CHAPTER 4

Learning Strategies, Teaching Strategies, and Conceptual or Learning Style

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INTRODUCTION AND OVERVIEW

From the mid- to late 1960s, Brian Lewis, Bernard Scott, and I conjectured that learning strategies, teaching strategies, and even plans of action have characteristic types which can be differentiated (Lewis & Pask, 1964, 1965; Pask, 1961, 1970, 1972; Pask & Lewis, 1968; Pask & Scott, 1971, 1972, 1973). Individual difference psychologies have maintained a similar stance and with greater precision regarding the nature of strategies. An overview of the approach taken by my own group in the 1960s is described in the remainder of this section. Learning and teaching strategies can, under appropriate circumstances, be substantially exteriorized or externalized for observation. Protocols can serve this purpose, but we used maplike representations of what may be known or learned. These representations were open to continuous evolution as further topics and relations between them were added by learners.

Later, these representations were seen to be manipulable systematically and without the imposition of rules that insult freedom of thought or creativity (about mid-1970s). The maps and representations of topics (communicable, shared, or public concepts, rather than personal con-

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cepts) were called "entailment structures." Later still, Kallikourdis, Scott, and I discerned that entailment structures are special and restrictive cases of "entailment meshes," in which shared, public concept relations constitute expressions in a "protologic" (Lp) (Pask, 1975a, b; 1976 a, b, c; Pask & Scott, 1973; Pask, Kallikourdis, & Scott, 1975).

An *entailment structure* consists of topics and connections among topics which show how they may be derived or understood from other topics. The *entailment mesh* recognizes that the entailment of one topic from others is a momentary situation that occurs during action or explanation; in fact, the relationships between topics are *not* static and hierarchical. "Lp" refers to a *protologic* developed out of Conversation Theory which is a model of what underlies cognitive activity. It is not a model of logic or language itself but rather a "substrate" for them; hence the qualifier, "proto," meaning "underlying." Its rules involve the processes by which, for example, the normally heterarchical relationship between topics unfolds into hierarchies. Its details encompass conflict detection and resolution, analogy, generalization, and models of innovation and memory.

Conversation Theory is a summarization of our assumptions and rationale from this early period. Conversations are behaviors, but special kinds of behaviors with hard-valued observables in the form of concept sharings, detected as "understandings." Conversations are, we believe, the first basic data of psychological, social, or educational theory. We see later that people can even have conversations with themselves. Conversations which may lead to concept sharing need not be verbal. Often they are gestural, pictorial, or mediated through a computer interface.

Understanding, like many of the terms of Conversation Theory, has an everyday use that is evocative of its rigorous and almost technical meaning within Conversation Theory. An understanding involves not only the topics that are related and their relationship, but the ability to transfer and apply the relationship to new situations. An "agreement over an understanding" is a hard-valued event that can be detected in an experiment. It involves individuals, each of whom exteriorizes his or her understandings and confirms that the other's entailments reproduce his or her own, previously internal, concepts.

The entailment mesh constitutes a network or map of topics which have no hierarchy or direction. Paths on this map are a learning strategy or a teaching strategy. A learning strategy or a teaching strategy consists of paths on the map marked to indicate specific conceptual events like examining, trying to learn about, learning about a topic (shared concept), or understanding a topic in the related context of others from which it may be constructed, reconstructed, or recalled. Such paths may

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consist of simple trees, a hierarchical branching and looping, and they may or may not employ analogies as structures. They often involve the creation of analogies, and they may employ or create generalizations.

A *style* is a *disposition* to adopt one class of learning strategy or one class of teaching strategy in the conversation of a tutorial. In an art school, this is usually by demonstration. In a high school, it is usually by verbal communication or laboratory experience. The question remains, to whom does this stylistic disposition belong? Individual difference psychologists seem to take it for granted that the unitary, partly autonomous unit "owning" a disposition and opting for one or the other class of strategy is a person. Of course, this may be so, but a broader perspective is needed if we are to make sense of the facts. Conversation Theory offers one such broader perspective. In this theory, we specify an individual (a psychological individual, or P-Individual) as partly autonomous. The P-Individual is only *partly* autonomous because he or she is open to the information transfer of a concept-sharing conversation between persons or between mental organizations in one person (both, in our sense, P-Individuals).

