THEORIES CONTRASTED: RUDY'S VARIABILITY IN THE ASSOCIATIVE PROCESS (V.A.P.) AND MARTIN'S ENCODING VARIABILITY

THESIS

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A paired-associate list of three-word stimuli and one-word responses comprised the first list of an A-B, A-Br paradigm. Each of the three words from the first-list three-word stimuli was singly re-paired with first-list responses to make up three of the second-list conditions. The fourth second-list condition used the first-list stimuli plus re-paired first-list responses. Results obtained were that: (a) nine of the sixteen subjects spontaneously shifted encoding cues from first to second lists, (b) evidence of significantly greater negative transfer occurred only in the A-B, A_{123}-Br condition, and (c) although not attaining significance level, across all A_i-Br conditions there were more errors on second-list learning for those not shifting encoding cues from first to second list. For those who did shift, performance was only slightly lower than the A-B, C-B control condition. Neither the encoding variability nor the associative variability theory was entirely supported. A gestalt interpretation was suggested.

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CHAPTER I

INTRODUCTION

The process of committing something to memory, as proposed by the verbal learning theories of Martin (1971) and Rudy (1974), can be conceptualized from the perspective of a two-stage framework. The first stage entails encoding--the second stage, association.

In the case of paired associate learning tasks, it is important to understand a frequently occurring duality. To the extent a learner can analyze a stimulus into components, the response will be associated with less than the entirety of the presented stimulus. If a highly meaningful stimulus, "DOG," were presented, the response would probably be associated with "DOG." But if a nonsense CVC (consonant-vowel-consonant) stimulus, "XOL," were presented, the literature shows that in most cases the response is associated to only a fragment ("X," "O," or "L") of the presented stimulus (Underwood, 1963; Cohen & Musgrave, 1964).

The disparity between nominal and functional stimuli arises not just because the learner looks for simplified modes of learning (Underwood, 1963). Both Martin (1971) and Rudy (1974) consider a nominal stimulus to be comprised of various aspects, some of which are more salient than others.

To give an example from research, for a nominal stimulus composed of a low-associative-value trigram surrounded by color, subjects' recall to the color component is much better than to the trigram component (Underwood, Ham, & Ekstrand, 1962). Saliency of stimuli need not be limited to class (colors, letters, patterns), but can also be determined by factors such as position. For instance, the 1970 study by Wichawut and Martin used nominal stimuli composed of three four-letter nouns. The third (or right-hand-positioned) noun evoked the best recall for the majority of the subjects. Thus it seems that the differential saliency among elements of the complex nominal stimulus also contributes to analysis, resulting in disparity between nominal and functional stimuli.

Martin contends that the encoding stage consists of "the elicitation of a perceptual response by the nominal stimulus, together with the consequent occurrence of an encoded version of that nominal stimulus" (Martin, 1968, p. 422). In other words, the entire stimulus will be scanned, and then some part of that nominal stimulus will be focused upon for use as the functional stimulus, or cue, for pairing with the response. It is important to note that once this cue has been selected, the other components of the nominal stimulus will not gain in associative value with the response until the selected cue correctly elicits the response. To go beyond the level of the individual item, if there be a list of ten paired associates, the noncue components of the nominal stimuli will not gain in associative value with the responses until for the entire list, the selected cues correctly elicit the responses (Wichawut & Martin, 1970). To use the above illustration of nominal stimuli, the low-associative-value trigrams would not be focused upon for use as cues until the learning process had gone on for a time sufficient to correctly link the color components and responses throughout the entire list. For the three four-letter-nouns stimuli, the first- and second-position nouns would not undergo association until the third-position elements correctly elicited their respective responses throughout the entire list. According to Martin, then, there is the first stage of encoding in which a component from the nominal stimulus is selected for association (see Figure 1). Once this component is selected, the remaining components of the stimulus gain no further associative value with the response until the second phase--association formation between the selected cue and the response--is completed.

Rudy says the entire stimulus will be scanned, but that the encoding phase cannot be characterized as a process of selecting a component of the nominal stimulus for association purposes. Instead, Rudy proposes that there is a variability in rate of association for the various stimulus components. In other words, a color might elicit the

Nominal Stimulus	Elements Are Scanned	An Element Is Selected
	A_1	
A_{123}	A_2	A_3
	A_3	

Fig. 1--Martin's encoding phase of memory

correct response sooner or more reliably than the low-associative-value trigram, but the trigram component is not being ignored as a cue. The third-position stimulus elements might elicit the correct response sooner or more reliably than the first- or second-position elements, but these other elements are not being ignored. All during the process of learning to associate the response with the stimulus, the various stimulus components are all being attended to or encoded. The most salient components will have the fastest rate of association with the response; the other components will have slower rates of association (the less the component's salience, the lower the rate).

Thus a fundamental difference between Martin and Rudy's views is that for Martin, the encoding of a nominal stimulus signals no further associative gains with the response for unselected nominal stimulus components until the second stage, association, is completed. For Rudy, the encoding of a nominal stimulus does not bar further associative gain for these unselected nominal stimulus components. Until a correct elicitation of the response, all components still undergo association formation. Once that criterion is met, then there is no further associative bonding between the components, whatever their salience, and response. The only way in which further association can occur is if the response recalled to the stimulus is incorrect. To paraphrase Rudy, when the subject encounters a stimulus, a prediction is made which forms the basis for recall performance. The results of comparing this prediction to what actually happens (wrong or right) determines whether or not further associative processing occurs. In general, the greater the disparity between prediction and outcome, the greater the degree of study the item will receive (Rudy, 1974). Figure 2 schematically presents Rudy's view.

Nominal Stimulus	Elements Are Scanned	Elements Associated with Response	
	A_1	A_3	-R
A_{123}	A_2	A_1	-R
	A_3	A_2	-R

Fig. 2--Rudy's view of the memory process

It is important to note that both Figures 1 and 2 represent an example of only one of many possible encoding outcomes. Depending on the type of stimulus and the subject, A_3 may be most salient, A_2 may be most salient, or A_1 may be most salient. This paper shows A_3 as being most salient only because the composite stimulus used in this study is more frequently associated with the response by means of the third element of a three-unit whole. In other words, this particular outcome is shown to familiarize the reader with the empirical conflicts specific to this study. This intent also underlies Figures 3 and 4.

