JOURNAL OF RESEARCH IN PERSONALITY 13, 530–545 (1979)

Individual Differences in Learning and Memory: A Unitary Information Processing Approach

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Recent research in the area of individual differences in learning and memory is reviewed from a cognitive perspective. Using the two-state model of memory as a framework, individual variations in attentional, short-term store, and long-term store processes are discussed. The focus is on using individual differences to evaluate nomothetic cognitive models, as well as on using cognitive models in guiding research on individual differences. Both within-individual and between-individual differences in basic processes are examined. In so doing, the importance of strategy choice is stressed using the concept of cognitive *flexibility*. Several promising directions, both methodological and theoretical, are noted and the value of using specific information processing models in the study of individual differences is emphasized.

The study of how people differ in their abilities to learn and remember has a decidedly uneven history. Short periods of enthusiastic activity inevitably seem to lead to long periods of what might best be called "hibernation." Furthermore, recurrent attempts to reintroduce the study of individual differences (e.g., Gagné, 1967; Jenkins & Lykken, 1957; Sargent, 1942) seem to be heralded only by those already committed, gaining few converts. We still cannot make very many firm statements based on our knowledge of individual differences. Nevertheless, the last decade has seen considerable activity within this "second tradition" of scientific psychology, and the growth appears to be continuing (see, for example, the recent reviews by Carroll & Maxwell, 1979; Eysenck, 1977). It is particularly encouraging to see an emphasis on the role of individual differences in the development of theory (e.g., Underwood, 1975), for any theory is necessarily a statement of optimism with respect to its domain.

This issue of the journal presents the work of a number of different investigators involved in studying *personality* differences and their role in

Portions of this article were previously presented in a symposium entitled "Personality and Memory" at the 86th annual convention of the American Psychological Association in Toronto, September 1978. Requests for reprints may be sent to Colin M. MacLeod, Division of Life Sciences, Scarborough College, University of Toronto, West Hill, Ontario M1C 1A4, CANADA.

0092-6566/79/040530-16$02.00/0

learning and memory. My purpose is to review the work in another area of individual differences, the *cognitive* approach to learning and memory. By necessity, this review will be highly selective, focusing on a single model and largely excluding the factor analytic evidence (but for an excellent review, see Carroll & Maxwell, 1979). Still, the hope is that it will help to reveal some of the parallels between the personality and cognitive approaches, some of the discrepancies, and some of the issues being ignored by both camps.

This article begins with a short introduction to the prototypical information processing model of memory, the two-state model. In part, this approach is adopted to complement the review by Eysenck (1977), which takes a levels-of-processing orientation (Craik & Lockhart, 1972). However, I believe that the two-state model offers a better organizational scheme and does not have the predictive problems recently pointed out by Nelson (1977) and Baddeley (1978). To reflect this concern, I have tried to suggest how one might phrase individual differences questions in terms of the two-state model. Using the component structures and processes of the model as an organizational framework, the next section of the article reviews an illustrative subset of the recent research in individual differences. In this, the largest section of the article, I have attempted as much as possible to integrate the rather disparate findings. The final section provides an overview and points to some of the emerging issues.

THE INFORMATION PROCESSING MODEL

The hallmark of cognitive approaches to the nomothetic study of learning and memory is their reliance on box models such as the one shown in Fig. 1. In this simplified version of the two-store model (cf. Atkinson & Shiffrin, 1968), inputs enter the system through modality-specific sensory registers. These are brief "clearing houses," upon which attentional processes operate to select situation-relevant information. The hub of the system is the short-term store (STS), which can be likened to "consciousness." Once selected information in the sensory register has been pattern recognized, it enters STS, the working memory (Baddeley & Hitch, 1974). Here a wide array of control processes, or strategies, can be called up from long-term store (LTS) and implemented. Among these are rehearsal schemes, encoding and decoding routines, and retrieval plans, to indicate just a few. The goal state is LTS, the permanent storehouse of information.

