	−0.03	−0.02	−0.03	−0.11	−0.06	−0.05	−0.05	−0.08	−0.11	−0.09	–	–	–	–	–	–	–	–	–	–	–	–	–
13.	Miscellaneous manufacturing	0.07	0.26	0.02	−0.03	−0.03	−0.03	−0.12	−0.07	−0.06	−0.06	−0.08	−0.12	−0.10	−0.07	–	–	–	–	–	–	–	–	–	–	–	–
14.	Electric, gas utilities	0.14	0.35	0.07	−0.05	−0.05	−0.05	−0.18	−0.10	−0.09	−0.09	−0.12	−0.18	−0.15	−0.10	−0.11	–	–	–	–	–	–	–	–	–	–	–
15.	Software	0.03	0.17	0.01	−0.02	−0.02	−0.02	−0.07	−0.04	−0.04	−0.04	0.05	−0.07	−0.06	−0.04	−0.05	−0.07	–	–	–	–	–	–	–	–	–	–
16.	Size	5.35	2.67	−0.02	0.16	0.03	0.07	−0.09	0.21	−0.26	−0.10	−0.06	0.03	0.32	−0.09	−0.28	0.14	−0.17	–	–	–	–	–	–	–	–	–
17.	$Size^2$	35.7	30.6	−0.05	0.18	0.00	0.05	−0.08	0.22	−0.21	−0.12	−0.06	0.00	0.37	−0.08	−0.23	0.07	−0.16	0.96	–	–	–	–	–	–	–	–
18.	Performance	26.0	4.98	0.02	0.19	0.05	0.07	−0.01	−0.12	−0.06	−0.03	0.15	−0.08	−0.18	0.16	0.16	−0.08	0.05	−0.04	−0.04	–	–	–	–	–	–	–
19.	Selection experience	0.69	0.46	0.02	−0.08	0.18	0.18	−0.04	−0.03	0.16	0.01	0.01	−0.04	0.14	−0.17	0.05	−0.19	0.07	−0.19	−0.13	−0.07	–	–	–	–	–	–
20.	Age	49.0	9.01	−0.04	−0.16	−0.08	0.12	−0.03	0.06	−0.09	0.02	0.02	0.32	−0.13	0.00	0.04	−0.02	−0.10	0.02	0.00	0.24	−0.05	–	–	–	–	–
21.	Technical education	0.51	0.50	0.07	−0.12	0.12	0.12	−0.05	−0.00	−0.08	−0.01	0.00	0.26	−0.19	−0.01	−0.29	0.23	0.00	0.11	0.06	0.07	−0.02	0.30	–	–	–	–
22.	Technical work experience	0.26	0.44	0.09	−0.07	−0.07	0.20	−0.07	−0.14	−0.12	−0.06	−0.06	0.11	−0.01	0.00	−0.16	0.32	0.10	0.07	0.01	0.04	0.10	0.29	0.57	–	–	–
23.	Technological emphasis	10.5	3.29	−0.08	−0.02	−0.13	−0.09	0.22	−0.13	−0.18	0.01	0.08	0.27	0.00	0.10	−0.28	−0.21	0.05	0.27	0.31	−0.03	−0.27	0.06	0.03	−0.03	–	–
24.	Risk orientation	26.9	8.45	−0.03	−0.05	−0.04	0.10	−0.00	−0.05	−0.04	0.20	0.20	0.18	−0.13	0.12	−0.17	−0.25	0.17	−0.15	−0.11	0.15	0.00	−0.02	−0.02	−0.03	0.51	–
25.	Successful experience[a]	22.75	18.22	0.00	0.30	0.00	−0.11	−0.15	0.23	−0.15	−0.12	0.00	0.07	0.17	−0.17	−0.13	0.16	−0.13	0.64	0.69	0.02	−0.02	−0.03	−0.05	−0.08	0.28	−0.10

N = 70.
[a]Based on 53 executives.