"P-Individual" may appear clumsy, but the idea is essential because it allows one of the symmetries of Conversation Theory to exist. There can be many P-Individuals within one person (when I take different and possibly conflicting viewpoints) as well as a P-Individual that is made up of many persons, such as a school of thought or a religion.

The technical criteria of "organizational closure" and "informational openness," underlying this distinction, are hardly in the province of this paper. Likewise, there are very thorough technical criteria that underlie the theory's usage of the term *understanding*, already noted as a specific indicator of concept sharing. The interested reader will find a review in Pask (1983), which also gives reference to expositions in cybernetic, mathematical and logical terms. The basic ideas are, however, quite familiar in ordinary language. A P-Individual is a personna; an understanding is the ability of two or more P-Individuals to exchange "what," "how," and "why by that method" questions and to provide mutually satisfactory replies. Such a transaction, which embodies the slightly refined common meaning of understanding, is a concept-sharing act. Of course, the agreement over an understanding need not be and often is not complete; for example, your concept of "tortoise" or "knitting" may be quite different from mine. Hence, agreement must be taken to include agreement to disagree, with some knowledge of why and how we disagree. If there is some agreement and some concept sharing, then your personal concept of "tortoise" and my personal concept of "tortoise" are mutually enriched by whatever is shared in dialogue. Further, a shared or public concept of "tortoise," some of it

yours and some of it mine, is created in the process and may be inscribed as a topic.

A topic, or shared concept, minimally consists of a description of how the concept is produced, that is, a means of recognizing or constructing or obtaining such a thing and a rationale for deriving it from other concepts. It is unlikely that such a statement would meet with much opposition if two or more P-Individuals in debate were necessarily individuals. However, Conversation Theory holds that P-Individuals are such that several may coexist in one brain (cf. Kelly, 1955, and Mildred Shaw's, 1980, insightful interpretation of Kelly's core-construct system).

At another extreme, particularly relevant in the context of educational or social institutions, there are P-Individuals that necessarily exist in several brains, for example, common norms or systems of rational belief. The hypothesis of Conversation Theory is that the dispositions to adopt certain learning strategies or teaching strategies, that is, styles, belong to P-Individuals of *any* type. This may imply that they are characteristics of people. More likely, as Laurillard once commented, they may characterize people in context, just as people have context bound, rather than absolute, personalities. (In the first and last chapters of this volume, Schmeck expressed a relativistic view, apparently consonant with this stance; cf. Ramsden, Chapter 7).

HYPOTHESES AND THE EARLY EXPERIMENTS

The hypotheses listed below are derived from Conversation Theory. So far, they have not been falsified, and the evidence obtained by other groups supports them. The present section of the paper concerns only one type of experiment, carried out in my own laboratory and in laboratory-monitored field studies. In both these and later experiments, I feel happier with detailed results. As many subjects as possible should be employed, but I am unconvinced by statistical amalgams of data, that this bias or preference is reflected in the studies.

The Existence of Learning Strategies

Early studies (e.g., Lewis & Pask, 1964) have shown that in perceptual motor learning under adaptively controlled conditions, learning strategies are in evidence. For example, in a coding task (Pask & Lewis, 1968) the differences are manifest in the detailed component-by-component records of response latency. In fact, it is possible to discriminate the *stringing* of sequential responses from *clumping*, in which the subjects act

like a pianist playing a chord. Also, these tendencies are related in the domain of coding skills (Pask & Scott, 1971) to the strategy preferred and most effectively used in building up a complex response.

Intellectual Learning Strategies

The first studies of intellectual learning took place in 1969 and are reported in Pask and Scott (1972) and summarized in Pask (1975a). In order to perform experiments of this kind, it is necessary to provide unfamiliar material to be learned. For this purpose, Dr. Scott produced taxonomies for two different types of "martian animal," the "clobbit" and the "gandelmuller." He provided graphic and written descriptions of each species: 40 cards in all, of which 10 showed typical subspecies; 15, contextual data about habits; 5, test types in the taxonomy; 7, physical characteristics; and 7 to indicate why names of parts or behaviors are used. Under free-learning conditions, the subjects could select cards as they wished and were required to give a tape recorded account of why any one was selected.

