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Organizational learning mechanisms and managers' perceived uncertainty

Shmuel Ellis and Noga Shpielberg

ABSTRACT

The present study examined the relations between perceived environmental/technological uncertainty among managers and intensity of use of organizational learning mechanisms. Confirming the research hypotheses, negative relations were found between the intensity of use of each of the five factors of organizational learning mechanisms (formal learning processes, information dissemination, training, information gathering, information storage and retrieval) and perceived environmental/technological uncertainty. These correlations were higher in the organizations that function under uncertain as opposed to certain environments. Finally, when perceived uncertainty was regressed on the five factors of organizational learning mechanisms, information gathering came out with a positive regression weight, that is, when organizational learning mechanisms like information dissemination, training or information storage and retrieval are held constant, information gathering is positively related to uncertainty.

KEYWORDS

environmental uncertainty ▪ organizational learning mechanisms ▪ structural contingency ▪ technological uncertainty ▪ uncertainty

Introduction

The concept of uncertainty has always been considered a key variable in explaining interpersonal communication behavior (Berger & Calabrese,

1975), organizational behavior (March & Simon, 1958; Pfeffer & Salancik, 1978) and strategic management (Porter, 1980). In the organizational context, it gained prominence when it was introduced as the key independent variable in the structural contingency model, where it was considered the main trigger for structural change in organizations. Structural contingency theory can be reduced to the following equation: organizational environment/uncertainty correlate with organizational structure, such that turbulent environment/high uncertainty produce an organic structure, while their opposites produce a mechanistic one. The better the fit, so defined, the higher the effectiveness of the organization (Burns & Stalker, 1961; Pennings, 1975; Walker & Weber, 1987; Williamson, 1975). That is, the more organic the structure the better it will function in a turbulent and uncertain environment, and conversely, the more mechanistic the structure the better it will function in a stable and certain environment.

More than three decades since its introduction, the contingency model is still controversial. Whereas early research found empirical evidence in support of the model (Burns & Stalker, 1961; Lawrence & Lorsch, 1967), subsequent studies have failed to do so (Fry & Slocum, 1984; Kopp & Litschert, 1980). One plausible explanation for the inconsistent findings was the multidimensionality of the construct of environmental uncertainty (Child, 1972). Another explanation was that fit could take different forms (Schoonhoven, 1981).

One may also argue that, paradoxically, the time lag between the occurrence of environmental changes and organizations' structural responses, might lead to ever-lasting misfit between environmental characteristics and organizational structure. Because structural changes, by definition, are time-consuming, during the time that organizational actors are preparing the appropriate structural response the environment can change again. In other words, the new structure does not necessarily fit the new environmental changes.

It seems that organizations must adopt other alternatives that are less time-consuming, more flexible and can serve the same role of adapting to changes in the organizational environment. In the present article we argue that organizational learning mechanisms (Lipshitz et al., 2002) may serve as an efficient substitute (or at least a complement) for organizational structure in reducing uncertainty. Similar arguments have adorned the introductions to numerous journal articles of the last decade. Daft (1995) and Dodgson (1993), for example, argued that organizations need to learn in order to adapt to the changing or uncertain environment and to improve performance. Freeman and Perez (1988) and Pavitt (1991) voiced the opinion that organizational learning is a response to the need for adjustment in times of

great uncertainty. Lei and Hitt (1996) suggested that organizations reduce uncertainty by developing core competencies through organizational learning. However, these arguments have never been subjected to empirical testing.

Environmental/technological uncertainty

Traditionally, both information theory and decision theory have viewed uncertainty as a characteristic of situations in which the set of possible future outcomes that are related to decision elements is identified, but where the related probability distributions are unknown, or at best known subjectively (Garner, 1962; Luce & Raiffa, 1957). The decision-maker, according to Bell et al. (1988) '. . . confronts an array of states-of-the-world, one of which will ultimately prevail and, given his usually vague information about which of these states will prevail, he must choose an action' (p. 20).