lized to examine the hypothesized moderation effects. Interaction terms between the measure of interest and each of the 17 criteria within the policy-capturing scenario were generated. A restricted model included control variables, criteria, and the hypothesized direct effects of the executive characteristics and firm perceptions. The variance explained in this model was then compared to the full model, which included all of the variables in the restricted model and interaction terms. Moderated regression is considered to be a relatively conservative method for examining interaction effects, as the interaction terms are tested for significance after all main effects are first entered into the regression equation (McGee *et al*., 1995). To gain further insight into the nature of the moderation effects, subsample analysis was conducted for those moderators that generated a significant difference in the restricted and full models. The overall sample was split at the median of the moderating variable, and separate regression models were generated for each subsample.

Table 4 shows the results of the hierarchical regression models used to test the direct effects. Two models were created. Model 1 included all 70 executives, while Model 2 included only those executives from firms that had prior experience with technology-motivated collaborative arrangements (53 executives). In both of the models, the control variables and the specific information included in the scenarios were entered in the first step and accounted for a significant amount of variance. In Model 1, the second step included all experience and perception variables hypothesized to have direct effects with the exception of perceived successful collaborative experience. The second step significantly improved the model ($F = 7.72$, $p < 0.001$). In Model 2, the second step included all the experience and perception variables hypothesized to have direct effects. Again, the second step significantly improved the overall model ($F = 7.99$, $p < 0.001$). Individual direct effects of the experience and perception variables could then be assessed by examining the direction and significance of the specific coefficients. For example, Hypothesis 1 proposed a negative relationship between the age of executives and their assessment of alliances. The coefficient associated with age is negative and significant for the sample of 70 (Model 1: $b = -0.03$, $p < 0.001$), providing support for Hypothesis 1a. Similarly, it was argued in Hypothesis 2a that having a technical education would positively influence an executive's ratings. The coefficient associated with technical education in Model 1 of Table 4 is positive and significant ($b = 0.35$, $p < 0.05$) and supports this hypothesis.

Hypothesis 2b suggested that executives will utilize different information, depending on

Table 4. Hierarchical regression models

	Model 1				Model 2[a]			
Variables	*b*	R^2	ΔR^2	*F*	*b*	R^2	ΔR^2	*F*
Step 1								
Control variables and specific information		0.338	0.338	31.06***		0.361	0.361	26.70***
Step 2								
Age	–0.03***				–0.02[t]			
Technical education	0.35*				0.43*			
Technical work exper.	0.49*				0.37*			
Technological emphasis	–0.03	0.348	0.010	7.72***	–0.04			
Successful experience					0.03***	0.377	0.016	7.99***

[t]$p < 0.1$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
[a]Based on 53 respondents.

whether or not they have a technical education (i.e., a moderation effect). Table 5 displays the results of the moderated regression models. The change in R^2 between the full and reduced model involving technical education was significant ($F = 1.89$, $p < 0.05$). Table 6 shows the results of the subsample analysis. Coefficients are shown only for those scenario attributes that were associated with a significant interaction term ($p < 0.05$) in the moderated hierarchical regression model. As anticipated in Hypothesis 2b, education does moderate the overall decision model. Specifically, those executives with a technical education more heavily weighted the significance of the technology to the firm's current strategy when evaluating potential technological alliances. There was no significant difference in the weighting of the threat-based information.

Hypothesis 3a contended that primary technical work experience would also be positively related to the executive ratings of potential alliances. Model 1 of Table 4 provides support for these arguments ($b = 0.49$, $p < 0.05$). Hypothesis 3b proposes that technical work experience would moderate the relationship between the alliance attributes and an executive's ratings of attractiveness. No empirical support was found for this hypothesis (Table 5).