Upon analysis of data from about 26 subjects, it was possible to discriminate subjects who tested large, global predicates. In all cases the subjects satisfied a criterion of 10 or more on a standard 30-item taxonomy-based questionnaire administered when subjects thought themselves proficient. In addition, half of the selected subjects were required to teachback the information to a participant experimenter prior to completing the questionnaire. *Teachback* is an iterative process of explanation (of each species and its proper discrimination), correction, and further explanation. In comparative studies, teachback is replaced by similar-seeming but ineffective procedures.

The learning strategies are called *holist*, preferring global predicates and relations of topics, and *serialist*, preferring not to use such relations and learning step-by-step. These are paralleled by teaching strategies of each type. One qualification is required. The holist learner may be either irredundant, eschewing redundant data (often known as enrichment data), or redundant and apt to use such data. Generally, the redundant holist learns less rapidly, takes considerably longer, and has faster but less-accurate recall of any tutorial material. The irredundant holist is more selective about the material used in teaching. Schmeck (1983) refers to a redundant holist as an "elaborative processor."

Matched and Mismatched Learning

It is easy to design and use a holist or serialist type of teaching program to guide a participant experimenter. This was done, with clob-

bits first and gandelmullers second, balanced against "gandelmullers" first and "clobbits" second. In each case, the instruction was iterative until complete mastery was secured. After that, subjects responded, several hours later, to test questions.

The matched consistently performed better than the mismatched. For example, the mismatched holists needed 4 to 7 iterative repetitions in contrast to 1 to 3 for matched serialists. Also, learners performing teachback are superior to learners with the ineffective control treatment regardless of whether they are serialists or holists. These results are, if anything, strengthened by later, detailed replications which also substantiate test-to-test reliability of the "clobbits" and the "gandelmuller" situations when their order is alternated (interscore correlations of .89).

In common with all such methods of exteriorizing concepts, any teachback process is likely to occupy 3 to 4 hours of effort, not counting the subsequent analysis of detailed data. Attempts to reduce the labor involved, by automatic control of administration and automatic recording, have been used with varying degrees of sophistication since the early 1970s. However, in order to be effective, the technique must be based upon a firm set of principles and, in the case of our group, those of conversation theory.

To summarize our findings at this early stage, the condition of understanding of a shared concept was obtainable by iterated teachback, and the resilience of an understood concept was affirmed by the superior retention of teachback learners. It was possible to specify learning strategies and teaching strategies as path markings (or classes of them) on a data representation, although, at the stage concerned, it was difficult to compare or refine them. Even so, the existence of distinct classes of strategy was sufficiently evidenced by the data in question. Strategic match or mismatch showed an influence upon learning—mismatch leading to difficulty in understanding and sometimes to complete misunderstanding of relevant topics. The converse result, that matching improves learning, was suggested, but it is less convincingly demonstrated because of an inherent ignorance of what the learner knows to begin with. These statements could, at this stage, only be demonstrated for the persons who participated, learners or teachers, but studies of the act of design suggested that the statements had greater generality (e.g., that designing can involve distinct P-Individuals in a single person).

A TYPICAL LARGER-SCALE SERIES OF EXPERIMENTS

A series of experiments, using partly automated methods, were carried out using 62 participants (who completed the series) from polytechnics of Kingston and Chiswick, United Kingdom. To indicate sub-

ject attrition in such detailed and lengthy experiments, the original sample contained 115 people, all selected by pretest in order to obtain rough equality of preferred strategy difference. These experiments were concerned with several issues: the means of determing learning strategy (i.e., the clobbit and the gandelmuller tests), the effect of securing understanding by teachback, stability over different subject matters (the operon cycle, the menstrual cycle, and an inductive inference task), and the influence of matched versus mismatched learning strategies.

Of the participants, 32 were exposed to the clobbit free-learning task to determine preferred learning strategy (holist or serialist). Then, the subjects engaged in a further session to perform the gandelmuller task in a matched or mismatched teaching program. Two-weeks later, they were taught the operon cycle in matched and mismatched conditions, and finally, they were given retention tests and teachback. Participants given ineffective control group teachback on clobbits received effective teachback on gandelmullers and on the operon cycle. Those given effective teachback on clobbits received ineffective teachback on gandelmullers and effective teachback on the operon cycle. All learning conditions were unrestricted. The remaining 30 students experienced similar sessions, but the free-learning task was the menstrual cycle, and the programmed tasks were the operon cycle and the inductive inference task. In both groups of participants, half of those receiving effective teachback had been selected and assigned as holists and half as serialist; half were presented with matched programs and half, mismatched.

