Strategic Management Journal
Strat. Mgmt. J., **37**: 1529–1546 (2016)
Published online EarlyView 7 October 2015 in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/smj.2414
Received 7 December 2013; *Final revision received 21 May 2015*

THE IMPLEMENTATION IMPERATIVE: WHY ONE SHOULD IMPLEMENT EVEN IMPERFECT STRATEGIES PERFECTLY

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Research summary: *We propose a theory that explains why the relentless pursuit of perfect implementation of strategy may be useful even in a world in which the strategies being implemented are far from optimal. We formulate a computational model in which an organization's strategy adapts based on performance feedback. However, the distinctive feature of our approach is that we abandon the "organization as a unitary actor" assumption, and model a separation of beliefs and actions. The central insight is that, given this separation, precise implementation has benefits beyond the well-known effect of enabling exploitation of good strategies. It enables the discovery of better strategies by allowing more effective learning from feedback on the value of current strategies.*

Managerial summary: *Given the reality that the strategies coming from the C-suite are seldom perfect, is it sensible for managers to place such a heavy emphasis on implementing them precisely? In this paper we develop a theory that explains why the answer may be "yes". In most organizations, the formulators and implementors of strategy are distinct. Imprecise implementation makes it difficult for the formulators to learn the value of their strategies, as neither success nor failure necessarily indicates something about the value of the strategy itself, when implementation is imprecise.*

INTRODUCTION

The links between strategy, organization, and performance have always been central to the field of strategic management (e.g., Chandler, 1962). In this perspective, the path to superior performance lies in the implementation (or "execution," as it is sometimes called), through appropriate organizational arrangements, of a strategy that is consistent with the environment that the firm finds itself in (e.g., Galbraith, 1973; Hrebiniak, 2006; Lawrence and Lorsch, 1967; Nadler and Tushman, 1997).

Perfect or precise implementation of strategy is not the same as successful performance; indeed defining it in terms of performance would be tautological. We define precision of strategy implementation as *the extent to which an organization's actions correspond to its strategic intentions* (Hrebiniak, 2006; Johnson, 2004; Neilson, Martin, and Powers, 2008; Noble and Mokwa, 2010; Yang, Sun, and Eppler, 2010). Thus, a company that seeks to pursue a low-cost strategy can be said to have implemented the strategy precisely if its costs indeed fall relative to its rivals; whether this leads to high profits or not depends on the appropriateness of the low-cost strategy in that particular industry.

Keywords: strategy implementation; adaptation; learning; exploration; exploitation
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While precise implementation of strategy cannot guarantee superior performance, it is frequently seen as a key ingredient for successful organizations. It is not easy to achieve, as lower level managers may not execute strategies precisely because some degree of employee discretion in actions is inevitable (Bernard, 1938; Simon, 1951), and no organization design can completely control behavior (Galbraith and Kazanjian, 1988; Govindarajan, 1988). Yet, the acknowledged difficulty of achieving it does not appear to have diminished the desirability of precision in strategy implementation in the world of managerial practice (see Bossidy and Charan, 2002; Hrebiniak, 2006; Noble and Mokwa, 2010; Yang, Sun, and Eppler, 2010).

In our view, the dominance of this "implementation imperative" —*the view that improving the precision with which strategy is implemented is always desirable*—in managerial discourse (see, for instance, Bossidy and Charan, 2002; Hrebiniak, 2006; Neilson *et al.,* 2008) is puzzling on at least two counts: It appears to repose too much faith in the quality of the strategies imposed "top down" on the organization, and too little in the value of variance generated through "bottom-up" exploration for better strategies.

There is no doubt that if the correct strategy were known ex ante, precise implementation would always be preferable to imprecise implementation. However, in a world of bounded rationality, the objectively correct strategy is rarely known. It is well recognized today, even by its proponents, that top-down strategic planning is seldom infallible and must constantly confront the challenge of inadequate local knowledge (e.g., Breene, Nunes, and Shill, 2007; Kaplan and Norton, 2005). Indeed, a key insight from the perspective on organizations as adaptively rational systems (e.g., Cyert and March, 1963; March and Simon, 1958; Simon, 1947) has been that imperfect implementation of strategy may in fact be a valuable source of "bottom-up" exploration for better strategies (Benner and Tushman, 2002; Burgelman, 1983; Eisenhardt and Brown, 1999; Levinthal and March, 1993; March, 1991). Put simply, if we cannot guarantee that our selected strategy is the best (which is typically the case in a world of bounded rationality), exploration should be valuable.

In this paper, we construct a formal computational model that helps us to understand why improving the precision of strategy implementation may be desirable *even* in a world in which there exists potential gains from bottom-up exploration and there are limits to the quality of top-down strategies. The resulting insights suggest an explanation for why the implementation imperative may not be misplaced in the discourse of management practice: it offers an argument for the "rationality of practice", as it were (which would of course be valid even if managers themselves were unaware of these benefits of increasing precision of implementation). Crucially, our analysis highlights sharply the conditions under which it is desirable to increase precision in implementation of strategy *despite* ignorance about the optimal strategy.

In keeping with typical models of organizational adaptation (Cyert and March, 1963; Denrell and March, 2001; Herriott, Levinthal, and March, 1985; March, 1991; Posen and Levinthal, 2012), we formulate a model in which an organization's strategy adapts based on performance feedback. Thus, for the organization in our model, initial beliefs about the right strategy may be inaccurate to varying degrees, but these adapt on the basis of feedback. In this sense, the model is a classic model of adaptive rationality through experiential learning, as it features belief and action revision through reinforcement learning on the basis of feedback on current actions (Sutton and Barto, 1998; Thorndike, 1998; see Puranam *et al.,* 2015 for an overview).

However, we enrich current models by explicitly incorporating the feature that the agent who holds beliefs and the agent who executes them are not the same. This recognizes the property that formal organizations are multiagent hierarchical systems in which delegation is pervasive (March and Simon, 1958; Simon, 1947). In the model, a manager holds a belief about the appropriate strategy for the organization at a point in time, and a subordinate then implements this belief. The manager then updates beliefs about the value of the strategy based on feedback about organizational performance.

Our model helps us to explore in a precise and rigorous way the general intuition that the process of learning from feedback should be more complicated when beliefs and actions are separated across agents in a multiagent adaptive system. Specifically, we study the effects of imperfect communication between the manager and the subordinate, imperfect observation of the subordinate's actions by the manager, and top-down exploration by the manager on the value of bottom-up exploration by the subordinate. Our results provide insights on the conditions under which increasing the precision of implementation by the subordinate is desirable, even if the strategies the manager wants the subordinate to implement are themselves unlikely to be perfect.

IMPRECISE IMPLEMENTATION AS A SOURCE OF EXPLORATION

Formal models of the process of search demonstrate the value of exploration—the trying out of alternatives with unknown value rather than alternatives with known values. In these models, exploration serves a useful purpose by making it more likely that better alternatives can be found. Excessive exploration, however, prevents exploitation of the valuable alternatives already known, giving rise to the famous exploration—exploitation trade-off in learning systems (Gittins, 1979; Holland, 1975; March, 1991; Sutton and Barto, 1998). Thus, some degree of variance in realized organizational actions around the intended action is a valuable source of exploration for better strategies (March, 1991), rather than something to be suppressed entirely.

To make these ideas concrete, consider the phenomenon of "bootleg innovation" in which individuals ignore top-down management directives, to make their own choices on how to invest company resources to pursue innovation (Knight, 1967). These efforts are in direct contravention of official strategy and so represent a failure of strategy implementation. Yet, it is now well documented that such deviations from strategy can be beneficial to the firm (Augsdorfer, 2005). Iconic cases include the story of Apple's graphic calculator, which was developed by two employees who worked on it without official authorization, and later despite being asked to desist. In fact they are believed to have sneaked into the premises to continue working on it even after they were no longer employed by Apple. Eventually, the product was recognized as a valuable add-on to the Mac OS.[1] Similarly, membrane filtration techniques for the production of pharmaceutical compounds are in wide use today, but were initially the result of bootlegging activity by scientists at Beecham (now Glaxo Smith Kline) in the 1980s, who continued working on it despite official orders to stop (Augsdorfer, 2005). Delegation in resource allocation decisions to functional and middle managers may produce a similarly useful divergence between intended and realized strategy in complex multilayered organizations (Bower, 1986; Burgelman, 1983).