Basically, the concept of uncertainty, as used by organization researchers, is derived from this view and has been adjusted to the organizational context. Duncan (1972) defined 'environment' as the relevant physical and social factors outside the organizational boundaries that are taken into consideration during decision-making. Burns and Stalker (1961) considered environmental uncertainty to be the result of changes in market composition and in technology. The same is true for Emery and Trist's (1965) four types of environmental texture – the placid–randomized, the placid–clustered, the disturbed reactive, and the turbulent environment. Uncertainty, according to this group of researchers, is embodied in the multidimensional nature of the environment (Downey et al., 1975). Whereas Child (1972) viewed environmental uncertainty in terms of the frequency of change, the degree of difference entailed by each change, and the degree of irregularity in the overall pattern of change, Duncan (1972) distinguished between instability and complexity (the number of factors comprising the environment and their heterogeneity) and developed an environmental typology based on simple–complex and static–dynamic dimensions. Finally, Shortell (1977) suggested a distinction between complexity and heterogeneity or diversity. Although these researchers propose different conceptualizations, all of them assume that uncertainty is a characteristic of the environment.

A number of studies utilizing technology as the independent variable in the structural contingency equation emphasized its relationship to uncertainty. These studies provided nominal definitions of technology rather than discussing its uncertainty implications. The relationship to uncertainty,

however, is quite apparent in most of the writings. The first to view technology or, in effect, the nature of the transformation process in the organizational subsystem, as the variable upon which structure is contingent, was Woodward (1958), whose study of 100 manufacturers classified technology according to complexity and described three types of production: unit or small batch, mass and process. In her study, the relationship of technology to uncertainty can be easily shown: unit production, for instance, involves a higher level of uncertainty than mass production because manufacturing requirements are less predictable. The same is true for the more elaborate classifications developed later, such as Perrow's (1967) widely used classification of technologies. The first dimension in this classification is exceptions, defined as the number of exceptional cases encountered in the work, or in other words, the degree to which stimuli are perceived as familiar or unfamiliar. The second dimension is that of search, which the individual makes when exceptions occur. Whereas the first definition clearly reflects a pattern of uncertainty, the second definition conveys response to uncertain situations.

Studies using technology in a narrow manufacturing context also imply that uncertainty is in fact the independent variable. This is true, for instance, for Blau et al.'s (1976) degree of mechanization of manufacturing equipment, Negandhi and Reimann's (1973) focus on the degree of continuity in the production process, Leatt and Schneck's (1982) degree to which knowledge about the raw materials is insufficient, and Hickson et al.'s (1974) degree of rigidity and automation.

Recognizing the importance of managers' perceptions of their environment, a second group of researchers used measures reflecting individuals' perceptions of the environment instead of the objective measures used earlier (Pennings, 1975). As Weick (1969) argued, organizations come to know their environments only via managers' perceptions. Similarly, Miles et al. (1974) suggested that individuals within organizations respond to what they perceive and that unnoticed events do not affect organizations' decisions and actions. Daft and Weick (1984) argued that organizations vary in their basic assumptions regarding their ability to analyze their environment and in their information elaboration style (active or passive). Babrow (2001) argued that communication shapes conceptions of the environment – both its composition and meaning.

In spite of the long history of uncertainty research, there is no one accepted model of perceived uncertainty. Common models are those of Duncan (1972) and Milliken (1987, 1990). Whereas Duncan proposed that uncertainty is a result of lack of information regarding environmental factors, not knowing the outcome of a decision and its losses if incorrect, and inability to assign probabilities to environmental factors, Milliken

classified uncertainty into a different set of categories of uncertainty: state, effect and response. The first kind of uncertainty has to do with managers' lack of understanding of how elements of the environment may be changing, that is, perceptions of environmental unpredictability. The second kind of uncertainty, 'effect uncertainty', occurs when the ability of managers to predict the impact of events on their organization is limited. The final category, 'response uncertainty', occurs in the absence of knowledge concerning available response options or as a result of the inability to predict the consequences of a given organizational response. Gerloff et al. (1991) showed that Duncan's measurement tool of uncertainty incorporates the three dimensions of the Milliken model as well.