Hypothesis 4a suggested a negative relationship between the firm's emphasis on technology and the executive's assessment of potential alliances. No support was found for this relationship (Model 1, Table 4). Hypothesis 4b suggested that executives will utilize different information, depending on their firm's technological emphasis. The hierarchical moderated regression model, as seen in Table 5, provides support for this hypothesis ($F = 1.76$, $p < 0.05$). Table 6 shows how executives varied in their decision models depending on the technical emphasis of their respective firms. In particular, the executives who perceived their firms to have an emphasis on technology placed greater weight on opportunities (i.e., the potential to learn, the significance of new technology to strategy) and relational risk (i.e., partner's cooperative history) and less weight on performance risk (i.e., potential for decreasing development risk).

Hypothesis 5 proposed that executives' perceptions of their firms' risk orientation influences their weighting of information considered. The change in R^2 between the full and reduced model was significant ($F = 2.26$, $p < 0.01$; Table 5). This provides support for Hypothesis 5. Furthermore, Table 6 shows that the primary differences lie in the weighting of performance risk attributes. Contrary to expectations, executives who perceive their firms to be risk seeking are more concerned with the ability to patent protect the technology and the availability of technological substitutes. There were no significant differences in terms of the weighting of information associated with relational risk.

Hypothesis 6a suggested positive direct effect between the successful experience (Experience × Success) that a firm has had with technology relationships and the executive's assessments of such opportunities. This scale was only applicable to those respondents from firms having a history of collaborative relationships. Thus, the number

Table 5. Moderated regression models

Moderator	Model	R^2	ΔR^2	ΔF
Technical education	Restricted	0.348		
	Full	0.358	0.010	1.89*
Technical work experience	Restricted	0.348		
	Full	0.352	0.004	0.79
Technological emphasis	Restricted	0.348		
	Full	0.358	0.010	1.76*
Risk orientation	Restricted	0.348		
	Full	0.360	0.012	2.26**
Successful experience[a]	Restricted	0.377		
	Full	0.397	0.020	2.91****

$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.0001$
[a]Based on 53 respondents.

Table 6. Subsample analysis of moderating variables[a]

Subsample model	1		2		3		4	
	Technical education		Technical emphasis		Risk orientation		Successful experience	
Attribute	Yes	No	High	Low	High	Low	High	Low
Strategic intent								
Significance of this technology to current strategy	0.42***	0.33***	0.46***	0.28***			0.40***	0.33***
Potential to learn from the relationship			0.13**	0.02				
Relational risk								
Favorability of potential partner's cooperative history			0.12***	0.07*				
Number of other potential partners							–0.02	–0.15***
Performance risk								
Potential for decreasing development risk			0.02	0.12***				
Ability to patent protect the technology					0.12**	0.05		
Availability of technological substitutes					–0.14***	–0.09	–0.09	–0.20***
Total expected cost for development							–0.08	–0.20***
Explained R^2	0.38	0.36	0.42	0.36	0.41	0.34	0.39	0.45

$p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

[a]Subsample analysis was done only when the overall moderated hierarchical regression model was significant.

Beta weights are given for those attributes associated with a significant interaction term in the moderated hierarchical regression model.

of respondents utilized was 53. Table 4, Model 2, indicates a significant and positive relationship ($b = 0.03$, $p < 0.001$) providing support for Hypothesis 6a. Finally, Hypothesis 6b posited that a firm's overall success with collaborative relationships would influence the type of information utilized by executives. The hierarchical moderated regression model for successful experience is shown in Table 5. There was a significant change in R^2 between the restricted and full models ($F = 2.91$, $p < 0.0001$). Thus, the data also lend support for Hypothesis 6b. The subsample analysis for successful experience, as reported in Table 6, suggests that those executives from firms that are perceived to have had alliance success in the past place more weight on opportunity-based information (i.e., the significance of the technology to current strategy) and less weight on threat-based information.

DISCUSSION

The empirical data presented in this study support the contention that top executives' experiences and perceptions influence the way they process information when asked to assess potential technological alliances. Age, technical education, technical work experience, and perceptions of firm success with other technological alliances were all directly related to top executives' assessments of technological alliances (Table 4). No support, however, was found for the assertion that the more firms are perceived to emphasize technology, the less attractive technological alliance opportunities will be to executives. This suggests that a company culture perceived to emphasize technology does not necessarily cause executives to be more critical of technological alliance opportunities.