Even when these bottom-up deviations from official top down strategy are not explicitly as intended as in bootlegging activities or delegated resource allocation, natural variations and even errors can often lead to improvements in organizational knowledge. The history of science and innovation is replete with instances of serendipity, which by definition must have arisen through deviations from plans (e.g., Merton and Barber, 2003; Nonaka and Takeuchi, 1995). Too rigid an emphasis on implementation of existing (imperfect) strategies may well curtail such useful variation. For instance, Benner and Tushman (2002) have documented the adverse consequence for exploratory innovation of process management techniques (such as total quality management) that are explicitly meant to reduce variation and improve alignment between strategy and employee actions (also see Benner and Tushman, 2003; Slater, Hult, and Olson, 2010). Edmondson (2008) has argued that too much focus on execution-as-efficiency crowds out opportunities for execution-as-learning.

This insight, that some degree of imprecision in implementation is actually desirable in a world in which the optimal action is rarely known ex ante, has also become quite deeply embedded in the management literature on organizational learning and innovation. An extensive literature has developed around the exploration–exploitation trade-off as well as proposed organizational solutions to manage it (e.g., Benner and Tushman, 2003; Gibson and Birkinshaw, 2004; Tushman and O'Reilly, 1996). Yet, this insight appears to have made few inroads into the world of strategy implementation. Senior managers continue to list improving strategy execution as among their top priorities,[2] and the practitioner literature offers many exhortations to improve relentlessly the precision of strategy implementation (Bossidy and Charan, 2002; Neilson *et al.,* 2008; Sull and Spinosa, 2007).

It is this discrepancy between what we know from theory about the exploration–exploitation

[1] http://mentalfloss.com/article/31077/when-his-project-was-canceled-unemployed-programmer-kept-sneaking-apple-finish-job

[2] http://www.conference-board.org/publications/publicationdetail.cfm?publicationid=1746

DOI: 10.1002/smj

trade-off and what we observe in practice in the context of strategy implementation that we try to bridge in this paper through a careful reconsideration of the theory, using the apparatus of a formal computational model. Such a model allows for a precise statement of assumptions in a manner that makes them transparent, and allows for an examination of the complex, nonlinear ways in which a system characterized by these assumptions behaves over time. Verbal theorizing alone does not offer either this precision or insight into dynamics, unless practiced by an extraordinarily gifted theorist (Adner *et al.,* 2009; Davis, Eisenhardt, and Bingham, 2007).

MODEL

Since the canonical representation of the exploration–exploitation trade-off across multiple literature streams is based on learning in the multi-arm bandit task (Denrell and March, 2001; Gittins, 1979; Sutton and Barto, 1998), we explore a model that uses the same task but features a separation of beliefs and actions across multiple agents. Posen and Levinthal (2012) provide a recent detailed introduction to the applications of the bandit model in the organizational sciences and related literatures. We therefore concisely describe the model in terms of its four basic components: the task environment, the agent's representation of the task environment, a process for transforming the agent's representations (i.e., learning), and a choice process through which the agent selects actions within the representation.

The *task environment* of the *n*-armed bandit model takes its name from analogy to slot machines in casinos (Holland, 1975). In the casino, a gambler faces a slot machine with *n* arms, each with unknown underlying payoff distributions. In organizational applications, the arms may represent different strategies, projects, or more generally choices with unknown expected payoffs and variances. As Posen and Levinthal (2012) note, the primary feature of this problem is that information about the value of an arm can only be obtained by selecting it. Thus at any point in time, an organization confronting such an *n*-armed bandit must choose one of the arms, which results in a payoff that is a realization from a (possibly arm -specific) probability distribution. These payoffs constitute visible performance measures for organizations such as profits, market share, or market capitalization.

We assume that our organization consists of a manager (M) and her subordinate, (S). In our model, M formulates strategies, communicates them to S (possibly imperfectly), and observes how S implements them (possibly imperfectly). S implements the strategy as understood by him, but imperfectly; this can be understood recursively to be the case because of S's own subordinates who implement S's intentions albeit with errors. Thus a natural interpretation of the roles of M and S might be that of a CEO and Divisional Manager in a multidivisional corporation.

Both agents, at any point in time may have a *representation* of the task environment in the form of beliefs (not necessarily knowledge) of the task environment, in terms of an associated set of estimated payoffs for each arm. Following prior work, we assume that for each arm $a \in \{1, 2, \ldots, n\}$, there exists an unknown true expected reward $Q^*(a)$ and based on the accumulated reward information, agent j's estimate of this (where $j \in \{M, S\}$), $Q_{jt}(a)$ at time *t,* is calculated as below

$$Q_{jt}(a) = \frac{1}{k_a} \sum_{i=1}^{k_a} r_i \tag{1}$$

The vector of $Q_{jt}(a)$'s thus constitutes the agent *j*'s representation of the task environment. Here, r_i represents the realized reward of the action a at *i*th trial and $Q_{jt}(a)$ is the average payoff for this arm after it has been <u>believed</u> to have been tried k_a times. (The fact that k_a is a belief will become critical when we introduce separation of belief and action into the model.) This rule for constructing the estimate comes from the assumption that the estimate of an arm's value at any point in time is the average of the entire history of rewards arising from having selected that arm (March, 1991; Posen and Levinthal, 2012). This is how the agent's representation of the task is *transformed* through feedback. Note that Equation 1 implicitly states that the estimate of the value of a strategy increases if its current performance exceeds the aspiration level defined by historic average, else it decreases.

To complete the specification of the model, we assume a standard choice process from the literature on bandit models. The probability of an agent *j* choosing action a at time t is calculated using the softmax rule as below, where n is the total number of alternative actions that the agent confronts.

$$P_{jt}(a) = \frac{\exp\left(\frac{Q_{jt}(a)}{\tau_j}\right)}{\sum_{i=1}^{n} \exp\left(\frac{Q_{jt}(i)}{\tau_j}\right)} \quad (2)$$

This softmax action selection rule has been found to describe effectively how humans select actions in trial-and-error learning situations (Camerer and Hua Ho, 1999; Daw *et al.,* 2006), and has also been used to model organizational adaptation processes (e.g., Posen and Levinthal, 2012). High values of agent-specific $\tau_j \gg 0$ will promote exploration, in the sense that the agent becomes more likely to select actions other than those currently believed to be the best, while low τ_j results in the current best belief to be selected.

The dynamic model represented by Equations 1 and 2 capture a reinforcement learning process whose variants are known under the labels of trial-and-error learning, experiential learning, operant or instrumental conditioning or "win-stay-lose-shift" rules in the relevant literatures in psychology, computer science, organization theory and evolutionary biology (Domjan, 2009; March, 1991; Nowak and Sigmund, 1993; Sutton and Barto, 1998; Thorndike, 1998).

The sequence of actions by the two agents M and S in the model can now be specified (See Figure 1):

Step 1

M inspects her representation and selects a strategy (arm) based on Equation 2. In our model, each arm represents a strategy, possibly a detailed set of instructions on which actions S should take to implement that strategy. M's beliefs may be erroneous in the sense that they may correspond only approximately to the real strategy necessary to maximize organizational performance given the particular environmental conditions. This is either because the beliefs are coarse, inaccurate, or both. The gap between underlying reality and the beliefs of the manager reflects imperfect knowledge of the manager. M may conduct some degree of *top-down exploration*; replacing τ_j with τ_M in Equation 2, as τ_M increases, M is more likely to choose a strategy other than what appears the best in M's current representation. M then communicates this choice a_{Mt} to S. In a very abstract form, we assume that the manager's orders are conveyed by setting incentives and exerting authority to motivate and direct the desired actions of the subordinate.