At the time of first eliciting a correct response, Martin would say that a particular cue and response are linked in memory independently of all other stimulus-component-response combinations (Martin, 1971). Rudy would say that at the time of first eliciting a correct response one of the cue-response pairings was now established in memory but that the remaining cue-response pairings were also in memory, though at a weaker associative strength (Rudy, 1974). At this point in time, then, Martin's view would portray the associative strength of the nominal stimulus to response to be a function of the selected cue-response combination (Martin, 1971). Rudy's view would hold that the associative strength of nominal stimulus to response would be a function of the combined links of not just the fastest-learned cue-response combination, but <u>all</u> the cue-response combinations (Rudy, 1974).

The differences in Martin's and Rudy's hypotheses become polarized when the memory process is viewed in terms of a negative transfer paradigm, such as the A-B, A-Br paradigm. Martin believes that variability can occur in the encoding phase, whereas Rudy believes that variability occurs only in the association phase. In other words, after learning the first list (A-B), presentation of the second list (A-Br) with its rearranged pairings will create a state in which what was formerly familiar and right is now familiar and wrong. Mechanisms for alleviating the conflict exist in the encoding phase according to Martin (1968), in the associative phase, according to Rudy (1974).

The way that the A-B, A-Br paradigm can test these opposing theories can more readily be understood by referring to Figures 3 and 4 in the following discussion.

Martin hypothesizes that the first list may be encoded and committed to memory using less than the total stimuli if these stimuli are complex and fragmentable into components. Whatever the stimulus components might be, presentation of the second list will cause difficulty since the cues that were effective in eliciting correct responses for the first list are still eliciting those same responses which are inappropriate for the second-list pairings. Martin would say that an alternative open to the subject would be recoding: picking a different stimulus component for combination with second-list responses. In other words, if the right-hand-positioned stimulus element had been

List A-B				List A-Br			
Encoding		Association		Encoding		Association	
Nominal Process	Functional Process	Nominal Process	Functional Process	Nominal Process	Functional Process	Nominal Process	Functional Process
A_{123}	$A_{123} \longrightarrow A_3$	A_{123}-B	A_3-B	A_{123}	$A_{123} \longrightarrow A_1$	A_{123}-Br	A_1-Br or C-B
stimulus is attended	scanning; element is chosen	stimulus plus response	element_3 plus response	stimulus again attended	scan for new element	stimulus plus response	element_1 plus response

Fig. 3--Martin's encoding variability within an A-B, A-Br framework

selected for first-list pairings, the subject might select the left-hand-positioned stimulus elements for pairings with the second-list responses. Using different stimulus cues for the two lists would then functionally reduce the level of negative transfer expected with the A-B, A-Br nominal paradigm to approximately that of the A-B, C-B paradigm. (The process of discarding the familiar first-list cues would probably give a slightly poorer performance than an A-B, C-B paradigm.) This sequence of events could be verified by presenting an A-B, A-Br paradigm and checking the learning rate of those subjects who shifted cue selection on second-list learning, the learning rate of those who did not shift, and the learning rate of the control group on the second list of the A-B, A-Br paradigm.

Rudy's hypothesis of the outcome of second-list learning differs from Martin's. Whereas Martin postulates a reduction in proactive negative transfer if the subject variably encodes the stimuli from list to list, Rudy says the only possibility of negative transfer reduction is a function of variability in the associative process. Rudy contends that the associative-process--attending to a stimulus and associating its functional components to the response at whatever rate their respective saliency parameters dictate--is not always "aroused" and functioning. Only to the extent that the response elicited is incorrect will this associative process occur. In the A-B, A-Br paradigm the stimuli remain the same from list to list. The rearranged responses of the second list "arouse" this associative process since there is now disparity between prediction and outcome for the stimulus-response pairings. But Rudy contends that the saliency values of the stimulus components will once again determine which of the components will enter fastest into association with the new response. Whereas Martin would say that a subject could select another, less-salient component for encoding, Rudy would say that no matter whether red meant "stop" in one case and "go" in another, red would always be easier to learn in association with a response than "ZFC," or the right-hand-positioned stimulus component would be easier to learn than the left- or middle-positioned stimulus components. Therefore, the stimulus component learning-rate hierarchy would be the same from first (A-B) to second (A-Br) list, and no reduction in negative transfer due to a shift in encoding would be possible (Rudy, 1974). A check on this sequence of events could be made by presenting an A-B, A-Br paradigm and testing to see if second-list responses were elicited by stimulus components different from those eliciting first-list responses.

There is little previous experimentation specific to this area of theory. The 1968 Martin and Carey study used two sets of high-meaningfulness--CVCs (consonant-vowel-consonants), and two sets of low-meaningfulness CCCs (consonant-consonant-consonants). Each of these sets of

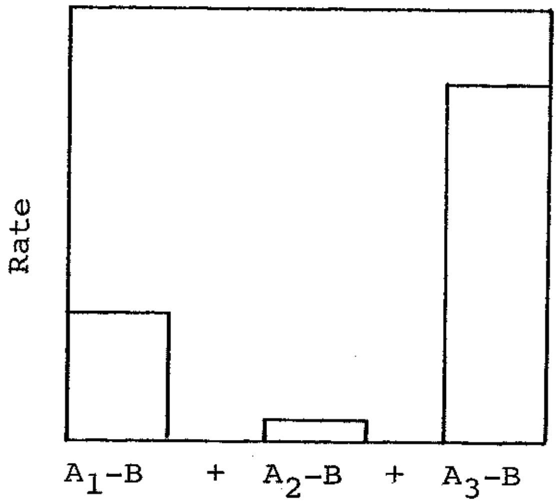
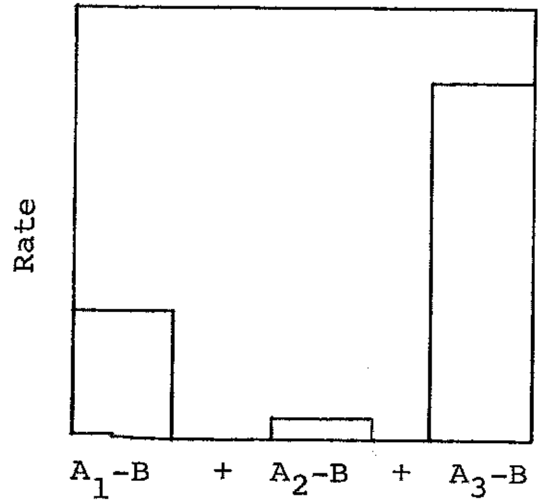
List A-B		List A-Br	
Stimulus Is Attended	Independent Component Association (Saliency Determined Rate) with the Response	Stimulus Is Attended	No Difference in Stimulus, No Change in Saliency; No Shifting Possible
A_{123}		A_{123}	