The study also found partial support for four of the five hypothesized moderating effects (Tables 5 and 6). Technical education and perceived firm technological emphasis, risk orientation, and previous success with collaborative activities all moderated executives' weightings of alliance attributes when asked to evaluate potential technological alliances. The fact that a technical education, but not technical work experience, moderated the use of information used by top executives is notable.

The subsample analysis on the significant interaction terms in the moderated regression model for technical education found that top executives with a technical education focused more on a piece of information that represented an opportunity for the firm to stretch their current store of resources (i.e., the significance of this technology to firm strategy) than did executives without a technical education (Subsample Model 1, Table 6). Technically trained executives did not, however, focus less on information related to threats than executives with nontechnical education. These findings and the fact that technical work experience did not moderate the weighting of information suggest that undergraduate technical education does more to focus executives on the technological opportunities associated with technological alliances than technical work experience.

Some support was found for all of the hypothesized differences in the weighting of opportunity and threat-based information by executives who perceive their firms to emphasize technology and to have had success with previous technological alliances (Subsample Models 2 and 4, Table 6). These executives place more weight on opportunity-based information (i.e., significance of this technology to strategy, and potential to learn) and less weight on threat-based information associated with performance risk (i.e., potential to decrease development risk, availability of technological substitutes, and total expected cost for development) than executives who perceive their firms to have less emphasis on technology and to have had less success with previous technological alliances. As predicted, executives who believe their firms emphasize technology also focused more on information that can be related to threats associated with relational risk (i.e., favorability of potential partner's cooperative history) than executives who did not have this belief. Likewise, executives who perceive their firms to have had success with previous technological alliances focused less on information that can be related to threats associated with relational risk (i.e., number of potential partners) than executives who did not have this perception.

Although top executives from firms perceived to have a risk-seeking orientation weighed information differently from executives from firms perceived to have a more risk-averse orientation (Table 5), they did not focus less on threat-based information than those that perceived their firms to be risk averse (Table 6). Rather, executives who perceive their firms to be risk seeking were more, not less, sensitive to the performance risks involved in technological development. They consistently considered the extent to which the technology to be developed could be patent protected and the threat of substitute technologies meeting market demand.

LIMITATIONS AND CONTRIBUTIONS

The study has some limitations. Because it is focused at the individual level, this study does not capture the enactment process that takes place at the organization level when top executives as a group or team assess potential technological alliances and make choices among the various alternatives (i.e., choices between alliances and choices between joint development, internal development or acquisition). Thus, the results suggest how top executives' experiences and perceptions influence their attitudes toward potential technological alliances and the kinds of information they attend to when individually assessing potential alliance opportunities but does not suggest how their attitudes and cognitive orientations might influence that of other executives when top executives as a group are called to make organizational choices. However, prior research has failed to consider how executives' cognitive understandings affect their individual interpretations of alliance opportunities. When individual differences in how executives evaluate strategic options are better understood, research can be conducted which looks at how these differences affect the organizational decision process. Auster (1994) called for research that incorporates cognitive and learning perspectives into the study of interorganizational linkages. This study begins at the most basic level, the individual top executive. Hopefully, future research will consider how individual cognitive and learning processes affect organizational knowledge structures.

Some could also take issue with the fact that this study used an experimental design, which could be perceived to be artificial and far removed from day-to-day management in organizations. The limitations of experimental designs are well documented, as are the limitations of field studies. Schwenk (1982) proposed that the limitations of these two methods of data collection can be somewhat addressed by using both methods in a complementary fashion. He suggested that the knowledge gained from more closely controlled experiments can be used to guide more grounded field research and the findings from subsequent field research can be used to guide experiments. Schwenk also argued that experiments are particularly effective in evaluating causal hypotheses because they remove the complexities and confounding events which make causal inference problematic in the field. Furthermore, Schoemaker (1990) argued that the policy-capturing methodology appears to be especially appropriate for capturing bounded and variable rationality because it seeks to portray frames of mind and processes of thought.

