

EXPLORATORY LEARNING, INNOVATIVE CAPACITY, AND MANAGERIAL OVERSIGHT

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When adaptation requires innovation, or the creation of variety, exploration is crucial. High levels of exploration thus imply variance-seeking rather than mean-seeking learning processes. In a study of 56 new business development projects, given high exploration, organizational learning was more effective when the projects operated with autonomy with respect to goals and supervision. As degree of exploration decreased, better results were associated with less autonomy on both counts. This contingent effect persisted even when I controlled for the emergence of deftness and comprehension.

To survive in Schumpeterian environments, organizations must be able to cope with increasing complexity and high-velocity change (Brown & Eisenhardt, 1998; Schumpeter, 1950). The principle of requisite variety suggests that effective adaptation requires sufficient internal variety (Ashby, 1952). Internal variety, in turn, is associated with exploration (March, 1991), involving the search for new organizational routines and the discovery of new approaches to technologies, businesses, processes, or products. Internal variety is relevant to several theoretical traditions: it is viewed as determination to gain new information at the expense of improving present returns in the rational choice model, as the core element of search in theories of limited rationality, as invention in theories of organizational learning, and as the pursuit of variation in evolutionary models. In short, exploratory learning is critical to the capacity of an organization to create variety, and hence, to adapt.

Although the importance of learning to adaptation is hardly controversial, managing exploratory learning is not well understood. My purpose in this study was to examine how managerial oversight processes influenced exploratory learning in new business development projects.

One perspective on learning emphasizes discovery through enactment and interpretation. Retrospective sense making acts as a selection mechanism (Daft & Weick, 1984; Weick, 1979). Success depends upon generating enough variations that at

least some will prove *ex post* to yield desirable results. The consequence of this form of learning is increased performance variance.

A contrasting perspective is that of directed search. Learning is characterized as a process that is amenable to *ex ante* planning and control (Lumpkin & Dess, 1996). It emphasizes limiting variety achieved by honing in on and deepening initial insights as experience increases (see Block & MacMillan, 1993). This form of learning tends to improve mean performance and decrease variance.

Scholars positing a contingency effect for degree of exploration have proposed a middle-ground argument (Cheng & Van de Ven, 1996; Pisano, 1994; Tushman & O'Reilly, 1997). In highly novel settings, groups should follow the variety-generating approach. This is because, absent a base of cause-and-effect understanding, experimentation generates information that cannot be obtained any other way. Given greater knowledge, groups can improve on what they already know (Burns & Stalker, 1961; see also Goold & Quinn, 1990: 55). This argument is intuitively appealing because it accommodates both the generation of variety and the improvement of mean performance. The open question is whether differences in the approach to learning imply differences in managerial oversight.

THEORY AND HYPOTHESES

Generation of Variety as a Correlate of Fitness

The idea that it is useful for organizations facing rapid change to generate internal variety appears not only in classic adaptive systems theory (Ashby, 1956) but also in several recent streams of research. For instance, Levinthal (1997) found that simulated organizations tended to adopt forms consonant with the requirements of a local peak in a "rugged

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fitness landscape." When the landscape changes, the peak can disappear. Absent sufficient internal variety to allow an organization to change to a new form, it is vulnerable to sudden and deadly obsolescence.

This phenomenon has been widely documented in empirical research. Tushman and Anderson (1986), for example, showed that faced with a change in underlying technology, industry incumbents found it nearly impossible to innovate in order to adapt to new competitive conditions. Instead, they failed. Henderson and Clark (1990) found equally devastating effects on firms facing architectural innovations. Leonard-Barton (1992) went so far as to argue for the presence of "core rigidities"—routines that actually inhibit an organization from innovating to accommodate new circumstances.

Despite the generally grim prospects, some firms do seem to be able to adapt when faced with new situations. One key difference between firms that are able to adapt and those that fail has to do with the ability to engage in exploration, even while improving existing routines (Levinthal & March, 1993; March, 1991; Tushman & O'Reilly, 1997). Their survival has to do with the competitive effects of variance. March (1991) concluded that when primacy matters in competitive interaction, pursuit of performance variance is more important than pursuit of improvement in mean performance. Focus on improving mean performance renders a firm vulnerable to opponents that may not be superior overall but that capture the right-hand tail of the performance distribution. As the right-hand tail of the distribution of potential performance increases, the possibility of losing out to a high-variance competitor increases. In effect, the mean-pursuing firm can stumble into a classic competence trap by settling on a solution shown subsequently by competitors to be inferior. Exploration is thus associated with adaptation because of its variance-increasing effects. By implication, the greater the environmental uncertainty, those organizations that prove to have superior abilities to manage exploration will be better able to adapt to changing circumstances.

The advantages of increased variance have been recognized not only in the learning literature but also in a complementary perspective on real options reasoning (Bowman & Hurry, 1993; McGrath, 1997; Mitchell & Hamilton, 1988). Real options reasoning highlights the financial benefits of increased variance. Given the same initial investment in exploration, those opportunities with higher variance have more option value under uncertainty, because poten-

tial returns are higher for the same potential downside loss.

Though it may take some time for maladapted firms to fail (Meyer & Zucker, 1989), those less able to adapt become weakened over time. This effect is exacerbated by the judgments of external stakeholders. Those firms perceived to be coping better will tend to attract greater levels of investment, will be able to access better labor, and be otherwise advantaged. Perceived ability to adapt can thus yield substantial advantages in terms of access to resources.

The argument suggests four implications relevant to adaptation. First, as the rate of environmental change accelerates, exploration increases in importance. Second, firms managed by those skilled at overseeing exploration processes will enjoy increasing advantages. Third, as the number of competitors increases and new sources of competition appear, advantages will accrue to firms using variance-seeking rather than mean-seeking strategies. Finally, exploratory learning behavior that is variety seeking should result in greater variance in both the novel knowledge and novel routines created, with a possible adaptation advantage.