Organizational learning mechanisms and uncertainty reduction

In order to adjust to the changing environment and to make appropriate strategic choices, organizations must become aware of on-going environmental changes (Hall & Saias, 1989), make sense of the environment (Daft & Weick, 1984; Weick, 1996), and draw the right lessons (make the best strategic choice, Child, 1997). Therefore, intensive activities helping the organization to learn from their experience and to know their environment better, can lead to more successful decisions with regard to internal adjustments (e.g. changes in organizational structure, personnel and use of technology) and with regard to the environment (e.g. new products or services, new suppliers, or new contacts in other organizations; Child, 1997; Levitt & March, 1988). Organizational renewal requires the organizational knowledge to keep pace with changes in the environment (Barr et al., 1992; Levinthal & March, 1993). Existing knowledge that can no longer accommodate or explain events in the environment must be altered, and new understandings of the environment must be developed for effective organizational adaptation.

In the present study we define organizational learning as the process through which organization members develop shared knowledge based on analysis of data gathered from or provided by multiple sources, including the organizational members themselves. Successful organizational learning depends on the acquisition and assimilation of diverse new bases of knowledge for subsequent actions (Ghoshal, 1987). Levitt and March (1988) described knowledge in terms of inferences that guide organizational behavior. These inferences may take various formal and informal forms like routines, rules, procedures, core competencies, strategies and technologies (Barr et al., 1992; Levitt & March, 1988).

Organizational members must invest effort in developing institutionalized organizational learning mechanisms (OLMs) aiming to revise and develop their knowledge by facilitating information gathering and elaboration, or by intensifying processes of information dissemination, storage, and retrieval (Lipshitz et al., 2002). To quote Ghoshal (1987), if it is to exploit its potential, 'the organization must consider learning as an explicit objective, and must create mechanisms and systems for such learning to take place. In the absence of explicit intention and appropriate mechanisms, the learning potential may be lost' (p. 432).

Examples of information gathering mechanisms are scanning units or boundary-spanning individuals (Daft & Huber, 1986; March et al., 1991), quality circles (Deming, 1988), external alliances and joint ventures (Badaracco, 1991; Hamel, 1991; Kogut, 1988), small-scale experimentation (Fiol & Lyles, 1985; Huber, 1991; Prahalad & Hamel, 1990), and various forms of after-action reviews (Carroll, 1995; Edmondson, 1996; Ellis & Davidi, 1999). In addition, organizations use mechanisms that help their members to interpret information, to exchange views, attitudes and information, and to transfer tacit knowledge that individuals carry with them, in order to create new organizational knowledge (Lee et al., 1992; Nonaka & Takeuchi, 1995). Extensive employee rotation across and beyond designated positions is an example of such mechanisms (Virany et al., 1992). Information analysis and combination mechanisms include designing information systems to assist in verifying, sorting and filtering the data that reach all parts of the organization (Cohen & Levinthal, 1990; Nonaka & Takeuchi, 1995). Organizations also establish cross-functional teams, allowing members to interpret information, and share views, attitudes and data, in order to make their environment more predictable (Carroll, 1995; Edmondson, 1996; Weick, 1996).

If these learning mechanisms do provide organizations with the relevant knowledge about their environment, a decrease in organization members' sense of uncertainty is to be expected. In other words, we hypothesize that the higher the intensity of use of organizational learning mechanisms, the lower organization members' sense of uncertainty.

Method

Sample

The sampling frame of the present research consisted of project managers, all members of the Project Managers Institute (PMI), resident in the USA. A quota sampling technique was used to construct the sample. The PMI

provided address lists and the industry type for each project. Participants were selected from a variety of industries: 988 managers were selected from industries such as computer software and hardware, electronics, information technology, and biochemistry, and 1009 from heavy industry, education and training, public services, ecological services, and construction, among others. The sample composition was based on the proportions of the two groups and their subgroups within the population – the members of the PMI. The PMI has about 20,000 members, of whom 12,000 are residents of the USA.