There are only two major departures in Fig. 1 from the Atkinson and Shiffrin (1968) model. First, there is a further subdivision of LTS into a semantic and an episodic component. This is consistent with Tulving's (1972) distinction between event-related information (episodic), and event-free knowledge (semantic). Second, the pivotal "rehearsal buffer" in STS used in the original model has been de-emphasized and now is

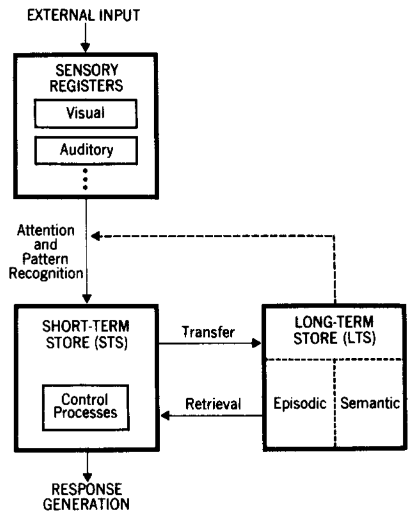

FIG. 1. The prototypical two-state model of memory.

included as one of the available control processes. This change reflects the recent focus on processing (as opposed to structural) variables in learning and memory (cf. Craik & Lockhart, 1972).

With this type of model in mind, one can begin to frame questions about individual differences in specific memory functions. A partial list of such questions might include:

(1) Do people differ in the capacity of their sensory registers?[1]
(2) Is attentional allocation ability a source of individual differences? Does the speed of pattern recognition vary between individuals?
(3) Can some people use STS more efficiently than others? Do some individuals have a larger set of available control processes?
(4) What sorts of control processes should be used to accomplish optimal transfer, and do these differ from person to person?
(5) Are individual differences in LTS primarily in the episodic or the semantic component? Does the efficiency of retrieval (and perhaps the utility of various cues) represent a distinct ability?

Clearly, these are all possibilities and, with a little imagination, one can generate numerous other candidates. Instead, let us look at some of the research this sort of model has generated, restricting discussion to post-perceptual processing.

[1] Although I am omitting any discussion of individual differences in preattentional processing, there is some evidence that this is an area worth pursuing. For instance, Snow (Note 12) discusses several studies of masking phenomena in iconic memory which clearly demonstrate inter-subject differences.

SOURCES OF INDIVIDUAL DIFFERENCES

Attention

To begin examining individual differences in attention, some sort of model is required. Kahneman (1973) and Norman and Bobrow (1975) have proposed rather similar systems based on the core notion of a single pool of attentional resources available for the individual to allocate. This class of models offers some rather straightforward possibilities for an individual differences analysis. For example, individuals might differ in how effective they are at mobilizing these resources when attention must be switched from one input to another. Gopher and Kahneman (1971) present evidence in support of this prediction—the ability to switch attention from one ear to the other is an orderly function of the proficiency of military pilots. The same sort of pattern emerged in a later study using bus drivers' safety records as the criterion variable (Kahneman, Ben-Ishai, & Lotan, 1973). Interestingly, driving ability is a rather poor predictor of errors in *focused* attention in these same studies. Apparently, safe drivers make fewer errors when switching attention, but are not superior otherwise! This suggests that a study of individual differences in decision making might have been quite revealing.

More recently, Lansman (Note 7) has approached the examination of individual differences in attention and memory from a different perspective. Her hypothesis was that attention might play a central role in a person's ability to maintain a memory load and perform another task simultaneously, a situation we find ourselves in all too often. She tested this hypothesis with a secondary task methodology, using verbal ability as the critical individual differences variable. Although a subject's digit span predicted how many items could be held in STS without attention (i.e., while performing a second, attention-demanding task), overall verbal ability was not predictive. Furthermore, verbal ability failed to predict rehearsal efficiency in STS, as measured by how much spare attentional capacity a subject had available to respond to an extraneous probe while performing a memory task.

