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Are the Important "Individual Differences" Between or Within Individuals?

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Within-individual differences have been a common finding in a variety of research areas. Such inconsistencies with individuals are argued to represent an important consideration for researchers concerned with between-individual differences. *Cognitive Flexibility* (availability in the individual's repertoire of several alternative types of strategies or processes, and ability to select the one(s) of the alternatives that are most effective for the required task) is suggested to be an important individual-difference variable. Some methodological problems in the assessment of cognitive flexibility as related to human memory are discussed, along with possible ways of overcoming these methodological difficulties, and some limited evidence for the importance of cognitive flexibility in research on personality as well as ability differences.

The hallmark of research on individual differences has been a search for underlying consistencies in the abilities or personality characteristics which differentiate between individuals or subgroups of individuals. That such individual differences exist, and are of substantial magnitude, is accepted almost without question by any serious researcher or careful observer of human behavior. Yet there probably is no area of behavioral research that has made less progress toward even the identification, much less the understanding, of its basic phenomena than have individual-difference researchers, despite nearly a century of widespread research efforts extending across virtually all of the major topical areas of psychology and related disciplines. This lack of substantial progress is the concluding theme of the 1979 Annual Review chapter on "Individual Differences and Cognitive Abilities," wherein Carroll and Maxwell contrast the minimal advances made by individual-differences researchers with the much more optimistic predictions made 25 years earlier by Carroll (1954).

This is an extensively revised and expanded version of a paper given for a symposium on Personality and Memory at the 1978 American Psychological Association meetings in Toronto, and is Technical Publication No. 83 of the Institute for the Study of Intellectual Behavior, University of Colorado. Unfortunately, Professor Battig passed away on June 27, 1979.

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For present purposes, however, the most noteworthy feature of the Carroll-Maxwell (1979) review is their several passing references to, e.g., "a number of significant learning-ability relations that varied with age and stage of learning" (p. 611); the possibility that individual differences "reflect simply flexibility in meeting the rather unusual requirements of the name-matching task" (p. 612); a claim that "analysis of these individual differences must take account of the type of problem, the individual's knowledge base, and the individual's characteristic solution strategies as they interact with problem type" (p. 617); an unpublished report that "to some extent subjects may change strategies when the structure or demands of the task make it appropriate to do so" (p. 619); and evidence that "subjects are highly flexible in using whatever memory attributes are appropriate in a given task" (p. 622).

Despite their frequency and concern with a wide range of individual-differences research areas, Carroll and Maxwell (1979) appear to view these quotations as little more than evidence for methodological shortcomings which limit the reliability or generality of any conclusions to be drawn from research on individual differences. No effort is made to relate this evidence for "within-individual differences" to the single direct and systematic discussion of such phenomena during the time period covered by the Carroll-Maxwell (1979) review. This uncited report (Battig, 1975) was based upon several attempts to assess the particular types of strategies or processes that a single individual was using on each of the several items constituting a list of materials to be learned. These results forced us to conclude that the typical individual is not at all consistent even in the processing techniques reported for two or more items that are virtually identical in composition. Instead, our typical individual subject is always quite capable of processing or responding to a given item in at least two quite different ways, and may even respond quite differently on repeated administrations of exactly the same task or test item.

Before reviewing and updating the substantial body of evidence for such within-individual differences or inconsistencies, it should be emphasized that they need not be viewed as fundamentally incompatible with more traditional approaches to individual differences. Within-individual differences however, do argue strongly against any meaningful differences between individuals that are based upon any single trait or ability that is assumed to characterize the individual consistently across a wide variety of tasks or situations.

Thus the present paper will attempt to accomplish more than merely arguing against the limitation of individual-differences research to the search for nonexistent consistencies which presumably relate to and account for the substantial variations between individuals in behavior. More importantly, it will be contended that the magnitude and nature of

within-individual differences, and the understanding of where and why they occur, may represent a more productive approach to the ultimate specification of the most important types of between-individual differences.

There is no need here to discuss further the exceedingly but understandably negative if not suppressive reactions that my initial arguments for the importance of within-individual differences (Battig, 1975) have elicited among individual-differences and experimental researchers alike. It is worth noting, however, some recent evidence that other influential researchers in individual differences as related to memory and cognition have also been forced to take into account the widespread inconsistencies characterizing any single individual's performance within even very simple types of cognitive or memory tasks to a greater extent than is acknowledged in the Carroll-Maxwell (1979) review.