A research questionnaire was mailed to the 1997 (988 + 1009) project managers. Three hundred and ninety-five project managers (19.8 percent) responded. This relatively low return rate was due, first of all, to the numerous incorrect names and addresses in the PMI directory (for example, many engineers studied in the USA, worked there for a few years and then left without reporting a change of address). The second reason was the lengthy questionnaire, and the third – the participants' low commitment to the research team. Low commitment and long questionnaire are the best predictors of a low response rate.

Questionnaire

The research questionnaire tapped the following issues.

Type of industry in which the project managers worked

Participants were asked to note what type of industry their project dealt with: (i) computers (software or hardware), (ii) electronics, (iii) information technology, (iv) biochemistry, (v) heavy industrial, (vi) education and training, (vii) public services, (viii) ecological services, (ix) construction, (x) other. Of the respondents, 191 selected the 'other' option to describe the industry in which their project operated. The majority of these organizations were consulting companies that carried out projects in more than one industrial domain.

Perceived uncertainty

Six items were selected for the scale, all of them adapted from Van de Ven and Ferry (1980). All the items reflect, on the one hand, environmental or technological triggers of uncertainty and, on the other hand, information paucity (the questionnaire is presented in Appendix I).

A factor analysis performed on the questionnaire revealed two factors. The first factor, items 1, 2 and 3, reflects complexity or difficulty, whereas

the second factor, items 4, 5 and 6, reflects perceptions of changeability. Alpha reliability coefficients for the two factors were .56 and .66, respectively. Because the two factors were correlated (r = .38) and as the alpha reliability coefficient for the whole scale (alpha = .75) was higher than for each of the two separate scales, and because the data analysis showed a similar pattern of results for both factors, we decided to use the overall score of the uncertainty scale as our dependent measure.

In order to test the discriminant validity of the questionnaire of perceived uncertainty, the sample was divided into two groups – industries operating in relatively highly uncertain environments and industries operating in environments characterized by relatively low uncertainty. This classification was constructed according to the traditional framework of environmental or technological analyses (see Duncan, 1972). The various industries were classified along two dimensions: complexity and changeability. The two dimensions were not measured in the present study, but projects were classified according to operational definitions of these two dimensions (complexity – number of factors, diversity of factors and connectedness; changeability – degree, pace and consistency). Each judge received few operational definitions exemplifying the various criteria of complexity and changeability. More weight was given to the dimension of changeability (Child, 1972, 1997). Thus, for example, high-tech industries, like electronics, computers, and pharmaceuticals, which are characterized by a complex and turbulent technology and business environment, were classified as highly uncertain, whereas the heavy industry and educational sectors were classified as being of low uncertainty.

Two members of the research ream independently classified the organizations into the two uncertainty categories. The inter-rater reliability coefficient (according to Tinsley & Weiss, 1975) was .88. Disagreements were resolved by consensus.

A *t*-test for independent samples showed that in accordance with our expectations, managers working in the high-tech sectors perceived their environment as more uncertain (M = 2.46; SD = .61) than did managers in the heavy industry and educational sectors (M = 2.30; SD = .54; $t(381) = 2.65$; $p < .008$; $\eta^2 = .018$).

Intensity of using organizational learning mechanisms

The present study used the organizational learning mechanisms questionnaire developed by Ellis and others (Ben Horin-Naot, 2002; Ellis et al., 1997; Globerson & Ellis, 1996). The questionnaire consists of 48 items addressing organizational mechanisms embodying the basic organizational learning

processes: information gathering and analysis, information dissemination, and information storage and retrieval (see Appendix II). In each of the items participants were asked to evaluate on a 1–5 bipolar scale to what extent does the activity/behavior exist in their organization. Factor analysis revealed five factors: formal learning processes, information gathering, information dissemination, training, and information storage and retrieval. Alpha reliability coefficients for each of the five factors were: formal learning procedures, .89; information dissemination, .83; training, .84; information gathering, .82; information storage and retrieval, .85.

