ASSIMILATION IN FORM MEMORY AFTER VERBAL LABEL ASSOCIATION TRAINING

by

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ABSTRACT

Two experiments were conducted to assess the effects of verbal label pretraining on recognition memory for random shape stimuli. In Experiment I, a prototype shape and one fourth-variation shape were paired with common labels, or different labels. The prototype was then designated the target shape to be remembered during recognition testing. For the recognition test, given either immediately following pretraining and target designation, two days later, or one week later, subjects rated their degree of certainty that test shapes were exactly like the designated target shape. In Experiment II, three different fourth-variation shapes received same- or different-label training. During recognition testing, given immediately after, two days, or one week following training, subjects rated their degree of certainty that test shapes were exactly like any shape seen during pretraining. The results supported previous findings which indicated that memory storage can be characterized as a dynamic process. In addition, Experiment II results indicated that label training of disparate shapes may influence the creation of a shape "schema," defined in terms of commonality of features between shapes.
INTRODUCTION

The present body of literature regarding memory for form places primary emphasis on the roles of encoding (e.g., Ellis and Daniel, 1971), or retrieval processes (e.g., Price and Slive, 1970) when accounting for observed changes in memory. Memory storage is generally viewed as a static component which does not contribute to memory change. Theoretical accounts of form memory (e.g., Ellis, 1973; Santa, 1975) emphasize encoding and retrieval, while essentially ignoring storage. Observations of the nature of changes in memory indicate that the characteristics of information retrieved after various retention intervals differ qualitatively from the characteristics of information previously encoded (e.g., Wulf, 1922; Daniel, 1972). Thus, research findings and theoretical accounts have been presented that emphasize either the role of encoding, storage, or retrieval processes in memory for form.

Ellis' (1973) conceptual coding hypothesis represents the best statement of the encoding point of view. The results of several studies indicate clearly that verbal labels affect memory for random shapes (Malloy and Ellis, 1970; Ellis and Daniel, 1971; Daniel and Ellis, 1972). In accounting for these findings, Ellis proposed that the encoding of visual stimuli is affected by the type of verbal
pretraining employed. His conceptual coding hypothesis argues that learning a distinctive verbal response for a visual stimulus increases the number of distinctive or unique features encoded for that stimulus. An equivalent verbal response associated with several stimuli should, on the other hand, force the encoding of fewer unique features and more of the features common to the stimuli sharing the label. As regards form memory, associating common labels to distinctive stimuli encourages attention to common features of the stimuli, resulting in a less distinctive encoding of the stimuli and poorer recognition performance. Distinctive labels encourage attention to distinctive stimulus features, resulting in superior recognition performance.

An alternative explanation of the effects of labeling on memory for form stresses the mediational function of labels during retrieval. Label relevance, as investigated by Price and Slive (1970), has been found to affect retrieval from memory. Price and Slive concluded that the use of relevant labels during training facilitates locating and retrieving a stored representation that matches the stimulus presented during recognition testing.

The influence of verbal labels on redintegrative memory tasks, requiring the retrieval and integration of visual information, was investigated by Santa (1975). Santa defined an integrated representation of a stimulus as one in which various portions of the representation are linked in
such a way that the presentation of one part will evoke the remainder of the representation. His integration hypothesis proposes that label training facilitates redintegrative memory performance because the verbal label mediates or references the various attributes of the shape stimulus. This requires the use of labels during the redintegrative task (i.e., in retrieval), in order to obtain the benefits of label pretraining.

Data from Santa's experiments indicated that the type of label employed during training is not essential to the facilitative effect that labels exert on redintegrative memory. Santa assumes that labels serve to integrate the parts of a visual representation, which increases the retrievability of various stimulus features. The label mediates between stimulus features so that separate parts are remembered in relation to the whole integrated representation. Without denying that verbal labels affect the encoding (or acquisition) of visual stimuli, Santa proposed that names influence not just encoding, but retrieval as well.

A third option for dealing with the problem of memory distortion is to consider the process of memory storage as a contributing factor. This approach has not been actively pursued since the time of the Gestalt psychologists, who considered memory to be a dynamic process. Based on Gestalt theory, verbal labels could serve to influence
qualitative changes in form memory during storage; through a process of "assimilation" between stimulus and memory, a new configuration (representation) in memory is produced over time.

A study by Daniel (1972) investigated the process of label-induced assimilation using a recognition memory paradigm. Daniel constructed shape continua ranging from a familiar prototype form (e.g., a duck) at one extreme, to an unfamiliar form at the other extreme. Pretraining consisted of showing subjects a single shape six variations removed from one of the original prototype shapes while, at the same time, presenting the verbal label appropriate to the prototype (e.g., "duck"). Recognition testing employed the trained shape (variation six) along with the other ten shape variations constructed from the appropriate prototype. Subjects rated their degree of certainty that each shape was or was not exactly like the shape they had been shown during pretraining.

