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Arguing that organizational memory affects key new product development processes by influencing the (1) interpretation of incoming information and (2) the performance of new product action routines, the authors introduce four dimensions of organizational memory, including the amount and dispersion of memory. Data from 92 new product development projects indicate that higher organizational memory levels enhance the short-term financial performance of new products, whereas greater memory dispersion increases both the performance and creativity of new products. They also find, however, that under some conditions of high environmental turbulence, high memory dispersion actually detracts from creativity and has no effect on financial performance. Under conditions of low turbulence, high memory dispersion promotes higher levels of creativity and short-term financial performance. These findings provide some initial evidence that knowledge is not an unconditionally positive asset and suggest that developing and sustaining valuable organizational memory may require attention not only to the appropriate levels of memory but also to managing subtle aspects of memory dispersion and deployment. These results imply that if organizations fail to understand the subtle ways in which different features of organizational memory influence product development, they may fail to harvest the full value of organizational learning.

The Impact of Organizational Memory on New Product Performance and Creativity

The past ten years have seen an explosion of experiments and insights into new product development approaches. Many of the new viewpoints argue that knowledge assets (Winter 1987) can be leveraged to achieve competitive advantage (Barabba and Zaltman 1991; Day 1994; Garvin 1993; Glazer 1991; Prahalad and Hamel 1990; Sinkula 1994). Even more important, because it requires the use of knowledge assets in a dynamic setting, scholars have increasingly envisioned product development as a process of organizational learning involving the acquisition, dissemination, and utilization of information (Day 1994; Dickson 1992; Imai, Nonaka, and Takeuchi 1985; Leonard-Barton 1992; Moorman 1995; Nonaka 1991). Understandably, researchers exploring the creation of new products have been

especially interested in discovery and creation processes, or generative learning (Dougherty 1992; Imai, Nonaka, and Takeuchi 1985). Therefore, considerable work has focused on ways organizations can *acquire* better information as a means to discover new knowledge. We argue that an equally important issue is the role of *stored* knowledge, or organizational memory, in new product development activities.¹ As Starbuck (1992, p. 176) suggests, "A knowledge-intensive firm may not be information intensive ... knowledge is a stock of expertise, not a flow of information."

The traditional business strategy and marketing strategy literature has long emphasized the role of organizational experience or familiarity with products and markets. This literature has suggested that firms are likely to be more successful if they stick to developing products and markets that reflect their core competencies (Ansoff 1988; Montoya-Weiss and Calatone 1994; Rumelt 1974; Varadarajan 1983). One resulting framework of this view, termed the *product/market matrix*, is limited to examining the effect of memory level on the financial performance of marketing

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¹There are, as we discuss throughout this article, models of organizational information processing that include the influence of organizational memory (Burgelman 1983; Cohen and Levinthal 1990, 1994; Cyert and March 1963; Leonard-Barton 1992).

strategies. There are, however, other organizational memory dimensions that exist, as well as additional marketing strategy outcomes that could be considered. Moreover, the view of experience offered by the strategy literature is also a main effects view that does not consider how the impact of organizational experience is influenced by rapidly changing environments. Specifically, it has tended to view experience and knowledge as unconditionally helpful to organizations (Day 1994; Montoya-Weiss and Calatone 1994; Zirger and Maidique 1990).

Recent work has begun to explore in more detail the various mechanisms through which stored information or memory may affect product development. For example, Garud and Nayyar (1994) suggest that organizations should develop routines for reactivating previously acquired knowledge in new product development. Likewise, Cohen and Levinthal (1990, 1994) find that high levels of previous learning increase a firm's absorptive capacity, which permits more effective use of extramural knowledge. Moreover, Day (1994, p. 38) describes new product development as a "key firm capability involving complex bundles of skills and accumulated knowledge."

In addition to postulating how memory may enhance new product development outcomes, recent work also highlights the possibility that memory actually may detract from new product development in some situations. Work by Burgelman (1983), Leonard-Barton (1992), and Dougherty (1992), for example, suggest that competencies may turn into barriers when organizations strive to develop creative new products. More generally, research on organizational learning and technological change highlight the possibility that stored memory may prove a liability when organizational environments are changing rapidly (Miner 1990; Tushman and Anderson 1986).

Recent work, then, suggests a complex and even contingent role for organizational memory in product development. We seek to explore and expand the field's understanding of memory's role in three ways. First, focusing on two specific dimensions in our empirical study, we develop a multifaceted conceptualization of organizational memory and suggest that memory's impact depends on which memory dimension is at work. Second, we propose that memory's impact depends on whether the product outcome is short-term financial performance or product creativity. Third, drawing on fundamental concepts in theories of organizational learning, we propose that memory's impact depends on the degree of exogenous turbulence faced by the firm. To explore these issues, we develop eight propositions about the specific impact of memory level and memory dispersion on new product short-term financial performance and creativity. We test our hypotheses with data from 92 new product development projects. Our results point to distinct roles for memory level and dispersion, as well as to important interactions between turbulence and memory dispersion. Our arguments and results imply, we believe, that if firms fail to understand the subtle ways in which different features of organizational memory influence product development, they may fail to harvest the full value of organizational learning.

ORGANIZATIONAL MEMORY

The Organizational View of Memory

Envisioning memory as an organizational phenomenon is consistent with a growing body of literature that suggests organizations process, use, and store information, and that these collective activities can be seen as distinct from individual manager activities (Cohen and Levinthal 1990, 1994; Cyert and March 1963; Daft and Weick 1984; Huber 1991; Kohli and Jaworski 1990; Moorman 1995; Sandelands and Stablein 1987; Sinkula 1994; Weick 1979). In this *organizational* view, organization members' actions may lead to organizational interactions with the world, which results in outcomes that are interpreted by people and shared among members, creating organizational memory in the form of shared beliefs, values, assumptions, norms, and behaviors (Argyris and Schon 1978; Dutton and Duncan 1987; Hedberg 1981; Levitt and March 1988; Sinkula 1994).

The notion of collective mental processes has been appropriately criticized as encouraging reification and generalizations of individual phenomena to group actions. However, organizational memory, as embodied in organizational artifacts and procedures, seems to clearly distinguish organizational from individual memory. For example, standard operating procedures can drive behavior even when people within the system no longer have individual memory of the experiences that generated the routines (Levitt and March 1988). Moreover, in some cases, groups may develop collective processes to accomplish tasks, even when individual members are not aware of the process (Hutchins 1991). Organizational memory, then, is not simply the sum of the memories of organizational members, because it may involve the interaction of several people, or even reside outside the awareness of specific people.

Organizational Memory Forms, Roles, and Characteristics

Forms. We propose that organizational memory may be manifested in three basic forms (Garud and Rappa 1994; Hedberg 1981; Walsh and Ungson 1991). First, memory is found in organizational *beliefs*, knowledge, frames of reference, models, values, and norms (Day and Nedungadi 1994; Deshpandé, Farley, and Webster 1993; Deshpandé and Webster 1989; Lyles and Schwenk 1992; Nelson and Winter 1982; Starbuck 1992), as well as organizational myths, legends, and stories (Martin 1982). For example, Epson promoted the shared value of aiming for "40% improvement" in its new product development activities (Imai, Nonaka, and Takeuchi 1985).