Results

Relations between organizational learning and perceived environmental/technological uncertainty

In order to examine the relations between the intensity of use of organizational learning mechanisms and environmental/technological uncertainty, we performed Pearson correlations and regression analyses of perceived uncertainty on the five OLMs factors in each of the two groups and across the two.

Confirming our research hypotheses, negative relations were found between perceived uncertainty and the intensity of use of each of the organizational learning mechanisms (Table 1). That is, the higher the intensity of use of organizational learning mechanisms, the lower the respondents' feelings of uncertainty. Furthermore, these correlations were higher in the

Table I Correlations between intensity of using organizational learning mechanisms and uncertainty

	Perceived triggers of uncertainty		
Whole sample	*Whole sample*	*Certain environment*	*Uncertain environment*
Formal mechanisms	–.272	–.189	–.329
Information dissemination	–.288	–.225	–.350
Training	–.203	–.242	–.200
Information gathering	–.125	–.106*	–.150
Information storage and retrieval	–.225	–.138	–.310

*Not significant.

organizations that functioned under uncertain as opposed to certain environments.

Regression analyses of perceived uncertainty on the five organizational learning factors yielded a significant regression model (R = .377; R^2 = .142; R^2_{adj} = .130; $F(5, 341) = 11.298$; $p < .001$). The regression coefficients are presented in Table 2. Interestingly, information gathering came out with a significant positive regression weight (as opposed to the other four factors and as opposed to its simple correlation with feelings or perceived triggers of uncertainty), and the effects of training and information storage and retrieval diminished almost to zero. In other words, when organizational learning mechanisms like information dissemination, training, and information storage and retrieval were held constant, information gathering was positively associated with uncertainty. Also, when other mechanisms were held constant, training and information storage had no effect on uncertainty. Finally, when the same regression model was performed separately on certain

Table 2 Regression coefficients of perceived uncertainty on organizational learning mechanisms

	Whole sample				
	b	*SE*	*beta*	t	p
Formal mechanisms	–.01	.004	–.244	–3.093	.002
Information dissemination	–.02	.006	–.243	–3.118	.002
Training	–.005	.005	–.072	–1.035	.302
Information gathering	–.024	.007	.283	3.624	.000
Information storage and retrieval	–.007	.008	–.064	–.953	.342
Certain environment					
Formal mechanisms	–.004	.037	–.118	–1.005	.316
Information dissemination	–.009	.054	–.198	–1.651	.101
Training	–.007	.043	–.165	–1.612	.109
Information gathering	–.009	.058	–.199	1.606	.110
Information storage and retrieval	–.003	.065	–.005	–.051	.959
Uncertain environment					
Formal mechanisms	–.09	.041	–.247	–2.14	.034
Information dissemination	–.139	.052	–.287	–2.680	.008
Training	–.01	.049	–.026	–.252	.802
Information gathering	.167	.057	.304	2.901	.004
Information storage and retrieval	–.09	.070	–.128	–1.266	.207

versus uncertain environments, a similar pattern of results emerged only when the environment was more uncertain ($R = .413$; $R^2 = .171$; $R^2_{adj} = .171$; $F(5, 148) = 7.29$; $p < .001$). The regression analysis did not yield significant results under a certain environment.

Intensity of learning in organizations operating in certain versus uncertain environments

In order to find out whether organizations that were classified as operating in relatively certain environments differ from those that operate in relatively uncertain environments, a multiple analysis of variance (MANOVA) was performed on the five factors of organizational learning mechanisms. The analysis revealed significant differences between the two groups (Wilk's lambda = .073; $F(5, 387) = 6.065$; $p < .001$), namely, across the five factors, organizations operating in uncertain environments differ in the intensity of use of learning procedures from organizations in relatively certain environments. However, the univariate analyses, presented in Table 3, showed that these differences are reflected in two factors only: formal procedures and training. Organizations operating under high environmental uncertainty placed less emphasis on formal mechanisms; managers in organizations operating in stable (certain) environments reported that their organizations invested more in training programs.