If one views Lansman's tasks as more in the "focused" attention tradition, then her results can be seen as consistent with those of Kahneman et al. (1973) and Gopher and Kahneman (1971). However, responding to a probe apart from the memory task does appear to be an attention-switching situation. Perhaps the inconsistency between the two sets of studies stems from the dissimilarity of the variables chosen to define the inter-subject differences. Whatever the reason, it still appears that the role attention plays in the memory system can be studied from the perspective of individual differences. In fact, given the problems in theorizing about attention, individual differences studies may provide fertile ground for testing nomothetic theories. Underwood (1975) already has indicated the importance of this enterprise to theory in general.

Short-Term Store Capacity

Perhaps the most pervasive feature of any individual differences approach to memory, be it factor analytic (e.g., Kelley, 1964), clinical (e.g., Erickson & Scott, 1977), or experimental (e.g., Underwood, Boruch, & Malmi, Note 13), is the emphasis on a memory span construct. In terms of the model, this is a direct attack on the capacity of STS. Span differentiates the extremes in STS capacity well, as studies of retardates (e.g., Chi, 1976) and mnemonists (e.g., Hunt & Love, 1972) clearly demonstrate. Although span may be less useful in discriminating capacity differences within the normal range of abilities (cf. Hunt, 1978; Matarazzo, 1972), it has had some success here as well. Furthermore, looking at several studies together, an interesting pattern has emerged over the last couple of years.

A popular hypothesis to account for individual differences in span relies on the notion that mnemonic strategies play a central role (e.g., Belmont & Butterfield, 1971; Ellis, 1970). Thus, rehearsal and chunking strategies should be crucial, as should temporal characteristics of the input. Appealing as this argument may be, it is almost certainly wrong. Studies of adults (Lyon, 1977) and children (Huttenlocher & Burke, 1976) have been fairly conclusive on this point. Why these differences exist is still an open question, but these studies show that the individual differences route could help clarify general theoretical concerns with the capacity of STS. In the context of the present model, this is a crucial direction to pursue.

Short-Term Store Search

The two-state model of memory hinges on the STS construct. For this reason, much of the research effort has been directed at defining the characteristics of STS. One of the most studied characteristics is the scanning of STS for target information, based on the paradigm introduced by Sternberg (1966, 1975). The picture that emerges from memory *scan* with respect to individual differences is very reminiscent of the picture observed with memory *span*—at the extremes, scanning times seem to be affected, but the pattern disappears in the normal range (cf. Hunt, 1978).

Harris and Fleer (1974) observed markedly slowed scanning in retardates and Hunt and Love (1972) observed very rapid scanning in their mnemonist subject. However, for college students varying in verbal ability, the results are far from straightforward. Hunt, Frost, and Lunneborg (1973) obtained slightly more rapid scanning in high verbal students, but this difference apparently is not reliable (Hunt, 1978). Furthermore, Chiang and Atkinson (1976) found the opposite result to Hunt et al. (1973), in that their male subjects showed slower scanning with greater verbal ability. To add to the confusion, verbal ability and scanning rate were unrelated in their female subjects! What are we to make of this?

For the present, the evidence seems to suggest little relationship between STS scanning and ability measures in the normal range. Perhaps, as Hunt (1978) suggests, a more demanding search task would reveal a more reliable pattern. One might consider, for example, a version of the "translation" scanning paradigm developed by Cruse and Clifton (1973). Still, it may be that searching STS is simply not a locus of individual differences in memory. If so (and we must await clarification), this will be an important finding. In any study of individual differences, it is important not simply to find differences, but to find an orderly *pattern* of differences. Finding no difference on some task assures us that our observed differences are not due to some unknown general factor that will produce a difference in any task. By the same logic, finding some process that is independent of a particular ability permits us to eliminate from consideration some theoretical accounts. Certainly, this is a fundamental goal of studying individual differences.

Control Processes in Short-Term Store

In the original Atkinson and Shiffrin (1968) model, the nature of control processes (apart from rote rehearsal) was left unspecified. Since the levels of processing framework was proposed (Craik & Lockhart, 1972), control processes have been emphasized in memory research, generally within the incidental learning paradigm. However, there has been little empirical interest in how individuals *differ* in these processes, despite some suggestive historical precedents (e.g., Plenderleith & Postman, 1957). Perhaps because of the qualitative effects sought in most of the current research (and the measurement problems involved in comparing performance across different incidental tasks), the additional problems involved in examining individual differences have seemed too great. Yet individual differences relationships need not be quantitative, as theoretical notions relying on "moderator variables" (cf. Wiggins, 1973) certainly demonstrate.