Degree of Exploration as a Key Contingency

If creating the ability to adapt were simply a matter of pursuing variance, the story would be simple. The dilemma, however, is that variance does not generate returns without some efforts to fix and develop the new knowledge. Too much variance seeking and a firm never capitalizes on its discoveries. Too little, and it can ossify. The critical issue appears to be how much existing knowledge is relevant.

When existing organizational knowledge gives an organization's members an understanding of the fitness terrain, it makes sense to optimize performance on a local peak, to use Levinthal's (1997) terminology. In contrast, when existing knowledge offers little insight, the local peak is no longer relevant, and the organization needs to gather enough new knowledge to make "long jumps" (Levinthal, 1997). This formulation implies that degree of exploration is a critical contingency for whether mean-enhancing or variance-enhancing learning is desirable.

If one accepts this contingency premise, then it makes intuitive sense that different forms of managerial oversight will be appropriate under different levels of exploration. This idea has some precedent in the literature. Cheng and Van de Ven (1996), for instance, found that when a group was attempting to converge on specific solutions, vari-

ance-reducing oversight processes helped it to do so. Rewarding achievement of targets leads learners to adjust their behavior so as to generate more desired and fewer undesired outcomes, improving mean performance, albeit at the expense of variance. Different behavior is appropriate for creating variance. When greater variance is sought, actions and outcomes should be loosely coupled, many alternatives should be tried, and it should be recognized that results not consistent with expectations don't necessarily lead to a change in behavior.

Different Oversight Behaviors for Different Levels of Exploration

Managerial influence is often characterized in terms of two forms of oversight. The first has to do with setting performance goals (Cyert & March, 1963; see also Lant, Milliken, & Batra, 1992) and the second with control over operational decisions and activities (Burns & Stalker, 1961; Ouchi, 1977). Although related, these are conceptually separate activities in the strategic control literature (Goold & Quinn, 1990).

At one extreme, managers may allow a group complete latitude in terms of goals, focusing on possibilities and opportunities. At the other extreme, managers may be directive, defining "specific project goals, objectives or outcome criteria" (Cheng & Van de Ven, 1996: 608). For the purposes of this study, *goal autonomy* represented the first extreme. When goal autonomy is high, managers do not specify goals, talent allocations, or lines of authority. A second way in which management exercises oversight is through the specification and supervision of operational activities. I call this second vehicle for exercising oversight *supervision autonomy*. To the extent that a group has high supervision autonomy, it will enjoy greater local discretion, which permits greater heterogeneity in day-to-day activities.

These definitions are the crux of the contingency argument. High levels of goal autonomy and supervision autonomy are associated with higher variance. I have suggested that high variance is desirable when exploration is high and potentially undesirable when it is lower. If this assertion holds, it calls into question taken-for-granted assumptions with respect to goal setting and control for high-exploration projects.

The desirability of establishing clear, measurable, and unambiguous goals, working relationships, and authority structures for projects is seldom questioned, and for good reason. Clear goals help to absorb uncertainty and create focus. A few clear metrics and clearly delineated responsibili-

ties reduce the cognitive burdens of making sense of uncertain situations. They can provide a guide to making trade-offs under conditions in which many activities compete for scarce time and attention (Levinthal & March, 1993: 97; March & Simon, 1993: 188; Thompson, 1967). The clearer the goal, the more meaningful it is in terms of rewards, incentives, and satisfaction, and the more it motivates behavior.

The behavioral learning and strategic management literatures, and the group dynamics and teamwork research streams all agree on such a view of goals. Consider the parallels between March and Simon's observation that "the greater the clarity of goals associated with an activity, the greater the propensity to engage in it" (1993: 188) and Chesney and Locke's conclusion that "specific, challenging goals lead to higher performance than vague, easy goals" (1991: 400). One might be forgiven for concluding that a fundamental assumption in managerial oversight is that it is valuable to set clear goals.

The idea that variance aids adaptation under uncertainty, however, calls this general principle into question. Indeed, defining clear goals, job responsibilities, and group membership may be unintentionally dysfunctional. Clear goals narrow the field of search, create a frame for the interpretation of new information, and increase the likelihood that data disconfirming the decision premises upon which the goals were based will be ignored (Kiesler & Sproull, 1992).

Effective goal setting is also difficult under true uncertainty (Knight, 1921). In uncertain situations, as opposed to situations characterized by risk, the range of outcomes and their probabilities are not known. *Before* this understanding can develop, organization members must first build (or "enact"; see Weick [1979]) a base of knowledge. Specific, measurable goals might prematurely truncate discovery processes that are critical to creating this base of knowledge. If deviation from such goals is considered personally threatening, recent research in the psychology of groups suggests that critical learning processes will be suppressed. These include feedback seeking, experimentation, and discussion of errors (Edmondson, 1999).

In short, for highly exploratory projects, little existing knowledge applies, and the objective is to gain knowledge about unfamiliar landscapes. Thus, variance is desirable, and effectiveness of learning stems from results that are not necessarily goal-directed. This argument suggests the first contingency hypothesis I examined:

Hypothesis 1. At high levels of exploration, increases in goal autonomy will be associated

with increases in learning effectiveness, and at low levels of exploration, decreases in goal autonomy will be associated with increases in learning effectiveness.

Somewhat less controversial are the contingent effects of exploration on supervision autonomy. Greater autonomy allows for innovation in problem solving, which has been often associated with adaptiveness. Autonomy helps minimize the strain on organizational information-processing capacity by loosening the coupling between those involved in an exploratory project and the rest of a company. Decisions can be made by the group charged with learning, without information having to travel through limited processing channels (Galbraith, 1973). Informal, ad hoc problem solving maximizes the range of possible responses to unpredictable problems.