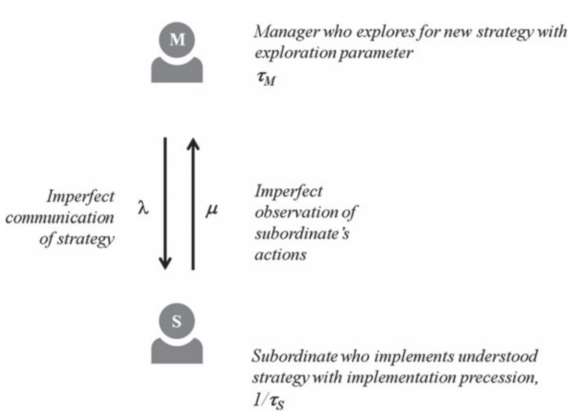

Figure 1. Model structure

Step 2

S receives the choice of M and updates his own representation by linearly combining his own representation and M's order: $Q_{St}(a_{Mt}) = \lambda \cdot Q_{St} + (1-\lambda) \cdot O(a_{Mt})$. The parameter λ represents the consequences of *imperfect communication* of strategy. When $\lambda = 0$, M has been able to communicate her desired strategy to S effectively, and S's new representation (Q_{St}) reflects this by increasing the estimated value for the action that M ordered (a_{Mt}) by an Order function (O) that increases the attraction of the corresponding arm by unity (the maximum expected payoff for any arm). For instance, in the case of a two-armed bandit, let's take the case when $Q_{St} = [0.5,\ 0.5]$ while $O(a_{Mt}) = [1, 0]$, with $\lambda = 0.5$. Then the subordinate's updated attraction $Q_{St} = 0.5 \times [0.5,\ 0.5] + 0.5 \times [1,\ 0] = [0.75,\ 0.25]$. Conversely when $\lambda = 1$, S effectively has not been influenced by M at all.

Step 3

S attempts to implement the strategy as understood by him, incorporating M's orders (if $\lambda < 1$) using Equation 2. Note that S's realized actions a_{St} is a function of his perception of M's dictated strategy, but also features possible divergence from it. These deviations could be thought to arise from lack of sufficient specificity of the understood strategy, or through insufficient motivation for the employee to take the desired action, or because of imperfect

Table 1. Key parameters (see also Figure 1)

Key model parameters	Name	Description
τ_M	Top-down exploration by manager	Increasing value indicates greater likelihood that M selects a strategy other than the most attractive one in M's current representation
λ	Imperfect communication of strategy by manager to subordinate	Increasing value indicates that M's selected strategy is NOT taken into account by S.
μ	Manager's probability of making an error when observing subordinates actions	Increasing value indicates greater likelihood that M believes that S has implemented one of the n – 1 strategies other than the one S actually implemented
$1/\tau_S$	Implementation precision	Decreasing value indicates greater likelihood that S selects a strategy other than the most attractive one In S's current representation. Bottom up exploration is τ_S

implementation of S's choices by S's own subordinates. *This divergence is inversely related to the implementation precision of the organization.* Thus, in an organization with low implementation precision the subordinate S may enact an action with some positive probability even if the strategy as understood by him does not require him to do so.

Replacing τ_j with τ_S in Equation 2, we use the parameter $1/\tau_S$ to operationalize the *implementation precision* of this organization: When τ_S is low, the subordinate's actions conform to the strategy as he understands it; as τ_S increases, the precision of implementation falls, and the patterns of subordinate choices essentially become random and no longer reflect the strategy as he understands it.

Step 4

The payoff of S's selected arm a_{St} is realized. M and S update their representations using Equation 1. While S knows his own selected actions perfectly, M observes the selected arm with probability of *observation error* μ, such that with this probability M thinks the selected action was one of the n arms at random. The parameter μ may be thought of as capturing the accuracy of measurement of implementation.

Note that a period in our model is an interval of time during which strategy stays fixed. Its calendar duration need not be small, nor does the duration have to be identical across periods. Rather our model describes any situation in which strategies are periodically refined on the basis of feedback (with the periods being of possibly long and unequal duration).

The resulting model now allows us to examine how this simple two-agent organization performs in a task environment that resembles a multiarmed bandit task (i.e., with discrete strategic alternatives whose value can only be learned through trying them), in which both bottom-up exploration (τ_S) as well as top-down exploration (τ_M) are feasible, and in which top managers may be unable perfectly to specify or observe the actions of subordinates (via λ and μ). Our experiments with the model involve varying these four parameters in systematic ways to observe the impact on organizational performance.

While we primarily conceptualize and discuss the model in terms of strategy implementation, the analytical structure more generally captures any process of experiential learning with separation of beliefs and actions (see Table 1).

ANALYSIS AND RESULTS

We operationalize this dynamic model by setting up an $n = 10$ armed bandit task. The true underlying reward associated with each arm is drawn from a beta distribution with both $\alpha = \beta = 2$. The beta distribution has been used in prior simulation studies as it has similar properties to the Gaussian distributions, but we can control its boundaries more precisely. The realized reward when an arm is actually selected in a trial is the true expected reward of that arm plus a noise term drawn from a normal distribution with zero mean and unit variance. The initial estimate of each arm's value held by M and S is assumed to be distributed uniformly as zero. The **Performance** for an organization in any period is simply the cumulative received payoff up to that period. This is a standard way to measure performance of the online search process typical of a bandit problem (Sutton and Barto, 1998), and highlights that for strategists it is the "area under the performance curve" (i.e., cumulative profits) that should matter because of the risk of mortality during the process of attaining steady state. To illustrate the underlying processes effectively, we also plot the exploration propensity and knowledge level of the organization, which are based on modified versions of the measures used by Posen and Levinthal (2012).

The Exploration propensity is the proportion of past periods in which the organization changed its strategy relative to the prior period, computed over all observed periods, and averaged across all organizations that have the same structural settings. For instance, at the end of period T, if the number of times the organizational strategy changed was k then exploration propensity becomes k/T. This is averaged across organizations.
More formally,

$$EP = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\delta_i(t)$$

where $\delta_i(t) = 1$ if the action choice at time t differs from the one at time $t-1$; otherwise, $\delta_i(t) = 0$. Note that N is the number of organizations (i.e., pairs of agents) in each scenario.[3]

The Knowledge level is the probability that in a given period, the strategy believed by the organization to be the best (i.e., has the highest expected payoff) is indeed the true best strategy. It is computed as the proportion of organizations in a given period for which the strategy believed to be the best (i.e., believed to have the highest expected payoff) is indeed the true best strategy. Specifically, it counts the number of organizations at the end period T in the simulation, whose belief of the highest expected payoff corresponds to the arm of the bandit with the highest expected payoff, and divides this by the total number of organizations. Formally,

$$K_L = \frac{1}{N}\sum_{i=1}^{N}\theta_i(T)$$

where $\theta_i(T) = 1$ if the belief of the highest expected payoff of organization i at the end period T corresponds to the true best payoff; otherwise, $\theta_i(T) = 0$. We report results for performance, exploration propensity and knowledge level averaged across 1,000 organizations over 500 periods.[4]

Scenario 1: Baseline case with no separation of beliefs and actions

As a baseline, we first reproduce the standard result on the exploration—exploitation trade-off with no separation of belief and action. We assume that $\tau_M \sim 0$,[5] $\lambda = 0$, and $\mu = 0$. While the organization does consist of two agents, M and S, these settings reflect a case where the two effectively act as one: there is no error in communication or observation between M and S, and the only source of exploration in the organization is the result of imprecise implementation by S of M's orders. This is equivalent to the organization being a unitary actor, with S serving as a perfect pair of hands and eyes for M; there is effectively no separation of beliefs and actions because M's beliefs are transmitted without error to S, and S's actions are transmitted without error to M.

Figure 2(a) shows how organizational performance changes over increasing levels of bottom-up exploration (τ_S). The vertical axis represents cumulative performance over 500 periods (the results are qualitatively the same with 1,000 periods), and the horizontal axis represents the inverse of implementation precision (τ_S). For the moment, we will

[3] Posen and Levinthal (2012) consider only the final period; their measure some of the parameters of the search process vary over time. In our model, this is not the case, so we construct a measure that uses the information more efficiently.

[4] In Posen and Levinthal (2012), the knowledge accuracy is measured using the sum of squared errors in belief compared to the true payoff. This indicates the degree of "pattern match" between the beliefs of the agents about the payoffs across the arms and the actual payoffs. In contrast, our measure involves "peak match"; i.e., it measures whether the highest arm in the belief is also the highest arm in reality.

