# INDIVIDUAL LEARNING AND ORGANIZATIONAL ROUTINE: EMERGING CONNECTIONS*

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The intent of this review essay is to draw attention to a striking convergence of work on learning being done—separately until now—by students of organizational learning and by psychologists interested in memory and in skilled performance. Issues being raised in the study of organizational learning are nicely complemented by current developments in psychology. They provide both confirmation of what organization theorists have intuited about individuals and a more differentiated understanding of skill-learning and memory that should enrich organizational theorizing and observation. The plan of the essay is to sketch an interesting example of recent work on both the organizational and psychological sides, then to discuss their points of contact.

In *Information and Organizations*, Arthur L. Stinchcombe has made a large-scale effort to extract and reframe central organization theory assertions of major figures such as Schumpeter, Chandler, and Simon. He synthesizes them with insights derived from his own observations of manufacturing, oil extraction, construction, and university administration to obtain a distinctive new perspective on organizations.

The result is a very stimulating argument that the variety of organizational forms we see about us are the product of a fundamental organizational dynamic: the seeking and processing of information about the organization's key uncertainties. In effect, organizational structure is viewed as a design for organizational learning, for acquiring information about the state of the world and for improving what the organization can do.

The foundation of organizational capabilities, in Stinchcombe's view, are the skills of its individual members. These he compares to small computer programs: "the parts of an individual's skill which are completely routinized are the parts that he or she does not have to think about—once a routine is switched on in the worker's mind, it goes on the end without further consultation of the higher faculties" (p. 63). The view is somewhat similar to that of Nelson and Winter (1982).

Information about uncertainties ("the news" as Stinchcombe often calls it) serves two purposes with respect to the repertoire of skills: in building/modifying its contents, the routines themselves, and in switching activation among those routines potentially relevant to the current context.

Building and modifying the repertoire are fundamental activities because they embody learning in routines, thus constituting a major form of organizational memory. The steady refinement of that repertoire generates much of the performance improvement we see in learning curve research (as in the article in this issue by Argote and Epple). The *rate* of such improvement can be dramatic, which causes Stinchcombe to remark that "at the beginning of a production run there is not much one can do that is as inefficient as buying the same activities today that one bought yesterday" (p. 372/133).

The *content* of the improvement can also vary greatly, depending on the organizationally determined flows of information that surround the learning. Hence the significance of the decision by DuPont, made famous by Chandler (1962), to place production of a new product under the control of those in contact with its buyers rather than under the control of those committed to efficient production of many different products.

In Stinchcombe's perspective, improving speed of routines and changing their detailed contents, along with accurate switching among existing routines, are major sources of competitive advantage or other forms of organizational success. Therefore organizational arrangements should be, and frequently will be, designed to acquire, as quickly and as reliably as possible, the information needed to drive these processes.

Stinchcombe exploits this view to produce illuminating discussions of many issues. For example: the tension captured in Schumpeter's distinction of invention from innovation (the best organization for the information requirements of invention may be systematically poor for its subsequent propagation); the organizational histories in Chandler (to Stinchcombe the account of DuPont seems largely correct, but that of Sears may not be); and Sabel's (1982) history of semiskilled factory production ("fordism" continued the long-term movement of the building of routines and of the switching among them from the level of the craftsman to the level of the factory management).

Given the centrality of building and exercising skills in the approach to organization developed by Stinchcombe—and by distinguished predecessors such as Nelson and Winter (1982) and Cyert and March (1963), it is salutary that cognitive psychology is exhibiting renewed interest in the learning and exercise of skills by individuals. An extremely interesting recent example is the work of Mark Singley and John Anderson, *The Transfer of Cognitive Skill* (1989). They show that modern experimental and computer modelling technique can cast considerable new light on how skills are acquired, and enacted. Their results, and those of other psychologists working in the area, reinforce many aspects of Stinchcombe's observations, suggest some corrections of his views, and offer many possibilities for deepening the development of a conception of organizations as processing information to learn and apply skilled routines.

The problem of transfer of learning has a very distinguished history in psychology, in large part because of its fundamental significance for education (Thorndike and Woodworth 1901). The early history of the subject was stimulated by questions such as, "Does learning Latin increase a student's ability to write clear English or to think logically about problems?" The answers to such questions must depend on the nature and extent of the overlap between the skills acquired in the initial learning (of, say, Latin) and those useful in the target task(s).

Singley and Anderson argue that this is a promising time to return to working on transfer of learning, after more than a decade in which psychology paid it relatively little heed, because modelling methods developed in cognitive science, in particular production system modelling, provide a natural framework for theory and observation. They feel that the production, the basic building block of such models, a small rule-like package with an activation condition and a action to be taken when that condition is met, provides an ideal formal analog for a component of a skill. Thus their central argument: the greater the overlap between the components (productions) acquired in learning one skill and those required for performance of a new target task, the greater the anticipated transfer of learning.

Singley and Anderson use data gathered through computerized tutorial programs to build production system models of performance in areas such as LISP programming, and problem solving in introductory calculus and geometry. They then show

that the degree-of-overlap idea can be used to make predictions about transfer to new target tasks, and that the predictions generally agree rather well with the observed performance of human subjects.

A key idea in their results is the distinction between what they call declarative and procedural forms of memory, and their identification of corresponding forms of skill. Here they connect their work on skill to a growing body of memory research showing that established skilled performance—both cognitive and motor—can be stored in a form of memory ("procedural") that has distinctive properties quite different from the properties of memory for facts, events, or propositions ("declarative" memory).