Informality provides an inducement for individuals to exercise greater individual discretion, in the words of Thompson (1967), and has been associated with greater motivation and commitment.

In contrast, formal job and role definitions, consistency of approach, and documented and standardized behavior are thought to interfere with the exercise of individual discretion (Thompson, 1967: 120). When the desired results are reliability, replicable performance, and safety, rather than novelty, conscious and heedful specification of activities is desirable (Weick & Roberts, 1993). Specified, well-codified tasks can be more readily maintained, are easier to enhance, and are easier to transfer and thus to replicate (Nelson & Winter, 1982: 117).

Supervision autonomy, in short, can also be expected to interact with degree of exploration. Variance enhancement is more likely to flourish in circumstances in which improvisation and experimentation are encouraged, in which information flows are frequent and dense, and in which roles and jobs are undefined. As more knowledge is gained, on the other hand, greater effort can be focused on developing "highly effective capabilities of limited scope" (Nelson & Winter, 1982: 126) through increasingly systematized, codified, and well-understood procedures. Guidebooks come to replace improvisation, roles and jobs become more clearly defined, and rules for "how we do things here" gradually replace trial and error. This has the effect of improving the mean rather than the variance of performance. This line of argument suggests the following hypothesis:

Hypothesis 2. At high levels of exploration, increases in supervision autonomy will be associated with increases in learning effective-

ness, and at low levels of exploration, decreases in supervision autonomy will be associated with increases in learning effectiveness.

METHODS

Sample and Respondents

The data analyzed here come from 56 exploratory projects, situated in large companies, that were designed to create new businesses. The projects were identified through company contacts based on research sponsorships or advisory arrangements. Senior executives of the companies identified the projects as new business development initiatives. Each project required a company to learn about new markets, products, or technologies. One firm (Hewlett Packard) contributed three projects, and another (American Reinsurance), two projects. The remaining firms contributed one project each. Forty-five percent of the sample consisted of manufacturing firms, and 50 percent were service firms. The remainder were in retail. Project objectives ranged widely, from commercializing a "state-of-the-art bipolar integrated circuit process" to developing a "replacement for a highly successful market-leading product."

The managers involved expected to be able to use the results diagnostically (I discussed results only after data collection). The responding companies contributed considerable employee and management time and, in two cases, funding, to the research process. The major advantage of using personal contacts and the promise of useful feedback was that respondents were professionally interested in the results and committed to making sure the data were accurate. These characteristics clearly distinguish the surveys I used from mailed questionnaires, which typically have low response rates.

The respondent set for each project included the person with primary responsibility for its success (the project leader) and at least three others in the organization with important project responsibilities. Respondents thus represented an expert reference group in an appropriate position to evaluate the constructs of interest. The need for me to impose judgments upon the data was thus reduced. The sampling strategy also captured the perceptual data upon which the respondents made their decisions, which Weick and Roberts (1993) suggested is crucial, since people behave in accordance with their perceptions, not in accordance with ostensibly objective data.

The respondents could be, but were not neces-

sarily, part of a team. Teams are popularly thought to represent working groups characterized by high commitment, high involvement, or intense connections to one another. This study did not exclude such groups, but it also included those operating in the more loosely coupled manner connoted by such terms as task force or confederation. Indeed, Weick and Roberts made it clear that a group can be relatively immature in a developmental sense, yet have an extremely well-developed collective mind (1993: 374–375). Throughout this study, I therefore prefer to use the word “group” rather than “team.”

The groups varied considerably from one another. Most consisted of a mixture of functional specialists and business generalists. With some exceptions, members of the groups had other responsibilities within their parent organizations. Groups constituted a mix of senior and junior people. The groups varied in terms of the ages and genders of respondents and whether or not they were located in the same place. Although I did not specifically collect survey data on this point, the groups represented in this study appeared (from field observation) to be representative of the kinds of groups their parent firms would use to pursue other strategic projects. Surveys were completed anonymously and returned directly to me through the mail by respondents, ensuring confidentiality.

Measures

I developed multiple questionnaire items that tapped each construct. Respondents rated each item on one-to-five Likert-type scales in which higher values were always associated with higher levels of the construct. I first averaged the responses of a project's members for each item and then totaled and averaged these average scores across items for each construct, thus obtaining an overall grand average for each construct. This method is similar to the approach employed by Gresov, Drazin, and Van de Ven (1989). They pointed out a major advantage of such an approach: when scores are totaled across several items in a large sample, with group responses to a large number of items, biases of individual responses are averaged out and the resulting interpretation of results is conservative because variance is compressed. Assumptions about normality are more easily justified, increasing confidence that parametric statistical methods are appropriate. The Appendix provides additional details about the measures.

Learning effectiveness. Learning occurs when people develop “knowledge about action-outcome relationships and the effect of the environment on

these relationships” (Duncan & Weiss, 1979: 84). To the extent that members of an organization can produce desired outcomes, they can be said to have developed “specific operational knowledge,” sometimes referred to as competence (Nelson & Winter, 1982: 99). Operational knowledge allows an organization to respond effectively to environmental conditions, making this a useful construct for approximating adaptive capacity.

Respondents were instructed to assess results achieved by their project over the last two months. A rating of 1 indicated that results were far worse than expected, and a rating of 5 indicated that results were far better than expected. These assessments were applied to ten generic objectives common to new business development projects.

Goal autonomy. This construct represents the extent to which a project team was granted autonomy with respect to goals, roles, and authority structures. Respondents were asked to position their projects between two semantic differentials, with a value of 1 indicating lower autonomy and a value of 5 indicating greater autonomy.