Table 3 Intensity of using organizational learning mechanisms in organizations operating under high versus low environmental uncertainty

	Environment								
	Certain			*Uncertain*					
	n	*M*	*SD*	*n*	*M*	*SD*	*F(1, 392)*	*p*	η^2
Formal mechanisms	214	2.72	0.72	179	2.52	0.75	7.365	.007	.03
Information dissemination	214	3.23	0.72	179	3.21	0.76	0.129	.719	.00
Training	214	2.74	0.75	179	2.90	0.75	4.037	.045	.01
Information gathering	214	2.69	0.75	179	2.69	0.74	0.001	.974	.00
Information storage and retrieval	214	2.95	1.05	179	2.92	1.14	0.063	.801	.00

*p <.045; **p <.007.

Discussion

The study investigated the relations between two constructs: environmental/technological uncertainty and organizational learning mechanisms. Regarding the construct of uncertainty, we first showed that managers who worked in relatively turbulent environments, having great potential to trigger feelings of uncertainty, did perceive their environment as less certain than did managers who worked in relatively stable environments. It should be noted that although the present study is not the first to use industry type to classify organizations according to level of environmental uncertainty (e.g. Brown & Eisenhardt, 1997; Lawrence & Lorsch, 1967), it is the first to test the implications of this classification on managers' perceptions of uncertainty.

We chose to treat the construct of organizational learning mechanisms by referring to intra-organizational procedures that reflect the five elements of learning in organizations. One may expect that various learning mechanisms will reflect more than a single learning element. For example, the procedures 'trainers are assigned to instruct new employees' and 'every new employee/manager receives a document summarizing the previous employee/manager's work' serve as both information-gathering and information-dissemination mechanisms. The procedures 'the organization nurtures and uses knowledgeable employees as authorities in certain managerial and professional fields ("Champions")' or 'there are regular team/department meetings for the purpose of on-going reporting and discussions' may serve information dissemination or information gathering. Despite these potential threats to the divergent validity of the organizational learning mechanisms, and even though combinations of empirical factors are always affected by the unique traits of the respondents, the factor analysis revealed five factors: formal procedures, information dissemination, training, information gathering, and information storage and retrieval. Theoretically, the formal procedures and training procedures could have been included in other factors like information dissemination, but as they had a common denominator, at least in the eyes of the project managers, they were treated as separate categories.

As expected, negative relations were found between perceived uncertainty and the intensity of using each of the organizational learning mechanisms. That is, the greater the intensity of using organizational learning mechanisms, the lower the managers' feelings of uncertainty. These negative correlations were higher in the organizations that functioned under uncertain as opposed to certain environments. It should be noted that our initial operationalization of environmental uncertainty according to type of industry is justified by the fact that kind of

environment moderated the relations between intensity of using OLMs and perceptions of uncertainty.

The most interesting finding of the present research was that when all other learning mechanisms are held constant, the regression coefficient of information gathering changes its sign from negative to positive. In other words, contrary to our expectations and to past empirical work (Daft & Weick, 1984; Tushman, 1977), it was found that when information elaboration mechanisms are not used, information gathering increases uncertainty. This finding has important implications for the role of information in organizational decision-making processes. As Feldman and March (1981) noted, information is gathered and used because it helps in making a choice. However, information overload increases the risk of being unable to comprehend the information or use it effectively in a decision. And, because information-gathering functions of the organization are typically separated from its information-using function, and gatherers have little incentive to avoid overloading users, the quality of decisions and organizational knowledge is impaired and uncertainty is increased.

The information overload effect underlines the role of organizational information-processing mechanisms. Information becomes meaningful as a consequence of the evaluative schemas that are used to process and assess it. Organizational members, through the sharing of information, and through interpretive processes, socially construct information filters through which information is selected and interpreted, and subsequently enacted through communication (Heath, 1994). It seems, according to the present study, that without these mechanisms the organization will face difficulties in elaborating and absorbing knowledge. The findings indicate that learning mechanisms are an integral part of the organization's absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002).