Of special relevance are Underwood's conclusions following a detailed report of a massive factor analysis of individual differences using 200 subjects each performing on 33 different memory tasks (Underwood, Boruch, & Malmi, 1978). From the perspective of Underwood's (1969) multiattribute approach to memory, the Underwood et al. (1978) results lead them to question "How can we have a simple and straightforward theory about the functions of a particular attribute when a subject, almost capriciously, decides to change the attribute that dominates his or her performance? How can we have a straightforward theory about how the frequency attribute mediates recognition memory and verbal-discrimination learning when a relatively minor change in instructions can cause subjects to ignore frequency information and transfer their attention to another attribute, or to a form of associative learning?" (p. 418).

A somewhat different kind of evidence for multiple strategies in the Clark-Chase (1972) sentence-picture verification task comes from the most recent publication based upon Hunt's long-standing research program on individual differences in basic information-processing mechanisms (McLeod, Hunt, & Mathews, 1978). After demonstrating at least two quite different patterns of results for individuals presumably using verbal as contrasted with pictorial representations of spatial relationships between two figures, these authors emphasize the inadequacy of single general models to account for their results and state that "the same ostensibly linguistic task can be approached in radically different ways by different people." These authors, however, do not take the necessary further step of considering the possible usage of both verbal and pictorial representations by a single individual, dismissing this as "neither new nor particulary interesting" (McLeod et al., 1978, p. 506).

The acknowledgement of important within-individual differences by both Underwood and Hunt, as well as in the Carroll-Maxwell (1979)

review, adds considerable strength to our arguments (Battig, 1975, 1979) for the prevalence of such inconsistencies within individuals, which originally derived from the evidence summarized in the following section.

Within-Individual Differences

Most of our research demonstrating widespread within-individual differences or inconsistencies in memory tasks has represented a secondary aspect of experiments concerned with some more general issues in verbal learning and memory. We simply have added to otherwise typical memory experiments some means of assessing the number and consistency of the processes or strategies which each subject actually uses on each of the several different items or pairs within a standard paired-associate, serial, or verbal-discrimination type of list-learning task. This is most easily accomplished through the use of some type of postexperimental questioning, but closely comparable results are also obtained when we use direct probes for particular kinds of processing after each trial (Posnansky, 1972, 1974), or require subjects to describe their strategy during the actual study period of a paired-associate item (Huang, Note 1).

Summarized in Table 1 is the evidence for within-individual differences emerging from eight quite different experiments. These experiments have in common only that each subject was asked either to describe or identify how each individual item or pair was learned, that is, what kind of process or strategy was used. The numbers in the last column of Table 1 represent the mean percentage of items on which the individual's most common or preferred processing strategy was reported. For all eight experiments, these percentages are based upon items or pairs which were selected from normative materials so as to be maximally homogeneous as to imagery, pleasantness, frequency, and/or meaningfulness. Moreover, the alternative strategies were relatively few (3–6) in number, and quite general in nature (e.g., imagery, phrase or sentence, word association, or repetition).

The eight experiments are ordered in Table 1 from highest to lowest according to these percentage within-individual consistency measures. These results show clearly that subjects use their preferred strategy for only a little over half of the items, with the mean percentage across all experiments in Table 1 being only 55.2%. Moreover, only about 5% of all subjects show perfect consistency in strategy usage across all of a set of maximally homogeneous items.

Thus we can say with considerable certainty that the typical subject in a memory experiment is quite inconsistent as to how different items from a homogeneous set are processed or learned. In fact, this inconsistency and use of multiple strategies is probably the most consistent result emerging from the various experiments (not all of which are included in Table 1) where we have attempted to assess strategy usage for each individual

TABLE 1
PERCENT CONSISTENCY FOR PREFERRED STRATEGY IN EIGHT EXPERIMENTS

Reference	Type of task	Strategy assessment	% Consistency
Mondani and Battig (1973)	Paired-associate	Post-exp. description	67.8
Posnansky (1974)	Serial (children)	Probes during learning	62.8
Huang (Note 1)	Paired-associate	Description during learning	59.7
West (Note 2)	Paired-associate	Post-exp. mult-choice	58.0
Posnansky and Battig (Note 3)	Verbal-discrimination	Post-exp. mult-choice	57.1
Battig and Weiss (unpublished)	Paired-associate	Post-exp. mult-choice	48.8
Posnansky (1972)	Serial (adults)	Probes during learning	45.0
Huang and Battig (Note 4)	Paired-associate	Post-exp. description	42.4

item. Certainly we have never found any evidence even approximating general consistency of strategy usage across all items within a single list that is to be learned and/or remembered.