Supervision autonomy. This scale was developed to assess the extent to which a project team was granted autonomy with respect to operating activities. Respondents were asked to position the typical way people handled operational tasks between two semantic differentials. A rating of 1 positioned a project closer to the “supervised” end of the dimension, and a rating of 5 positioned the project closer to the “autonomous” end of the dimension.

Degree of exploration. This measure captures how, and in what ways, newness manifested itself in a project—whether in the product, technology, resources employed, or markets sought. This measure of exploration has the advantage of allowing an overall assessment of how exploratory a project is across a number of dimensions. Respondents were asked to provide a rating in response to the question, “To what extent are the following project characteristics or factors new to your firm at the moment?” A value of 1 meant “to no extent (not new at all),” and a 5 meant “to a very great extent (entirely new).”

Adequacy of the Measures: Reliability, Validity, and Bias

I paid considerable attention in this study to issues of reliability, validity, and possible bias. I sought face (or content) validity by constructing measures that were consistent with previous fieldwork and the received literature. I also built upon previous empirical work in designing the study.

Evidence that the measures were valid was supported by the fact that they were central to significant managerial decisions (such as resource allocation, personnel change, and accelerating and, in some cases, terminating, projects) and were provided as the basis for continued sponsorship of further research by decision makers in the firms.

A strong test for validity, according to Carmines and Zeller, is criterion validity, in which one seeks "correspondence between the test and the criterion" (1979: 17), with correspondence usually estimated by the size of their correlation. Unfortunately, most of the projects in the samples were in progress. A subsample of 20 projects, however, had progressed to the point of generating revenues, one important indicator of adaptation through new business development. This subsample allowed the following test for criterion-related validity: For each of the 20 projects, revenues forecasted in the business plan and actual revenues were compared. The differences between these numbers (representing the *actual* deviations from revenue targets for these projects) were then correlated with the learning effectiveness scores (which measured the *perceived* deviation from targets) obtained from the survey at the time of the initial plan. The correlation between the actual difference in revenues and the learning effectiveness score was positive at .53, and significant ($t = 3.17, p < .001$), supporting the criterion validity of the learning effectiveness measure.

I also tested for the discriminant validity of the scales, meaning the extent to which they measured a single underlying construct, not multiple constructs. I calculated the correlation among items within each construct and then the correlation between items in the construct and items in each other construct, using the averaged composite scores for the team. In every case, the within-construct correlations were greater than the correlations across constructs. The correlations among variables were not statistically significant.

A concern with survey measures is whether the fact that respondents are using a single instrument influences their responses. Podsakoff and Organ (1986) suggested use of Harmon's single-factor test to test for such biases. The basic assumption is that if a substantial amount of common method variance is present, either a single factor will emerge from the factor analysis or one general factor will account for the majority of the covariance in the independent and dependent variables. I ran five separate factor analyses, combining items for the dependent variable with items for different independent variables. In every one of these factor analyses, more than one factor with an eigenvalue

greater than one was obtained. In addition, items from the different constructs separated cleanly; no item from one construct had a loading of greater than .5 on a factor associated with another construct. I also examined the scree plots, which showed no sign of a common method factor.

I further ran a correlation analysis between each project leader's performance assessment and that of the rest of the group. These correlated at the .05 level or better. Thus, group responses corresponded with the perceptions of the individuals who were not only most responsible for the outcomes of the projects, but who were also the least vulnerable to inward-looking myopia.

I also ran a test in which I split the sample of respondents within the larger project teams and conducted a correlation analysis for the main effect variables. The correlations were all significant at the .05 level and had the same signs as the results below. Since different respondents completed the relevant sections of the questionnaires for the dependent and independent variables, these correlations could not have been a result of common response bias.

Potential Confounding and Control Variables

I captured data on potential confounding variables using the group's survey responses, survey responses from the project leaders, and publicly available data. Where theory suggested that variables other than those in the hypotheses might explain variance, control variables were included. These were the deftness of a project group, its level of comprehension, its firm's industrial sector and size, and the size of the project. As the results below show, the main effect variables showed a consistent pattern even after the control variables were taken into account.

Deftness. Weick and Roberts (1993) introduced the concept of "group mind" to explain how individuals can act interdependently and heedfully to produce reliable results, even when no single individual within a system knows how the whole system works. This idea has been empirically extended to innovation contexts and shown to have a strong association with group performance outcomes (McGrath, MacMillan, & Venkataraman, 1995; McGrath, Tsai, Venkataraman, & MacMillan, 1996). One indicator of a group with a developed group mind, according to my previous work (McGrath et al., 1995), is that it behaves with "deftness." This represents joint activity in which organizational members know what action a situation requires, can anticipate what parts of that action

can be done by others and trust them to do it, and are willing to do their part.

Deftness was measured in this study with the semantic differential scale previously used by McGrath et al. (1995). A value of 1 implied low deftness, and 5 indicated greater deftness.

Comprehension. Comprehension implies that individuals' know-how regarding cause and effect is connected. No single individual in a group needs to understand how the whole system works in order for the group to mount an adaptive response. Weick and Roberts (193: 366) were clear on this point, noting that a group comprehends when the knowledge necessary to find a solution exists within itself and that this knowledge is made actionable by deft interdependent activity.

Comprehension was also measured by the scale used by McGrath and colleagues (1995). The construct measured the extent to which respondents believed their group had access to knowledge with respect to cause-effect relations. A rating of 1 meant that a respondent believed that within his or her group, "we have no idea" of causality in the item being addressed. A value of 5 meant the respondent felt "we know exactly."

Both deftness and comprehension have been empirically found to have significant performance effects, which suggested that it was important to include them as control variables in this study.¹

Industry. Industrial sector is thought to affect both structure and performance. Sector dummy variables were included in the regressions as control variables to account for any possible interference from these effects. Three categories of industry were used: service, manufacturing, and other.