The full experimental design and data for the development of the style indices appear in a series of reports (Pask, 1977, 1978, 1979). The most effective style assignment index consisted of the following set of measures: the frequency of naming, the intentions expressed by learners as to their goal for learning, and the details of the free-learning data when learners were directing their own paths (e.g., exploration of the subject matter), deliberate information search based on curiosity or uncertainty, search for one specific datum, search for several specific data, testing a single-predicate hypothesis, testing a large predicate or relational hypothesis. Some additional indices are obtained in sessions of free recall administered by the apparatus, notably when learners repeat certain topics and the extent to which the order of topics in free recall mirrors the order in which topics were covered during learning. As a further source of discriminative data, retrospective determinations of style were carried out after teachback and recall. Most determinations were influenced by whether or not the previous teachback was effective or ineffective (in the latter case, no explanations were obtained). Other tests (embedded figures, the "circles" test, the "analogies" test, and logical problem solving) were carried out, but yielded correlations that, although marginally significant, are modest.

Serial learners showed intention to search for specific data. Holist learners showed intention to test a large predicate or relational hypothesis. Holist learners selected a large number of data cards, while serialists selected a small number of data cards. Matched performance was better than mismatched performance. Matched task scores were better than mismatched task scores. Teachback performance was better than ineffective, control group teachback performance.

In addition, confidence was measured on the following dimensions: uncertainty about hypotheses, correct belief, uncertainty about the next topic to select, and belief in correctness of what to select next. These components are a multidimensional index of doubt. For holist learners uncertainty about the next topic to select and belief in correctness of what to select next were significantly higher than the others. For operation learners, correct belief was significantly higher than the other dimensions.

Perhaps the most puzzling, but also the most consistent, finding is the constancy of strategy type over all these tests as well as different-in-content learning situations. The enigma lies in the invariance of *personal* style, rather than P-Individual style. We should predict change in perspective with learning experiences for different learning contexts. In fact, these experiments started with a half-and-half split in each group, and there are in the 32-member group, 18 serialist and 14 holist learners. In the 30-member group, there are 17 serialist and 13 holist learners. Further, this constancy is manifest at all of the sampled intermediary phases. This was perplexing in that we approached the whole project with the assumption that context, or contextual demands, would far outweigh stylistic consistency as a determiner of choice of strategy, that is, we expected less consistency in an individual's choice of strategy. For more complete descriptions of these projects, the reader is referred to Pask (1977, 1978, 1979, 1983), and de Gelder (1981).

THE USE OF "CASTE" AND OF "INTUITION" AND THE NOTION OF STYLE

Just before 1973 a computer-regulated interface for exteriorizing conceptual events became operational as a laboratory exteriorizing tool. It is known as CASTE, or course assembly system and tutorial environment. Further, the "conceptual maps" of topics Pask (1975a,b) had been replaced by sophisticated, less-arbitrary forms of cartography. The representation employed was a form of entailment mesh.

As before, a *conceptual map* is an entailment structure, showing hierarchical connections (directed arrows) which indicate how the topics

may be derived. The entailment mesh has relations rather than arrows, and it shows how particular entailments may arise for purposes of explanation or action. For example, I can explain (to use the very tired example from Conversation Theory) a circle using a compass and a plane ("By using the instrument of a compass, which works like such and such when used on a plane, a figure called a circle is made"). This shows how understanding a circle might entail the topics of compass and plane. However, (and this was the next step from entailment structure) it is equally valid to explain a compass from circle and plane ("A circle is made upon a plane by the manipulation of this instrument called a compass."). And again to explain a plane from circle and compass. Thus, the entailment mesh was developed, which does not contain any arrows and allows more of the everyday complexity, flexibility, and "chemistry" of understanding to be represented. An "understood topic" is one for which teachback has been obtained. Teachback involves not only saying what other topics that topic may be derived from, but also how those topics relate to reproduce the topic. It is not enough merely to parrot back a definition; the topic must be used in a novel way that shows the learner's ability to manipulate the topics and their entailments and produce a novel interaction.