To date most academic research on alliances in general, and technological alliances in particular, is based on field research. The results of these field studies provided the foundation for the experimental design used in this study. By using an experimental design many of the complexities that confound causal hypothesis testing in field studies were controlled. The study supports the contention that individuals are boundedly rational and that variance in rationality between actors results from differences in mental understandings that result from differences in experiences and perceptions. Moreover, the theory presented and tested suggests that variable rationality is not necessarily irrational. Too often scholars have implied that variances in decision making due to the information processor is somehow irrational or biased. It can be argued that the results of this study provide new insights that may be used to guide future field research.

Although the potential technological alliances assessed in the study were experimentally designed, there is some justification for the belief that executives participating in the study did not see it as far removed from the day-to-day management of organizations. First, top executives of high-technology firms helped to construct the instruments used. These executives agreed that an analysis of potential alliances that had been rated by company staff or consultants along a few important dimensions was realistic. Secondly, 71 percent of the respondents had experience in selecting and negotiating technological alliances in their own firms and could put the created scenarios into a realistic context. Finally, executive education programs and consultants are actively measuring executives' cognitive understandings, noting cognitive gaps and biases, and developing special training programs in an effort to improve organizational decisions and firm performance (e.g., Senge, 1990). This suggests that executives recognize the importance of knowing what they believe and how their beliefs affect the decisions they make.

Another potential limitation of the study is that it is cross-sectional and, thus, cannot capture the dynamic aspects of the executive's decision process. The factors that might influence what information an executive might acquire for decision-making purposes, how the decision-making process itself is structured (e.g., a single decision point vs. multiple decision points), or how executives' discretion may be limited are not considered in this study (e.g., Dutton and Duncan, 1987; Hambrick and Finkelstein, 1987). Field research may better address these issues.

The overall effect size in terms of variance explained by executives' experiences and perceptions is relatively small. However, given the nature of the experimental design, this is not surprising, nor a reflection on the value of the findings. In a highly structured experiment examining executive decision processes, the objective information included in the scenario is expected to dominate in terms of explaining variance (Hitt and Tyler, 1991). Moreover, experiments are known to be conservative in terms of effect size.[2]

IMPLICATIONS FOR THEORY AND RESEARCH

The results of this study contribute to theory development and suggest future directions for research. While prior decision-making research based on cognitive modeling has focused primarily on moderating influences (e.g., Hitt and Tyler, 1991; Ireland *et al*., 1987), this study considers both direct and moderating effects of executives' experiences and perceptions. Although the results of this study suggest that the moderating effects of these factors provide more explanatory power than the direct effects, the study points out the potential for factors such as technical education, technical work experience, and successful firm experience to shift executives' cognitive assessment of alliances, acquisitions, or even new product opportunities up or factors such as age to shift cognitive assessment down. Thus, these factors can make executives more or less disposed to participating in technological alliances, acquisitions, or new product development. These findings suggest that future strategic decision-making research should consider both the direct and indirect effects of executives' experiences and perceptions.

Some organizational researchers have not found support for Dearborn and Simon's (1958) supposition that executives define problems largely in terms of the goals and tasks of the functional areas with which they have been most closely associated (e.g., Waller *et al*., 1995; Walsh, 1988). Inconsistent findings have resulted in a somewhat limited understanding of how functional work experience influences the decisions of top executives. The data reported in this study suggest that researchers who have considered the effects of work experience without controlling for educational training may have unintentionally confounded their results. The high correlation between technical education and technical work experience, reported in Table 2, supports the possibility that some of the effects reported to be related to work experience may well be the result of early formal education. Future research should be careful to separate educational experience from work experience by partialing out the variance in executives' decisions attributed to each.