Absorptive capacity has four underlying dimensions: acquisition, assimilation, conversion and exploitation (Zahra & George, 2002). The first, acquisition, reflects the capability to acquire knowledge and is based on the firm's prior knowledge structures, skills and capabilities, gained by learning by doing (Huber, 1991; Levinthal & March, 1993; Nelson & Winter, 1982), information scanning (Fahey, 1999), interactions with customers and companies (Lane & Lubatkin, 1998; Nonaka & Takeuchi, 1995). The second dimension, assimilation, is the capacity to process and understand the information obtained from external sources. The retentive capacity, or, in other words, organizational knowledge, depends on this socio-cognitive process (Szulanski, 1996). As already noted, comprehension depends on a firm's prior experiences (existing knowledge structures). The third dimension, conversion, indicates a firm's capacity to internalize the external

knowledge and make it a part of its own repertoire (Fichman & Kemerer, 1999; Nonaka, 1994). Copying and adapting standard components that have been developed by other companies and using them with minimal investment are examples of conversion. Finally, the fourth dimension, exploitation, has to do with the organization's ability to retrieve knowledge that has already been created and internalized for use in the creation of new goods or new knowledge.

With the exception of information gathering, the organizational learning factors are involved in each of the four components of organizational absorptive capacity. The results of the present study demonstrate that when they are held constant, new information cannot easily be assimilated into the organizational memory and thus contribute to reducing uncertainty. In other words, information gathering alone is not sufficient for reducing uncertainty; when organizations lack the right mechanisms for information processing, information search might be negatively related to feelings of uncertainty.

Although the present findings make much sense, they are still general and not focused in particular socio-cognitive processes. Much research is still needed in order to understand how various learning mechanisms contribute to absorbing new information, or when and why the same mechanism functions as a buffer to the same (or other) piece of data, and of course, how organizations can control these processes.

Surprisingly, when we compared organizations that work in certain and uncertain environments, no significant differences were found in the intensity of use of learning mechanisms such as information gathering, information dissemination and information storage and retrieval. Furthermore, it was found that organizations operating in uncertain environments use fewer formal learning procedures than those in certain environments. One explanation for these results is methodological. In contrast to the dichotomous measure of kind of environment, perceived uncertainty was measured on ordinal scales, thus increasing the probability of finding higher correlations with the five learning mechanisms. A second explanation is simply that organizational learning mechanisms are not developed as a strict response to environmental uncertainty; they are an outcome of 'institutional isomorphism' (DiMaggio & Powell, 1983). Organizations want to adopt the structure and managerial techniques that are used by the other organizations with which they interact. According to DiMaggio and Powell (1983), organizations mimic or model each other when they face uncertainty, and they look for answers to their uncertainty in the way in which other organizations in their field have faced similar uncertainties. However, since the definition of a field or a network is quite elastic, they imitate behaviors of irrelevant

organizations. Finally, organizations take forms that are institutionalized and legitimized by the state (Meyer & Rowan, 1978) or by highly appreciated organizations (Baum & Oliver, 1991).

The finding that organizations from certain environments used more formal learning mechanisms than organizations functioning under uncertain environments needs further attention. This finding is in line with structural contingency theory. A high degree of changeability implies that reliance on formal channels is less feasible (Hovarth et al., 1981). Strict codification and documentation of employee duties and of work procedures is more likely to be irrelevant or even to interfere with organizational response. Thus, although in each of the environmental uncertainty groups, the correlation with perceived triggers of uncertainty and feelings of uncertainty was negative, as expected (the higher the intensity of using the formal or informal mechanisms the lower the perceived uncertainty), the mean intensity of use of formal mechanisms was higher in the organizations operating in certain environments.

The research findings supported the main thesis of the present study, namely, organizational learning mechanisms may serve as an efficient substitute (or at least a complement) for organizational structure in reducing uncertainty. Research on learning mechanisms may re-fuel structural contingency research. It would be interesting to learn under what conditions organizations will increase their use of learning mechanisms; will they do so only when they cannot afford structural changes or is it a better strategy in general to use OLMs instead of effecting structural changes if they want to remain flexible. Furthermore, whereas it is almost impossible to examine structural changes across time, it is quite easy to examine organizational learning mechanisms.