Cognitive Flexibility

Although there can be no question about the existence of extensive within-individual differences or inconsistencies in processes or strategy usage, the more important questions concern *why* individuals are so inconsistent and what (if anything) is accomplished by using a wide range of different processing strategies. One possible answer is that the use of multiple strategies reflects merely confusion or uncertainty as to how to go about trying to perform optimally on a particular task or problem. Another more interesting answer is that multiple strategies enhance performance, by increasing the likelihood that an optimal strategy will be selected and used for any individual item. Even more likely is that both of these, and perhaps other answers as well, are partially correct, depending upon the individual or the type of task involved.

That the usage of multiple strategies will enhance performance seems to follow especially closely from typical definitions of problem-solving ability, or even of general intelligence. A problem exists, and problem-solving takes place, only when the initial attempt to solve the problem is unsuccessful and the individual must search for and try out alternative strategies in order to achieve problem solution. Therefore, since most subjects will typically approach any behavioral experiment by viewing the task as a problem to be solved, they can be expected to try out different strategies or processes in an effort to find the one(s) that are optimal for the task at hand.

The foregoing speculations suggest that within-individual differences or inconsistencies in strategy usage may represent an important dimension of differences between individuals in what for present purposes will be termed *cognitive flexibility*. This follows from my previous suggestion (Battig, 1979) that the most important source of individual differences may be "differences in the range of available processing mechanisms or strategies, and the ability of the individual to select and use those strategies which are most effective for the task at hand" (p. 30). More specifically, cognitive flexibility will be defined here as incorporating two major aspects: (1) the availability in the individual's repertoire of a large number and wide range of alternative types of strategies or processes and (2) the ability to select the one or more of these alternatives that are most appropriate and effective for the required task or problem.

Since this definition of cognitive flexibility appears virtually synonyous with problem-solving ability, it seems curious that problem-solving researchers have had little if anything to say about individual differences in such cognitive flexibility as related to problem-solving performance.

There has actually been more attention to flexibility as a factor in structural models of intelligence or personality (e.g., Cattell, 1971; Guilford, 1967). Moreover, rigidity (the absence of such flexibility) formerly was considered a personality characteristic of considerable research interest (e.g., Luchins & Luchins, 1959), although the term rigidity has virtually disappeared from the current literature. In addition, differences in cognitive flexibility have recently been shown to be closely related to performance on such simple information-processing tasks as perceptual encoding and grouping of strings of letters (e.g., Cosden, Ellis, & Feeney, 1979).

Yet the problem-solving literature contains nothing relevant to cognitive flexibility that advances substantially beyond the present author's early observation that "When the presence of several possible responses and the likelihood that the first response will be correct are made synonymous with problem-solving ability, it seems curious that problem-solving efficiency was not enhanced by flexibility of approach" (Battig, 1957, p. 103). The Battig (1957) analyses of word-formation problem-solving, however, showed that any facilitation of problem-solving by flexibility was heavily dependent upon the extent to which such flexibility was useful in finding a satisfactory solution to the problem.

This problem-solving research is important for present purposes primarily because it alerted the author to the importance of within-individual variability. Certainly it had little direct impact either on problem-solving or any other area of research, although there have been occasional studies showing problem-solving performance to be related to measures of flexibility (e.g., Gavurin, 1975).

Returning to cognitive flexibility as related to memory, however, there is some suggestive but far from conclusive evidence that memory performance can be improved if more different processes or strategies are employed (Battig, 1979, pp. 28–29). One of the experiments represented in Table 1 (Huang, Note 1) also showed that one-week-delayed uncued pair recall (but not cued response recall) was improved on word pairs where subjects had switched to different strategies across repeated study trials, relative to pairs for which a single type of strategy was used consistently. Another unpublished doctoral dissertation in our laboratories showed significant positive correlations of the order of .7 between recall performance and number of different types of reported strategies (Barrow, Note 5). More direct experimental evidence comes from Bird's (1976, 1977) demonstrations that if subjects change to different types of processing across successive trials on, e.g., a Brown-Peterson short-term memory task, there is substantial release from proactive interference and consequent facilitation of short-term emory performance.