Note that when the degree of exploration is low, as it is in many of our specifications (either for boss or employee), then the pattern match measure based on sum of squares does not explain choices actually made, because action selection is greedy.

[5] τ cannot be zero in softmax strategy. Therefore, we used $\tau = 0.01$ instead of zero as the minimum value we can use for computations.

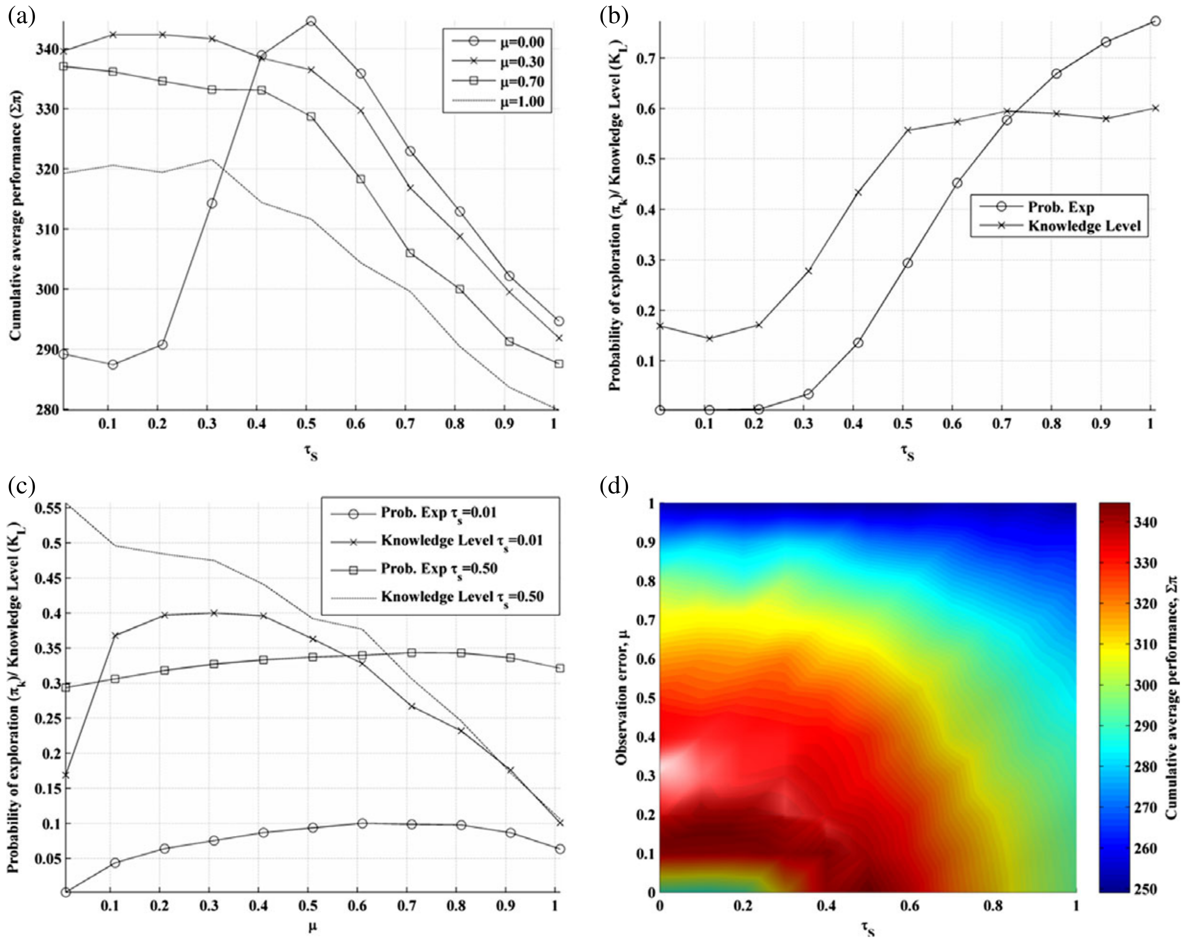

Figure 2. (a) Cumulative organizational performance ($\Sigma\ \pi$) and bottom-up exploration τ_S with varying observation errors (μ) and ($\lambda = 0$, $\tau_M \sim 0$). (b) Propensity to explore, Knowledge level and bottom-up exploration τ_s with observation errors ($\mu = 0$), and ($\lambda = 0$, $\tau_M = 0$). (c) Propensity to explore and Knowledge level with varying observation errors (μ), and ($\lambda = 0$, $\tau_M \sim 0$, $\tau_S = 0.01$ or 0.5). (d) The substitutive relationship between bottom-up exploration (τ_s) and observation errors (μ)

focus on the line showing organizational performance for $\mu = 0$ (Figure 2(a) reports results for this and the next set of experiments together to conserve space). This inverted-U shaped line with an optimal $\tau_S = 0.5$ replicates the well-known exploration and exploitation trade-off: a moderate level of subordinates' deviation from strategy delivers superior long-term performance as it brings in a chance of probing unknown alternatives at the cost of not doing what they ought to be doing. Figure 2(b) helps to understand the underlying trade-off more clearly. Decreasing implementation precision—or equivalently, increasing bottom-up exploration—leads naturally to greater propensity to explore, as well as improvements in knowledge from exploration. However, beyond a certain level of exploration, improvements in knowledge cannot be utilized, because implementation of the strategies based on this knowledge is difficult. This generates the internal optimum for $\tau_{S.}$ While we plot the knowledge level for M, the knowledge level for S is the same in this setting, because M perfectly observes S's actions and updates her own beliefs in the exact same way as S does.

These results establish the baseline intuition that the unbounded pursuit of perfection in implementation is unlikely to be optimal in a world that has the features of the multiarm bandit task we have set up—where the best strategy is unknown ex ante and the value of strategies must be discovered through trial and error. This underlines the point that when the organization effectively has no

DOI: 10.1002/smj

separation of belief and action (because $\lambda = 0$, and $\mu = 0$), and imperfect implementation is the only source of exploration by the organization ($\tau_M \sim 0$), then perfect implementation is not optimal, because bottom-up exploration is valuable (i.e., $\tau_S > 0$). As March (1991:p.71) is widely cited for noting, organizations that "engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of experimentation without gaining many of its benefits," whereas organizations that "engage in exploitation to the exclusion of exploration are likely to find themselves trapped in suboptimal stable equilibrium." For an organization with no separation of beliefs and actions, some degree of imperfect implementation is therefore useful in a world in which initial knowledge is poor.

Scenario 2: Observation errors in the measurement of implementation success

In Scenario 1, we modeled the organization as acting effectively like a unitary actor, as there was no separation between beliefs and actions, even though these were held by two different agents. We now introduce the first element of separation between beliefs and actions by considering a scenario in which the manager sets strategy and communicates this perfectly to the subordinate, who executes the strategy imperfectly (as before); however now the manager observes the subordinate's actions but with a probability of erroneous observation ($\mu > 0$).

This scenario focuses on the challenge of being able to measure the success of implementation (i.e., whether subordinates did what they were told to) independent of organizational performance. There are a number of reasons why in hierarchical organizations, superiors may be unable to observe perfectly the actions of subordinates. These include distinct bases of knowledge, distinct physical locations, different timescales of operation as well as the sheer cognitive burden on a superior in a hierarchical structure faced with the prospect of observing a large number of direct and indirect subordinates. Yet, imperfect means to observe a subordinate's actions may still be possible. Balanced scorecards, key performance indicators and management by objectives allow measurement of implementation success, albeit imprecisely. Interestingly, performance measures of lower level organizational units can correspond to implementation performance as seen from higher levels of aggregation. For instance, internal targets for production cost or customer service lead time are measures of the successful implementation of strategies aimed at lowering costs or improving customer willingness to pay. The variability in the existence and precision of these measures is captured by μ.

In this set of experiments, we keep other variables $\tau_M \sim 0$ and $\lambda = 0$. Thus we are investigating a single consequence of separating belief from action (between M and S respectively)—that M can no longer know with precision what actions S actually undertook. Obviously, if there were no separation of belief and action, and the organization were a unitary actor, then this problem would not arise. At the same time, we continue to assume that there is no communication problem between M and S, and that M does not introduce any top-down exploration.