Given the large number of potential control processes, where should one begin searching for individual differences? Possibly, the ability to choose an optimal control process and to implement it effectively could be a source of differences. If so, we should look for this superordinate ability before focusing on individual subprocesses. Consider for example a concept that might be called *flexibility* of information processing. Exactly this sort of idea has appeared in two recent reports, one from the attentional domain and one from the verbal learning tradition.[2]

[2] It is worth pointing out that similar concepts have been put forth in the domain of personality differences related to memory. Both Mueller (1979), in discussing anxiety, and

Keele, Neill, and de Lemos (Note 6) have begun to develop a theory of what they call "attentional flexibility," which relies on the importance of attention switching, as discussed earlier. As they explain the logic of their research, "If a trait exists, then people that can rapidly switch set on one task should also be able to rapidly switch set in a different kind of setting." They have investigated the relationships among a set of tasks including handling unexpected signals and switching from one dichotic message to another. The results are encouraging for the concept of attentional flexibility in that performance across their tasks is systematically related, although the question of how to predict which individuals possess this trait remains to be tackled.

Battig (1979) has introduced a concept he calls "cognitive flexibility" which he uses to focus attention on intraperson differences in verbal learning and problem solving. While most of the work I have discussed involves differences between people, Battig rightly recognizes the crucial nature of differences *within* an individual under varying circumstances.[3] Battig defines cognitive flexibility in terms of two main assumptions: (a) "the availability in the individual's repertoire of a large number and wide range of alternative types of strategies and processes" and (b) "the ability to select one or more alternatives that are appropriate and effective for the required task." Noting the similarity of this concept to factors found in models of personality and intelligence, it is nonetheless a useful way of conceptualizing a higher-order control process.

In his own earlier research, Battig had demonstrated the importance of verbal ability in a word-guessing task (Battig, 1957) and had shown that instructed subjects provided with the appropriate information could alter their performance accordingly (Battig, 1958). In a more recent pair of studies in another domain, a similar observation has been made. MacLeod, Hunt, and Mathews (1978) showed that a group of subjects solved simple sentence-picture problems in two different ways, depending on the individual's spatial ability. However, given the appropriate instructions and training, subjects can be led to adopt either of the two strategies successfully (Mathews, Hunt, & MacLeod, Note 9). This sort of approach, observing an intersubject difference and then essentially providing an explicit control process to examine intrasubject differences, may prove to be a valuable method for pursuing Battig's idea of cognitive flexibility.

Davis and Frank (1979), in discussing field dependence, have invoked a flexibility notion. Although there is some temptation in both the personality and cognitive enterprises to rediscover "general intelligence," I believe that this can be avoided and that flexibility is a useful concept.

[3] Of course, we are aware of these differences at an introspective level, but studies such as Folkard's (1975) examination of diurnal variation in arousal and cognitive skills point to the importance of this within-person dimension.

I have already pointed out the similar attack used by Lyon (1977) and by Huttenlocher and Burke (1976) to study the role of rehearsal and grouping processes in memory span differences. Another pair of recent studies extends our knowledge concerning the role of rehearsal in memory. Fagan (1972) showed that high-IQ subjects rehearsed earlier list items more than did lower-IQ subjects, resulting in the high-IQ subjects showing higher recall for these items. However, high-IQ subjects recalled fewer items from the recency portion of the list. Cohen and Sandberg (1977) found what appears initially to be a conflicting result. In their study, the correlation between IQ and recall was restricted primarily to the recency portion of the list. How are these findings to be reconciled?