CASTE was a laboratory installation that occupied two rooms. But a portable, less-powerful facility called INTUITION was developed that could be employed in schools and colleges, thus allowing for the representation of different types of learners in different institutional environments. Also, programs were designed for many subject matters, such as meiosis and mitosis, probability theory, physical chemistry, heat engines seen in the context of thermodynamics, the reign of Henry VIII, the Tsembaga ritual regulation cycle (an anthropological subject), diseases of the thyroid system, and many others.

These studies lasted for 6 years or more and covered an admixture of materials and types of learner, about 60 in the laboratory and some 95 completed (out of over 170 initiated) in colleges or schools. Typically, experiments with detailed, meticulous recordings lasted over spaced sessions between 7 and 12 hours each. These studies confirmed all of the original findings. For example, "understood" topics are resilient, people do adopt strategies of learning, a mismatch of learning and teaching strategies leads to no relevant learning, and matching leads to more effective learning than that achieved in an arbitrarily programmed situation.

As entailment meshes became recognized, it was possible to discriminate, with greater refinement, between types of learning strategy and their relation to inherent structures of subject matter, whether determined by an author's predilections, institutional constraints, or the

subject matter itself. These distinctions, refined by using CASTE and INTUITION, are more clearly related to the content of this paper later when dealing with those strategies influencing dispositions called "styles."

Some distinctions, however, merit attention at this point. For example, among all holists, it is possible to recognize (a) those who depend upon the use of valid analogies or generalizations given within the material, that is, those having both contrast and similarity; and (b) those holists who depend upon the creation of valid analogies and generalizations between topics. This latter method incidentally seems to be one of the most productive ways of learning—by invention or discovery. These valid analogies are distinct from mere similitudes and overgeneralizations that do not contain contrasts and which are commonly found to be unproductive. The analogies that learners set down may be either valid or positively misleading. In the context of "hard to learn" subject matters, counterproductive holistic learning gives rise to casual *globetrotting*, a learning pathology.

Teachers, authors, or experts do much of the same (i.e., analogize productively or not). As a matter of fact, in the CASTE environment, the author–teacher–learning distinction becomes only one of dominant role. During the creation of the subject matter representation, clearly the author is dominant. Then, CASTE adopts the role of teacher whenever it presents material based on this underlying representation. However, the learner must teach the teacher what is not known, as well as certain aspects of his or her learning style. Also, the learner adopts the teacher's role in order to teach back the concepts to CASTE to confirm understanding, and finally, in its most full-blown form, CASTE allows the learner to become author.

Among serialistic learners, it is possible to distinguish at least the following two types. One is the operation, or local rule, learner who progresses logically, step-by-step, moving to a different context only when he or she has assimilated one portion thoroughly and often asking for tutorial guidance in which topics to tackle next. The other is the rote learner, who follows the prescribed and narrow path. Unless the subject matter is of trivial extent or the learner virtually has eidetic imagery, rote learners have little chance of success in making use of the knowledge they have acquired, although they may perform quite competently in multiple choice or other types of examinations where special memorization skill places them at an advantage.

From these descriptions it may appear that serial learners learn rules that holistic learners do not. If so, that misconception must be remedied. Successful serial and holistic learners both come to grips with rules, perhaps of their own making or perhaps inherent in the subject

matter. The serial learner is inclined to focus upon local, small-predicate rules and the holstic learner upon global, large-predicate rules. The previously noted redundant holist tends to use dispersed and over-specified (i.e., enriched) rules, whereas the irredundant holist is happier with pure (i.e., minimally specified) rules. Finally, if this terse account still suggests that one type or another is at an advantage, then it is misleading. The evidence strongly suggests that successful learning does involve innovation or discovery but also the *integration* of both local and global rules. Both serial and holistic strategies are needed to achieve understanding.

TESTS OF CONCEPTUAL AND LEARNING STYLE

Soon after CASTE and INTUITION were in use, we became aware of the need for test learning situations yielding scores which could be used to predict which learning strategies were likely to be successful with certain individuals. A pair of tests were constructed. They have excellent covalidity and are based upon the same form of entailment mesh, relating topics (shared concepts) that have models as well as descriptions. They both require participants to learn a quantity of unfamiliar but thematic material. There are global as well as local rules, but prediction, in Bruner's (1975) sense of "going beyond the information given," is required of respondents, as well as the recall of whatever has been learned.

