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ABSTRACT

Memory has been defined as traces left behind by past information processing. One approach to the study of everyday memory is to isolate reliable differences between individuals in the ways in which they process information when preparing for test events. The Inventory of Learning Processes, consisting of four scales, i.e., Deep Processing, Elaborative Processing, Fact Retention, and Methodical Study, assesses dimensions of learning behavior and conceptual activity characteristic of college students. Deep Processing assesses the extent to which a student critically evaluates, conceptually organizes, and compares and contrasts information being studied. Elaborative Processing is a strategy of applying information to one's own life and personalizing it. Both scales are assumed to be measures of "depth" and "breadth" of processing that lay down more enduring memory traces. Studies have shown that students who score high on the Deep Processing scale are better at structuring information and have better reading comprehension and that students who score high on Elaborative Processing have greater mental imagery ability, tend to reorganize information in personal ways and thus are better at learning long lists, and are significantly better creative writers. The Deep Processing and Elaborative Processing scales together assess a dimension of "thoughtfulness." Many students may be able to improve their academic performance by learning to process information deeply and elaboratively. (PAS)

INDIVIDUAL DIFFERENCES IN DEPTH AND BREADTH OF PROCESSING

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Individual Differences in Depth and

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Our approach to the study of everyday memory has been an attempt to isolate reliable differences between individuals in the ways in which they process information when preparing for test events. We have accepted the assumption of Craik and Lockhart (1972) that memory is simply a by-product of thinking: traces left behind by past information processing (cf. Craik & Lockhart, 1972; Lockhart & Craik, 1978). Furthermore, we have accepted the assumption that some processing activities leave behind more enduring memory traces than do other processing activities. Within our framework, we use the term learning strategy to refer to that pattern of information processing activities that people engage in when confronted by a learning task, and if they demonstrate a predisposition to favor a particular strategy, then we say that they are manifesting a learning style. Thus, a style is simply a strategy that one used with cross-situational consistency.

We spent six years developing and validating a measure of learning style consistent with these definitions. My colleagues and I ( chmeck, Ribich & Ramanaiah, 1977) derived an inventory by factor analyzing the responses of 503 students to 121 self-report, inventory items. The items were developed by experts from the various specializations within the

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general domain of human learning and memory, with the objective of representing the research findings and processes of their specific areas of expertise. The processes were converted to behavioral descriptions phrased in terms of the environment and activities of a typical college student. The final Inventory of Learning Processes contained 62 of the original 121 items grouped into four scales which assess dimensions of learning behavior and conceptual activity characteristic of college students.

The first scale of the Inventory of Learning Processes was labeled Deep Processing. It contains 18 items that assess the extent to which a student will critically evaluate, conceptually organize, and compare-and-contrast the information being studied. The second scale revealed by the factor analysis contained 14 items which assessed the extent to which students will translate new information into their own terminology, apply it to their own lives, generate concrete examples from their own experience, and use visual imagery for the purpose of encoding new information. We call this scale Elaborative Processing. Elaborative Processing refers to the more concrete associations or examples that a person can generate from his or her own experience regardless of which level of Deep Processing they employ. Elaborative Processing is a strategy of applying information to one's own life or personalizing it, while Deep Processing is a more "academic" exercise in verbal classification and categorical comparison.

Fact Retention is the third scale revealed by the factor analysis. The scale contains only seven items but we have found it to be a very useful predictor of academic performance. People who score high on the scale, carefully process (and thus store) details and specific pieces of information regardless of what other processing strategies they might chose to employ. The fourth scale in the inventory is called Methodical Study. Those who earn high scores on the scale claim to study more often and more carefully than other students do, and they claim to employ methods similar to the systematic techniques recommended by the classic "How to Study" manuals (e.g., type your notes, outline the text, study every day, never cram for exams, etc.).

Ed Grove and I (Schmeck & Grove, 1979) compared the learning styles of 790 high and low college achievers. We used college grade point averages and scores on the American College Testing (ACT) entrance examination as our measures of academic achievement, and we used the Inventory of Learning Processes as our measure of learning style. We found that the most successful college students were significantly higher on Deep Processing, Elaborative Processing, and Fact Retention, and were slightly lower on Methodological Study.

The remainder of the present paper is devoted to the construct validity of the Deep and Elaborative Processing scales. These scales are assumed to be measures of "depth" and "breadth" of processing: two types of processing that presumably lay down more enduring memory traces. You will note, of course, that much of my terminology is borrowed from Fergus Craik and his colleagues. However, we have used their work in analogical fashion. If you ask for our definition of "depth of processing", we will point to the Deep Processing inventory scale. We will not point to the incidental learning studies carried out by Craik and his colleagues. We do not yet know whether we are really talking about the same construct as Craik when we use the term "depth of processing." However, we do believe that Benton Underwood was right when he argued that we should search for natural, unmanipulated variation on dimensions revealed by laboratory research as a way of validating the laboratory-derived constructs.