Second, organizations learn from experience particular ways of doing things that become encoded in formal and informal *behavioral routines*, procedures, and scripts (Cyert and March 1963). Formal routines may be reflected in standard operating procedures (Winter 1987) or in managerial and technical systems and capabilities (Brown and Eisenhardt 1995; Leonard-Barton 1992); informal routines may involve scripted interactions (Orr 1990; Seeley Brown 1993). New product development routines may, for example, guide the types of information-sharing mechanisms used (Eisenhardt and Tabrizi 1995) or specific project steps such as prototype production. They may also direct the overall development process itself, such as when key go-no-go decision points become required steps or when the ISO

(International Organization for Standardization) 9000 routines for documentation become standard procedures. Imai, Nonaka, and Takeuchi (1985), for example, describe the "rugby approach" used by Honda teams, which involves the entire team running the full length of the new product development process, in contrast to a "relay approach," which involves functions handing off the product at distinct times. Likewise, Orr (1990) observes informal information sharing routines among Xerox service representatives who repeatedly gather around a communal coffee machine to share their field experience.

Third, memory is found in an organization's *physical artifacts*, which embody, to varying degrees, the results of prior learning (Epple, Argote, and Devadas 1991; Garud and Rappa 1994; Leonard-Barton 1992). For example, Epple, Argote, and Devadas (1991) provide evidence from an investigation of a truck plant that knowledge may become embodied in tooling, programming, and assembly line layout. Others have suggested that memory is reflected in organizational structure and ecology (Argote 1995; Leonard-Barton 1992; Levitt and March 1988; March 1991; Walsh and Ungson 1991). Furthermore, in new product development, Imai, Nonaka, and Takeuchi (1985, p. 354–58) describe "a special corner within the factory where workers could experiment," "holding meetings in a large room with glass walls," and the use of a system in which "all the team members are located in one large room." Features of products and product lines (such as product design, materials, packaging, and logos) are also important physical artifacts associated with organizational memory.

Roles. In all three forms, organizational memory is likely to perform two fundamental roles: interpretation and action guidance. Organizational memory performs an *interpretation role* by filtering the way in which information and experience are categorized and sorted (Cohen and Levinthal 1990; Daft and Weick 1984; Day 1994; Day and Nedungadi 1994; Dutton and Jackson 1987; Jackson and Dutton 1988; Sinkula 1994; Walsh and Ungson 1991). Organizational memory also performs an *action guidance role* by dictating or influencing individual and group action (Amburgey and Miner 1992; Cyert and March 1963; March and Simon 1968; Suchman 1994; Walsh and Ungson 1991). Memory, for example, may contain a protocol for a new product development stage that guides team members' actions. The action guidance role represents one of the most powerful features of organizational memory in much traditional research. Cyert and March (1963), for example, emphasize the power of standard operating procedures in driving organizational action, whereas Nelson and Winter (1982) stress the overarching impact of organizational routines.

Characteristics. In addition to memory forms and roles, organizational memory can be viewed as having several dimensions or characteristics: amount, dispersion, accessibility, and content. The *level*, or amount, of organizational memory refers to the amount of stored information an organization has about a particular phenomenon. High levels of experience in a product category or the accumulation of knowledge or skills indicate higher levels of memory. An abundance of memory has been theorized to influence a firm's demand for new market information (Dickson 1992; Sinkula 1994). Regarding this point, Weiss and Heide (1993) find that the greater the prior experience of organiza-

tional buyers, the less likely they were to engage in information search activities.

Organizational memory also varies in the degree to which it is *dispersed*, or shared, throughout the organization. As Walsh and Ungson (1991, p. 62) note, "organizational memory is not centrally stored, but distributed across different retention facilities." Organizational memory by its nature involves some degree of dispersion throughout the organization. However, there may still exist variance in the degree to which organizational members adopt firm knowledge and skills, which is determined, in part, by how firm activities are designed and structured to facilitate diffusion across the organization (Nonaka and Nicosia 1979; Webster and Wind 1972). The presence of distinct organizational subcultures suggests that memory is not necessarily shared by all members (Cohen and Levinthal 1990; Deshpandé and Webster 1989; Martin and Siehl 1983; Smircich 1983).²

Organizational memory also varies in *accessibility*, or the extent to which it can be retrieved for use (Day 1994; Garud and Nayyar 1994; Walsh and Ungson 1991). As Day (1991, p. 8) notes, "Organizations without practical mechanisms to 'remember' what worked and why have to repeat their failures and rediscover their success formulas over and over again. Memory mechanisms are needed to ensure that useful lessons are captured, conserved, and can be readily retrieved when needed."

Finally, the *content* of organizational memory refers to the meaning of collectively stored information (Walsh and Ungson 1991). Increasing evidence points to memory as consisting of two types of knowledge: procedural and declarative (Cohen 1991; El Sawy, Gomes, and Gonzalez 1986; Sinkula 1994). Procedural memory refers to process memory or memory of underlying skills for performing tasks (Nelson 1982). An organization may know, for example, how to develop prototypes. Declarative memory refers to the memory of concepts, facts, or events. Memory here might consist of knowledge about customer preferences, or the technical features of a firm's product line (Day and Nedungadi 1994). Another type of memory content could be found in the distinct cultural characteristics of an organization. For example, memory content may reflect more clan, market, bureaucracy, or adhocracy characteristics (Deshpandé, Farley, and Webster 1993). Memory content is therefore likely to be revealed, in part, in an organization's culture.³

A Definition of Organizational Memory

Using this review as a basis, we define *organizational memory* as collective beliefs, behavioral routines, or physical artifacts that vary in their content, level, dispersion, and accessibility. This view of memory is consistent with that of

²Although our approach focuses on the *degree* of dispersion, dispersion could be further conceptualized as a multidimensional construct that also reflects the *structure* of that sharing. The structure of information distribution may include, for example, one-way or two-way transmissions and horizontal or vertical structures. Hence, we include a variable in our model that may partially control for the effects of the structure of information-sharing activities within the firms we studied.

³Following Deshpandé and Webster (1989), culture is reflected in an organization's values and norms. Therefore, if culture is the source, memory content will have a value or norm component. However, as conceptualized, organizational memory is much broader than organizational culture, because, in addition to values and norms, memory includes behavioral routines and physical artifacts that reflect prior learning.

Day (1994, p. 44), who defines organizational memory as "a repository for collective insights contained within policies, procedures, routines, and rules that can be retrieved when needed," but is more circumscribed than that of Walsh and Ungson (1991), who suggest that organizational memory is composed of the structure of its retention facility, the information contained in it, its effects, and the information acquisition and retrieval processes.

CONCEPTUAL FRAMEWORK

Our conceptual framework focuses on how two organizational memory dimensions, level and dispersion, influence the success of new products. These dimensions were selected because, as we subsequently suggest, both have been described in the literature as having a positive effect on new product development activities. However, our framework suggests that the effect of these memory factors depends on what type of new product outcomes is being examined and on whether the firm operates within a turbulent environment.

In discussing this framework, we first introduce the two focal new product outcomes investigated here. Second, we present the effect of organizational memory level and dispersion on each new product outcome. Third, we discuss the moderating effects of environmental turbulence on the organizational memory-new product outcome relationships.