Figure 2(a) also demonstrates the effects of observation errors (μ) on cumulative organizational performances over various levels of bottom-up exploration (τ_S). There are two key aspects of these results worth noting. First, as observation error (μ) increases, the optimal level of implementation error (τ_S) moves toward zero. As observation errors get larger, the implementation imperative (i.e., gains from improving precision of implementation) also strengthens. Second, when implementation is perfect (i.e., there is no bottom-up exploration, $\tau_S \sim 0$), then optimally observation error is greater than zero.

To understand the intuition behind these results, it is useful to turn again to a graph of the propensity to explore and the knowledge level (Figure 2c). The first thing to note is that observation error itself is a source of exploration for the organization. By decoupling the link between received payoff and the probability of selecting the same action again, observation error induces a degree of exploration. It is modest because it decreases the probability of selecting the same action after a good outcome (an increase in exploration), but may also increase the probability of taking the same action after a bad outcome (a decrease in exploration). To see this, consider a case where S selects action 1, and a good payoff is received (i.e., a payoff above the current value estimate of that action). In the absence of observation error, this would raise the value estimate of that action and make it more likely to be selected again. In the presence of observation error, because the received payoff is likely to be attributed to some other action, this is less likely; therefore the organization de facto explores. Conversely, if the

DOI: 10.1002/smj

payoff were bad (i.e., below current value estimate of the action), in the absence of observation error, this action would be less likely to be selected in the next round. However, with observation error, because the payoff is attributed to some other action, there is a higher (but still small, as action 1 is just one of m – 1 actions that have "escaped" being attributed to the poor performance) chance that the same action is selected again (which indicates a decrease in exploration).

The second consequence of observation error is on the knowledge of M. Observation errors interfere with the learning process represented by Equation 1 because the values of both a and k_a held by M will be erroneous; in effect, error in updating of beliefs is introduced (through μ), which will result in a bias in the estimated value of the action. This is because with observation error, by definition, there is a nonzero probability that the estimated value of a selected action is incorrect; even if the action to which the realized payoff is erroneously attributed is random, the lack of correct update to the selected action is systematic. As a consequence, as observation errors increase, there is a decrease in knowledge level for M (Figure 2c). To contrast this with the consequences of bottom up exploration, compare with Figure 2(b) and with Figure 2(a) when $\tau_M = 0$; excessive bottom-up exploration lowers performance but not knowledge levels. Put differently, imprecise implementation creates exploration but not bias in beliefs; observation errors create exploration and bias. Figure 2(d) shows optimal (highest performing) combinations of implementation errors and observation errors; they are substitutes in organizational performance, but not perfect substitutes because of the bias introduced by observation errors.

The implications of these results are that in organizations capable of precise implementation of strategy, a modest level of observation errors could usefully contribute a degree of exploration. As can be seen in Figure 2(a), when there is no bottom-up exploration, organizational performance is highest when observation error is $\mu = 0.3$. Indeed up to a value of $\tau_s < 0.3$, adding observation error always increases performance. However, at lower levels of implementation precision (i.e., higher levels of τ_s) adding observation error diminishes performance. One reason for this is simply too much exploration: if the organization was already close to the optimal degree of exploration, then increasing exploration must harm performance. The other is that as observation error increases, knowledge levels diminish. Thus as observation errors increase, the implementation imperative strengthens, as the optimal level of bottom-up exploration declines.

Therefore we can conclude that the implementation imperative is likely to be strong despite potential gains from bottom-up exploration when it is difficult for senior managers to observe exactly what the subordinates have done—in other words, when it is difficult for them to assess the precision of implementation. This is the first way in which a separation of beliefs and actions can lead to an implementation imperative, despite all the usual arguments for the benefits of exploration in a world of poor initial knowledge (March, 1991; Sutton and Barto, 1998).

Scenario 3: The effect of imperfect communication of strategy

So far we have assumed that the strategy of the top manager is communicated perfectly to the subordinate; the challenge lies in implementing it. While it may be tempting to view imperfect communication as part of the problem of implementing strategy, we believe there is a gain in analytical clarity by separating the two; after all, it is possible that a poorly communicated strategy is perfectly implemented.

In the next set of experiments, we investigate the effects of imperfect communication of strategy by M to S (i.e., λ). The other variables are kept at $\tau_M \sim 0$ and $\mu = 0$. This corresponds to an organization in which we have introduced a second way in which a separation between beliefs and actions may exist by considering a scenario in which the manager sets strategy, the subordinate executes the strategy imperfectly (as before); however now while the manager observes the subordinate's actions perfectly ($\mu = 0$), she may be unable to communicate her selected strategy to the subordinate ($\lambda > 0$).

It is a recognized challenge for senior level managers to communicate their intended strategy effectively to lower level managers charged with implementing the strategy (Alexander, 1985). In part this challenge arises from the somewhat abstract nature of strategy itself; but more critically, it is the consequence of vertical specialization. Managers at different layers in a hierarchy know and are capable at different things. While lower level managers may understand their world in terms of fairly detailed if narrow scope representations, senior managers necessarily utilize more abstract

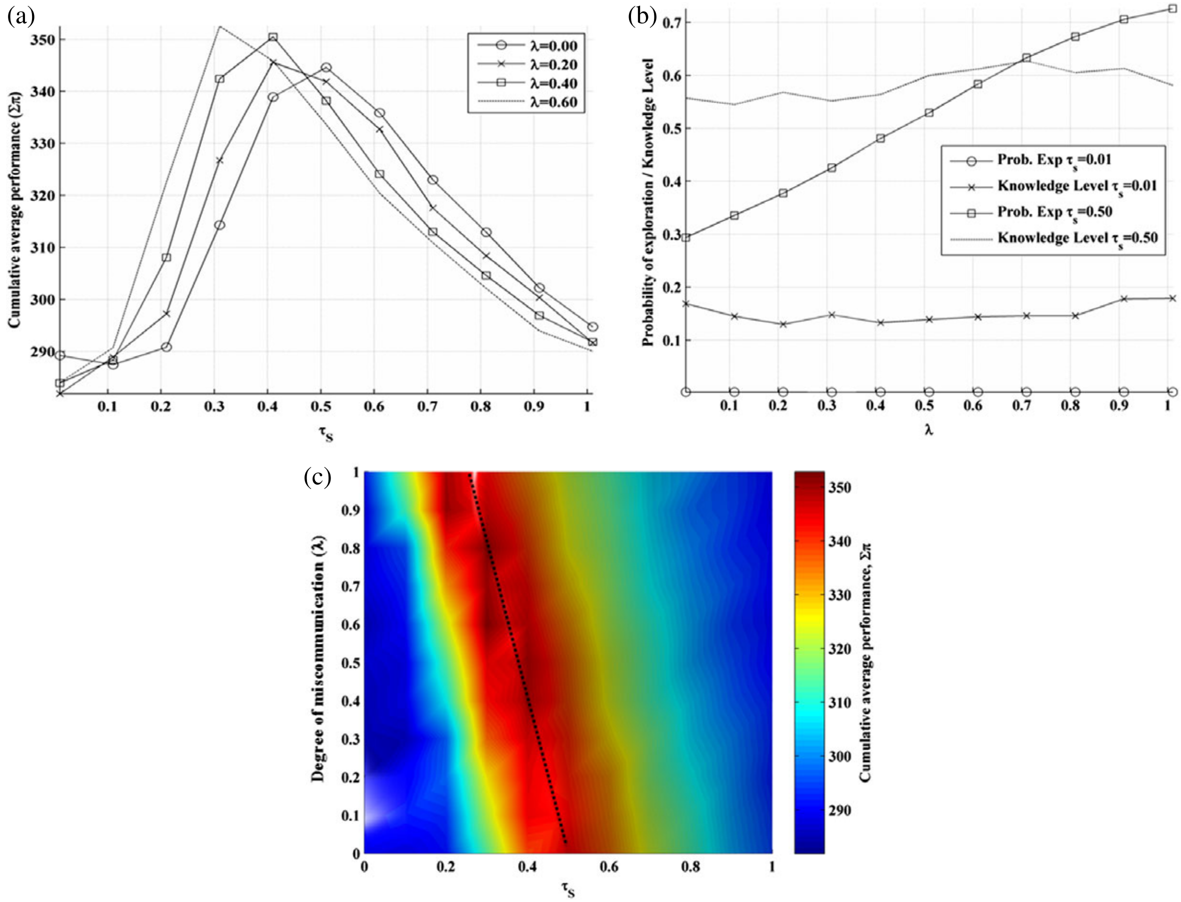

Figure 3. (a) Cumulative organizational performance ($\Sigma\,\pi$) and bottom-up exploration τ_s with imperfect communication (λ), and ($\mu = 0$, $\tau_M \sim 0$). (b) Propensity to explore and Knowledge level with varying degrees of imperfect communication (l), and (m = 0, $\tau_M \sim 0$, $\tau_S = 0.01$ or 0.5). (c) The relationship between optimal bottom-up exploration (τ_s) and imperfect communication (λ), with ($\mu = 0$, $\tau_M \sim 0$)