Singley and Anderson illustrate the difference between these forms of memory for skill by means of an analogy to computer programs, which may exist as complied machine language (procedural), or as high level language source code (declarative). The former is rapidly executable, but difficult to repair and closely tied to a specific hardware environment. The latter can be repaired or generalized to other environments more easily, but can be executed, in a typical case, only be a very slow interpretation process. There are many similarities and some interesting differences with the view of individual skills offered by Stinchcombe and quoted above.

Many of the key studies behind the procedural/declarative distinction have been done with amnesia patients who may be unable to remember the daily visits of therapists or daily exposure to apparatus, instruction, and task, but still show task improvement. For example, such patients have been able to learn to solve the Tower of Hanoi Puzzle or to improve their play at checkers, (Cohen 1984). Such results are the basis of the inference that skills may be acquired and stored in a form different from the storage and access of memories for episodes of personal interaction or for abstract statements of rules. Another striking feature of such patients is that their responses in priming experiments are nearly normal even when their recall is severely impaired. Cues in context elicit established responses although the patients may not recall previous similar episodes.[1]

If research continues to develop the idea that individual skills have distinctive properties derived from their being stored in a particular kind of memory, there may be many important organizational implications. Four are sketched here, presented in the context of the perspective developed by Stinchcombe. They are not conceived as resolving established research questions, but rather in the spirit of indicating the kind of fertile development that is now taking shape, defining an area of coming beneficial interaction between organization theory and psychology.

(1) The results indicate that many of the properties of skills, for example their ability to operate with substantial independence of long-term memory of events or episodes, can be found in both motor and cognitive skills. Most familiar examples used by organization theorists are for motor operations, such as driving a car or touch typing. But now we can expect to find this independence in cognitive activity too. Consider this extreme observation reported by Warren McCulloch (1965, pp. 88–89):

> I have seen a man of over 80 years of age walk into a meeting of a Board of Directors and for over 8 hours work out from scratch all the details necessary for the sale of a complete railroad. He pushed the other men so as to get every piece of evidence on the table. His judgement was remarkably solid. The amount of detail involved in the transaction was enormous, and it actually took over 6 hours to get all the requisite details on the map. He summarized that detail at the end of the meeting, in a period of half an hour, very brilliantly, and when he came out he sat down, answered two letters that were on his desk, turned to his secretary, and said, "I have a feeling that I

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[1] Excellent reviews are in Squire (1987) and Tulving and Schachter (1990).

should have gone to a Board of Directors Meeting." He was not then, or at any later time, able to recall one iota of that meeting...

Good observers of organization have often noticed a dissociation of skilled action from verbal deliberation in organizations, but frequently attribute it to a mind/body difference. Zuboff (1988) in her work on impacts of computers on workplaces follows such a line and then must struggle to interpret the similarities of insurance claim processors to factory workers. A procedural/declarative distinction makes it much easier to see how workers in the two settings can be like each other in their reactions to computing and unlike their managers.

(2) Stinchcombe closes his volume with the qualification that he has not been able to provide "a theory of errors". That is, his reasoning often rests on the assumption that forms of organization persist because, on average, they work better than alternatives. But he cannot say as much as he might like about when and how they may work badly. The more detailed development of the psychology of skill offers the possibility of progress against such limitations.

Much of the psychological work is centered on the ability to characterize errors. VanLehn's (1989) models of learning to subtract are verified by detailed predictions of errors made on tests. Singley and Anderson identify a characteristic kind of error, which they argue is the main form of negative transfer of learning, as identical to the Einstellung (or "set") effects studied since the 1940s. In such experiments familiar features of a context evoke well-established action patterns (activate procedural knowledge), even though a more reasoned analysis (involving declarative representations) would indicate another, more suitable course of action. In the laboratory, subjects can often be induced to form routines for tasks so that they will miss "obvious" opportunities for improved performance (i.e., they make the equivalent of three right turns when they could have made one left.).

At the organizational level, consider the famous story from the Cuban missile crisis study by Allison (1971, p. 109): Russian soldiers told to maintain secrecy of their arrival and dressed in civilian clothes went onto the docks and nonetheless formed up into ranks and marched away, making themselves easy to identify and count.

(3) Procedural memory in individuals also appears to be more specific to the mode of communication in which it is initiated (e.g., verbal vs written) than is the case with declarative memory (Graf et al. 1985). A skill learned in one mode may not be available if triggering information is presented in another mode. As a result there may be interesting implications for the recurring tension between "theory" and "practice" found in large organizations trying to systematize behavior learned in small work groups. (Brown and Duguid discuss such tensions in their contribution to this issue.) Observations by Powell (1989) on efforts to learn from joint ventures indicate that diffusion of new practices throughout a partner organization may be better achieved by means of personnel rotations than via publication of research studies documenting the joint venture practices.

(4) Declarative memory appears to decay more rapidly than procedural. This is consistent with many observations, including the finding that people can speak correct sentences in a language they once knew, long after they have forgotten the formal grammatical rules they were taught (Bahrick 1984). It is also consistent with observations often reported by systems analysts trying to define computer programs to duplicate current behavior: there are practices in organizations that are performed regularly long after the actors have ceased to be able to give a convincing account of their purposes (Sheil 1981). With some additional work, we may become better able to characterize the domains in which actions can persist while reasons come and go (Zald 1970; Allison 1971).

This point, especially taken together with its predecessors, begins to suggest that organizations may have a counterpart of what has been called for individuals a "cognitive unconscious" (Rozin 1976), a stock of memory and know-how that is not readily accessible to ordinary recollection and analysis.

It is, as has been noted, too early to be sure about the generality of examples such as those just discussed. But it is the right time to assert that students of organizational learning are going to benefit from working out the detailed implications and validity of a rich (re)new(ed) source of ideas.

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