Firm size. Commonly found to influence dimensions of structure (such as complexity) and to have important effects on such variables as degree of innovativeness and available slack, firm size (measured as the logarithm of the number of employees) was included as a control variable.

Project size. Project size might have confounded my results because it represents slack resources and signifies the scope of a project. The complexities of coordinating very large projects may also limit the effects of managerial oversight. Project size was measured as the number of people working on a project.

RESULTS

Table 1 presents means, standard deviations, and correlations. No variable was highly skewed, so all variables were sufficiently close to a normal distribution to justify assumptions of normality. I computed the variance inflation factor (VIF) for all variables in the study. Results suggested no need for concern with respect to multicollinearity. I also checked the assumption of homogeneity of variance. The Levene statistic for the independent variables was satisfactory, except in the case of the exploration variable, where it was marginally unsatisfactory. Significant and positive correlations between learning effectiveness, the dependent variable here, and deftness and comprehension suggested that it was important to include these constructs in the analysis. There was also a negative and significant correlation between goal autonomy and learning effectiveness, as might be expected, given the consensus in received theory that ambiguous goals interfere with a group's ability to perform well. Goal autonomy was also significantly and negatively correlated with deftness, consistent with the same argument. Goal autonomy and supervision autonomy were also positively and significantly correlated, and so I analyzed them separately in considering the interactions.

Regression results are reported in Table 2, which displays coefficient estimates and *t*-statistics. Model 1 in Table 2 omits the management variables and includes only the degree of exploration and the control variables as independent variables.² The only significant predictors in this model are deftness and comprehension, as might be expected from theory. In model 2, the goal autonomy and supervision autonomy constructs are added. Goal autonomy is significant in this model, in addition to deftness and comprehension. Model 3 is a test for interaction effects between goal autonomy and exploration, and model 4 is a test for interaction effects between supervision autonomy and exploration. Both models show a significant increase in the multiple squared correlation coefficient (R^2) over the models without the interaction terms, and these terms are significant in both models, suggesting support for both Hypothesis 1 and Hypothesis 2. A final model, model 5, was included to test for an interaction between goal autonomy and supervision autonomy, but this interaction term was not significant, and the improvement in R^2 relative to models without interaction terms was modest.

Hypothesis 1 suggests that under highly explor-

¹ I appreciate the developmental concerns of an anonymous reviewer with respect to the descriptions of deftness and comprehension in this study.

² I did run a regression model with only the control variables. The results were virtually identical to model 1 in Table 2.

TABLE 1
Means, Standard Deviations, and Correlations^a

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9
1. Learning effectiveness	3.25	0.41									
2. Goal autonomy	2.40	0.58	-.38**								
3. Supervision autonomy	3.07	0.49	.02	.45**							
4. Deftness	3.66	0.40	.49**	-.50**	-.09						
5. Comprehension	3.54	0.36	.28*	-.07	-.04	.26					
6. Degree of exploration	2.80	0.66	.03	.14	.20	.01	-.14				
7. Firm size ^b	3.33	0.96	-.48	.01	.06	.07	-.01	-.01			
8. Project size	6.80	4.12	-.19	.22	-.01	-.16	.15	-.15	.09		
9. Service dummy	0.44	0.50	.27*	-.07	-.09	.16	.01	.02	-.18	.09	
10. Manufacturing dummy	0.38	0.50	-.16	.12	.19	-.17	.03	-.06	.68**	-.05	-.70**

^a $n = 56$.

^b Logarithm.

* $p < .05$

** $p < .01$

atory conditions, greater goal autonomy will be positively associated with learning effectiveness but that this relationship will be reversed under less exploratory conditions. The data presented here appear to support this set of relationships. Model 3, incorporating an interaction between goal autonomy and exploration, offers support for Hypothesis 1. The interaction term has a significant and positive coefficient estimate (1.60, $p = .039$, under a two-tailed test). This result indicates that as the degree of exploration increases, increasing goal autonomy is associated with increasing learning effectiveness.

Given that the results report standardized coeffi-

cient estimates, the interaction coefficient for goal autonomy can be interpreted following partial differentiation, as described by Schoonhoven (1981). Figure 1 displays the results graphically. The analysis suggests that increased learning effectiveness is associated with increased goal autonomy when exploration is more than 0.75 standard deviations above its mean value.

Hypothesis 2 suggested that more exploratory situations call for greater supervision autonomy and vice versa. The data also support a contingency effect for this construct. Model 2 in Table 2 suggests that despite their high correlation, goal autonomy and supervision autonomy do have different effects

TABLE 2
Results of Regression Analysis for Learning Effectiveness^a

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Goal autonomy		-0.28 [†]	-1.17*	-0.28 [†]	-1.52 [†]
Supervision autonomy			0.13	-1.05*	-0.59
Exploration	0.05	0.07	-1.10 [†]	-2.29*	-0.02
Deftness	0.40**	0.27 [†]	0.25 [†]	0.31*	0.28 [†]
Comprehension	0.24 [†]	0.26 [†]	0.24 [†]	0.23 [†]	0.24 [†]
Firm size	-0.08	-0.07	-0.02	-0.08	-0.08
Project size	-0.17	-0.12	-0.23 [†]	-0.31*	-0.15
Service sector dummy	0.27	0.29 [†]	0.27	0.19	0.36*
Manufacturing sector dummy	0.15	0.14	0.14	0.10	-0.18
Goal autonomy × exploration			1.60*		
Supervision × exploration				2.84*	
Goal autonomy × supervision autonomy					1.72
Adjusted R^2	.25	.27	.33	.35	.29
F	3.38**	3.01**	3.40**	3.73***	3.05**
ΔR^2			.06	.07	
F			4.03**	5.04**	

^a $n = 56$.