Cohen and Sandberg argue that subjects relied on LTS in Fagan's free-recall task, while subjects in their modified serial-recall task relied on STS, suggesting that two separate factors are involved. They point out, in addition, that their task was unique because order information was critical. This leads to a rather tantalizing observation—the importance of order information seems quite pervasive in a broad array of individual differences studies. Consider the familiar Brown-Peterson short-term memory paradigm, where subjects have to hold a small set of stimuli in STS during a variable-length period of distraction. Hunt, Lunneborg, and Lewis (1975) found that subjects high and low in verbal ability differed in their number of errors in recall, and that a major distinction was in retention of order information. The subjects with high verbal ability were more successful in retaining the item order. Hunt et al. (1973) report a study by Nix that converges nicely on this result. Using a variant of the Brown-Peterson task, Nix demonstrated that subjects low in verbal ability showed equivalent release from proactive interference (Wickens, 1970) to that evidenced by subjects high in verbal ability when order of item recall was not considered. However, scoring for order, she found that the high-ability subjects performed better. Furthermore, this differential sensitivity to order in high-ability subjects reappeared in a difficult temporal order judgment task conducted by Poltrock and reported by Hunt et al. (1975).

Martin (1978) has provided confirmation of the results of Hunt and his associates. In her first experiment, she found that memory span, while unrelated to free-recall performance on either short-term memory or long-term memory tasks, was positively correlated with ordered recall. This pattern was consistent in a second experiment which again showed order information, but not item information, to be related to span.

In these studies, order information was useful (or even required) in performing the task. What about instances where relying on order can be detrimental? Schwartz (1975) reports that high-anxiety subjects rely on order more than do low-anxiety subjects in recall, resulting in poorer overall performance for the high-anxiety subjects. Additionally, Day

(Note 3) reports that her inflexible, language-bound subjects rely on order information that impedes the more semantic organization adopted by the flexible, language-optional subjects. Of course, the semantic strategy is more effective in solving the problem. Perhaps the availability of a control process to employ order information can be seen as one manifestation of the subject's cognitive flexibility. Apparently, order sensitivity underlies a variety of individual differences, both in terms of personality and cognition. This would be a worthwhile topic to follow up more systematically.

While it would be a simple matter to outline isolated individual differences in other control processes, I believe this might serve more to obscure than to clarify the issues. Research in this area is in need of a more unified approach if questions about optimal transfer strategies and the interrelationships of various (classes of) control processes are to be answered. What I have tried to illustrate is one possible framework, cognitive flexibility, and two areas to which it might be applied.

Episodic Long-Term Store

An obvious tactic for beginning to disentangle the many attributes of LTS is the factor analysis of a wide array of long-term memory tasks. If certain component processes are critical to several tasks, corresponding factors should emerge. For example, factors corresponding to temporal order or organizational clustering would be intuitive candidates. In an attempt to do this, Underwood, Boruch, and Malmi (Note 13) conducted a factor analysis on 22 variables from standard long-term memory tasks such as free recall, paired-associate learning, and verbal discrimination. Unfortunately, what appeared were five factors that seem to be highly task-bound (e.g., paired-associate learning and verbal discrimination). Although Carroll (1978) points out that there seems to be a second-order factor corresponding to associative memory, these results are still quite discouraging. [Interestingly, though, Underwood et al. suggest that subjects may possess sufficient *flexibility* to overshadow task-appropriate memory attributes.] Furthermore, Masson (Note 8) has factor-analyzed 30 standard memory tasks and arrived at a similar impasse. For the present, at least, a different approach will be required.

Consider a second approach proposed by Yen (1978) that is more in the spirit of the basic two-state model. Yen fitted a particular information processing model (Rumelhart, Note 10) to the individual learning curves of grade-school students. She examined two types of learning material, paired associates and word definitions, finding reliable individual differences in two parameters of the model, acquisition rate, and long-term retention.[4] The correlations between each of these parameters and her

[4] Hunt et al. (1973) report an analysis of the relationship between trials to acquisition and long-term retention in paired-associate learning. Over three types of lists, they observed the

preferred measure of ability were sizable, despite the restricted range of her subjects on the ability test. Yen's study illustrates a successful model-specific approach to studying differences in LTS characteristics. Furthermore, it is an elegant demonstration of the value of a well-specified model in investigating individual differences in learning and memory.