Other experiments represented in Table 1, however, have shown little if any relationship between memory performance and number or consis-

tency of reported strategies. This lack of relationship is particularly evident in the most recent unpublished study by Battig and Weiss, which also offers some suggestive evidence concerning possible reasons for these inconsistent and negative results. Unfortunately, neither the percentage within-individual consistency measures shown in Table 1, nor number of different types of strategies used by a given individual, provide sufficiently accurate quantitative measures of within-individual inconsistencies. Thus in the Battig-Weiss experiment we attempted to represent such within-individual differences in terms of an informational uncertainty measure (Attneave, 1959) based upon the proportions of items for which each of the six alternative strategies (sentence or phrase, picture or image, meaning or association, repetition, other, or no strategy) were reported by each subject. Despite its greater apparent adequacy, however, the informational uncertainty measure for these data also showed only a slight and insignificant correlation of .05 with delayed retention as measured by cued recall.

Further analyses based upon the informational uncertainty index of inconsistency did provide some evidence concerning a major limitation of the present attempts to infer cognitive flexibility from measures of within-individual inconsistencies in strategy usage. As suggested in the initial paragraph of this section, such within-individual differences are likely to characterize individuals who are confused or unmotivated, as well as individuals who are using multiple strategies productively so as to enhance their performance. If so, it would be expected that high levels of inconsistency (as measured in this instance by informational uncertainty) might characterize both individuals with very poor and very good memory performance.

In an attempt to evaluate this possiblility, the variablity of cued recall scores across subjects was compared for individuals with high, medium, and low informational uncertainty measures of inconsistency in strategy usage. Although the recall variability was in fact higher for individuals with high than with moderate inconsistency in strategy usage, recall variability was also high for individuals with low informational uncertainty scores. Thus individuals with either high or low levels of inconsistency in strategy usage, as measured by informational uncertainty, showed greater variability in recall performance than did individuals with average levels of informational uncertainty, although these variability differences were only marginally significant.

The main conclusion to be drawn from these analyses of within-individual differences as related to memory performance in the Battig-Weiss experiment is that both high and low levels of consistency of strategy usage may characterize not only individuals with especially good memory performance, but also individuals with poor memory performance, at least under the conditions of this experiment. Most important,

it appears that variability of strategy usage alone may be an inadequate index of the kind of cognitive flexibility defined in the present paper that is suggested to be directly related to memory performance.

Heterogeneity of Materials

Our inability thus far to develop adequate measures of cognitive flexibility in strategy usage, which separate those individuals using multiple strategies productively to enhance memory performance from individuals whose variablity reflects merely confusion and/or lack of motivation, suggests either that the suggested cognitive-flexibility dimension of individual differences is of little present scientific value, or that a different approach to its assessment must be developed. Such an alternative approach is proposed in this section, based upon a simple methodological change which may enhance the importance of cognitive flexibility for effective memory performance sufficiently to permit its clearcut demonstration and investigation even with the currently available inadequate indices of cognitive flexibility.

More specifically, it appears likely that the usage of a wide variety of different types of materials within a single learning list or task should enhance the importance of cognitive flexibility for optimizing memory performance. If memory is in fact facilitated by increased cognitive flexibility, this should be particularly true under conditions where a wide range of different kinds of materials must be memorized, so that quite different strategies are optimal for different items.

This suggested shift from homogeneous to heterogeneous types of materials for the evaluation of cognitive flexibility follows directly from a comparison of the previously cited Underwood et al. (1978) factor analysis of individual differences across a wide range of memory tasks, with a subsequent more limited factor analysis of a smaller subset of memory tasks (Malmi, Underwood, & Carroll, 1979). These two studies produced quite different results, despite their inclusion of very similar types of memory tasks. Underwood et al. (1978) found relatively small interrelationships between their 33 memory tasks, with a median pairwise correlation of .18 and only 7% of their pairwise correlations being larger than .5. That these are not atypical results is demonstrated by their close correspondence with a quite different factor-analytic study of individual differences in memory by Masson (Note 6; see also Battig, 1979) which showed a median pairwise correlation of .17 and only 3% of these correlations as large as .5.