One test, the "Spy Ring History Test," is concerned with the development of an espionage network in which the agents have specific roles (local rules), and their activity, founded upon a logic of permission rather than implication, influences the form of network by global rules. Questions of both a predictive and a recall type are detailed, and it is possible to infer a great deal about how a student goes beyond the information predictively as well as how recall takes place.

The other test, matched and covalid, is concerned with the manufacture and distribution of heroin. The synthesis proposed in the heroin test is chemically possible but nowadays is uneconomic and always was rather hazardous. Both tests occupy about 3½ hours and may be administered either manually or through a computer program. Further, provided that the form of the entailment mesh, with models included, is invariant, a user is able to manufacture versions which may be more suited to a given population. The originals are, henceforward, called the "Spies" and the "Smugglers" tests. Several alternative tests have been produced in other laboratories.

Since instruments of this kind are crude, relative to the scrutiny of

CASTE records or to the personal attention of one participant experimenter, it is only possible to detect general dispositions or styles of conceptualization and learning. However, these results have predictive value.

The scoring scheme of the latest version admits to considerable latitude. No particular scoring method is sacrosanct and there are numerous possibilities. Braten (1982), Laurillard (1980, 1981; Laurillard & Mirante, 1981), and Lindstrom (1983) have produced equally reliable and, in certain respects, more-informative scoring systems. All of the systems are reliable and yield useful correlation with aptitudes as well as specific skills and their performance.

Our own group uses the following indices:

1. A versatility index (V) based upon forecasting rather than given data, interpolative or predictive, and requiring the invention of more or less perspicuous analogy relations.
2. An index (X) chiefly of global pattern recall.
3. An index (Y) of global rule recall. The sum of Y and X is the score called *comprehension learning*, or C score.
4. An index (U) of local rule and operation recall. Rote learning of lists of messages, in contrast to the local rules that agents use, is discounted, so far as possible. Rule learning is known as an operation learning skill.
5. An index (R) of rote recall (chiefly of message lists). On the whole, with performance in mind, this index should be counted against the learner.
6. An index (S) of semantic recall.
7. A neutral (N) score, indicating that the material said to be studied has, in fact, been studied. This index has no discriminative stylistic value but, if it is below a reasonable level, the data may as well be discarded as guesswork.

In addition, learners are required to provide a written or pictorial account of what events they believe to have occurred during the period covered. This story given an adequate length and sufficient content, plays a quite crucial role in the analysis of results.

Cross correlation between the scores is passably high and reached the level for the V, U, and C scores of between .40 and .58 or .50 and .81 (depending upon the calculation of indices) for 74 learners. We used paired participants in teacher training colleges, youngsters at Queensgate school with mandatory "learning-to-learn" classes, and older persons at Henley grammar school/6th form and college/first-year university. Apart from the Queensgate group and one Henley group, there is a strong operation learning bias. The reverse difference appears for the groups first mentioned. The V score has the property of increasing if both C and U are high. But it was highest at Henley.

There are significant correlations between components of these stylistic tests and other psychometric instruments (analogies, progressive matrices, AH5, and others), but the correlations are smaller. There are large correlations between the V, C, and U indices (between .53 and .70) and learning success on CASTE for the Henley group and one group of teacher training students.

Academic performance is harder to assess. The U score relates most strongly to academic success in biology and physical chemistry, but there is also predominance of this operation learning style among all academically successful students, some being also versatile (V) and having sensible, but not often high, C scores. Others have found significant correlations with task performance, especially in various aspects of computer programming, and problem solving, in both laboratory and real-life situations.

Stylistic Tests and Learning to Learn

It is useful to add that these stylistic tests have been employed not only in various psychometric, style-discriminatory studies, but also in the context of specific "learning-to-learn" studies. Various researchers have maintained the existence of a general skill of learning to learn which is open to acquisition by most people. Learning to learn novel material is closely related to innovation and probably to the versatility index. It is possessed by some people who are able to approach and to appreciate novel contingencies or subject matters and to make their own way. They are able, on the one hand, to adopt roles and make decisions as individuals or as leaders in a group and, on the other hand, to organize and assimilate a body of subject matter with minimal direction from outside. The skills required (generally called learning-to-learn skills) may even be manifest in a design or invention context, where to some extent such skills are mandatory; in scholarship, where they are desirable; or in an action-oriented situation.