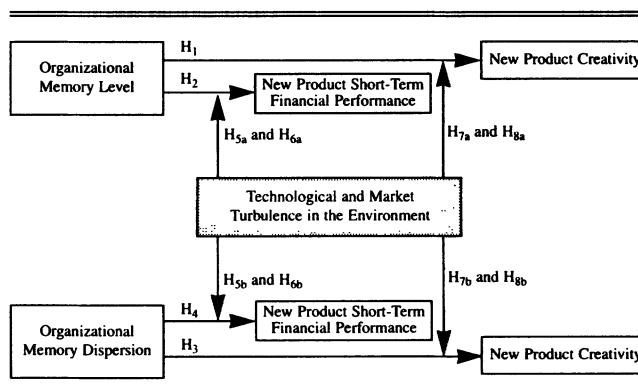
Focal New Product Outcomes

The two new product outcomes that we investigate are new product creativity and new product short-term financial performance. *New product creativity* refers to the degree to which a new product is novel and has generative capacity (i.e., the potential to change thinking and practice) (Andrews and Smith 1996; Wilton and Myers 1986; Zaltman, Heffring, and LeMasters 1983). *New product short-term financial performance* is defined as the level of new product profitability and sales that occur within the first year of introduction (Griffin and Page 1993; Montoya-Weiss and Calantone 1994). These outcomes were selected because others have suggested that they are influenced by organizational-level information processes (Day 1991; Dickson 1992; Glazer 1991; Jaworski and Kohli 1993; Imai, Nonaka, and Takeuchi 1985; Moorman 1995; Narver and Slater 1990; Sinkula 1994). Moreover, there is often a tension between the creativity and the short-term financial performance of new products, because highly creative products may have greater potential for short-term performance problems due to the difficulty of changing consumer or retailer acceptance of the product, while offering the possibility of greater long-term financial gain given the possibility of their revolutionizing a product category (Adams and Lacugna 1994; Andrews and Smith 1996; Kleinschmidt and Cooper 1991). These tensions are played out in the hypotheses that are depicted in Figure 1.

The Effects of Organizational Memory on the Performance and Creativity of New Products

The effect of organizational memory level. A high level of organizational memory would typically be present when a new product project or action phase represents familiar territory, a new product represents a modest change in an old project, the technological or customer basis for a new prod-

Figure 1
THE INFLUENCE OF ORGANIZATIONAL MEMORY ON NEW PRODUCT CREATIVITY AND PERFORMANCE



uct is part of the firm's longstanding repertoire, the length of team members' service is high, or a particular new product development phase—such as prototype development—is a well-developed competency.

Previous research has observed that change becomes more difficult as memory in a particular domain increases. This effect has been referred to as a *competency trap* (Levitt and March 1988; March 1991), a *core rigidity* (Leonard-Barton 1992), *routine rigidity*, or *functional fixedness* (Dickson 1992) for the organization. In the area of new product development, observers also have reported from qualitative studies that higher levels of memory inhibit any actions outside preexisting action patterns (Ghemawat 1991; McDonough 1993). Likewise, both Leonard-Barton (1992) and Dougherty (1992) describe instances in which groups with strong memories are least able or likely to deviate from prior action patterns during new product development (see also March 1979).

An important alternative possibility is that memory actually could enhance creativity. For example, research on related topics suggests that some forms of creativity thrive in the presence of memory. For example, organizational improvisation, which involves firms acting extemporaneously without a plan, has been described as involving the recombination of routines to produce novel outcomes (Weick 1993a, b). More generally, research on adaptation has stressed the recombination of prior routines as a crucial source of novel activities (Holland 1975). Likewise, Cohen and Levinthal (1990) find that organizational memory—as reflected in prior research investments—can enhance an organization's ability to assess and import new outside information, which could promote creativity. Specifically, Cohen and Levinthal (1994, p. 237) suggest that "fortune favors the prepared firm" (see also Feldman 1989). Taken together, these ideas and data imply that high organizational memory could actually enhance creativity in new product development.

Empirical research on new product development itself, on balance, has tended to support the potentially negative impact of memory on new product development creativity, however. This leads us to hypothesize:

H₁: The greater the level of organizational memory for a new product domain, the lower the level of new product creativity.

The next question concerns the impact of organizational memory level on the financial performance of new products. Theory and current research imply that high levels of memory, while inhibiting new product creativity, may enhance their short-term financial performance by increasing efficiencies and the likelihood that previous successes will be repeated (Cyert and March 1963; Duncan and Weiss 1979; Walsh and Ungson 1991). Much new product development research shows that for many products, strong memory reduces the chances of poor outcomes by increasing efficiency and decreasing the chances of costly errors (Cooper and Kleinschmit 1986). This line of reasoning is consistent with the finding that higher performing new products typically have higher levels of marketing and technological synergy between the new product and the firm's existing competencies (Montoya-Wiess and Calatone 1994; Varadarajan 1983; Zirger and Maidique 1990). Therefore, together with H_1 , this suggests that organizational memory level is likely to reduce the creativity of new products while increasing their short-term financial performance.

H_2 : The greater the level of organizational memory for a new product domain, the greater the new product short-term financial performance.

The effect of organizational memory dispersion. The effect of memory dispersion on new product outcomes is less clear on the basis of a review of the extant literature. Recall that memory dispersion refers to the extent to which organizational members share an understanding of organizational beliefs, behavioral routines, and physical artifacts.

One stream of literature suggests that greater dispersion leads to more creative and better financially performing new products. For example, Hutt, Reingen, and Ronchetto (1988) find that creative new product initiatives are more likely to be characterized by a greater number of communication links between organizational functions. Others point to the critical role of dispersing information across organizational functions, such as marketing and research and development (R&D), in the success of new product innovations (Gupta, Raj, and Wilemon 1986; Moenaert and Souder 1990a, b). This research suggests that the dispersion of memory enables functions to understand one another, improves their ability to cooperate, facilitates cross-fertilization, and may reduce the tendency of individual functions to become confined by their own thought-worlds (Dougherty 1992; Souder 1987). As Imai, Nonaka, and Takeuchi (1985, p. 544, emphasis added) note, "Project members are expected to interact with each other extensively, to share everything from risk, responsibility, information, to decision making, and to acquire *breadth of knowledge and skills*." How memory gets dispersed is not the subject of the present research (see Griffin and Hauser 1992, 1993, 1994; Hutt, Reingen, and Ronchetto 1988). However, when dispersed, collectively held knowledge appears to improve both the creativity and financial performance of new products.

Another stream of research suggests that lack of memory dispersion or heterogeneity within organizations should have a positive effect on innovation and creativity (Burgelman 1983; March 1991; Quinn 1986). From this perspective, groups with similar values, identical information, or overlapping competencies should be less capable of producing actions that deviate from their prior activities than would more heterogeneous groups (Gigone and Hastie 1993). In

addition, some researchers have suggested that much organizational innovation comes from recombining routines or ideas in new ways or by mixing routines that were previously separate (Nelson 1982; Nonaka 1990). This line of reasoning implies that high memory dispersion could inhibit creativity because it would reduce heterogeneity in the organization, which, in turn, restricts the number of routines, ideas, and competencies available for recombining or for generating new actions. The early marginalized roles of product champions for Post-It notes or Hitachi lasers embody this idea (Garud and Nayyar 1994; Peters 1988).

One way to reconcile these conflicting perspectives and findings is to propose a curvilinear relationship between memory dispersion and new product creativity, in which moderate levels of dispersion promote the highest levels of new product creativity. Moderate levels are predicted to promote the greatest creativity because organizations have both the breadth and cross-fertilization that dispersion provides while maintaining some heterogeneity among members. Under these circumstances, members share a language and understanding of problems and solutions but retain some distinctive skills and knowledge. This view is supported by conceptual literature on group performance that suggests that too much diversity restricts communication but too much similarity may restrict the range of observations available for recombination (Katz and Allen 1982), and by Fiol (1994), who suggests that team diversity *and* unity jointly promote higher levels of collective learning. Under this form of the relationship, moderate levels of dispersion have elements of both heterogeneity and homogeneity and therefore maximize new product creativity.⁴

H_3 : There exists a curvilinear relationship between dispersion of organizational memory for a new product domain and new product creativity such that moderate levels of dispersion produce the highest levels of new product creativity and high and low levels of dispersion result in lower levels of new product creativity.