Fig. 4--Rudy's V.A.P. hypothesis within an A-B, A-Br paradigm

stimuli were paired differently with the digits one through nine, and an A-B, A-Br paradigm was set up. An A-B, C-B control paradigm was also used. Aural anticipation was the learning procedure used. In other words, the stimulus (spelled) was presented over earphones, and the subject had three seconds in which to orally give the response before the response was presented over the earphones. Once the lists were learned, recall tests were given. After the taped signal "Ready," a trigram was presented over the earphones. Three of these presentations were followed by a buzz, which in turn was followed by re-presentation of the same trigram, to which the subject was instructed to emit the first digit response that came to mind. This was the no-delay test condition, utilizing three of the nine trigram stimuli. For the other six trigrams, a bell rang after trigram presentation, upon which signal the subject began doing a symbol-cancellation task. Either 10 or 30 seconds later, the buzzer sounded, the trigram was re-presented, and the subject was to emit a digit response. The three delays were distributed evenly, but unpredictably, over this sequence of nine tests.

After having tested 12 subjects in this manner, another 48 were tested in the same way except that all trigrams were presented once at each delay interval, and additional tests were included. In these additional tests, first-list responses were asked for in response to the aural presentation of first-list stimuli; second-list responses were asked for in response to second-list stimuli.

The results relevant to this discussion showed that the A-B, A-Br paradigm yielded negative transfer relative to the A-B, C-B paradigm only when the stimuli were of high meaningfulness. Low-meaningfulness stimuli showed the A-B, A-Br paradigm to functionally approximate the A-B, C-B control paradigm. Martin's encoding variability theory could very easily explain this pattern. The high-meaningfulness stimuli (CVCs) would not be easily analyzed. The tendency would be to encode the nominal stimulus as a single, meaningful whole. The negative transfer involved in learning the second list (A-Br) would be as high as the A-B, A-Br paradigm commonly suggests. The low-meaningfulness stimuli (CCCs) would not as easily be encoded as a single, meaningful whole. On the contrary, most commonly the subject would encode the nominal stimulus by its first (leftmost) consonant for association with the response (Postman & Greenbloom, 1967). Upon encountering the second-list learning task, the subject would have the chance to encode the CCC in a different way. The first-list encoding was not sufficiently encompassing to exclude a second analysis and encoding of the nominal stimulus. Therefore, the low-meaningfulness stimuli would allow a nominal A-B, A-Br paradigm to parallel an A-B, C-B paradigm, which is what the Martin and Carey (1971) results show.

There are two studies that would suggest Rudy's theoretical position to be more correct. The 1970 Williams and Underwood study, Experiment I, employed an A-B, A-Br paradigm. Six low-meaningfulness CCCs were used as stimuli. The trigrams were paired with the digits one through six for A-B, and re-paired for A-Br. To control stimulus selection, a technique developed by Rabinowitz and Witte (1967) was used. One letter of the trigram was printed in red with the other two in black ink. If, in the first list, the first letter of the trigram were in red and in the second list the third letter of the trigram were in red, the "forced" encoding variability from first to second list would transform a nominal A-B, A-Br paradigm into an A-B, C-B paradigm. However, if the first letter were red for both lists, the paradigm would be, both nominally and functionally, A-B, A-Br.

The design employed in Williams and Underwood's Experiment I had three treatments for A-B learning. The trigram stimuli either had no letters in red, the first letter in red, or the last letter in red. For the second list, A-Br, these same three treatments were also given orthogonally to the A-B treatments. The paired associates of both first and second lists were learned by the anticipation method. In other words, the subject first saw the CCC stimulus in a memory drum window and then had two seconds in which to orally give the response before the memory drum would present both CCC stimulus and digit response. Instructions familiarizing the subject with the anticipation procedure made no mention of red letters. Subjects were divided into three groups: those tested at the end of A-B learning by responding with as many of the trigram letters as possible to orally presented digits, those tested in the same manner but following A-Br (second list) learning for Br-A associations, and those tested for both B-A associations (at the end of first-list learning) and Br-A associations (following second-list learning).

Analysis of the recall tests showed the color variable to have markedly influenced stimulus selection. The red letter was most often recalled in conjunction with the digit response in all treatments. This was true for both A-B (first-list) and A-Br (second-list) recall test results. An exception to red lettering being recalled occurred in the A-Br condition in which the third letters of the CCC stimuli were in red. Recall tests showed high recall of the first letter (relative to the middle letter) in addition to high recall of the red third letter.

Groups given recall tests following both first-list and second-list learning showed higher total trigram recall than groups given only one recall test (either following A-B or else A-Br learning). However, the pattern of the results was the same for all groups.

The groups in which shifts in functional encoding from first to second lists were minimal were: (a) no instructions were given for list A-B, the first letter of the trigram was in red for list A-Br (0-1); (b) the first letter of the trigram was in red for both A-B and A-Br lists (1-1); and (c) the third letter of the trigram was in red for both A-B and A-Br lists (3-3). A total of 42 true intrusions (errors in A-Br learning in which A-B pairings are incorrectly given) occurred for these groups. Only five true intrusions occurred for maximal shift groups (0-3, 1-3, 3-1). This portion of the evidence supports Martin's contention that a shift in functional encoding from list to list functionally transforms the A-B, A-Br paradigm and its attendant negative transfer into something approximating the A-B, C-B paradigm and its lower level of attendant negative transfer.