and broader representations. These distinctive "thought worlds" they inhabit also imply communication difficulties between them (Dougherty, 1992). While senior managers may be able to convey the general sense of their intentions, there may be significant gaps between how lower level managers understand these intentions in the operational terms they are accustomed to dealing with. The importance (as well as the difficulties) of being able to communicate the organization's strategy therefore takes center stage in managerial discourse on strategy implementation (Bossidy and Charan, 2002). The parameter λ in our model captures the extent to which this is achieved; low values indicate relatively unambiguous communication of strategy in a manner that the subordinate's understanding of the managers preferred strategy is high; high values indicate that the subordinate's understanding of the manager's preferred strategy actually bears no connection to the manager's preferred strategy.

The results of this set of experiments are reported in Figure 3(a). There are again two key aspects of these results. First, as the extent of imperfect communication (λ) increases the optimal level of implementation error (τ_S) moves toward zero. In other words, as the difficulty of communicating strategy from M to S increases, the stronger the implementation imperative (i.e., there are incentives to improve implementation precision). Second, when implementation is perfect (i.e., there is no bottom-up exploration, $\tau_S \sim 0$), then communication error does not appear to have a significant impact on organizational performance.

To understand these results, as before, it is useful to turn again to a graph of the propensity to explore and the knowledge level (Figure 3b), for the

DOI: 10.1002/smj

case when there is no bottom-up exploration as well as for the optimal value of bottom–up exploration when there is no constraint on communicating strategy. It is clear that imperfect communication of strategy, by itself, is not a source of exploration for the organization. However, when there is bottom-up exploration, it is leveraged by imperfect communication.

The intuition can be understood as follows: Consider first the case when S engages in bottom-up exploration. When M's selected strategy is conveyed perfectly to S, it effectively makes that strategy much more salient (i.e., with a higher value estimate) than even in M's own representation. For the same action value estimates, S would have to explore more when $\lambda = 0$ to escape making a greedy choice (the one ordered by M). Perfect communication of strategy effectively dampens S's exploration. As the degree of imperfect communication increases, it lowers the weight placed on M's preferred choice in S's representation. Therefore it allows for greater exploration by the organization, for the same level of bottom-up exploration by S.

Now consider the case, when neither M nor S engage in any exploration, so that the organization as a whole engages in greedy search; the first choice with a payoff that is better than the estimates of the rest (recall we start all estimates at zero) will be the choice picked in perpetuity. More importantly, *both M and S will always prefer the same choice*, which S will pick in a greedy manner. Increasing the degree of imperfect communication of strategy does not affect this result, because all that imperfect communication does, when neither M nor S explore, is to change the weight that S places on M's preferred choice in her own representation; but because neither explore, their representations are identical anyway. For this reason, imperfect communication leverages bottom-up exploration by S, but does not contribute any exploration by itself; it undoes the dampening of exploration that would have occurred with perfect communication. This is a significant difference between the consequences of observation error (Scenario 2) and imperfect communication.

A second important distinction between the consequences of observation error and imperfect communication can also be seen in Figure 3(b); the effect of imperfect communication on the knowledge of M is benign—it does not harm knowledge level in any way. In contrast, as we saw in Scenario 2, observation errors introduce bias in the beliefs of M. Note that these consequences are not necessarily because of the hierarchical relationship between M and S; rather they are because of a separation of belief and action between M and S, which could arise even if they were peers. Figure 3(c) shows optimal (highest performing) combinations of imperfect communication levels and bottom-up exploration; as communication of strategy is clearer, the optimal level of bottom-up exploration must increase for the organization as a whole to explore sufficiently.

The implications of these results are that the organization in fact benefits from imprecise implementation when strategy is communicated effectively by senior managers to their subordinates; bottom-up exploration is valuable in these conditions. Conversely, the implementation imperative is likely to be stronger when it is *harder* to communicate strategy effectively from top managers to their subordinates. Further, our results suggest that the inability of top managers to communicate strategy clearly may be less of a problem—both for organizational performance and their own understanding of the optimal strategy—than the inability to observe how strategy was implemented in the sense that both organizational performance and the level of knowledge is relatively less sensitive to the top manager's ability to communication strategy (see Figures 3c vs. 2d and 3b vs. 2c).

Therefore we can conclude that the implementation imperative is likely to be strong despite potential gains from bottom-up exploration when it is difficult for senior managers to communicate exactly the strategies they want implemented. This is the second way in which a separation of beliefs and actions can lead to an implementation imperative, despite the usual benefits of exploration with poor initial knowledge.

Scenario 4: The effects of simultaneous top-down and bottom-up exploration

So far we have assumed that M does not explore; only S engages explicitly in explorative actions (as a consequence of imperfect implementation). In the next set of experiments, we examine the consequences of top-down exploration by M on the optimal value of bottom-up exploration by S. Top-down exploration could arise from strategic analysis, R&D, trial investments in corporate ventures, and skunk-works. These all represent ways in which M is motivated to engage in non-greedy selection of strategy, to be conveyed to