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Appendix I

Perceived environmental/technological uncertainty questionnaire

1. What percent of the time are you generally sure of what the outcome of work efforts will be?
2. In the past 3 months, how often did difficult problems arise in your work for which there were no immediate or apparent solutions?
3. About how much time did you spend solving these work problems?
4. How similar are the day-to-day solutions, problems, or issues you encounter in performing your major tasks?
5. During a normal week, how frequently do expectations arise in your work that require substantially different methods or procedures for doing it?
6. How often do you follow about the same method or steps for doing your major tasks from day to day?

Appendix II

Organizational learning mechanisms questionnaire

Formal learning procedures

1. Each project/assignment has up-to-date directions and follow-up procedures on file.
2. Every new employee/manager receives a document summarizing the previous employee's/manager's work.
3. There is a strictly observed overlap time for departing and arriving managers.
4. There are follow-up procedures upon completion of tasks.
5. Information is continually provided concerning the various tasks within the organization.
6. The organization insists on putting procedures in writing.
7. A report is written upon completion of each task.

8. There are on-going investigative procedures for checking causes of mishaps and failures.
9. There are on-going investigative procedures for analyzing successes.
10. Control and performance evaluation are built into each project's plan (professional or managerial).
11. Business or professional plans are modified according to on-going feedback.
12. Departments have formalized relationships similar to the supplier–customer relationship.
13. Individuals/teams are able to receive performance evaluation reports immediately.
14. Analysis of failure and successes is followed by modification of procedures, instructions and work methods.

Information dissemination

1. The reward system encourages participation. For instance, bonuses are given for successful teamwork.
2. In spite of the division of the organization into various units, mobility of employees exists within the organization according to need.
3. Employees share information willingly with one another.
4. Individuals do not hesitate to ask for assistance when a problem arises.
5. Willingness to help and to share information is used as a criterion for evaluation.
6. The organization nurtures and uses knowledgeable employees as authorities in certain managerial and professional fields ('Champions').
7. There are regular team/department meetings for the purpose of on-going reports and discussions.
8. There are updating and coordinating meetings among various teams.
9. Supply of information and professional support are integral parts of this supplier–customer relationship.

Training

1. Individual training programs are standard practice.
2. Group training programs are standard practice (courses, seminars, lectures).
3. External consultants are used.
4. Employees are sent to external professional development programs.
5. Trainers are assigned to instruct new employees.
6. There is a regular supply of professional and managerial literature.

7. Significant resources (time, money, personnel) are allocated for learning.
8. The performance of other organizations is used as a benchmark for evaluation and learning.
9. Funds are set aside for the professional development of individual employees.
10. There is a procedure for rotation of roles/occupations.

Information gathering

1. The organization initiates meetings among its employees after working hours.
2. Think tanks are utilized in various areas.
3. There are professional linkages with other organizations.
4. Information is continually provided about the fields of expertise of various individuals within the organization.
5. The organization is involved in joint ventures/undertakings with other organizations in the areas of development or production.
6. The organization is involved in joint ventures/undertakings in business matters.
7. Every employee knows that he/she has the responsibility to gather relevant information from outside the organization.
8. Team meetings regularly include reports detailing advances in the relevant professional and business information.

Storage and retrieval

1. There is an efficient system for gathering and analyzing professional and business information.
2. There are archives where data, procedures, performance reports and the like are on file and may be retrieved at any time.
3. There is a computerized filing system within the organization.
4. There is a simple way to retrieve information on any relevant subject.
5. Information is indexed by categories for easy retrieval.

Shmuel Ellis is currently the chair of the department of undergraduate management at the faculty of management, Tel Aviv University. He holds a PhD in social psychology from Tel Aviv University. His academic interests center on the relations between uncertainty, organizational structure and mechanisms of organizational learning, processes of organizational knowledge creation and management, organizational and managerial cognition and learning from experience.
[E-mail: sellis@post.tau.ac.il]

Noga Shpielberg is an organizational consultant. She holds a BA in liberal arts and an MSc in organizational behavior, both from Tel Aviv University.