There were two measures of second-list learning: (a) mean number of correct responses on the first two trials of A-Br learning and (b) mean number of trials to criterion on A-Br learning. On these two measures of learning performance there was no significant difference between "shift" and "nonshift" groups. Williams and Underwood hypothesized that both positive and negative factors accrue with functional encoding shifts from first to second lists. The total of these positive and negative factors amount to a performance level equal to that of those not shifting functional encodings from list to list. Furthermore, if given no instructions or red lettering from list to list (0-0), the stimulus recall was much the same for both lists. Williams and Underwood took this to be an indication that a spontaneous change in functional encoding occurs seldom enough that encoding variability, even if it exists, occurs too seldom to be of theoretical usefulness for the overall picture of transfer performance.

A study cited by Postman and Underwood (1973) as being most damaging to Martin's encoding variability hypothesis is the 1970 Goggin and Martin study. There were six groups learning two lists in an A-B, A-Br paradigm. Three of the six groups learned List 1 to a criterion of six out of seven (6/7). The other three learned List 1 to a criterion of seven out of seven plus 50% overlearning (7/7 + 50%) of however many trials had been necessary to attain the seven-out-of-seven criterion. Second-list learning was continued for 16 trials. Two control groups learned only the first list and then engaged in a rehearsal-preventing task that lasted as long as second-list learning of the other six groups. One of the two control groups learned the first list to a criterion of six out of seven (6/7); the other, to a criterion of seven out of seven plus 50% overlearning (7/7 + 50%). Then all subjects were given a stimulated recall test.

The stimuli were two dimensional, each being a particular black geometric shape on a distinctly colored background. The responses were never displayed, the subject having to orally guess the digits one through seven.

There were three experimental conditions at each of the two degrees of List 1 learning: Stay, the dimension that was correlated with correct responding in List 1 was also correlated with correct responding in List 2 (the other dimension was irrelevant). In the Switch condition, correct responses were correlated with one dimension for the first list, but the subject would have to switch to the other dimension for correct correlation with responses in the second list. In the Free condition, only one of the two stimulus dimensions was relevant to correct responding (as in the two previous conditions). However, both dimensions were perfectly correlated with the responses in List 2, giving the subjects a choice as to which dimension to use as the basis of List 2 learning.

The stimulated recall test was the same for all groups and conditions. The values of the dimension that had been relevant in List 1 learning were first presented (three-second exposure and a three-second blank window on the memory drum). The subjects were to call out the first digits that came to mind. In other words, both Lists 1 and 2 responses were being called for. After a six-second interval, the values of the dimension irrelevant to List 1 learning were likewise presented. Again, Lists 1 and 2 responses were called for.

Analyses of results showed increased retroactive inhibition for List 1 associations in the Stay and Free conditions. The trade-off was in transfer. Those using the same dimension for encoding from list to list, whether forced to as in the Stay condition or chosen as in the Free condition, encountered less proactive transfer than those forced to switch encodings from list to list, as in the Switch condition. The point is that the subjects did not spontaneously recode in the face of an interference situation, as Martin (1968) would have predicted. They evidently placed "adaptive weight" on transferring from List 1 learning their functional attention to the List 1 relevant dimension to the List 2 learning problem, this in ignorance of poor performance on a later test for retroaction effects (Goggin & Martin, 1970). In other words, it is postulated that because the subjects did not know that they would later be tested for List 1 responses in addition to List 2, they simply elected for the easiest mode of learning List 2 given the earlier experience of List 1. Therefore, even if given two perfectly relevant dimensions, they used the one relevant from List 1 learning.

This pattern generally held over both variations (shape and color) of List 1 stimulus relevancy and over lesser (6/7) and greater (7/7 + 50%) criterions of first-list learning.

The purpose of this research is to empirically test these conflicting views. If Martin's view were correct, some cue-selection shifting and consequent reduction in negative transfer on second-list A-Br learning should occur. If Rudy's view were correct, there should be no stimulus-component shifting whatsoever, precluding the possibility of functionally reducing the negative transfer level in an A-B, A-Br paradigm.

CHAPTER II

METHOD

Subjects

There were 128 North Texas State University students, male and female, who volunteered participation in exchange for extra credit points in their undergraduate psychology courses. They were assigned to experimental conditions on the basis of a randomized block running roster of conditions and their order of appearance in the laboratory.

Design

The A-B, A-Br experimental group learned a first list (A-B) to a criterion of one perfect trial. Following this, they were given a retention test for the list they had just learned. Then, according to their order of appearance, they were assigned to one of four second-list (A-Br) conditions. Table I portrays the possibilities.

The first condition required subjects to learn a second list in which the leftmost stimulus element (A_1) from the first list (A-B) was now paired with a different first-list (A-B) response. The second condition required subjects to learn a second list in which the middle stimulus element (A_2) from the first list (A-B) was now paired with a different first-list (A-B) response. In the third condition, the rightmost element (A_3) was now paired with

with a different first-list (A-B) response. And in the fourth condition, the entire (A_{123}) stimulus from the first list (A-B) was now re-paired with a different response from the first (A-B) list.

TABLE I

THE A-B, A-Br GROUP'S FOUR CONDITIONS

Condition	List 1	Retention Test	List 2	Retention Test
1	A_{123}-B	A_{123}-B	A_1 -Br	A_{123}-B+Br
2	A_{123}-B	A_{123}-B	A_2 -Br	A_{123}-B+Br
3	A_{123}-B	A_{123}-B	A_3 -Br	A_{123}-B+Br
4	A_{123}-B	A_{123}-B	A_{123}-Br	A_{123}-B+Br

A second retention test was given to all four conditions. This retention test asked for the A stimulus (all three elements), the first-list B responses to the A stimulus elements, and the Br second-list responses to the A stimulus elements.

The A-B, C-B control group also learned the same first list (A-B) to a criterion of one perfect trial. Following this, they too were given a retention test for the list they had just learned. Then, according to the order of their appearance, they were assigned to one of four second-list (C-B) conditions.

The first condition required subjects to learn a second list in which a novel single element (C_1) was paired with the first-list B response. The second and third conditions also learned single-element (C_2 and C_3, respectively) novel stimuli paired with the first-list B responses. The fourth condition required subjects to learn a novel three-element stimulus (C_{123}) paired with the first-list B responses. Table II shows the control group conditions.