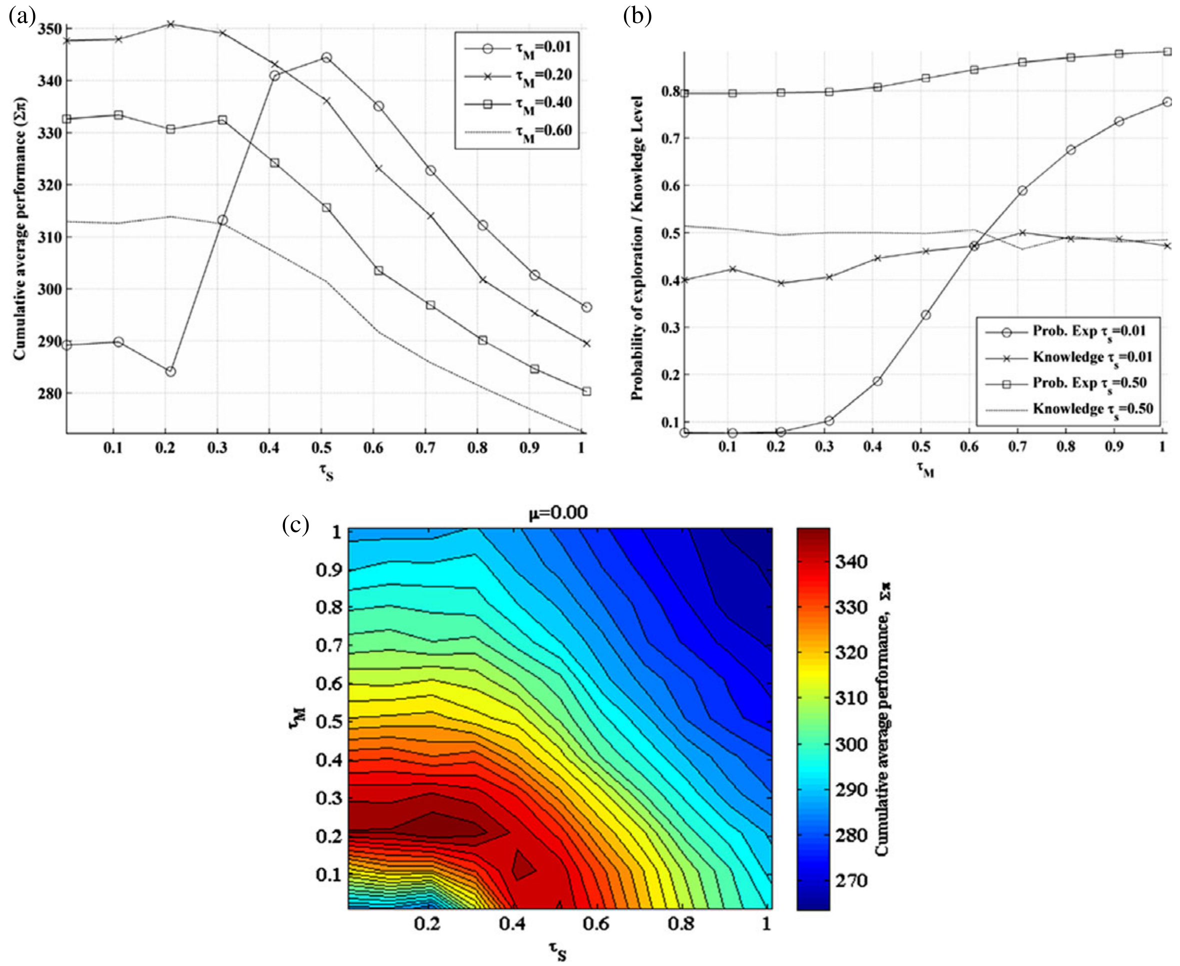

Figure 4. (a) Cumulative organizational performance ($\Sigma\ \pi$) and bottom-up exploration τ_s with top down exploration ($\tau_M > 0$), with ($\lambda = 0, m = 0$). (b) Propensity to explore and Knowledge level with varying degrees of bottom up exploration (τ_S), and (m = 0, $\tau_S = 0.01$ or 0.5, $\lambda = 0.0$). (c) Cumulative average performance over varying top down (τ_M) and bottom up exploration (τ_S) with ($\mu = 0$), and no communication error ($\lambda = 0$)

S for implementation. We hold $\lambda = 0$ and $\mu = 0$ so that we can focus purely on the interaction between bottom–up and top-down exploration. This corresponds to an organization in which both top-down and bottom-up exploration are taking place, but there are no observation errors or imperfect communication of strategy.

Figure 4(a) shows that when λ and μ are zero, the optimal degree of bottom-up exploration declines with top down exploration. This is a fairly intuitive result, as in effect the organization overexplores when there is both top-down and bottom-up exploration, so that if M is engaging in exploration, then there is value in increasing the precision of implementation (i.e., an implementation imperative exists). Figure 4(b) shows that the level of overall exploration by the organization increases significantly as top-down exploration occurs in addition to bottom-up exploration, though there is no perceptible improvement in knowledge level.

Figure 4(c) shows optimal combinations of top-down and bottom-up exploration. An interesting subtlety emerges here; it is clear that top-down and bottom-up exploration are substitutes, but the rate of technical substitution is not unity; a higher level of exploration by the subordinate than the manager is necessary for a given level of performance to be achieved. This is because when M does not explore and there is no miscommunication. As we have seen in the results of Scenario 3, the subordinates exploration is effectively dampened down. Consequently, the subordinate would need to have a higher value of τ_S to produce the same level of organizational exploration as would be achieved by a lower value of top-down exploration τ_M, if only the manager were exploring. As a consequence, optimal $\tau_M = 0.2$ when $\tau_S \sim 0$, whereas optimal $\tau_S = 0.5$ when $\tau_M \sim 0$, assuming no observation error or miscommunication.

In sum, these results show that bottom-up exploration through imperfect implementation can be a substitute for top-down exploration but that the rate of substitution is not one for one. As a consequence, the implementation imperative is stronger in organizations that do engage in top-down exploration. However, if top-down exploration is equally as costly as bottom-up exploration, then top-down exploration accompanied by efforts to improve the precision of implementation is to be preferred. Further, our results also show that the effects of observation error and miscommunication are qualitatively robust to the introduction of top-down exploration in addition to bottom up exploration.

Robustness checks

To examine the robustness of our results in two different ways (Appendix S1), first we looked at the joint effects of all three mechanisms—imperfect communication, observation and top-down exploration—on the existence of the implementation imperative. This was a way of checking whether our understanding of individual mechanisms helps us to make sense of these interactions. To begin with, we looked at the interplay of communication and observation error, holding top-down exploration to zero. We found that optimal combinations of observation error and miscommunication, in organizations with no other source of exploration, involve nonzero values of both. Next, we considered the case of interaction between observation error and top-down exploration (no communication error). We found that increasing observation errors worsen performance and create an implementation imperative; i.e., an incentive to improve implementation, even if we allow for some degree of top-down exploration. Finally, we considered the interaction between top-down exploration and communication error (no observation error). We found that as the level of miscommunication increaseds, there is again an implementation imperative. Additionally, as the level of miscommunication increases, top-down exploration, quite naturally becomes irrelevant. Finally, we also obtained results with positive values of observation errors, communication challenges, top-down and bottom-up exploration. We found a pattern of results that is qualitatively consistent with those reported in the paper.

Second, we checked the robustness of our results to different distributional assumptions and the magnitude of noise in the system. We used the normal distribution instead of beta distribution to generate the payoff functions and our results are qualitatively unchanged. We also checked the impact of increasing noise. Specifically, we increased the level of uncertainty in the payoffs by changing the standard deviation of the white noise term (originally $e \sim N(0,1)$) from s.d. = 1 to 1.2 and 1.5 and looked at the cumulative performance with increasing bottom- up exploration across different levels of observation errors. The results show that up to a certain level of noise (e.g., s.d. = 1.2) the overall patterns are robust and consistent with what we found, but eventually the organization's search process is overwhelmed by noise. For instance, if s.d. is set as much as 1.5, neither the manager nor the subordinate can learn from their choices of actions. Thus, for the task environment to be sufficiently noise free to allow organizational learning is a boundary condition for our arguments. Put differently, learning must be feasible for our central insight—that precise implementation enables the discovery of better strategies by allowing more effective learning from feedback on the value of current strategies—to be relevant.

CONCLUSIONS

On the face of it, the glorification of "relentless execution" in a world in which the strategies being executed are rarely infallible appears puzzling. Yet, as our analysis shows that it may be a sensible stance in a world in which beliefs and actions—i.e., strategies and their implementation—are separated across organizational actors. While our model is conceptualized in terms of the iterative process of strategy formation and implementation (through organization redesign; for instance, see Galbraith and Kazanjian, 1988), the analytical structure more generally captures any process of experiential learning with separation of beliefs and actions—either because the actions are delegated to somebody other than the individual who holds the beliefs being enacted (e.g., as in strategy implementation) or more generally, because the realized action deviates from intention (because of uncontrollable environmental factors, for instance). In particular, we highlight that none of our results necessarily require that the agents M and S be hierarchically related; what matters is that beliefs and actions are separated. While hierarchical ordering is one way in which this is achieved, a division of labor in terms of idea generation and execution among peers would have the same effects.

The key results from our model are that increasing the precision of strategy implementation becomes more desirable when (1) it is harder for managers to observe the actions of their subordinates, (2) when it is harder for top managers to communicate their strategy effectively to their subordinates, and (3) when top managers also engage in exploratory efforts of their own. The boundary conditions are that ex ante the best strategy is unknown, top managers are willing and able to revise strategies based on feedback, and the feedback from the environment is not too noisy to enable this revision in beliefs in an adaptive manner (i.e., learning is possible).

These conditions also suggest empirical tests: all else being equal, we should expect to see optimally a greater emphasis on implementation precision (and a consequent performance advantage) when good strategies are unknown ex ante, when observation and communication down the administrative hierarchy may be constrained, and when top management engages in significant strategic exploration (for instance, through frequent strategic reviews or trial investments).