Another model-dependent approach was alluded to earlier, that used by MacLeod et al. (1978) to examine strategy choice in performing a sentence-picture verification task (e.g., to verify that PLUS ABOVE STAR is false with respect to ‡, cf. Carpenter & Just, 1975). Depending on a subject's spatial ability, two qualitatively different models applied. For 27% of the subjects (16 of 59), the task seemed to be performed as if comparing holistic images; these were the subjects high in spatial ability. The remaining 43 lower-spatial subjects used a more analytic comparison process described as linguistic in nature. Cooper (Note 2) has found a strikingly similar pattern in her studies involving comparison of figural shapes. The subjects whose strategy she calls Type I "could be comparing a visual memory representation with a test shape in a holistic, parallel fashion," while the subjects using the Type II strategy "could be using a more analytic comparison process." Cooper (1976) reports that 29% (7 of 24) of her subjects studied thus far have used the Type I strategy. Unfortunately, because of her relatively small sample, Cooper has been unable to conduct a correlational study involving spatial ability similar to the MacLeod et al. analysis.

That this is not a coincidence seems virtually certain. Day's (Note 3) work with her language-bound and language-optional subjects dovetails neatly with the above results. For example, in naming U.S. states, language-optional subjects "may rely more heavily on a mental map," while language-bound subjects may "rely more heavily on language-oriented means." Although we do not know the relative frequencies of Day's two groups in the population, she points out that "there appear to be more language-bound subjects than language-optional subjects in the general population."

Such convergence across several disparate types of research is exciting and encouraging for the study of individual differences. Simultaneously, we can discover reliable processing differences and evaluate nomothetic

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following correlations: −.66 for number-verb pairs, −.15 for number-noun pairs, and −.03 for number-adjective pairs. They conclude that their results "certainly do not lend strong support to the proposition that there is a unitary memorizing ability." However, they did not relate their results to extra-experimental ability measures, so we have no idea of the range of abilities represented. Furthermore, high negative correlations between acquisition and retention have been observed elsewhere (e.g., −.64 for number-noun pairs by MacLeod, 1976). Although item effects may be involved, it is clear that this issue requires further investigation, particularly in light of Yen's findings.

models, exactly the sort of goal Underwood (1975) has advocated. In addition, as Mathews et al. (Note 9) have shown, we can then attempt to teach these strategies as a means of evaluating flexibility. This "double-barreled" procedure offers a systematic, model-governed methodology for the study of processes operating in STS that are critical in promoting information to LTS and perhaps even in determining the form of the LTS representation. It may be, too, that this approach will provide a link to individual differences research in other related areas, such as that of mental imagery (for reviews, see Ernest, 1977; Marks, 1977).

Semantic Long-Term Store

One of the tasks most frequently used in information processing analyses of individual differences has been the matching task developed by Posner and his colleagues (Posner & Mitchell, 1967; Posner, Boies, Eichelman, & Taylor, 1969). In the prototypical version of the task, two letters appear and the subject is required to indicate whether the letters have the same name. Thus, the response is "same" to "AA" and "Aa," but "different" to "AB" or "Ab." Of particular interest is the finding that physical identity trials ("AA") take less time than do name identity trials ("Aa"). This difference is taken as a measure of time to access the name code in semantic LTS, since presumably only name identity trials require access to LTS. The work of Hunt and his colleagues (Hunt et al., 1973, 1975) has repeatedly demonstrated a reliable relationship between the access measure and verbal ability. The pattern of results suggests that high verbal-ability subjects can access codes in LTS more rapidly than low verbal-ability subjects. Furthermore, in extensions to other groups of subjects (e.g., retardates), a quite orderly pattern of results has been obtained.

More recent work in other laboratories has replicated and extended these findings. I will mention only two of these studies, since Hunt (1978) reviews the evidence in detail. The first strongly supports Hunt's results. Goldberg, Schwartz, and Stewart (1977) varied the abstractness of the relationship between the stimulus pairs by using physically identical words (DEER-DEER), homonyms (DEER-DEAR), and cohyponyms (DEER-ELK). They observed that as abstractness increased so did the difference between subjects high and low in verbal ability.