TABLE II

THE A-B, C-B GROUP'S FOUR CONDITIONS

Condition	List 1	Retention Test	List 2
1	A_{123}-B	A_{123}-B	C_1 -B
2	A_{123}-B	A_{123}-B	C_2 -B
3	A_{123}-B	A_{123}-B	C_3 -B
4	A_{123}-B	A_{123}-B	C_{123}-B

<u>List and Apparatus</u>

The first list (A-B) for all conditions of the experiment had eight paired associates. A group of three common, unrelated four-letter nouns made up each stimulus. Each response was also a four-letter noun. Thus, one of the pairs was: MAID - DIAL - FORT - CUBE. The four nouns were arranged horizontally on memory drum tape with a noticeable gap separating the stimulus group and response.

The first-list (A-B) retention tests for all conditions of the experimental and control groups had thirty-two pages. These pages singly presented either a left (A_1), middle (A_2), or right (A_3) stimulus element or else a response (B). All other elements associated with the presented cue word were represented by blanks with underlines, e.g., ____ - ____ - FORT - ____. The order of occurrence of the words in the booklet was randomized and varied from subject to subject.

The second list for the experimental group (A-B, A-Br) presented the same eight stimuli as in the first list. In other words, the subject again saw MAID - DIAL - FORT. The position of the stimulus elements was not varied from first (A-B) to second (A-Br) list. However, the first-list B responses were now re-paired with these stimuli, so that instead of CUBE being the correct response work for MAID - DIAL - FORT, it was now SNOW.

The second retention test for the A-B, A-Br experimental group had forty pages. Singly presented on each of these pages was either a left (A_1), middle (A_2), or right (A_3) stimulus element or else a first-list response (B) or a second-list (Br) rearranged response. The unsupplied elements were again represented by positional cues of underlines and dashes. An example would be: ____ - ____ - ____ - CUBE - ____. The five possible blanks were to contain, in order, A_1, A_2, A_3, B, and Br.

The control group (A-B, C-B) had the same first list and first-list retention test booklets as described above for the A-B, A-Br experimental group. The second list differed in that the stimulus elements were new to the subject. The fourth condition for the control group required subjects to learn a new stimulus comprised of three elements (C_{123}) with the first-list B responses. The other three conditions required the subject to learn only a single element with the first-list B responses (either C_1, C_2, or C_3). There was no second retention test for the control group (A-B, C-B) conditions.

Several controls were put on the list designs. To prevent performance from reflecting idiosyncracies peculiar to the A-B and C-B lists, two sets of lists were made. What was designated as A-B for Set I served as C-B for Set II. Conversely, what was designated as C-B for Set I served as A-B for Set II. Equal numbers of subjects were assigned to these sets. Whatever possible effects list differences could precipitate were thus balanced across subjects.

The ordering of stimulus elements was also balanced across subjects. Thus the left-, middle-, and right-position elements labeled, respectively, 1, 2, and 3, were varied across all subjects so that equal numbers received each of the stimulus element orderings 123, 132, 213, 231, and 321 in each condition.

The rest of the apparatus for this experiment consisted of a Stowe memory drum, some example cards of the paired-associate format to aid in explanation of the task, and some pencils used by the subjects to respond to the retention tests.

Procedure

After introducing the subject to the nature of the lists he was to see, the performance expected of him, and the scoring procedures, the first list (A-B) was run on the Stowe memory drum. An anticipation method was used for list learning. The subject first saw the three-element stimulus with a blank space on the right. After a two-second interval, the memory drum shifted the paired-associate list so that the same three-element stimulus came into the viewing window, but this time the response word was also presented. This completed paired associate was also shown for two seconds before the next paired associate was presented. This pattern of stimulus, stimulus plus response, new stimulus, new stimulus plus new response was repeated until all paired associates had been shown. There was then a four-second interval during which the memory drum window remained blank. The same eight paired associates were presented on successive trials in this same format. Each list was presented in five different semi-random orders to prevent serial learning of the responses. The possibility of increased practice on a given paired associate was further guarded against by the limitations that no paired associate could begin more than one of the five successive orders, and a paired associate presented at the end of one trial could not begin the immediately succeeding trial.

After learning the first list to a criterion of one perfect trial, the subject was given the first-list retention test with instructions as to its use and the format to be followed. The subject was to write down, in their proper positions, as many of the missing three words as he could recall. Guessing was explicitly allowed. Upon finishing a page, the subject was instructed to not look back again. There was no time limit.

Upon completion, the subject was given a second list to learn to a criterion of one perfect trial. (Again there was variation in the starting list and successive trials.)

The A-Br condition was given a second retention booklet to fill out following second-list learning. Again the nature of the booklet and instructions as to its use were given. The only difference in the first and second retention booklet explanation was in noting that there was now an additional fifth blank for recall of the second-list (A-Br) response.

CHAPTER III

RESULTS

Comparability of all groups was checked by comparing performance on rate of first-list learning. A 1 X 8 analysis of variance on errors to first-list (A-B) criterion yielded a nonsignificant F (7, 120) $<$ 1.

Several 2 X 4 analyses of variance were run on second-list performance. The first was on trials to criterion. Table III presents the group mean performances. A significant F (1, 120) = 7.27, $p < .01$ resulted when the performance of the A-B, A-Br groups was compared to that of the A-B, C-B groups.

TABLE III

MEAN NUMBER OF TRIALS TO SECOND-LIST CRITERION

	Paradigm					
	A-B, A-Br			A-B, C-B		
Condition	Mean	SD*	N*	Mean	SD	N
left element (A_1 or C_1)	5.13	2.53	16	4.82	1.76	16
middle element (A_2 or C_2)	5.56	2.50	16	4.63	2.25	16
right element (A_3 or C_3)	6.13	3.46	16	5.38	2.80	16
all elements (A_{123} or C_{123})	9.56	4.84	16	5.50	4.10	16

*SD--standard deviation, N--number of subjects

As can be seen from Table III, the A-B, A-Br groups encountered more difficulty than the A-B, C-B groups in attaining second-list criterion. Comparison of the four stimulus conditions (A_1-Br + C_1-B constituting one condition, A_2-Br + C_2-B constituting a second, A_3-Br + C_3-B constituting a third, and then A_{123}-Br + C_{123}-B constituting the fourth) also resulted in a significant F (3, 120) = 4.41, $p < .01$. A Newman-Keuls test showed the fourth condition (A_{123}-Br + C_{123}-B) to perform significantly worse (thereby indicating greater difficulty in reaching criterion) than each of the other three stimulus conditions. The differences between the other three did not attain significance. The interaction F (3, 120) = 2.34, $p > .05$ was nonsignificant in this analysis.