Although a curvilinear relationship is expected for the effect of memory dispersion on new product creativity, memory dispersion is expected to have a positive linear relationship with the short-term financial performance of new products, because high levels of dispersion increase the effectiveness and efficiency of decision making and implementation. In fact, as dispersion levels increase, the team's mental model becomes unified, which results in timely, cost-effective decisions that help realize a firm's new product financial goals. Moreover, as was reviewed previously, the literature on information-sharing mechanisms in cross-functional efforts, such as total quality management and quality function deployment, suggests that shared knowledge and vision improve the short-term financial performance of product development activities by enhancing cross-functional understanding and cooperation (Day 1994; Griffin and Hauser 1993; Hauser and Clausing 1988; Imai, Nonaka, and Takeuchi 1985), as well as by improving team efficien-

⁴It would also be reasonable to argue that the form of this curvilinear relationship should be a U-shaped curve, in which high and low levels of dispersion promote the highest levels of creativity. Nevertheless, we chose to integrate both of the literatures and in so doing, believe the best representation of the relationship is an inverted-U. This form suggests that moderate dispersion has elements of both heterogeneity and homogeneity, and therefore maximizes new product creativity.

cies in making decisions and taking action. This does not mean that the team is making the most creative decisions, which we believe will happen under moderate dispersion levels (H_3). Therefore, the creativity-dampening risks of too much dispersion will not have the same impact on short-term financial performance, because cross-functional efficiencies are maximized, not compromised, in high dispersion level groups.

H_4 : The greater the dispersion of organizational memory for a new product domain, the greater the new product short-term financial performance.

The Moderating Effect of Environmental Turbulence

The turbulence associated with an organization's environment is expected to moderate the effect of organizational memory on new product outcomes. One of the most fundamental tenets in theories of organizational learning holds that the value of organizational memory is contingent on the setting in which the organization operates (Argote and Eppel 1990; Cyert and March 1963; Levitt and March 1988). Memory, after all, reflects learning from experience, and that experience occurs at a specific time in a specific setting. This insight is consistent with contingency theory's argument that bureaucratic structures—which rigidly institutionalize lessons from prior experience—can enhance performance under stable conditions, whereas more organic structures are needed for turbulent conditions (Lawrence and Lorsch 1967; Mintzberg 1979).

Several important mechanisms may produce such environmental effects. At a minimum, the value and impact of stored prior learning may deteriorate with environmental change (Achrol 1991; Glazer 1991). As Weiss and Heide (1993, p. 221) note, "a rapid pace of technological change creates uncertainty that can be competency destroying" (Tushman and Nelson 1990; see also Anderson and Tushman 1990; Tushman and Anderson 1986). Even more important, memory may stand in the way of effective action in a turbulent environment, which restricts the organization to inappropriate actions.

We focus on *technological turbulence*, that is, the degree of change associated with new product technologies (Glazer and Weiss 1993; Jaworski and Kohli 1993; Weiss and Heide 1993), and *market turbulence*, that is, the rate of change in the composition of customers and their preferences (Jaworski and Kohli 1993, p. 57). Both types of turbulence may have a potentially disruptive effect on memory's positive effect on new product short-term financial performance, because turbulence is likely to reduce the value of prior learning, which forces the organization to search for and process more information about the environment (Lawrence and Lorsch 1967; Sinkula 1994; Weiss and Heide 1993). Rapid environmental change also may stimulate metalearning, in which the people in organizations learn to identify patterns of environmental behavior, but organizations in turbulent environments generally find it difficult to cope and survive. Given this view, we expect the positive effect of organizational memory level (H_2) and dispersion (H_4) on the short-term financial performance of new products to be weakened under conditions of high technological or market turbulence:

H_5 : The greater the technological turbulence associated with the environment, the weaker the positive relationship between

organizational memory (a) level and (b) dispersion and new product short-term financial performance.

H_6 : The greater the market turbulence associated with the environment, the weaker the positive relationship between organizational memory (a) level and (b) dispersion and new product short-term financial performance.

Although environmental turbulence may reduce the value of organizational memory for performance, there is a potentially positive effect of environmental turbulence for the effect of memory levels on the development of creative new products. Specifically, if high organizational memory levels reduce the potential for creative new products (H_1), a fast-changing environment may attenuate this possibility because high levels of environmental change may act as triggers to "unlearn" current new product routines (Cyert and March 1963; Hedberg 1981; Starbuck 1976).

Considering the relationship between memory dispersion and new product creativity (H_3), we suggest that organizations may be better off with internal heterogeneity under turbulent conditions (Aldrich 1979; Lawrence and Lorsch 1967; March 1991). Under conditions of internal heterogeneity (low dispersion), firms can draw on previously marginal ideas or competencies that may act as crucial creative engines in times of high turbulence (Burgelman 1983; Feldman 1989; Miner 1990). For example, a firm producing vacuum tubes that has a well-dispersed technical memory (about vacuum tube technology) would be worse off when transistors are discovered, than another firm that has a less dispersed memory, but includes a small deviant group of engineers who are interested in transistor technology. This reasoning implies that under conditions of high turbulence, we might expect high memory dispersion (high homogeneity) to have a negative effect on creativity. Under conditions of low turbulence, however, high dispersion may have a positive effect on creativity. This positive effect may accrue from a new product team's ability to recombine shared knowledge into creative new products (Borko and Livingston 1989; Dougherty 1990, 1992; Nelson 1982; Nonaka 1990; Weick 1993a, b). We therefore hypothesize,

H_7 : The greater the technological turbulence associated with the environment, (a) the weaker the negative relationship between organizational memory level and new product creativity and (b) the weaker the positive relationship between organizational memory dispersion and new product creativity.

H_8 : The greater the market turbulence associated with the environment, (a) the weaker the negative relationship between organizational memory level and new product creativity and (b) the weaker the positive relationship between organizational memory dispersion and new product creativity.

METHOD

Sample and Procedure

The initial sample consisted of 396 firms in the 1992 *Advertising Age* list of top 200 advertisers. After eliminating firms for which the questionnaire was inappropriate (i.e., no new product development occurred), the overall sample was reduced from 396 to 300. Of the eligible sample, 92 firms (31%) responded. In terms of process, three weeks following the first mailing, nonrespondents were telephoned, reminded of the questionnaire, and encouraged to complete and return it. Two weeks following the calls, a second mailing was sent to nonrespondents. No systematic differences

were found between those who responded before and after the second mailing (Armstrong and Overton 1977).⁵

Vice presidents of marketing were used as informants because of their organizational knowledge and access to strategic and financial information (Aguilar 1967). Informant firm tenure levels averaged 18 years, which is comparable to other samples of informants at this level (Larwood et al. 1995).⁶ When completing the survey, informants were asked to focus on the most recent product development project that had been in the market for a minimum of 12 months for which their division was responsible. If new products did not fall under their purview, informants were asked to forward the questionnaire to the appropriate vice president in their division. All questions regarding the organization, then, focused on the division as the unit of analysis.

Measurement

Appendix A contains all of the measures and their sources. Memory level was operationalized by measuring the amount of knowledge, experience, and familiarity an organization has in a product category. Memory dispersion level was measured by the degree of consensus or shared knowledge among new product participants. The assumption underlying this approach is that when organizational memory is dispersed, members' beliefs would intersect or converge on a particular topic. If, for example, informants noted that there was little consensus among people working on the product, a reasonable conclusion would be that team members' beliefs were based on different assumptions, experiences, and information. Note that this approach to measuring memory dispersion reflects the collective underpinnings of organizational memory. That is, the defining element—degree of convergence—is assessed as a property of the collective.

Technological and market turbulence were measured with Jaworski and Kohli's (1993) operationalizations, which focus on the pace of technological change and customer changes in the industry (see also Glazer and Weiss 1993; Weiss and Heide 1993). Finally, organizational bureaucratization, which will be entered in the model to control for the structure of information dispersion, is defined as the degree to which an organization is managed through formalized relationships and centralized authority (John and Martin 1984) and is measured with Deshpandé's (1982) scales.