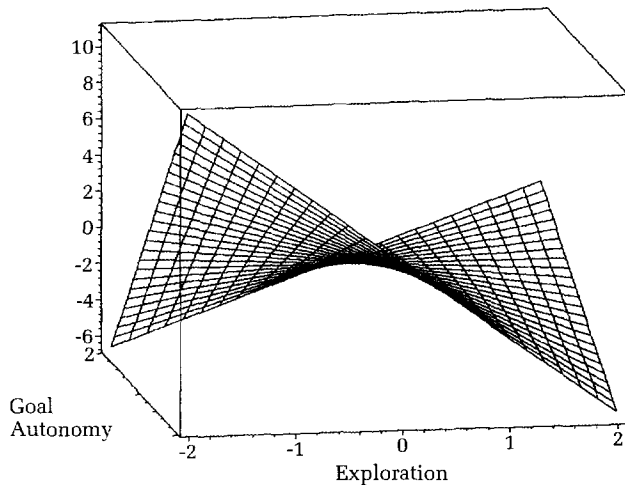
[†] $p < .10$

* $p < .05$

** $p < .01$

FIGURE 1

Interaction between Goal Autonomy and Degree of Exploration for Learning Effectiveness



$Learning\ effectiveness = -1.2 (goal\ autonomy) + 1.10 (exploration) + 1.60 (goal\ autonomy) \times exploration.$

$\delta Learning\ effectiveness/\delta goal\ autonomy = -1.2 + 1.6 (exploration).$

This is 0 when exploration = 0.75, less than 0 when exploration < 0.75, and greater than 0 when exploration > 0.75.

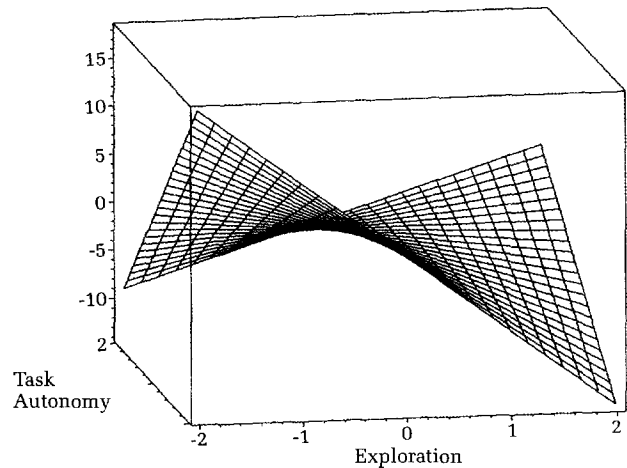
on learning effectiveness. The coefficient estimate for supervision autonomy is positive (but not significant), as opposed to the coefficient estimate for goal autonomy, which is negative and significant. However, when the interaction between exploration and supervision autonomy is included in model 4, the interaction term is positive and significant (2.84, $p = .015$), and including it raises the adjusted R^2 from .27 (for model 2, without interaction effects) to .35. As before, the results can be analyzed using partial differentiation. These are displayed graphically in Figure 2.

Hypothesis 2 is supported. When exploration is more than 0.37 standard deviations above its mean value, or for most of the upper range of exploration, increased supervision autonomy is associated with increased learning effectiveness, but for the lower part of the range, the opposite holds true. This implies that for exploratory situations, increasing supervision autonomy has a positive association with learning effectiveness, but when there is greater knowledge available to a project group, increasing the degree of supervision has a positive association with learning effectiveness.

As expected, deftness and comprehension, indicators of a more highly developed group mind, were positively and significantly associated with learning effectiveness in all five models tested.

FIGURE 2

Interaction between Task Autonomy and Degree of Exploration for Learning Effectiveness



$Learning\ effectiveness = -1.05 (supervision\ autonomy) - 2.25 (exploration) + 2.85 (supervision\ autonomy) \times exploration.$

$\delta Learning\ effectiveness/\delta supervision\ autonomy = -1.05 + 2.85 (exploration).$

This is 0 when exploration = 0.37, less than 0 when exploration < 0.37, and greater than 0 when exploration is > 0.37.

These associations support their inclusion and empirically support the theory advanced by Weick and Roberts (1993).

Firm size, a correlate both of age and of slack, was not significantly correlated with any of the main effect variables, and it was not significant in the regression models. The relationship between project size and learning effectiveness was negative in all the regression models and only significantly negative in the two models (models 3 and 4) including the interaction terms. Controlling for project size was thus warranted. Controlling for industrial sector appears to have been important. Although the manufacturing dummy showed no significant correlations with the main effect variables or significant coefficient estimates, the service sector dummy did. It had a positive and significant correlation with learning effectiveness and a positive and significant coefficient estimate in models 2 and 4 in Table 2. This pattern suggests that in the future, researchers seeking to generalize across industry settings would be well advised to consider possible sector effects in interpreting results.

Taking into account all the control variables, the results presented here suggest that when it comes to exploratory learning effectiveness, both degree of exploration and selection of oversight strategies matter. At different levels of exploration, the same

oversight strategies had different associations with exploratory learning effectiveness.

DISCUSSION

The results presented here are consistent with a small but growing body of empirical work on the importance of exploration to adaptive learning. Pisano (1994), for instance, found that in situations in which firms were attempting to introduce new products on a strong basis of underlying scientific knowledge, laboratory experimentation was effective in shortening development times. This relationship did not hold in exploratory situations. When underlying knowledge was relatively low, no amount of what Pisano termed "learning before doing" reduced the time spent. A core conclusion of Pisano's study was that "there is no one best approach to learning . . . it depends on the nature of the firm's knowledge environment" (1994: 98). My findings echo this conclusion.