A second study using a different procedure purports to disconfirm predictions derived from the findings of Hunt and Goldberg et al. Hogoboam and Pellegrino (1978) presented their subjects with a category name followed by a set of single words and single pictures to which the subjects responded "yes" or "no" as a function of whether the items were category members. Neither picture nor word verification reaction times showed a reliable relationship with verbal ability. However, their task was not a matching task, and they were not dealing with difference scores. Furthermore, their claims aside, nothing in the previous work leads directly to any predictions concerning picture processing. Thus, the lack of a relationship between verbal ability and picture categorizing time stands apart from the earlier findings. The lack of a relationship for words is more puzzling, but may stem partially from the fact that subjects were provided with the category name in the Hogoboam and Pellegrino study whereas they had to access it from LTS in the Goldberg at al. study. Rather than constituting a refutation of the conclusion regarding code access based on the matching studies, the Hogoboam and Pellegrino results provide a theoretical and methodological challenge to them. It will be interesting to see how this is resolved.

Code access is only one aspect of semantic LTS that could be examined. The structure of semantic space is also a potential source of individual differences, but there has been little research in this area. Apart from a demonstration by Loftus and Loftus (1974) that advanced graduate students in psychology show a superior organization of psychologists in various areas to that evidenced by first-year students, I know of none. As always, separating structure from process is a complex problem, but this appears to be one area where the results could be very informative. Analyses of the type conducted by Smith, Shoben, and Rips (1974) should be considered as a means of investigating individual differences in semantic LTS.

CONCLUDING COMMENTS

This brief review has only scratched the surface of the information processing approach to individual differences. For example, I have not covered the many studies related to developmental trends in individual differences (e.g., Bisanz, Danner, & Resnick, Note 1; Keating & Bobbitt, 1978), nor those related to aging (some of which are reviewed by Eysenck, 1977). Neither have I discussed the work on more complex cognitive tasks such as reading (e.g., Jackson & McClelland, 1979) and comprehension (e.g., Perfetti & Lesgold, 1978). Instead, I have restricted my attention solely to basic processes within the framework of the two-state model.

The field is in a period of rapid growth which I believe will continue and escalate. Hopefully, one of the directions taken will be to systematize some of the discrepant findings reported here. Hopefully, too, the organization provided by information processing models will be a guiding force in this growth. It seems quite possible that one of the reasons for the uneven history of the field has been the lack of structure, the tendency to study individual differences in a haphazard fashion without benefit of theory. More consideration will have to be given to the higher-order theoretical issues (cf. Carroll, 1978; Hunt & MacLeod, 1978) as well as to the more specific ones.

In terms of the two-state model, many questions remain unanswered. Certainly, the control processes utilized in STS must be investigated more fully within the context of specific models, as in the case of scanning. Transfer and retrieval, the processes connecting STS and LTS, are obvious sites for individual differences analyses, as is the organization of semantic memory. Yen's work serves well as an example here. New theories such as the controlled-automatic distinction (Schneider & Shiffrin, 1977) may be put to the individual differences test (e.g., Hunt, McKee, & Yantis, Note 5). More specific theories of encoding and retrieval in STS (Gorfein, Note 4), of retrieval from LTS (Shiffrin, Note 11), and others will also make predictions that are testable by examining within-individual and between-individual differences. As Melton concluded in his general comments at the Conference on Learning and Individual Differences in 1967:

> We cannot possibly have a good theory of the processes involved in remembering, either in a short-term or a long-term sense, unless we have procedures for assessing the status and change of such processes within individuals. As long as we throw possible within-individual and between-individual differences together in a measurement, we have no way to think clearly about the effects of the variables in experiments . . . the sooner our experiments on human memory and human learning consider the differences between individuals in our experimental analyses of component processes in memory and learning, the sooner we will have theories and experiments that have some substantial probability of reflecting the fundamental characteristics of those processes.

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