The second of the 2 X 4 analyses of second-list performance was on errors to criterion. Table IV presents group mean performances. When the performance of the A-B, A-Br groups was compared to that of the A-B, C-B groups, a significant F (1, 120) = 9.65, $p < .01$ resulted. Again the A-B, A-Br groups had greater difficulty in reaching second-list criterion. Comparison of the four stimulus conditions (A_1-Br + C_1-B, A_2-Br + C_2-B, etc.) also resulted in a significant F (3, 120) = 5.97, $p < .01$. However, the interaction F (3, 120) = 2.67, $p = .05$ was at significance level, calling the main effects into question. Therefore simple effects tests were run and of the four stimulus conditions

(A_1-Br + C_1-B, A_2-Br + C_2-B, etc.), only the A-B, A_{123}-Br versus A-B, C_{123}-B mean performance difference was significant, F (1, 30) = 7.85, $p < .01$.

TABLE IV

MEAN NUMBER OF ERRORS TO SECOND-LIST CRITERION

	Paradigm					
	A-B, A-Br			A-B, C-B		
Condition	Mean	SD*	N*	Mean	SD	N
left element (A_1 or C_1)	11.75	9.94	16	10.13	6.00	16
middle element (A_2 or C_2)	12.81	8.41	16	10.00	7.82	16
right element (A_3 or C_3)	19.06	15.94	16	13.19	11.95	16
all elements (A_{123} or C_{123})	31.69	18.86	16	13.94	16.91	16

*SD--standard deviation, N--number of subjects.

A Newman-Keuls analysis of the four stimulus conditions of the A-B, A-Br experimental group (A_1-Br, A_2-Br, A_3-Br, and A_{123}-Br) showed the A_{123}-Br stimulus condition to have significantly worse performance scores than each of the other three A-B, A-Br stimulus conditions. A Newman-Keuls analysis of the four stimulus conditions of the A-B, C-B control group conditions (C_1-B, C_2-B, C_3-B, and C_{123}-B) showed no significant differences.

The last of the 2 X 4 analyses of variance focused upon errors summed over the first and second trials of second-list learning. Table V presents group mean performances. A significant F (1, 120) = 9.86, $p < .01$ resulted from the comparison of the A-B, A-Br groups to the A-B, C-B groups. The A-B, A-Br groups performed significantly worse than the A-B, C-B groups. Another significant F (3, 120) = 4.42, $p < .01$ resulted from the comparison of the four second-list stimulus conditions (A_1-Br + C_1-B, A_2-Br + C_2-B, etc.).

TABLE V

MEAN NUMBER OF ERRORS ON FIRST AND SECOND TRIALS OF SECOND-LIST LEARNING

Condition	Paradigm					
	A-B, A-Br			A-B, C-B		
	Mean	SD*	N*	Mean	SD	N
left element (A_1 or C_1)	6.25	3.09	16	6.38	3.14	16
middle element (A_2 or C_2)	6.81	3.66	16	5.94	3.32	16
right element (A_3 or C_3)	9.44	3.74	16	6.69	4.00	16
all elements (A_{123} or C_{123})	11.13	3.18	16	6.81	3.90	16

*SD--standard deviation, N--number of subjects.

A Newman-Keuls range test showed the fourth stimulus condition (A_{123}-Br + C_{123}-B) to have significantly worse scores than the first (A_1-Br + C_1-B) and second (A_2-Br + C_2-B) stimulus conditions. The interaction F (3,120) = 2.52, $p > .05$ was not significant.

Since Martin predicted a reduction in proactive interference if a shift in encoding cues occurred from first to second list, the retention booklets from first- and second-list learning were studied to identify the subjects who shifted in each stimulus condition. This identification process proceeded as follows: Any stimulus element that elicited a correct response, was correctly recalled given the response, or was correctly recalled in conjunction with another stimulus element or response was counted as an effective cue. The cue position predominantly used in learning first-list (A-B) responses classified the subject as using either stimulus position one (left), two (middle), or three (right). The majority of subjects used a particular element position for encoding listwide and were easily classified. The few remaining subjects were categorized by determining which of the stimulus positions was used more frequently than the other two. Second-list (A-Br) retention booklets were likewise used to determine the cue position predominantly used for learning the second list. The subjects who shifted the elements encoded from the first (A-B) to the second (A-Br) lists could then be determined for each stimulus condition. For subjects in the A-B, A_1-Br condition, 12 of the 16 subjects shifted encoding cue position from first to second list; for the A-B, A_2-Br condition, 15 of the 16; for the A-B, A_3-Br condition, 7 of the 16; and for the A-B, A_{123}-Br condition, 9 of the 16.

A series of 2 X 3 analyses of variance were run on the shifters, nonshifters, and controls in the first (A_1-Br) and third (A_3-Br) second-list stimulus conditions. (The A_2-Br stimulus condition was omitted from analysis because there was only one subject to represent the nonshifting group. Trying to generalize statistical results from a sample size of one would be meaningless.) The first analysis focused on trials to second-list criterion. Table VI presents group mean performances. Comparison of A-B, A-Br shifters, A-B, A-Br nonshifters, and the A-B, C-B controls yielded a nonsignificant value of F (2, 58) = 1.42, $p > .05$.

TABLE VI

MEAN NUMBER OF TRIALS TO SECOND-LIST CRITERION

	Paridigm								
	A-B, A-Br Shifters			A-B, A-Br Nonshifters			A-B, C-B Controls		
Condition	Mean	SD*	N*	Mean	SD	N	Mean	SD	N
A_{123}-B, A_1-Br	4.92	2.78	12	5.75	1.71	4	4.81	1.76	16
A_{123}-B, A_3-Br	5.00	1.83	7	7.00	4.24	9	5.38	2.80	16

*SD--standard deviation, N--number of subjects.