Hitt and Tyler (1991) did not find support for the hypothesized moderation effects of executives' risk orientation on the relationship between objective decision criteria and strategic evaluations of acquisition candidates. They suggested that their failure to find support for this hypothesis resulted from the fact that most of the top executives in their study were risk seeking. The results of this study indicate that the firm's risk orientation, rather than the executive's, influences the executive's strategic decisions on behalf of the firm. This seems logical for three reasons: (1)

[2] In a recent review of effect size estimates, Fern and Monroe (1996) argue that the explained variance from contrived experiments should not be expected to be sizable, and are typically lower than those found in comparable field studies. Experiments, however, are better able to uncover significant causal relationships rather than assessing realistic effect sizes (Fern and Monroe, 1996). In addition, when specifically testing for moderation effects, Champoux and Peters (1980) argue that the magnitude of change in variance explained may not be an effective means for determining the relevance of theoretical or practical insights.

individuals' general risk orientation, considered to be a personality characteristic, may be far removed from their cognitive risk orientation in a specific situational context such as company involvement in technological alliances; (2) executives are asked to make judgments or choices on behalf of the organization; and (3) the consequences of the choices executives make in an organizational context will be rewarded positively or negatively by the organization.

Finally, the executive characteristics that moderated the weighting of alliance attributes during the assessment of potential technological alliances also influenced the amount of variance explained by alliance attributes and controls (Table 6). Thus, the alliance attributes and control variables included in this study are better predictors of the assessments of potential technological alliances for some executives than for others. Future research may suggest important alliance attributes and moderating factors not considered in this study, which may increase the predictability of executives' assessments.

IMPLICATIONS FOR PRACTICE

The results of this study have implications for practice. First, the study supports the premise that more technically trained individuals need to occupy top executive positions and become involved in making strategic decisions (Heilmeier, 1993). According to this study, executives with technical training are more sensitive to the significance of the technology to firm strategy than are executives without this training (Table 5). This is not to imply that the CEO must necessarily have technical training, or that all top executives in technology-oriented companies should be technically trained. It does, however, suggest that some executives with technical training should be included in organizational decisions related to technology development.

Secondly, the findings provide insight into why some firms invest a great deal of time and effort into molding executives' thinking to fit the organizational mind set or dominant logic (Prahalad and Bettis, 1986). These findings suggest that companies may be able to modify the mental models executives utilize when asked to make judgments on behalf of the company (Reger and Palmer, 1996). Executives' information processing, in this study, was predictably affected by their perceptions of their companies' emphasis on technology, risk orientation, and experience with technological alliances. This predictability should help the firm make consistent strategic decisions even when different executives are required to make choices.

The study does not, however, refute the possibility that companies may recruit executives who already possess cognitive models that are valued by the company (Barr, Stimpert, and Huff, 1992). Firms in technology-oriented industries and those that recognize the importance of an emphasis on technology may hire executives with technical degrees or individuals that believe that technological development is very important to a firm's future success. Thus, the study supports the idea that a firm may both influence the mental understandings used by executives during decision making, as well as recruit individuals with mental orientations that support the goals of the firm.

The study's results have implications for firms looking for technological partners. Both company and executive characteristics may be useful for screening and selecting potential partner firms. For example, past successful experience influences not only the likelihood that a company will pursue such a relationship, but also the factors that are more heavily weighted in the decision process. Executives who perceive their companies to have less successful technological alliance experience incorporate more information related to relational and performance risk (i.e., threats) than did executives who perceive their firms to have more successful experience but were less sensitive to information regarding the significance of the technology to firm strategy (i.e., opportunities). Those executives who perceive their firms to have more successful experience appear to be less concerned about threats and more focused on strategic opportunities. On an individual level, those executives with technical degrees and work experience appear to be more receptive, overall, to the notion of technological collaboration. Thus, firms wishing to collaborate with another firm may initially want to approach executives in the potential partner firm who possess a technical background and who can then 'champion' the idea.