In sharp contrast to these unimpressive correlation across different memory tasks, the more recent Malmi et al. (1979) study showed much larger pair-wise intercorrelations with a median value of .66 and all but 3% larger than .5. Thus the factor analysis of the Malmi et al. (1979) data was indicative of a strong single "general memory" factor or at most two

highly correlated factors, in contrast with the several weak factors emerging from the Underwood et al. (1978) and Masson (Note 6) studies. One major difference of the most recent Malmi et al. (1979) study from its two predecessors (Masson, Note 6; Underwood et al., 1978) was their use of a much wider variety of word materials which were sampled randomly from all 5-letter words appearing in Thorndike and Lorge (1944). The consequent heterogeneity of the Malmi et al. (1979) word lists contrasts sharply not only with the more homogeneous word lists constituting any single task used by Underwood et al. (1978) and Masson (Note 6), but also with the vast majority of studies of human memory where words are taken from a single restricted source and "mixed lists" of different types of words are in widespread disrepute.

Suggestive evidence consistent with the foregoing analyses of heterogeneity of materials as a prerequisite to any strong relationship of increased cognitive flexibility to effective memory can also be derived from a comparison between the two paired-associate studies (Huang, Note 1; Barrow, Note 5) described in the previous section as showing such a relationship, and the unpublished Battig-Weiss evidence for little if any flexibility-memory relationship. The materials in the latter experiment were carefully selected so as to be highly homogeneous, and closely comparable types of words were used for all subjects. Much more heterogeneous lists, including concrete-concrete, concrete-abstract, abstract-concrete, and abstract-abstract word pairs, were used for each subject in Huang's (Note 1) demonstration that uncued pair recall was best if subjects had switched strategies for individual pairs across trials. Barrow (Note 5) based her analyses showing strong relationships of memory to number of different types of reported strategies upon lists containing all possible combinations of high- and low-imagery pairs with three levels of pleasantness (pleasantness-neutral-unpleasant), although any given subject learned a single homogeneous list of only one of these six types of pairs. Half of the pairs in each of Barrow's (Note 5) various lists, however, consisted of pairs intentionally selected for the high between-subject variability in their imagery ratings (Toglia & Battig, 1978) which presumably enhanced their variability also in encoding and applicable strategy alternatives. Further evidence that a wide variety of different kinds of materials may enhance the relationship between memory and number of different alternative strategies comes from Barrow's (Note 5) additional finding that when this relationship is based upon different individual pairs rather than subjects, the resulting correlation increases from .714 to .988.

That flexibility-memory relationships become stronger with more heterogeneous types of materials has yet to be shown under conditions where heterogeneity of materials is systematically varied within a single experiment. Such an experiment is presently in progress, however, in the

form of a master's thesis in our laboratories by Kathleen Weiss, wherein both heterogeneity of paired-associate learning materials and number of different types of strategies used by subjects are systematically manipulated, and scores are obtained for all subjects on several psychometric tests including some tests of cognitive flexibility. Until Weiss' study is completed, it would be premature to go beyond a preliminary suggestion that greater heterogeneity of materials may provide a more optimal situation for demonstrating and evaluating any relationships whereby memory is enhanced by greater cognitive flexibility.

Cognitive Flexibility and Personality

Although our current emphasis upon cognitive flexibility as related to memory and problem-solving appears more consistent with cognitive flexibility as an ability than as a personality variable, I would prefer to leave this question open and am quite willing to consider cognitive flexibility as an important dimension of personality. At the 1978 American Psychological Association symposium upon which the present paper is loosely based, I concluded with the following challenge to researchers interested in personality factors as related to memory:

> Can you rule out the possibility that any superiority of memory for individuals with e.g., low anxiety, high extraversion, or greater field independence, may really be due to the greater cognitive flexibility shown by low-anxious, extraverted, or field-independent individuals? I submit that you can't, and thus remain convinced that cognitive flexibility, despite the serious conceptual and methodological problems in measuring and evaluating it, still represents the most promising individual-differences variable as related to memory."

Somewhat to my surprise, nobody to date has attempted to meet this challenge, and Mueller (1979) reports direct evidence that low-anxiety subjects are more likely than high-anxious subjecs to engage in both semantic and nonsemantic types of incidental processing in a free-recall task. Thus I see no reason to withdraw or modify this challenge, and am hopeful that within-individual differences and cognitive flexibility will soon assume their rightful place as a key emphasis of future research on individual differences, instead of their current treatment as a troublesome nuisance that has no real significance for the understanding of individual differences, as conveyed by the most recent review of individual differences by Carroll and Maxwell (1979).

REFERENCES

Attneave, F. *Applications of information theory to psychology.* New York: Holt, 1959.