Eisenhardt and Tabrizi (1995) found a similar result when investigating strategies for accelerating product development under uncertainty. They concluded that under high uncertainty, the use of prototypes, rapid iteration, and sense making through direct contact were more valuable than a "compression" strategy in which well-understood links in a system were squeezed together. Variance-creating strategies, in other words, were more valuable than mean-enhancing strategies.

Cheng and Van de Ven (1996) similarly found that when a group was engaged in innovation, learning initially stemmed from chaotic patterns of interaction, in which outcomes and consequences were not tightly coupled. Subsequently, and under resource pressure and the need to bring a product to commercialization, the group they observed relied increasingly on more clearly defined goals and more formal supervision. As does my study, they offered evidence supporting the conclusion that variance generation and mean enhancement are each appropriate under different conditions of exploration.

When more existing organizational knowledge applies to the problems in a project, a management approach conducive to narrowing and focusing the project group seems to be associated with learning effectiveness. When, however, the projects in this sample were faced with high levels of exploration, the opposite appeared to hold. Learning effectiveness was a function of more goal autonomy and greater supervision autonomy.

This study thus complements and enhances the conclusions of previous studies. The measures used here offer an inexpensive, easily replicable

way both to diagnose the nature of the learning challenge facing a group and to determine whether the management approach being used to navigate this challenge is appropriate.

Limitations

Although the usual caveats with respect to perceptual, cross-sectional data apply, considerable care has been taken to attend to concerns of reliability, validity, and generalizability. As Crampton and Wagner (1994) concluded, a blanket condemnation of self-report measures is inappropriate, and instead what should be encouraged is awareness of the danger of precept-percept effects. The reader should remain aware that the data are derived from self-report surveys of respondents identified by project managers.

Measures of the constructs were obtained from several knowledgeable insiders, so individual biases and distortions should be mitigated. The danger of distortion is limited when respondents are asked to rate objective organizational characteristics, rather than subjective, personal feelings (see Spector, 1992). The respondents were all individuals of some skill, judgment, and talent, else it is difficult to imagine why they would have been allocated significant responsibilities in strategic projects. On the average, their perceptions must at least correspond closely enough with objective reality to have landed them their current (important) assignments.

The survey process for this study was typically initiated as part of a collaborative arrangement in which a firm sought to use the data as feedback for enhancing its effectiveness. Thus, the firms too had an interest in providing accurate data. Finally, confidentiality was assured for respondents, reducing their incentive to artificially inflate or disguise their responses.

Implications and Future Research Directions

This study calls into question the assumption that groups tend to learn more effectively when goals and tasks are clearly specified. It suggests the need for scholars to rethink the boundary conditions under which this general principle applies. At high levels of exploration, learning effectiveness was associated with variance-increasing patterns of managerial oversight, rather than with mean-increasing patterns. This finding flies in the face of the conventional wisdom that learning will improve when a group's members share specific goals and targets.

This study suggests important links between the-

ories of adaptation in uncertain environments and theories of organizational learning. It offers empirical evidence supportive of March's (1991) argument. When higher variety is needed, less oversight is valuable. When less variety is needed, more oversight is appropriate. Moreover, it identifies and measures specific managerial oversight behaviors that tend to covary with one or another form of learning.

The idea that under uncertainty, variance in performance can matter as much as means do suggests the need to question other well-accepted management practices. Take the evaluation of success and failure. As my earlier research (McGrath, 1999) suggested, management oversight that is pervasively success seeking in a narrow sense can lead an organization to generate insufficient variety. This happens because deviation from plan in a negative direction can be branded a failure, which tends to squeeze out variety and inhibit learning (Edmondson, 1999). This phenomenon would not occur if managers recognized the benefits of extending the right-hand tail of the performance distribution, even at the cost of encountering failure along the way. My current observations also suggest that researchers need to rethink taken-for-granted dependent variables for studies of learning and adaptation. When variance is important, you can expect failure, and it might, surprisingly, be quite useful.

This study suggests that different management oversight behaviors are needed to diffuse discoveries than to generate high-variance new knowledge. This distinction creates a dilemma for organizational design. To increase variance, loose coupling is useful. In loosely coupled systems, the potential for local discovery is maximized (Orton & Weick, 1990). Tighter coupling, on the other hand, helps diffuse variations across multiple units. Incorporating both design principles within a single organization is no mean feat. Thus, understanding how the new knowledge generated by exploration is diffused and incorporated into new businesses remains an important question for future research.

My results also suggest more heterogeneity in organization-environment interactions than is commonly posited. Scholars studying environmental contingencies have conventionally viewed firm-level challenges as imposed by environmental conditions. In their classic treatise on organic and mechanistic systems, for instance, Burns and Stalker (1995) conceptualized environments as uniform across competing firms. In this study, I characterized the degree of exploration partially as a function of a firm's existing knowledge, rather than as a purely exogenous con-

struct. This definition matters, because a heterogeneous and firm-specific organization-environment interface implies that different management oversight behaviors are indicated even when firms face more or less identical environmental challenges.

A firm with considerable absorptive capacity (Cohen & Levinthal, 1990) may find itself operating at the lower end of the exploration scale, while another firm facing the same conditions may find that it is in a high exploration mode. Uncertainty for one firm, in the sense described by Knight (1921/1971) is risk for another, with probabilities that may be estimated and outcomes that can to some extent be predicted. By implication, path-dependent consequences of previous investments exert a heavy influence on future possibilities. Two-panel studies, in which the predictor variables are collected at one time and project outcomes at another, would be a useful way to begin assessing these dynamics.

Relatedly, my results also suggest that there might be considerable utility in formally including the exploration construct in "resource-based" explanations of strategic performance (Amit & Schoemaker, 1993). The typical view is that resource accumulations have more positive than negative potential (for an exception, see Miller and Shamsie [1996]). The difficulty is that under Schumpeterian competition, yesterday's competencies may offer little advantage in tomorrow's markets, and the routines accumulated in serving today's customers may get in the way of serving those of tomorrow.