Following the data collection, measures were subjected to a purification process involving unidimensionality, reliability, and discriminant validity assessments (see Anderson 1987; Bagozzi and Phillips 1982; Churchill 1979; Gerbing and Anderson 1988). To assess unidimensionality, the measures were divided into three subsets of theoretically related

variables: the two organizational memory measures, the two new product outcomes, and the two environmental moderators. Because of the small sample size, this approach was chosen over examining all variables in a six-factor model, which violates the recommendations made by Bentler and Cho (1988) to not exceed a five-to-one ratio of sample size to parameter estimates. Results suggest that the three models fit well: the memory variables ($\chi^2_{(26)} = 28.74$, $p = .323$, goodness-of-fit index [GFI] = .938), the two new product outcomes ($\chi^2_{(19)} = 26.60$, $p = .114$, GFI = .930), and the two environmental moderators ($\chi^2_{(34)} = 58.16$, $p = .006$, GFI = .900).

Within these three models, discriminant validity was assessed by constraining and freeing the phi coefficient. The model with the free coefficient was found to be superior to the fixed coefficient for the two organizational memory variables $\Delta\chi^2_{(1)} = 9.18$, the two new product outcomes $\Delta\chi^2_{(1)} = 11.34$, and the two environmental moderators $\Delta\chi^2_{(1)} = 13.42$, suggesting independent constructs. In addition, because the memory measures are new, discriminant validity was assessed and found between the memory variables and measures of individual manager use of information (Deshpandé and Zaltman 1982), organizational use of information (Moorman 1995), and different forms of organizational culture (Deshpandé, Farley, and Webster 1993).⁷ Finally, the reliability of the measures was found to exceed standards for acceptance.⁸ In Table 1, we present psychometric information and a correlation matrix of all measures.

General Theory Testing Approach

The hypotheses were examined in two regression models, with the two new product outcomes as dependent variables. Following accepted guidelines for examining interactions, for each model, the main effects associated with the two organizational memory variables and turbulence were entered in addition to their interaction effects (the product of the memory variables and the moderators). Following the conceptual framework, a quadratic form of the memory dispersion variable also was entered in the model with new product creativity as the dependent variable. The main effect variables were mean-centered before we constructed the interactions and quadratic versions to reduce the potential effects of collinearity (Cronbach 1987). Significant interactions were investigated with the slope analysis procedures specified in Aiken and West (1991) to improve understanding of the coefficients. These procedures enable significant relationships to be understood at different levels of the continuous moderator variables without creating categorical

⁵The results of these tests are the following (where ER = early responders and LR = late responders): memory level (ER = 5.29, LR = 5.17, $t_{(91)} = .34$), memory dispersion (ER = 5.50, LR = 5.37, $t_{(91)} = .69$), technological turbulence level (ER = 3.98, LR = 4.23, $t_{(91)} = -.76$), new product performance (ER = 4.90, LR = 4.65, $t_{(91)} = .71$), and new product creativity (ER = 5.18, LR = 4.65, $t_{(91)} = .71$).

⁶Informant tenure levels were not collected during the initial administration of the questionnaire. However, half of the organizations were subsequently telephoned and this information was gathered as a safeguard to ensure that respondents had enough organizational experience to be capable of assessing organizational memory, though recent evidence has found an insignificant relationship between firm tenure levels and executives' articulation of their corporate visions (Larwood et al. 1995).

⁷Results indicate that the critical value ($\Delta\chi^2_{(1)} = 3.84$) was exceeded in all tests: memory level and individual instrumental use of information ($\Delta\chi^2_{(1)} = 32.18$); memory dispersion and individual instrumental use of information ($\Delta\chi^2_{(1)} = 26.52$); memory level and organizational instrumental use of information ($\Delta\chi^2_{(1)} = 5.06$); memory dispersion and organizational instrumental use of information ($\Delta\chi^2_{(1)} = 9.79$); memory level and clan cultures ($\Delta\chi^2_{(1)} = 21.58$), market cultures ($\Delta\chi^2_{(1)} = 4.46$), adhocracy cultures ($\Delta\chi^2_{(1)} = 11.82$), and bureaucracy cultures ($\Delta\chi^2_{(1)} = 14.58$); as well as memory dispersion and clan cultures ($\Delta\chi^2_{(1)} = 9.65$), market cultures ($\Delta\chi^2_{(1)} = 10.16$), adhocracy cultures ($\Delta\chi^2_{(1)} = 26.04$), and bureaucracy cultures ($\Delta\chi^2_{(1)} = 35.05$).

⁸The only exception, memory dispersion, also could be argued to be a reflective, rather than a formative, scale. This status would suggest that conceptual considerations regarding construct space coverage, and not reliability assessments, should be the evaluative criteria.

Table 1
MEASUREMENT INFORMATION

	<i>Mean</i>	<i>S.D.</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Organizational Memory Level	5.26	1.62	.96						
(2) Organizational Memory Dispersion	5.46	.82	.33*	.62					
(3) Technological Turbulence	4.06	1.44	-.06	-.01	.84				
(4) Market Turbulence	4.01	1.17	.09	.13	.17	.70			
(5) New Product Short-Term Financial Performance	4.82	1.51	.40*	.43*	-.01	.11	.95		
(6) New Product Creativity	5.12	1.24	-.02	.27*	.19	.16	.13	.78	
(7) Organizational Bureaucratization	3.21	1.24	.12	-.39*	-.03	.08	-.19	-.28*	.85

* $p < .05$.

Note: The coefficient alpha for each measure is on the diagonal (and in italics) and the intercorrelations among the measures are on the off-diagonal.

versions. For both models, variance inflation factors were estimated to examine collinearity and found to be below harmful levels (Mason and Perreault 1991). In addition to these predicted effects, organizational bureaucratization also was entered as a control variable in the models for the reasons described previously. Table 2 presents model estimation results.

RESULTS

Overview

Results show that, overall, the two models were significant: new product short-term financial performance ($R^2 = .310$, $F_{(9,83)} = 4.135$, $p = .0001$) and new product creativity ($R^2 = .255$, $F_{(10,82)} = 2.816$, $p = .0001$). As was noted previously, in testing the interaction hypotheses, the main effects associated with the moderator variables (market and technological turbulence) must be entered into the regression model (Pedhazur 1982). Therefore, several nonhypothesized main effects also are noted. Results indicate that technological turbulence has a significant positive main

effect on new product creativity ($b = .204$, $t = 2.286$) but no effect on new product short-term financial performance. Market turbulence has no main effects. Finally, the control variable, organizational bureaucratization, has no effect on the short-term financial performance of new products and a marginal negative effect on their creativity ($b = -.200$, $t = 1.837$).

The Impact of Organizational Memory Level

The first two hypotheses examine the effect of organizational memory level on new product outcomes. H_1 predicts that higher levels of organizational memory reduce new product creativity. Results indicate a nonsignificant relationship between memory level and new product creativity, which fails to support H_1 , though the relationship is in the expected direction ($b = -.089$, $t = -1.123$). H_2 predicts a positive effect for organizational memory level on new product performance, which the results support ($b = .258$, $t = 2.787$).