I'll begin by taking a closer look at the Deep Processing scale. Our research indicates that the student who earns a high score on this scale is very conceptual, spending time categorizing, critically evaluating the appropriateness of the categorizations, and comparing and contrasting categories with one another. The strategy of Deep Processing seems to be the most powerful one revealed by the development of the inventory in that it is the scale that most frequently relates to performance in the learning setting, both classroom and laboratory.

We can provide a personality sketch for the Deep Processor based upon some of our research findings. People who earn high scores on the Deep Processing scale are calm, confident, responsible, flexible, and have considerable metacognitive insight with regard to their cognitive functioning. Calmness is suggested by the finding that the Deep Processing scale related negatively to neuroticism (Schmeck and Spofford, in press), manifest anxiety (Schmeck and Ribich, 1978), test anxiety (Schmeck and Ribich, 1978), and writing anxiety (Meier, McCarthy, and Schmeck, in press). Confidence and responsibility are indicated by the positive relationships obtained between Deep Processing and both self-efficacy (i.e., confidence) and internality (i.e., personal responsibility) on the locus of control dimension of personality (Meier, McCarthy, & Schmeck, in press). Flexibility is indicated by the fact that Deep Processing relates positively to both independent and conforming achievement striving behaviors

(Schmeck & Ribich, 1978), and to androgyny (i.e., absence of rigid sex roles; Tracy, Schmeck & Spofford, 1980). Metacognitive insight is indicated by the finding (Meier, McCarthy, & Schmeck, 1982) that subjects high on the Deep Processing scale are more accurate in estimating their ability to perform the various cognitive activities necessary to produce good written compositions.

Let us now consider the cognitive processes demonstrated by those who score high on the Deep Processing scale. Fred Ribich and I (Schmeck and Ribich, 1978) found that those who earn high scores on the scale are higher on critical thinking ability as indicated by scores on the Watson-Glaser Critical Thinking Appraisal. In another study, (Schmeck, Ribich, and Ramanaiah, 1977), we had subjects watch a video-taped introductory psychology lecture while supposedly trying to "judge its complexity." Afterword, subjects took an unannounced 30 item multiple-choice test composed of 15 test items demanding high level cognitive skill and 15 items requiring low level cognitive skill (Bloom, 1956). Subjects were not warned of the test because we wanted to determine whether style would have an effect even when situational demands were at a minimum. Test results showed that performance on the test questions was related to the student's score on the Deep Processing scale, with Deep Processors scoring higher overall and earning especially high scores on higher level test questions which demanded greater thinking ability.

In another study (Schmeck, in press) we had subjects fill in the Inventory of Learning Processes and then study long lists of words in preparation for a test of memory. Subjects were then given a cued-recall test with half of the cues semantic in nature (relating to the meanings of the words studied) and half phonological or shallow in nature (rhymes of the words). The results suggested that subjects who earned high scores on the Deep Processing scale remembered more words then given cues that were semantic in nature (e.g., synonyms), while those who earned low scores remembered more words when given superficial, shallow cues (rhymes). Overall, it appears that those who score high on Deep Processing attend more to meanings and less to shallow, superficial aspects of the material being studied.

In 1979, Fred Ribich and I (Ribich & Schmeck, 1979) gave subjects three different learning style measures (including the Inventory of Learning Processes). We also administered verbal lists and textbook learning tasks and collected data on 13 different learning outcome measures. Results taken as a whole indicated that the most important dimension assessed by any of the learning style measures was deep processing, and the greatest amount of variability on the learning outcome measures was predicted by the Deep Processing scale of the Inventory of Learning Processes.

In 1977, Fred Ribich (Ribich, 1977) measured the ability of subjects to organize lecture material into theoretically ideal conceptual networks (tree diagrams that force one to process information to considerable conceptual depth). Dansereau and his colleagues (Dansereau, et al., 1979) have devised a learning strategy training program to improve comprehension and retention of information by teaching students to develop tree structures similar to those studied by Ribich. However, Ribich gave his subjects no training in the use of such networking strategies. He simply had them listen to a lecture covering the concepts of behavior modification and then diagram those concepts with tree structures. In addition, they filled out the Inventory of Learning Processes and the Otis-Lennon Mental Ability Test. Ribich found that those who earned high scores on the Deep Processing scale were better at structuring information than those who were low on Deep Processing, and this success was independent of their intelligence.