The combined A-B, A-Br shifters, A-B, A-Br nonshifters, and A-B, C-B controls in the first (A_1-Br) and third (A_3-Br) stimulus conditions also yielded a nonsignificant F (1,58) < 1, $p > .05$. The interaction F (2,58) < 1, $p > .05$ was nonsignificant.

The second 2 X 3 analysis was on errors to criterion. Table VII presents group mean performances. A nonsignificant F (2, 58) = 1.04, $p > .05$ resulted when a comparison was made of the performances of the A-B, A-Br shifters, the A-B, A-Br nonshifters, and the A-B, C-B controls. The combined A-B, A-Br shifters, A-B, A-Br nonshifters, and A-B, C-B controls in the first (A_1-Br) and third (A_3-Br) stimulus conditions showed no significant difference in performance: F (1, 58) = 3.27, $p > .05$. Interaction was nonsignificant, F (2, 58) < 1, $p > .05$.

TABLE VII

MEAN NUMBER OF ERRORS TO SECOND-LIST CRITERION

	Paradigm								
	A-B, A-Br Shifters			A-B, A-Br Nonshifters			A-B, C-B Controls		
Condition	Mean	SD*	N*	Mean	SD	N	Mean	SD	N
A_{123}-B, A_1-Br	11.08	10.66	12	13.50	8.58	4	10.13	6.00	16
A_{123}-B, A_3-Br	15.14	10.57	7	22.11	19.21	9	15.07	11.59	16

*SD--standard deviation, N--number of subjects.

The last of the 2 X 3 analyses was on errors summed over the first and second trials of second-list learning. Table VIII presents group means. Comparison of the A-B, A-Br shifters, the A-B, A-Br nonshifters, and the A-B, C-B controls yielded a nonsignificant F (2, 58) = 1.79, $p > .05$. There was a significant F (1, 58) = 4.88, $p < .05$ for the comparison of the A_1-Br (shifters, nonshifters, and controls combined again) and the A_3-Br (also combined) conditions. The third-element group had a significantly worse performance record in comparison to that of the first-element group. There was a nonsignificant interaction F $(2, 58) < 1$, $p > .05$.

TABLE VIII

MEAN NUMBER OF ERRORS ON FIRST AND SECOND TRIALS OF SECOND-LIST LEARNING

	Paradigm								
	A-B, A-Br Shifters			A-B, A-Br Nonshifters			A-B, C-B Controls		
Condition	Mean	SD*	N*	Mean	SD	N	Mean	SD	N
A_{123}-B, A_1-Br	5.58	2.87	12	8.25	3.20	4	6.38	3.14	16
A_{123}-B, A_3-Br	9.00	4.00	7	9.78	3.73	9	8.60	3.25	16

*SD--standard deviation, N--number of subjects.

Separate analyses of variance were made on the shift and nonshift conditions alone. The results confirmed the finding of no significant differences in performance. All Fs < 1.

Analyses of covariance were made upon the A-B, A_{123}-Br shifters and the A-B, A_{123}-Br nonshifters using errors to first-list criterion as the covariate. Dependent measures were trials to second-list criterion, errors to second-list criterion, and errors summed over first and second trials of second-list learning. All analyses resulted in a nonsignificant F $(1, 15) < 1$, $p > .05$.

CHAPTER IV

DISCUSSION

The A-B, A_{123}-Br condition was the situation in which the responses were paired differently from list to list but the multiple-component stimulus remained unchanged from first to second list. In this situation, Rudy's theory predicts that there would be no shift in encoding from first to second list. Since nine of the sixteen subjects did shift, his theory is disconfirmed on this prediction.

A comment concerning experimental design might be made at this point. Tests for encoding cues have been commonly accomplished by a single recall test given after learning both first and second lists of the A-B, A-Br paradigm (e.g., Martin & Carey, 1971; Goggin & Martin, 1970). Rather than let possible confounding effects from the process of second-list learning occur, it seems much more direct to give the stimulated recall test for first-list encoding immediately after first-list learning, and the second-list stimulated recall after second-list learning. The advantages are that first-list stimulus encoding is more directly tested, thereby giving a more valid basis for assessment of later shifting--and a clearer view of overall first-list paired-associate recall is given. This procedure was followed in this study.

Martin predicted that of those subjects who did shift encoding cues from the first to the second list, there would be a functional reduction in the level of A-B, A-Br negative transfer to a level close to that of an A-B, C-B paradigm. The analysis of covariance on the A-B, A_{123}-Br condition gave no significant indication of such results. The small group sizes and consequent lack of power of the statistical test may be responsible for the difference, but, even so, the A_{123}-Br analyses of covariance showed no stable trend of one group's supremacy over the other. This finding is in agreement with results from both the 1970 Williams and Underwood study and the 1970 Goggin and Martin study.

While the effects occurred at a nonsignificant level, the specific predictions from Martin's theory were almost classically reflected in the single-element stimulus second-list conditions (A_1-Br, A_2-Br, and A_3-Br). The subjects who were required to shift encoding cues from first to second list performed just a little worse than the A-B, C-B controls. The A-B, A-Br nonshifters consistently performed worse than either the A-B, A-Br shifters on the A-B, C-B controls. This portion of the results is in agreement with the findings of the 1971 Martin and Carey study, in which reduced negative transfer was found for the subjects who shifted encodings.

In reference to the results obtained from the single-element second-list conditions, it must be pointed out that the small sample size may have kept the analyses from attaining significance. In other words, the consistent trend of the results might be considered as support when the small sample size is taken into account.

The significant difference that did occur in the 2 X 3 analyses on shifters, nonshifters, and controls showed that subjects using the third-position element for encoding fared significantly worse on the first two trials of second-list learning than did those who had used the first-position element. This may be a reflection of the superior performance given by subjects who shifted from first to second list (see group means of Table VIII). There were twelve subjects in the first-position element group who shifted, whereas there were only seven of these better-performing shifters in the third-position element group. Therefore the weight of the combined performance of shifters, nonshifters, and controls may have rested with the shifters in the first-position element group--and with the nonshifters in the combined performance for the third-position element group. This can be thought of as further indirect evidence that a shift in encoding cues from first to second list reduces negative transfer.

The findings of greater negative transfer in the A_{123}-Br than in the A_1-Br, A_2-Br, or A_3-Br conditions could be handled by either Martin's theory, Rudy's theory, or a gestalt point of view.