Considering the effect of technological turbulence, H_{5a} and H_{6a} predict that the greater the technological and market

Table 2
STANDARDIZED ESTIMATES OF HYPOTHESIZED RELATIONSHIPS

Independent Variables	Dependent Variables					
	New Product Short-Term Financial Performance			New Product Creativity		
	Prediction	Actual		Prediction	Actual	
Organizational Memory Level	(H_2 , +)	.258* (.092)		(H_1 , -)	-.089 (.080)	
Organizational Memory Dispersion	(H_4 , +)	.582* (.196)			.418* (.184) ^a	
Memory Dispersion × Memory Dispersion				(H_3 , ∩ ^c)	.086 (.126)	
Memory Level × Technological Turbulence	(H_{5a} , -)	-.025 (.061)		(H_{7a} , -)	-.013 (.053)	
Memory Level × Market Turbulence	(H_{6a} , -)	.007 (.069)		(H_{8a} , -)	-.017 (.060)	
Memory Dispersion × Technological Turbulence	(H_{5b} , -)	.054 (.150)		(H_{7b} , -)	-.402* (.135)	
Memory Dispersion × Market Turbulence	(H_{6b} , -)	-.351* (.165)		(H_{8b} , -)	-.156 (.145)	
Technological Turbulence ^a		-.093 (.104)			.204* (.089)	
Market Turbulence ^a		.044 (.125)			.062 (.109)	
Organizational Bureaucratization ^b		-.064 (.125)			-.200† (.108)	
Adjusted R^2		.310			.255	
F-statistic		4.135*			2.816*	

Note: The degrees of freedom for the new product short-term financial performance model were (9,83), whereas they were (10,82) for the new product creativity model. Standard errors are in parentheses.

* $p < .05$.

† $p < .10$.

^aFollowing Pedhazur (1982), the main effects associated with both the interactions and the quadratic terms must be entered into models examining interaction and quadratic hypotheses.

^bOrganizational bureaucratization is a control variable reflecting the structure of organizational information sharing activities.

^c H_3 predicts an inverted-U relationship.

turbulence, respectively, the weaker the positive relationship between organizational memory level and new product short-term financial performance. Results indicate no significant interactions between memory level and either type of turbulence on financial performance (see Table 2), which suggests that memory level positively influences new product performance in this sample regardless of environmental turbulence. These results fail to support H_{5a} and H_{6a} .

Likewise, H_{7a} and H_{8a} predict that technological and market turbulence, respectively, weaken any negative effect of memory levels on the development of creative new products. Results indicate no interaction between memory level and turbulence on creativity in these data.

The Impact of Organizational Memory Dispersion

The second set of hypotheses focuses on the effect of organizational memory dispersion on new product outcomes. H_3 predicts that a moderate level of memory dispersion promotes the highest levels of new product creativity. Results do not support this prediction but instead find a non-significant quadratic dispersion term ($b = .086$, $t = .680$) and a positive main effect dispersion term ($b = .418$, $t = 2.266$), which suggests there is a positive linear relationship between memory dispersion and creativity. H_4 predicts that greater dispersion of organizational memory increases new product short-term financial performance. Results support this prediction ($b = .582$, $t = 2.965$).

Results also suggest, however, that the impact of memory dispersion on the short-term financial performance of new products is weakened by market turbulence, which supports H_{6b} ($b = -.351$, $t = -2.124$). Specifically, as market turbulence increases, the relationship between memory dispersion and short-term financial performance decreases. A follow-up slope analysis examining this interaction (Aiken and West 1991) indicates that the relationship between memory dispersion and financial performance is insignificant under conditions of high market turbulence ($b = -.012$), becomes positive at moderate market turbulence ($b = .436$), and is even stronger at low market turbulence ($b = .885$). In short, memory enhanced short-term financial performance when there was little turbulence but had no effect on short-term financial performance in the presence of high turbulence. No support for a similar effect for technological turbulence was found, however, which fails to support H_{5b} .

Technological turbulence did, however, have a significant negative interaction with memory dispersion on new product creativity ($b = -.402$, $t = -2.964$). A follow-up slope analysis examining this interaction (Aiken and West 1991) indicates that the relationship between memory dispersion and new product creativity is negative under conditions of high turbulence ($b = -.385$), becomes positive at moderate turbulence ($b = .298$), and is strong and positive at low turbulence ($b = .981$). These results support H_{7b} . Market turbulence does not, however, moderate the impact of memory dispersion on new product creativity, which fails to support H_{8b} (see Table 2).

DISCUSSION

We provide an initial attempt to fill an important gap in the new product literature by expanding our vision of organizational memory in the new product context and exploring some of its effects using systematic quantitative data.

The Nature of Organizational Memory

An important first contribution of this work is the fine-grained description of organizational memory forms, roles, and characteristics. Although many of these issues have been discussed in other research (e.g., Walsh and Ungson 1991), we systematically integrate these concepts into a definition of organizational memory, which results in several important advances. First, we describe three ways in which memory may be manifested: as shared beliefs, behavioral routines, and physical artifacts. Second, two distinct memory roles were identified—both interpretive and action guidance roles. Third, four distinct dimensions of organizational memory were identified, two of which were examined empirically in this research. Fourth, this view of memory extends prior work by Walsh and Ungson (1991). On the one hand, it reaffirms their emphasis on the multidimensional character of memory, and the subtle processes involved in creating and sustaining it. On the other hand, our framework diverges from their emphasis on memory as part of an interpretive system. Specifically, our approach gives memory standing as an organizational feature that can be deliberately created and modified, and whose features can materially affect firm outcomes.

Further research could fruitfully assess the effects of other memory characteristics on new product activities. For example, further work could examine the competitive implications of different levels of procedural and declarative memory content. The contrasting possibilities can be seen in the classic example of the early development of the VCR, when Ampex held crucial tape recording patents (declarative memory) but lacked crucial product development skills (procedural memory) for the mass market. In contrast, Sony, JVC, and others had relatively weak scientific (declarative) memory regarding some key aspects of tape technology (Lurie 1987). However, these firms used powerful electronic product development skills (procedural memory) to develop commercial VCR products after gaining access to Ampex's knowledge. Because the procedural memory content was less easy to imitate than the declarative memory content, U.S. firms were not able to replicate quickly the content of the memories of the Japanese firms, which resulted in U.S. firms' inability to compete successfully in this product market (Lurie 1987; Teece 1987).

The Link Between Memory and New Product Development Outcomes

In our empirical study, we explore how two dimensions of memory—level and dispersion—affect two different new product outcomes: financial performance and product creativity. Two broad findings emerge. First, memory may influence financial performance and creativity in different ways. Second, environmental turbulence appears to moderate memory's impact on performance. In particular, higher memory dispersion did not enhance financial performance under conditions of market turbulence, whereas it actually harmed creativity under conditions of technological turbulence. These broad findings, along with more specific features of these relationships, point to important priorities for practitioners seeking to improve product development processes by enhancing organizational memory, and suggest fruitful areas for further research.

Before considering these issues, however, it is important to note the aspects of this study that should be kept in mind

while interpreting these results. For this initial empirical study, we used single informants at high levels of the organization to achieve a broad organizational view. Although the use of multiple informant designs remains the exception in most marketing studies, such an approach would provide a better test in some respects, though such designs are not without their methodological concerns. Despite these concerns, future studies might profit from seeking multiple informants to enhance the validity of organizational memory measures (Bagozzi and Phillips 1982).

In addition, that our informants assessed new product development projects after their completion raises the potential of a retrospective justification bias. This would occur if informants, knowing the outcome of projects, tended to give responses for the independent variables consistent with their knowledge of the outcome. Our informants provided their assessments of these variables in the context of other measures, thus making it less likely they would pay attention to the congruence of their assessments with new product outcomes. Moreover, survey questions were designed to focus informant attention on the appropriate time period for each variable, in part to help avoid this effect. Nonetheless, further work could fruitfully seek to measure memory variables before project outcomes are known to alleviate such concerns.