Among other methods of promoting these general learning-to-learn decision skills, we have the possibility of administering stylistic tests to a group and then giving them feedback regarding their scores. After this group has engaged in the same learning experience (say, of "Spies" or of "Smugglers"), the resulting scores are offered as indices of difference, explaining roughly how they are derived. The differences pinpoint the distinct strategies employed by the participants, and they encourage free discussion of the relative advantages of each approach. At the end, a cued recall review of the discussion is conducted by the leader. Similar situations have been engineered using CASTE in more interesting contexts (such as the Team Decision System, discussed later) and others have employed more socially oriented techniques.

The immediate results, although difficult to quantify, have yielded positive but far from dramatic results, the most salient beneficial effects being a marginal improvement. A far more useful and convincing result is that greater than 20% of participants, commonly mature people who have often to act in real-world group or individual projects, return after intervals of 6 months to 1 year and often at considerable inconvenience to ask advice upon their specific projects. They say that they have "got the idea" of the training sessions and, further, "have used their acquired skill." In the studies conducted by my own group, consultancy of this type is always promised. This is not a typical laboratory result, but a practical and heartening finding which deserves record since it suggests that researchers and professionals must perhaps expect an interval of 6 months to 1 year's duration before their labors bear fruit.

THE ENIGMA OF STRATEGY AND STYLE

In academic learning or innovative training, it looks as though people do adopt one or other type of strategy as a personal style. The prediction is that P-Individuals (persons, separate mental organizations in one person, or organizations identifiable as a group of people) should do so, but at the actual person level, our results seemed to be unduly positive. This finding, noted previously, remains enigmatic.

Our conjecture is that the person-oriented correlation can be largely ascribed to institutional constraints. These constraints, especially for preuniversity science students, are imposed by examination techniques and the necessary serialization of tuition, a point confirmed by the dominantly serial bias in style for this category of students. A less-prominent but holistic bias pertains to architecture and art students evaluated by jury methods or cumulative assessment. The institution, viewed as a P-Individual, determines that academic success shall depend upon a certain, and for the most part, serial orientation, and it is hard to recommend practical means of alleviating this state of affairs, especially since institutions provide a significant social as well as academic utility. The pity is that effective learning is not optimized by an enforced mismatch of style, and that point is borne out by noting that other-than-academic pursuits (be they astrology or pop music) have often been learned in a matched but scholastically atypical manner.

In order to demonstrate that fixity to persons does not always occur, rather fixity to P-Individuals (including whole institutions), it proved necessary to examine occupations in which changes of perspective are essential constituents and to reanalyze much of the standard data.

A series of experiments was carried out under classroom conditions over four sessions in a high school setting. The students were matched for their "streaming" in class, their assessed academic ability, and their age. Each session lasted a double period of about 2¼ hours. The design was balanced with respect to the stylistic tests Spies and Smugglers. Of the four sessions, one was devoted to the administration of a stylistic test. The next session was devoted to a test battery including Raven's Advanced Progressive Matrices and the Lancaster Learning Inventory. The next was devoted to the stylistic test not used in the first experiment, and the last to a test battery of the AH5 test, the analogies test, and the Inventory of Learning Processes.

So far as this study is concerned, there were 53 students completing Spies in the first session and 74 completing Smugglers in the first session. Correlations exist between stylistic tests and versatility, comprehension, and operation learning indices (as well as the neutral index). The correlations ranged from .47 to .70.

Between versatility and the normalized product of operation and comprehension learning there is a correlation of .84, indicating that both dispositions are needed in order to be versatile. The intercorrelations of comprehension learning and operation learning are about .55, and intercorrelations between these and problem-solving test scores (notably Raven's Progressive Matrices and the AH5) are fairly high, between .40 and .60. Correlations between the Spies and Smugglers test gave satisfactory values between .54 and .77. In fact, this consistency of the person's strategic preference across tests (and subject matters) is curiously high, as I noted above.

Due to the experiences of other researchers, the data obtained from this experiment were reanalyzed. The crucial matter was one open-ended question asking for an illustrated story of what the respondent believed to have caused the thematic changes that occur and how their predictions are made.