CONCLUSION

This study was motivated by a wish to develop a finer-grained understanding of the mechanisms through which managerial oversight of the process of exploration assists or hinders learning effectiveness in new business development projects, which represent a critical source of variety. The study supported some conventional wisdom with respect to managerial oversight but suggested the need to question other premises.

Evidence presented here suggests that the degree of exploration does indeed, as March (1991) suggested, matter. Further, the degree of exploration is a critical organizational contingency. This means that simple rules, such as "always set clear goals," may not have the same effects across the range of exploration. Managers and scholars with this insight might manage projects differently or study them differently, taking into account level of exploration.

I have argued that the key difference between projects with high levels of exploration and those

closer to existing organizational knowledge is their contribution to variance. This study thus follows a behavioral learning tradition that suggests that the most fruitful form of learning is not always learning that takes you where you meant to go and that discovery and recognition can be as important as planning and control. In a context in which challenges to existing organizations by new firms or new forms appear to be emerging with greater frequency and with more potentially devastating effects, managing variance-generating processes begs to be better understood.

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APPENDIX Measures

- Learning Effectiveness $\alpha = .85$
- “Please assess the performance of your project over the last two months, on each of the following dimensions.” (1 = “results were far worse than expected”; “results far better than expected”).
- Meeting budget objectives
 - Meeting staffing objectives
 - Meeting major deadlines
 - Meeting quality objectives
 - Meeting reliability objectives
 - Meeting cost objectives
 - Meeting efficiency objectives
 - Meeting user/client satisfaction objectives
 - Meeting service objectives
 - Meeting objectives overall
- Deftness $\alpha = .88$
- “Please assign a score which positions your project between the two statements made for each item.” (1 positioned a project toward the left on the semantic differential scale, represented below by the first statement; 5, toward the right).
- Few of the others in the team always know what to do./All the others on the project team always know what to do.
 - Few of the others in the team are competent to do what is needed./All the others in the team are competent to do what is needed.
 - Few people on the team can depend on one another to do what is needed./All people on the team can depend on one another to do what is needed.
 - Few people on the team know what information is important to the others./All people on the team know what information is important to the others.
 - On this project, there are many hidden agendas./On this project, here are very few hidden agendas.
 - Important information often gets held up./Information flows quickly.
 - Important information often gets withheld./Information never gets withheld.
 - Important information is often distorted./Information is always accurate.
 - New people joining the project find it very difficult to be accepted./New people joining the project are very easily assimilated.
 - Few people on the team understand one another./All people on the team understand one another—we all “speak the same language.”

Few people on the team can depend on one another to implement decisions./All people on the team can depend on one another to implement decisions.
 Information needed to move the project forward is simply not available./We have all the information that we need to move the project forward.
 The project is very short of key skills./All key skills are in place.
 Team members are uncomfortable challenging one another./ Team members are very comfortable challenging one another.
 There is little agreement that correct decisions are being made./There is general agreement that correct decisions are being made.
 I get little feedback regarding my contribution./I get rapid and open feedback regarding my contribution.
 Individuals tend to pursue their own interests in execution of the project./Individuals suppress their interests in favor of project interests.
 I am given no opportunity to provide open feedback regarding the contribution of others./I am given a great deal of opportunity to provide open feedback regarding the contribution of others.

Comprehension $\alpha = .88$

"To what extent do you feel YOUR TEAM understands each of the following aspects of your project?" (1 = "we have no idea at this stage"; 5 = "we know exactly.")

Key sources of revenue
 Who key customers are
 The customer need being satisfied
 The competition you face in filling this need
 Where, when & how customers will use your offering
 Risks to the customer of buying your offering
 How to price your offering
 Legal or regulatory matters affecting your business
 The main sources of risk to your firm
 Support services which must be provided
 The cost of resources
 How key operations need to be carried out
 Factors which interfere with operations reliability
 Factors which interfere with output quality
 Costs of your operations
 Major bottlenecks preventing improved operations

Goal Autonomy $\alpha = .82$

"Please assign a score which positions your project between the two statements made for each item." (1 positioned a project toward the left on the semantic differential scale, represented here by the first statement; 5, toward the right).

Goals are clearly defined/goals are left open.
 It is very clear who is working on the project./It is not at all clear who is working on the project.
 Lines of authority are precisely defined./Lines of authority are fluid.

Supervision Autonomy $\alpha = .81$

"Please assign a score which positions your project between the two statements made for each item. (1 positioned a project toward the left on the semantic differential scale; 5, toward the right).

Operations depend on formal, sophisticated control and operation systems. Most operations depend on informal relations and norms of cooperation.
 We mostly follow documented procedures and maintain established standards./We often disregard procedures if the task at hand seems to require it.
 We try to ensure that most team members take a consistent approach to their work./We tend to encourage people to vary a great deal in their approach to their work.
 Most people's activities are well-defined by their formal job descriptions./The work most people do varies a great deal, depending on the situation at hand.
 We believe in developing thorough plans and executing them well./We believe in setting general directions and adapting as we go.
 Most job-related communications are vertical, up and down the organization./Most job-related communications are horizontal.

Exploration $\alpha = .88$

"To what extent are the following project characteristics or factors new to your firm at the moment?" (1 = "to no extent"; 5 = "to a very great extent").

The people who are working on the project
 The product or service offered
 The market or clients served
 The customer/client need to be met
 Those paying for or funding the offering
 The users of the offering
 The competition faced
 The systems used
 The know-how of the project team
 The skills of the project team
 The technology used in the project
 The distribution channels for the product

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