Finally, our data show meaningful variance in terms of organizational memory and project outcomes, which reduces concerns about limited scope in our sample. However, assuming our sample of projects is representative of product development projects in general, it is likely to contain a large proportion of projects involving the modification of existing products. Therefore, our results may not be generalizable to more radical projects. Hence, an important avenue for further work would be to determine if our results are replicated in samples with higher proportions of more radical projects. These issues notwithstanding, the study's results offer interesting implications for both practitioners and marketing theorists, which we next consider.

New Product Outcomes

The effects of memory differ between the two new product development outcome dimensions studied here. In particular, memory level enhances relatively short-term (one year) financial performance, but not creativity. Market turbulence moderates the impact of memory dispersion on financial performance, whereas technological turbulence moderates the impact of memory dispersion on creativity, but not on short-term financial performance. This pattern highlights that memory may have varied effects on different features of product performance. There are additional indicators of success in new product activities, including customer measures and time-to-market measures (Griffin and Page 1993). By implication, the effect of memory level and dispersion may vary for these other outcome indicators as well.

One implication of our work for practitioners, then, is to underscore the importance of sensitivity to organizational memory's potentially distinct impact on different new product outcomes. Many firms are in the process of creating increasingly sophisticated organizational memory systems in which they make engineering drawings, parts specifications, costs, and other concrete features of prior products available

to in-house designers and even vendors. Some firms also seek to institutionalize the new product development process itself through efforts to achieve ISO 9000 certification. Other organizations are experimenting with new organizational structures that affect the nature and availability of organizational memory (Womack, Jones, and Roos 1990). Our results support the importance of identifying which product outcomes the firm seeks to enhance and attempting to link these activities to memory in order to enhance specific outcomes over time.

The results also support the importance of careful attention to the multiple dimensions of new product outcomes in theoretical research. They are consistent with predictions that memory may have different effects on different outcomes, which reduces the likelihood that we will find a simple formula linking memory to new product outcomes. For example, research linking memory dimensions with key additional outcomes, such as timeliness, long-range financial outcomes, and whether a product becomes a dominant design, may offer potentially important frontiers for such work (Foster 1986; Schoonhoven, Eisenhardt, and Lyman 1990).

The Effect of Organizational Memory Level

Our research augments previous work concerned with the relationship between new products and a firm's existing competencies, which has often viewed knowledge assets as having unconditionally positive effects. For practitioners, our results support a great deal of the marketing strategy literature and practice by finding that a reliance on memory (which represents stored information and competencies) in new product development increases new product financial performance (Ansoff 1988; Montoya-Weiss and Calatone 1994; Rumelt 1974; Varadarajan 1983). However, we did not find active support for the prediction that high memory levels would detract from product creativity, but we did find that high memory levels failed to enhance creativity.

Our finding that high memory level enhanced financial return but did not enhance creativity also reinforces practitioner concern about the possible dangers of formalizing new product development processes. Specifically, many firms are now formalizing new product development procedures, sometimes in pursuit of ISO 9000 certification or supplier qualification programs. Yet, to the degree a firm seeks to enhance new product creativity, formal procedures aimed at increasing the level of memory may have little or no value. These firms might want to look to other dimensions of their organizational memory (beyond just trying to capture the most information possible) in seeking to institutionalize their best practices.

Turning to theoretical issues, that high memory levels neither enhances nor detracts from product creativity in our study leads us to speculate that memory level may be less important than how flexibly or inflexibly a firm holds its knowledge (March 1979). Further research could consider moderating factors in the firm's culture or structure that may reflect a flexible approach to what has been learned in the past or that encourage careful reconsideration of current routines and knowledge (Barabba and Zaltman 1991; Olson, Walker, and Ruekert 1995). In addition, the relationship between memory level and creative product outcomes may be influenced by stage of the new product development

process, whether the organization uses a team approach, and the nature of the product itself. In addition, we believe it will be important to begin to study more systematically the actual processes through which memory level affects outcomes, through, for example, longitudinal study of the creation and deployment use of specific organizational routines.

The Effect of Organizational Memory Dispersion

Memory dispersion had a positive effect on both the financial performance and creativity of new products in this sample. Moreover, the impact of our measure of memory dispersion on new product outcomes was stronger than the impact of the measure of memory level. This implies that the degree to which knowledge and skills are shared among organizational members may be more important than the sheer amount of organizational memory in some settings.

Recall that we had predicted a positive effect for memory dispersion on product financial performance and a curvilinear effect for dispersion on product creativity. Our results support the former and show only a simpler linear effect for dispersion impact on creativity. The question of whether dispersion has a linear curvilinear effect merits further study, however. We utilize a simple measure of dispersion and do not attempt to characterize the structure of such dispersion. If memory is dispersed in a hierarchical manner (as opposed to a network fashion), its impact may vary. In addition, the lack of a curvilinear effect may arise from the scope limitations of our sample. For example, the maximum point in the curvilinear relationships may shift to some degree depending on whether a product is more incremental or radical.

Environmental Contingencies and the Effect of Memory Dispersion

Following previous theory and research that environmental turbulence has the potential to affect the value of memory, we introduce market and technological turbulence as moderator variables into our study. Although these factors did not moderate the impact of memory level, they did influence the way memory dispersion affects product outcomes.

We find that technological turbulence has an important effect on dispersion's impact on product creativity. In the presence of high technological turbulence, high levels of memory dispersion—which involves shared understanding and homogeneous knowledge—actually detract from creativity. This significant interaction provides a partial explanation for the conflicting literature on dispersion, suggesting that both high and low levels of dispersion foster creativity. Specifically, it implies that organizations may be better off with internal heterogeneity under conditions of high turbulence, because diverse pockets of knowledge and skills enable them to increase their probability of exploiting emerging opportunities.

This finding has two important implications for new product development practice. First, it provides further support for the commonly held view that in the presence of turbulence, heterogeneity may provide value (Burgelman 1983; Miner 1994; Tushman and Romanelli 1985). In this case, heterogeneity of views among the team members enhanced new product creativity. This finding, then, supports the view that early in the S-curve of technological evolution, or during periods of radical transition, it makes sense to have some level of variety on teams to enhance the creative process

(Anderson and Tushman 1990). This variety can be achieved through differences among team members in terms of functional background, product category experiences, firm-level tenure, or individual traits and perhaps even can be shaped by the information provided to the team by senior management (Cox 1993; Katz and Allen 1982; Nemeth 1986).

Second, under conditions of low technological turbulence, high dispersion (or homogeneity) actually enhances creativity. This finding implies that, in some settings, creativity may not require the addition of variation or disagreement among participants. Specifically, creativity in these settings may arise from either creative firm-level goals or development processes that permit participants to make creative use of their shared knowledge, such as when they recombine shared ideas into new forms (Nelson 1982; Nonaka 1990).

These results also imply that practices involving the utilization of stored information may need to vary when attempting to achieve creative outcomes in different environments. For example, in turbulent environments, creativity may be achieved by *infusing varied knowledge* into the product development process. Therefore, mechanisms for accessing specialized and divergent knowledge from internal or external sources, as well as processes for ensuring its usage, represent important challenges for organizations seeking creative new product development. On the other hand, we speculate that shared memory may result in new product creativity by *recombining shared knowledge* (Holland 1975). For example, Dougherty (1990, 1992) finds that successful new product groups were able to combine their perspectives, but only when they operated in a highly interactive and iterative fashion by participating in concrete tasks together and violating routines.