There are also normative implications to be drawn from executives' perceptions of their firms' success with technological alliances. Perceptions of firm success with technological collaboration appear to make top executives less critical of potential technological partners they are evaluating for future cooperation and therefore more favorable toward alliances in general. This may be because the firm has accumulated organizational assets related to cooperation which make future collaboration easier or more beneficial (Dierickx and Cool, 1989), as argued in the theory section. This may also result, however, from an overconfidence bias (i.e., 'because we have been successful in the past we are confident that our technological alliances will be successful in the future'). As reported in Table 5, executives from firms perceived to have been successful in prior technological alliances did not attend to the potential risks associated with these types of alliances. This lack of attention to pertinent information regarding risks may cause executives to enter into technological alliances that are not in the best interest of the firm. Executives who believe that their firms have been successful in the past should, therefore, be careful to evaluate appropriate risk-related information when assessing potential technological alliances.

CONCLUSION

As competition becomes more global and the costs of technology development rise, firms are establishing networks of strategic alliances. This study's findings support the contention that executives' experiences and perceptions regarding their companies' context influence the cognitive models they use when asked to make alliance assessments. Furthermore, subsample analyses provided insights into how specific executive attributes affect what information is noticed and how it is cognitively weighted when technological alliances are evaluated. Thus, the study helps to address a need in the literature in terms of integrating behavioral and cognitive research with research on interorganizational relationships (Auster, 1994).

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APPENDIX: EVALUATION REPORT FOR TECHNOLOGY AND POTENTIAL PARTNER FIRM ***JV***

Technology and partner characteristics		Low 1	Mod. low 2	Average 3	Mod. high 4	High 5
1.	Significance of the technology for your company's strategy	(x)	( )	( )	( )	( )
2.	Life cycle phase of the technology (e.g., Low = Introduction, High = Decline)	(x)	( )	( )	( )	( )
3.	Existing skill capability your company has to develop this technology	( )	(x)	( )	( )	( )
4.	Importance of 'learning by doing' associated with the technology	( )	( )	(x)	( )	( )
5.	Total expected cost for developing the technology	( )	( )	(x)	( )	( )
6.	Number of other potential partners with similar joint development capabilities	( )	( )	( )	(x)	( )
7.	Extent of asset specific investments required (i.e., capital investments that cannot be used for other purposes)	( )	( )	( )	(x)	( )
8.	Favorability of potential partner's cooperative history	( )	( )	( )	(x)	( )

APPENDIX: EVALUATION REPORT FOR TECHNOLOGY AND POTENTIAL PARTNER FIRM ***JV***

Technology and partner characteristics	Low 1	Mod. low 2	Average 3	Mod. high 4	High 5
9. Potential for broad corporate application of the technology	(x)	( )	( )	( )	( )
10. Extent to which the technology can be patent protected	( )	( )	( )	(x)	( )
11. Potential for decreasing development risk through the cooperative relationship	( )	( )	( )	( )	(x)
12. Extent to which your company has information regarding this technology, relative to the potential partner	(x)	( )	( )	( )	( )
13. Your company's potential to learn from the cooperative relationship	(x)	( )	( )	( )	( )
14. Extent of technological substitutes currently available	( )	( )	( )	( )	(x)
15. Potential for increased exposure to related market opportunities	( )	(x)	( )	( )	( )
16. Compatibility of operating and management styles between your company and partner	( )	( )	( )	( )	(x)
17. Extent to which cost commitments are contingent on favorable technological outcomes	( )	( )	( )	(x)	( )

Based upon the information provided above, and your experience and knowledge, please rate the attractiveness of this situation for a cooperative/partnering relationship. Place an X in the appropriate space.

Very unattractive __ __ __ __ __ __ __ Very attractive
1 2 3 4 5 6 7

What is the probability that you would recommend this cooperative relationship? Place an X in the appropriate space.

Low probability __ __ __ __ __ __ __ High probability
1 2 3 4 5 6 7