Martin would say that the A_{123}-B, A_{123}-Br condition had not only shifters, but nearly an equal number of non-shifters. The poorer performance of this group could be a reflection of both shifters' and nonshifters' performances combined. However, the fact that the analysis of covariance on this condition turned up no significant differences between shifters and nonshifters on second-list transfer performance tends to weaken this interpretation's plausibility.

Rudy would say that the multiple elements of the A_{123}-B, A_{123}-Br condition were each contributing to negative transfer. The single-element second-list stimulus conditions would have fewer first-list associations to re-pair. In other words, Rudy suggests that the key to performance lies in the nature of the first- and second-list stimuli--Martin, in the combined performance of shifters and nonshifters.

The results of this experiment find both Martin's and Rudy's theories not so much incorrect as incomplete. Martin's theory in particular handles trends found in A_{123}-B, A_i-Br conditions. But the more complex condition, A_{123}-B, A_{123}Br is only partly handled by either Martin (who correctly predicts some spontaneous shifting in encoding cues) or Rudy (whose additive associative interference concepts can plausibly interpret the significantly heightened negative transfer encountered). The more complex stimuli are eliciting either different or added mechanisms. Subjects seem to be reacting to this highly fragmented, complex stimulus condition as though it were one whole unit. This last statement is based upon this study's finding that the A_{123}-Br negative transfer is greater than the sum of the A_1-Br, A_2-Br, and A_3-Br negative transfer effects. Such a finding negates total support for encoding or associative variability theories, and calls for additional theorizing from a gestalt perspective to explain the totality of negative transfer phenomena.

APPENDIX

PAIRED ASSOCIATE LISTS FOR FIRST- AND SECOND-LIST LEARNING

Stimulus Order 123

List A-B

FORT - DIAL - MAID - CUBE

BOAT - SCAR - QUIZ - MONK

TEAM - BATH - PLUM - DUSK

JAIL - VINE - PIPE - SNOW

WORM - RAKE - TUBA - SEAT

BAND - WALL - IRON - JOKE

HISS - KITE - LUMP - NEWS

VERB - WELL - CARD - EXIT

Stimulus Order 123

List A_1	List A_2	List A_3	List A_{123}	List Br
FORT	DIAL	MAIL	FORT - DIAL - MAIL	SNOW
BOAT	SCAR	QUIZ	BOAT - SCAR - QUIZ	JOKE
TEAM	BATH	PLUM	TEAM - BATH - PLUM	EXIT
JAIL	VINE	PIPE	JAIL - VINE - PIPE	SEAT
WORM	RAKE	TUBA	WORM - RAKE - TUBA	MONK
BAND	WALL	IRON	BAND - WALL - IRON	CUBE
HISS	KITE	LUMP	HISS - KITE - LUMP	NEWS
VERB	WELL	CARD	VERB - WELL - CARD	DUSK

These lists give the paired associates used in first-list (A-B) and second-list (A_1-Br, A_2-Br, A_3-Br, and A_{123}-Br) learning for the A-B, A-Br experimental conditions. The A-B, C-B control conditions used the same A-B list as just given. The second list learned for each of the four conditions (C_1-B, C_2-B, C_3-B, and C_{123}-B) follow.

Stimulus Order 123

List C_1	List C_2	List C_3	List C_{123}	List B
BAIT	CITY	PLOT	BAIT - CITY - PLOT	CUBE
ACRE	PILL	FUME	ACRE - PILL - FUME	MONK
SILK	HOST	ACID	SILK - HOST - ACID	DUSK
FILM	BELL	NAME	FILM - BELL - NAME	SNOW
TAPE	ODOR	HOLE	TAPE - ODOR - HOLE	SEAT
LIFE	VASE	TIRE	LIFE - VASE - TIRE	JOKE
DIET	HERD	PITY	DIET - HERD - PITY	NEWS
MOSS	RACE	MILK	MOSS - RACE - MILK	EXIT

To control any effects of list differences, these two sets of lists were interchanged. The list serving as A-B served equally as often for C-B, and vice versa.

REFERENCES

Cohen, J., & Musgrave, B. Effect of meaningfulness on cue selection in verbal paired associate learning. _Journal of Experimental Psychology_, 1964, _68_, 284-291.

Goggin, J., & Martin, E. Forced stimulus encoding and retroactive interference. _Journal of Experimental Psychology_, 1970, _84_, 131-136.

Martin, E. Stimulus meaningfulness and paired associate transfer: An encoding variability hypothesis. _Psychological Review_, 1968, _75_, 421-441.

Martin, E. Verbal learning theory and independent retrieval phenomena. _Psychological Review_, 1971, _78_, 314-332.

Martin, E., & Carey, S. Retroaction, recovery, and stimulus meaningfulness in the A-B, A-Br paradigm. _American Journal of Psychology_, 1971, _84_, 123-133.

Postman, L., & Greenbloom, R. Conditions of cue selection in the acquisition of paired-associate lists. _Journal of Experimental Psychology_, 1967, _73_, 91-100.

Postman, L., & Underwood, B. Critical issues in interference theory. _Memory and Cognition_, 1973, _1_, 19-40.

Rabinowitz, F., & Witte, K. Stimulus selection as a function of letter color. _Journal of Verbal Learning and Verbal Behavior_, 1967, _6_, 167-168.

Rudy, J. Stimulus selection in animal conditioning and paired-associate learning: Variations in the associative process. _Journal of Verbal Learning and Verbal Behavior_, 1974, _13_, 282-296.

Underwood, B. Stimulus selection in verbal learning. In C. N. Cofer & B. S. Musgrave (Eds.) _Verbal Behavior and Learning_: _Problems and Processes_. New York: McGraw-Hill, 1963, pp. 33-47.

Underwood, B., Ham, M., & Ekstrand, B. Cue Selection in paired associate learning. _Journal of Experimental Psychology_, 1962, _64_, 405-409.

Wichawut, C., & Martin, E. Selective stimulus encoding and overlearning in paired associate learning. _Journal of Experimental Psychology_, 1970, _85_, 383-388.

Williams, R., & Underwood, B. Encoding variability: Tests of the Martin hypothesis. _Journal of Experimental Psychology_, 1970, _86_, 317-324.