Environmental turbulence also moderated dispersion's impact on financial performance. Specifically, when market turbulence was moderate or low, dispersion enhanced financial performance. However, when market turbulence was high, dispersion had no effect on financial performance. This result, like the previous one, may imply that building valuable memory systems is harder under conditions of environmental turbulence. Specifically, if market turbulence reduces the value of organizational memory for financial performance, organizations may need to turn to additional information mechanisms to supplement the value of memory. Formal experimentation, rapid prototyping, and improvisation, for example, may represent processes that create new working knowledge in situations for which long-term organizational memory provides insufficient guidance (Eisenhardt and Tabrizi 1995; Moorman and Miner 1996; Weick 1993a).

Finally, we turn to the theoretical implications of our findings on the interaction of dispersion and turbulence. In general, the results reaffirm that turbulence can reduce the value of shared knowledge within organizations. However, we note that technological and market turbulence does not uniformly affect outcomes. Technological turbulence does not moderate the dispersion-financial relationship, for example, nor does market turbulence moderate the dispersion-creativity relationship. These findings suggest it may be time to address links between specific aspects of environmental turbulence and memory, rather than assume broad environmental features with uniform impact on organizational memory's value.

Overall, these results extend thinking that has tended to advocate either homogeneity or heterogeneity in organizational knowledge. For many decades, for example, it was assumed that specialization, which can be seen as fragmented organizational memory, was an efficient way to capture and use knowledge (Scott 1987). Today, popular wisdom has reversed that assumption, often calling for shared knowledge and redundancy as a simple answer to produce new product success (e.g., Griffin and Hauser 1994; Nonaka 1990). Both our theoretical development and empirical results point to a more complex world. Further research could explore more carefully the precise mechanisms through which consensus and heterogeneity affect outcomes in different new product development environments (Guzzo and Salas 1995; Watcher 1983). More broadly, researchers may want to explore factors beyond variation among persons, such as the ways in

which new, interactive information systems and new organizational designs affect the balance between heterogeneity and homogeneity in product development projects. Further research should also probe how these dispersion effects are influenced by their occurrence during certain stages of the new product development process. For example, it is widely assumed that heterogeneity is more useful in the early stages of the process, when new knowledge appears to be more necessary; however, we lack systematic empirical data supporting this view.

Finally, in considering the effect of memory dispersion, further research would benefit from accounting for its specific content. We speculate that if a firm's memory is dispersed, but contains primarily procedural knowledge about how to innovate, it could produce successful products even under turbulent conditions. However, we speculate that de-

Appendix A STUDY MEASURES

I. Independent Variables		III. Dependent Variables	
<i>Organizational Memory Level</i>	<i>New scale</i>	Rate the extent to which the product has achieved the following outcomes during the first 12 months of its life in the marketplace.	
(Seven-point scale, where 7 = strongly agree and 1 = strongly disagree)		<i>New Product Performance</i>	<i>Moorman (1995)</i>
Prior to the project, compared to firms in our industry, my division had:		(Seven-point scale, where 7 = high and 1 = low)	
•a great deal of knowledge about this category.		•Sales relative to objective	
•a great deal of experience in this category.		•Profit margin relative to objective	
•a great deal of familiarity in this category.		•Return on assets relative to objective	
•invested a great deal of R&D in this category.		•Return on investment relative to objective	
<i>Organizational Memory Dispersion</i>	<i>New scale</i>	<i>New Product Creativity</i>	<i>Moorman (1995)</i>
(Seven-point scale, where 7 = high and 1 = low)		(Seven-point scale, where 7 = high and 1 = low)	
Rate the degree of consensus among the people working on the project for the following new product areas:		•Challenged existing ideas for this category—Did not challenge existing ideas for this category*	
•product design		•Offered new ideas to the category—Did not offer new ideas to the category*	
•brand name		•Creative—Not creative*	
•packaging		•Spawned ideas for other products—Did not generate ideas for other products*	
•promotional content			
•product quality level			
II. Moderator Variables		IV. Control Variables	
<i>Technological Turbulence</i>	<i>Jaworski and Kohli (1993)</i>	<i>Organizational Bureaucratization</i>	<i>Adapted from Deshpandé (1982)</i>
(Seven-point scale, where 7 = strongly agree and 1 = strongly disagree)		(Seven-point scale, where 7 = strongly agree and 1 = strongly disagree)	
•The technology in this product area is changing rapidly.		•Whenever employees have a problem, they are supposed to go to the same person for an answer.	
•Technological changes provide big opportunities in this product area.		•There is little action taken until a superior approves the decision.	
•It is very difficult to forecast where the technology in this product area will be in the next five years.		•If employees wished to make their own decisions, they would be quickly discouraged.	
•A large number of new product ideas in this area have been made possible through technological breakthroughs.		•Going through the proper channels in getting a job done is constantly stressed.	
•Technological developments in this product area are rather minor.*		•Employees have to ask their boss before they do almost anything	
<i>Market Turbulence</i>	<i>Jaworski and Kohli (1993)</i>	•Any decision employees make has to have their boss' approval.	
(Seven-point scale, where 7 = strongly agree and 1 = strongly disagree)		•There is no specific rule manual detailing what employees should do.*	
•In our kind of business, customers' product preferences change quite a bit over time.		•In this organization, everyone has a specific job to do.	
•Our customers tend to look for new products all the time.			
•We are witnessing demand for our products and services from customers who never bought them before.			
•New customers tend to have product-related needs that are different from those of our existing customers.			
•We cater to much the same customers that we used to in the past.*			
		V. Discriminating Variables	
		(These variables were used only in discriminant validity exercises, not in the model testing.)	
		<i>Organizational Culture</i>	<i>Deshpandé, Farley, and Webster (1993)</i>
		<i>Organizational Instrumental Use of Market Information</i>	<i>Moorman (1995)</i>
		<i>Individual Manager Instrumental Use of Market Information</i>	<i>Deshpandé and Zaltman (1982)</i>

*These items were reverse-coded prior to scale construction.

clarative memory would not retain its value in turbulent conditions.

CONCLUSION

Recent theorizing on product development emphasizes the crucial impact of information processing on product success and the importance of organizational, in addition to individual, learning. A key result of learning is the creation of memory. Surprising, the literature presents a somewhat fragmented theoretical panorama for memory's impact on product development and almost no quantitative research on its direct impact on new product success. We argue that an organization's memory can best be conceptualized as having several distinct and independent dimensions. We examine the effects of memory level and dispersion on two key product outcomes: new product short-term financial performance and new product creativity. Although fewer than half of the hypothesized relationships were supported, our results do indicate that level of memory enhances product performance and that memory dispersion affects both performance and creativity. In addition, we find that memory dispersion can sometimes detract from creativity and have no influence on performance in the presence of high turbulence, whereas it can enhance creativity and performance when there is low turbulence.

These results imply that marketers must address not only the ongoing information-gathering processes for product development, but look deeply at the question of current organizational memory if they are to harvest the full value of organizational learning. Specifically, our data indicate that developing and sustaining valuable organizational memory may require attention not only to the appropriate levels of memory, but also to managing subtle aspects of memory dispersion and deployment.

Appendix B

Organizational Memory Level

Definition:

Memory level refers to the amount of stored information or experience an organization has about a particular phenomenon.

Example:

A new product development team has competed in a product category for an extensive period of time.

Measurement:

Memory level was measured by asking respondents to evaluate the amount of knowledge, experience, and familiarity the relevant organizational unit had in a product category prior to beginning the project.

Organizational Memory Dispersion

Definition:

Memory dispersion refers to the degree to which organizational memory is shared throughout the relevant organizational unit. If memory is widely shared, memory dispersion is high. If memory is not widely shared, memory dispersion is low.

Example:

Members of a new product team have similar knowledge about the market, the product, and the new product development process.

Measurement:

Memory dispersion was measured by the degree of consensus or shared knowledge among new product team participants. Several aspects of the new product development process were listed and respondents were asked to rate the degree of consensus among the people working on the project.

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