Only some of the students furnished intelligible accounts, susceptible to reanalysis. Some provided pictorial augmentation. Forty-four student respondents did so, and these results were examined using a pair of impartial judges. The judges opted for classification as "analytic" (outside the system) and "involved" (inside the system, i.e., as an agent or smuggler or inhabitant of the countries described in the thematic test material). Each of these 44 intelligible story responses were analyzed and classified with virtually no disagreement and assigned to the category of "analytic" or "involved." Of these, 25 people did change perspective from one test (context) to the next, and 19 people did not do so. Among the 25 people who changed perspective between tests (acted as different P-Individuals in the different tests), the intercorrelations be-

tween tests were between .04 and .50, and for those 19 who did not change, intercorrelations were between .65 and .90. Thus, some learners were more sensitive to context and more versatile in approach than were other learners. McCarthy and Schmeck (Chapter 6, this volume) and Schmeck (Chapter 12, this volume) maintain that this suggests a difference in personality development.

Design appears to be an occupation in which success depends upon frequent changes of perspective, but our first experiments, in the design of electronic circuits, gave disappointing results. The fact was that optimal design is, under these circumstances, substantially predetermined by the relevant stylistic stereotypes.

However, architectural design, examined in a fairly informed way at the Architectural Association School of Architecture in London, is a different matter altogether. In order to compromise between informality, open-endedness, and controlled rigor, experiments were carried out upon the design of an intruder alarm system (several designs being submitted due to variations in the brief). In this context, there is no significant correlation between the interpolated Spies and Smugglers stylistic tests, so that it seems people do not adopt the same style or act as the same P-Individuals throughout this design process.

In addition, further evidence comes from studies using a Team Decision System (TDS) in which stylistic test indices are admirable predictors of an ability to plan (a prerequisite of complex decision making) but not of *using* plans under conditions of overload. The TDS merits attention since it is able, used as a computer-regulated interface, to exteriorize strategies of action, tactics, and planning strategies where responsibility is delegated.

The method involves one or more "commanders," each in charge of at least two "ships," or any commander of necessity delegating tactic responsibility for at least two ships. The tactics ordained are subsequently executed (the "ship" is an independent microprocessor operating in a further independent, environmental processor, and a tactic is a context-dependent program). The method used is a measure of complex decision making.

In these studies, planning ability is predictable from stylistic tests. In fact, for a sample of 19 subjects who undertook two or three missions each lasting between 3 and 4 hours, the versatility correlation with planning was .95, the operation score .91, and the comprehension score .56. These figures, obtained by quantifying tactic construction, are highly significant. But there is no significant correlation between style and the effective use of tactics. Readers interested in planning should also consult Das (Chapter 5, this volume).

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GENERAL CONCLUSIONS

It seems evident that distinctive learning strategies exist. These may be derived from unfoldments (pathways) of canonical, evolving representations (maps of topics and their relations) of what may be known or rationally believed, that is, an entailment mesh. Given this tangible form of both subject matter and individual strategy, it is possible to make detailed comparisons of strategies, whether they are of learning (how to learn about a shared concept) or action (how to reach a goal).

There are also certain distinct styles, or dispositions to adopt classes of strategy. The original conversation theory prediction was that styles would be characteristic of specific P-Individuals or partly autonomous mental organizations. Later it seemed that styles belonged to specific people and applied to learning situations involving a great variety of distinct entailment mesh.

More recent and detailed analyses of the initial data also support the original hypotheses, especially that one person may be the residence of several coexisting P-Individuals (points of view, perspectives, frames of mind) or to use Laurillard's phrase "people in context." I would also argue (along with Ramsden, Chapter 7, this volume) that the institutional constraints of an institution-sized "P-Individual" are to be held responsible for the initially apparent person-fixity of conceptual and learning style, which seemed both counterintuitive (a designer, for example, must change point of view) and inherently counterproductive. However, I am still perplexed by the extent to which some individuals persist in using the same strategy across contexts. Some students appear, of sheer necessity, to be institutionally consigned to a mismatched and ineffective form of intuition, examination, and the like, insofar as their style does not match the serialist style of academic or training institutions. Also, some persons seem more flexible, versatile, and context-sensitive than do other persons.

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