Battig, W. F. Some factors affecting performance on a word-formation problem. *Journal of Experimental Psychology,* 1957, **54,** 96–104.

Battig, W. F. Within-individual differences in "cognitive" processes. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola Symposium.* Hillsdale, NJ: Lawrence Erlbaum Associates, 1975.

Battig, W. F. The flexibility of human memory. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing and human memory*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1979.

Bird, C. P. On the role of processing requirements in short-term memory . *Journal of Experimental Psychology: Human Learning and Memory*, 1976, **2**, 234–243.

Bird, C. P. Proactive inhibition as a function of orienting task characteristics. *Memory and Cognition*, 1977, **5**, 27–31.

Carroll, J. B. Individual differences. *Annual Review of Psychology*, 1954, **5**, 127–148.

Carroll, J. B., & Maxwell, S. E. Individual differences in cognitive abilities. *Annual Review of Psychology*, 1979, **30**, 603–640.

Cattell, R. B. *Abilities, their structure, growth, and action*. New York: Houghton Mifflin, 1971.

Cosden, M. A., Ellis, H. C., & Feeney, D. M. Cognitive flexibility-rigidity, repetition effects, and memory. *Journal of Research in Personality*, 1979, **13**, 386–395.

Clark, H. H., & Chase, W. G. On the process of comparing sentences against pictures. *Cognitive Psychology*, 1972, **3**, 472–517.

Gavurin, E. I. Relationship of anagram solving to measures of divergent production and letter rearrangement. *Journal of General Psychology*, 1975, **92**, 231–235.

Guilford, J. P. *The nature of human intelligence*. New York: McGraw-Hill, 1967.

Luchins, A. S., & Luchins, E. H. *Rigidity of behavior*. Eugene, OR: University of Oregon Books, 1959.

Malmi, R. A., Underwood, B. J., & Carroll, J. B. The interrelationships among associative learning tasks. *Bulletin of the Psychonomic Society*, 1979, **13**, 121–123.

McLeod, C. M., Hunt, E. B., & Mathews, N. N. Individual differences in the verification of sentence-picture relationships. *Journal of Verbal Learning and Verbal Behavior*, 1978, **17**, 493–507.

Mondani, M. S., & Battig, W. F. Imaginal and verbal mnemonics as related to paired-associate learning and directionality of associations. *Journal of Verbal Learning and Verbal Behavior*, 1973, **12**, 401–408.

Mueller, J. H. Anxiety and encoding processes in memory. *Personality and Social Psychology Bulletin*. In press.

Posnansky, C. J. Probing for the functional stimulus in serial learning. *Journal of Experimental Psychology*, 1972, **96**, 184–193.

Posnansky, C. J. An investigation of serial learning and retention processes in children. *Journal of Experimental Child Psychology*, 1974, **18**, 127–148.

Thorndike, E. L., & Lorge, I. *The teacher's word book of 30,000 words*. New York: Teachers College, Columbia University, 1944.

Toglia, M. P., & Battig, W. F. *Handbook of semantic word norms*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1978.

Underwood, B. J. Attributes of memory. *Psychological Review*, 1969, **76**, 559–573.

Underwood, B. J., Boruch, R. F., & Malmi, R. A. Composition of episodic memory. *Journal of Experimental Psychology: General*, 1978, **107**, 393–419.

REFERENCE NOTES

1. Huang, S. I. *Effects of concreteness on long-term retention: Differences in concreteness or in types of idiosyncratic processing*. Unpublished doctoral dissertation, University of Colorado, 1976.
2. West, J. N. *Investigating the effect of prior sleep on subsequent waking memory*. Unpublished doctoral dissertation, University of Colorado, 1974.
3. Posnansky, C. J., & Battig, W. F. *The effects of imagery value and intrapair association value upon verbal discrimination learning*. Tech. Rep. 8, University of Colorado, Institute for the Study of Intellectual Behavior, June, 1973.

4. Huang, S. I., & Battig, W. F. *Associative directionality in paired-associate learning as a function of concreteness and intrapair relatedness*. Tech. Rep. 42, University of Colorado, Institute for the Study of Intellectual Behavior, August, 1975.
5. Barrow, N. K. H. *Word affect and imagery effects in recognition and recall memory*. Unpublished doctoral dissertation, University of Colorado, 1976.
6. Masson, M. E. J. *A multivariate approach to the study of memory and problem solving*. Unpublished master's thesis, University of Colorado, 1977.