Given this ability to see the inherent structural relationships among ideas, one might expect students who score high on the Deep Processing scale to have better reading comprehension. We have shown this to be the case in two separate studies. In one (Schmeck, 1980), we administered the Nelson-Denny Reading Test along with an old classic measure of study habits (the Survey of Study Habits and Attitudes) and my own Inventory of Learning Processes. We found that my inventory was clearly a better predictor of reading comprehension than was the Survey of Study Habits and Attitudes, and my Deep Processing Scale was clearly responsible for most of the predictive power of the inventory.

In another study (Schmeck and Phillips, in press), we administered my inventory along with the Iowa Silent Reading Test, and attached two open-ended, essay questions concerned with the last reading passage to the end of each test. The answers to these essay questions were scored by using a rating system (called "SOLO") developed by John Biggs, an Australian researcher. Biggs' (1979) SOLO scoring system is designed to evaluate the level of processing evidenced within a larning outcome (in the present context, this would be the answer to an essay question). We found that my Deep Processing scale was positively related to Biggs' measure of level of processing, and both measures were positively related to scores on the Iowa Silent Reading Test. It is our view that the conceptual analyses routinely carried out by those who score high on Deep Processing are responsible for their greater reading comprehension skills. We suspect that they attend more to ideas and the interrelationships among ideas and less to the precise wording of passages while they are reading.

The second scale revealed by the factory analytic development of the Inventory of Learning Processes was labeled Elaborative Processing. Elaborative Processing is another way in which the student can form more intricate and enduring memory traces. When students process elaboratively (or broadly), they think of concrete associations or examples from their own actual experience and they apply the information to their own lives, thereby personalizing it. Ribich and I (Schmeck and Ribich, 1978) found that students who score high on Elaborative Processing have greater mental imagery ability than those who score low. In addition, we (Ribich & Schmeck, 1979) found that such students tend to reorganize information in very personal ways, using their own unique organizational systems. This greater use of imagery and subjective organization might explain why Schmeck, Ribich, and Ramanaiah (1977) found that individuals with high scores on Elaborative processing were significantly better at learning long lists of concrete words for a free-recall memory test.

Meier (1981) found that creative writing performance was significantly related to scores on the Elaborative Processing scale, but it was not related to scores on the Deep Processing scale. This suggests that the ability to personalize, concretize, and visualize information is more important in creative writing than is the more "academic" skill of abstracting and comparing and contrasting abstractions. I should add, however, that Dan Lockhart and I (Lockhart & Schmeck, in press) found that the Deep Processing scale was the sole predictor of performance on a research paper that students prepared for a course in research methods. The paper required students to use theory to explain and predict data.

Taken together, the Deep Processing and Elaborative Processing scales seem to assess a dimension of "thoughtfulness." There is a positive relationship between the amount of thought given to an idea and the probability that the idea will be recalled later. Also, there seems to be a relationship between the type of thought and the quality of recall. All thoughts are not created equal. Those which lead to categorization and comparison of chosen categories with other potential categories are more likely to improve recall. Likewise, those which translate ideas into personal terminology and operations and define it with personal experiences contribute more to recall.

Future research should determine the extent to which learning style interacts with ability and developmental level. Students with less ability might be incapable of using certain learning strategies. This might also be true of individuals during the earlier stages of cognitive development. The relationships generally obtained between intelligence test scores and school achievement might be due to intelligence placing limits on information processing activities; i.e. by limiting thinking it limits learning. This would be true if (as I am assuming) learning is simply a by-product of thinking. My colleagues and I have already determined that Deep Processing requires a certain amount of verbal aptitude (Tracy, Schmeck, & Spofford, 1980) and critical thinking ability (Schmeck & Ribich, 1978).

It is also likely that future research will reveal relationships between learning style and the stages of cognitive development described by both Jean Piaget (1963) and William Perry (1970). It is unlikely, for example, that one could process deeply before attaining the stage of formal operations described by Piaget and the relativistic and commitment phases described by Perry. Furthermore, there is evidence (e.g., Vu, 1977) that individuals may function at higher developmental levels in one academic content domain and a lower cognitive levels in other content domains. Thus, we may find that a student engages in Deep Processing, for example, in social sciences, while using Fact Retention and Methodical Study in the physical sciences (the reverse is equally possible). Similarly, aging might lead to changes in learning style. Labouvie-Vief (1977; in press) describes the elderly as deep processors who think in terms of global ideas and rules-of-thumb while retaining few details and specifics. Thus, as age increases beyond the age of 50, I would expect scores on Deep Processing to increase and scores on Fact Retention to decrease.

Since I assume that a learning style is simply cross-situational consistency in the use of a particular learning strategy, and since research has shown that learning strategies are teachable, I also assume that learning styles can be modified. As I noted above, ability and developmental level place limits on learning styles, but I believe that many students can still significantly improve their academic performance by learning new strategies. I especially feel that students should learn to process information deeply and elaboratively, but an excessively persistent deep processor might also profit from some training in fact retention.

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