The broader insight from our analysis is that when there is a separation of belief and action, as is frequent in organizations because of delegation, precise implementation has benefits beyond the well-known effect of enabling exploitation of good strategies. It also enables the discovery of better strategies by allowing more effective learning from feedback on the value of current strategies. This occurs through three mechanisms.

First, precise implementation of currently understood strategy by subordinates avoids the attribution problem that confronts the strategist who cannot perfectly observe if subordinates have indeed executed the desired strategy—whether to ascribe unexpected outcomes to the strategy or to the implementation. More precise implementation allows the strategist to escape this inference problem: she can discard poor beliefs and possibly engage in top-down exploration for better strategies. To highlight the intuition of this underlying mechanism, consider the following illustration of the CEO's dilemma when faced with an underperforming business unit:

> *"Could the unit's lackluster performance have more to do with a mistaken strategy than poor execution? More important, what should he do to get better performance out of the unit? Should he do as the general manager insisted and stay the course—focusing the organization more intensely on execution—or should he encourage the leadership team to investigate new strategy options?" (Mankins and Steele, 2005)*

The challenge here is whether to attribute divergence between expected and actual performance to mistaken strategy or to faulty implementation—and this is a central feature of experiential learning with difficult to observe actions. Our results show that as this attribution problem becomes more severe (as μ increases), it can dwarf any bottom-up exploration benefits of imperfect implementation. This suggests one reason why precise implementation may be useful even with bad strategy and why the implementation imperative may be so widespread in practice (Bossidy and Charan, 2002; Hrebiniak, 2006; Noble and Mokwa, 2010 Yang, Sun, and Eppler, 2010). This is because precise implementation solves the attribution problem highlighted in the example above, allowing easier rejection of poor strategies (and possibly a search for better ones), as well as making better use of existing good strategies. These two benefits come at the expense of any potential gains from bottom-up exploration that poor implementation might have allowed.

A corollary of our results is that if an organization wishes to benefit from bottom-up exploration that results from imperfect implementation (i.e., by increasing τ_S), it must also invest in improving its ability to measure implementation success (i.e., by reducing μ). If organizations wish to benefit from the bottom-up exploration that arises from imperfect implementation they must nonetheless invest in making the actual actions of employees easier for top managers to observe. This subtle balancing act between autonomy of action but closeness of observation is not an easy one to pull off. Edmondson (2008) draws on her research in hospitals to observe that

"*IHC (a hospital), for example, recognized that physicians, as highly educated experts, might resist process guidelines developed by a committee. For that reason and others, IHC does not discourage doctors from deviating from the guidelines. In fact, the organization invites them to, anytime they judge that good patient care requires it. The only condition: They have to help IHC learn by entering into the computer what they did differently—and why. This valuable feedback is captured in the system and periodically used by the expert teams to make updates or refinements . . . ..*"

She goes on to note that

"*It's not easy for a hospital, or any other organization facing cost constraints, to do this. Disciplined reflection takes productive resources off-line, and conventional management wisdom can't help but see this as lost productivity. Nonetheless, the only way to achieve and sustain excellence is for leaders to insist that their organizations invest in the slack time and resources that support this step.*"

A second advantage of precise implementation is that it prevents excessive exploration at the aggregate organizational level because of the inadvertent exploration introduced by the imperfect communication of strategy from senior managers to subordinates. If the downward communication process of strategy and upward observation of action is unavoidably noisy, then improving implementation may help to improve organizational performance by reducing what is, in effect, suboptimally excessive exploration. While miscommunication and observation error may seem like two sides of the same coin (as both result from the separation of beliefs and actions), there are fundamental distinctions between the two. Imperfect communication leverages bottom-up exploration, but does not contribute any exploration by itself: it merely "undampens" bottom-up exploration that would have resulted from perfect communication of strategy. Observation error, on the other hand, is itself a significant source of exploration for the organization. However, while the effect of miscommunication on the knowledge of the strategist is benign, observation errors introduce biases. The implications is that a strategist who is a great communicator but cannot observe the quality of implementation may be more harmful to the organization than one who is a poor communicator but a good observer of implementation performance, assuming the same imperfect strategy *ex ante* for both.

Third, precise implementation also prevents excessive exploration at the organizational level when top managers are also exploring—and indeed this is particularly important when there are observation errors and miscommunication of strategy. Under these circumstances, there is a strong implementation imperative. Indeed we can say that for the same cost of bottom-up and top-down exploration, top-down exploration (and a strong implementation imperative) is to be preferred rather than vice versa. This is primarily because the communication of strategy is effectively a dampener on bottom-up exploration.

These benefits of implementation as a stimulant to organizational adaptation suggest a rationale for the implementation imperative, in the sense that increasing implementation precision may be useful even with bad initial strategies propounded by the senior managers for each of these reasons. Viewing strategy implementation as a learning process for the strategist thus generates a fundamentally different insight about the value of implementation: unlike the static case, when the intuition says, "good beliefs, good implementation; bad beliefs, bad implementation", with learning by the strategist, precise implementation can be useful even with bad beliefs (Bossidy and Charan, 2002; Hrebiniak, 2006; Yang, Sun, and Eppler, 2010).

Our results point to two broader implications for theory and practice. First, given the separation of belief and action (leading to some degree of communication and observation errors between the senior managers and their subordinates), top-down exploration enjoys some natural performance advantages over bottom-up exploration. This is quite unrelated to any dominance, status, or firm-wide (i.e., across unit) coordination related advantages that top managers enjoy but is rather the simple consequence of the attribution problem that arises because of the separation of beliefs and actions.[6] This introduces an important refinement

[6] The literature on agency problems in economics emphasizes a different motivation related problem that arises from hidden action in principal–agent relationships (e.g. Gibbons, 2005). Our approach emphasizes the coordination problem of attributing feedback generated by the agent's action correctly to the belief held by the principal.

DOI: 10.1002/smj

to traditional unitary actor models of organizations (Cyert and March, 1963; Denrell and March, 2001; Herriott *et al.,* 1985; March, 1991).

Second, our results also indicate that a top-down approach favoring the precise implementation of strategy as designed by top managers may typically dominate the bottom-up exploration for new strategies in terms of organizational performance, within the boundary conditions of our model (i.e., opportunities exist to revise strategies based on feedback and separation of belief and action). This is because, while bottom-up exploration through imperfect implementation may produce good ideas, they are neither likely to be able to be translated into organizational action precisely, nor is their value likely to be discovered easily. Note that our results suggest that the implementation imperative would be strong even in a world in which there is zero top-down exploration. Further, it is also worth noting that our results do not imply that deliberate strategies are automatically privileged over emergent ones (Mintzberg, 1979, 1990). Indeed, the revision of strategy over multiple periods through feedback that is central to our model is a classic instance of an emergent process of strategy formation. Rather, our point is that, given separation of belief and action, the process of discovering better emergent strategies than are originally intended is more likely to succeed when bottom-up exploration through imperfect implementation is curtailed. This is because imperfect implementation and resulting bottom-up exploration may well generate some new strategic alternatives, but these are also unlikely to be recognized as such and adopted by the organization.

In sum, the theory we develop explains why the relentless pursuit of improvements in implementation may be useful even in a world in which the strategies being implemented are far from optimal. The rationale is tied closely to the relaxation of the unitary actor assumption to account for the fact that actions and beliefs are often separated in organizations. Our analysis shows that this separation between beliefs and actions can increase the value of precise implementation even when the top-down strategies to be implemented are of poor quality and there are potential gains from bottom-up exploration through deviating from the intended strategy.

ACKNOWLEDGEMENTS

The authors thank Jerker Denrell, Thorbjorn Knudsen, Sangyoon Li, Oliver Bauman, Ulrik William Nash, Gael Le Mans, Hart Posen, Sendil Ethiraj, Gabriel Szulanski and Chengwei Liu for helpful suggestions. Participants in the "First Cut" seminar series in Singapore also provided helpful feedback. Puranam acknowledges funding from the European Research Council under Grant # 241132 for "The Foundations of Organization Design" project.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix S1. Joint effects of three mechanisms-imperfect communication, observation and top-down exploration, on the existence of the implementation imperative.

DOI: 10.1002/smj