In an immediate recognition test, Daniel found that subjects gave higher ratings to variations that differed from the target training shape by being less similar to the prototype. After two days delay, however, variations between the training shape and the prototype received higher ratings. These data indicated that familiarity or "memory strength" shifted toward shapes more similar to the prototype shape, the shape that best depicted the form suggested
by the label provided during pretraining. According to Daniel, experimenter-assigned labels exerted an effect during storage, producing the observed shift in recognition performance over time.

A study by Daniel and Toglia (1976) lends additional support to the Gestalt interpretation of random shape recognition memory. Random polygons with 16 sides served as prototype shapes for continua extending to twelve variations. During pretraining, subjects were either presented with equivalent label training on two variations (one common label was paired with two similar but distinct shape stimuli) or with distinctive label training (different labels were paired with similar but distinct shape stimuli). Following the designation of one variation as the target shape to be remembered, subjects were given a single-stimulus recognition test in which they were shown all 13 continuum shapes (the prototype plus twelve variations). Subjects were asked to rate their degree of certainty that each test shape was exactly the same as the shape they had been told to remember.

Daniel and Toglia found that the recognition gradient for distinctive-label trained subjects contained a mode centered over the correct designated target shape. The recognition curve then progressively declined on either side of the modal response. Equivalent-label training, on the other hand, produced an equally steep and identically
shaped gradient, except that the mode was displaced over the first variation toward the prototype shape.

Although distinctive-label training produced results accounted for by the conceptual coding hypothesis, the shape of the equivalent-label gradient was not consistent with Ellis' (1973) hypothesis. If equivalent-label training had influenced the encoding of common stimulus features, the gradient should have been generally flatter, reflecting the generalization among the test stimuli. Since the equivalent-label gradient was just as steep as the distinctive-label gradient, equivalent-label subjects apparently distinguished among the shapes as well as the distinctive-label subjects did. The principal difference between the groups was in the mode of the recognition gradients—equivalent-label subjects consistently chose a different shape in the recognition test than the target shape, while distinctive-label subjects correctly chose the target.

These results led Daniel and Toglia to suggest that the Gestalt notion of assimilation of items stored in memory could be a plausible explanation for the shifting found in the equivalent-label gradient. As postulated by the Gestalt theorists, dynamic forces operating during memory storage may lead to assimilation between the initially encoded target shape and the other shape suggested by the same label. As a result, a new configuration (shape representation) is produced in memory. This new configuration is
retrieved during recognition testing, resulting in the selection of a shape more similar to the prototype than to the original target shape.

Daniel and Toglia have provided a viable procedure for studying the nature of memory storage processes. While their results cannot, as they acknowledged, unequivocally distinguish between effects occurring during storage and effects occurring in encoding, the concept of assimilation does seem to be required by their findings. Accounts emphasizing general failures in discrimination, such as Ellis (1973), could not explain the steep recognition gradient with a displaced mode produced by the equivalent label groups.

Same- or equivalent-labeling of different complex shapes allows for one of two outcomes: first, same-labeling may exert little or no influence on acquisition and subsequent discrimination between shapes; problems in discrimination may ultimately be attributable to the visual similarity ("confusability") between shapes, not to the practice of providing the same name for different shapes. The second outcome, supported experimentally, is that same-labeling influences generalization between stimuli during recognition testing; subjects will select a new intermediate shape as appearing more familiar than the actual training shapes with which they have had previous experience. Either of these outcomes can be reconciled with an encoding point
of view; recognition inaccuracies can be seen as the result of initial faulty encoding or acquisition.

The introduction of differential retention intervals prior to recognition testing is required to determine whether the observed shifting between same-labeled shapes occurs during memory storage or during encoding. If the shifting tendency changes progressively during the retention interval, it is reasonable to conclude that dynamic processes in memory storage are responsible for the shift.

The purpose of this paper is twofold: the first objective is to determine whether dynamic processes occurring during storage of information introduce qualitative changes in memory for form. The second objective is to assess and elaborate on the Gestalt notion of "assimilation" as a plausible model of the dynamic processes that may affect information placed in memory storage.
METHOD

Shape Stimuli

All shape stimuli employed in the present study consisted of prototype shapes and shape variations generated as described by Daniel and Toglia (1976). Basically, all prototypes and variations were constructed by the following procedures. First, a 16-sided random polygon is generated to serve as a prototype shape. Every point of this prototype polygon can be viewed as the center of a small circle with a radius of one unit (here, one unit equals 1/20 inch or 1.27 mm). Each point can be displaced one unit's length in a direction randomly chosen by selecting a number between 1 and 360 degrees (see Figure 1). When all 16 points have been similarly repositioned, lines are drawn connecting the points to form a new 16-sided figure. The resultant shape is designated as the first variation. Points are then moved one more unit in the same direction to produce a second variation, and so on, to produce a continuum of variations. Each variation is visually very similar to its immediate neighbor variations, and less visually similar to variations further removed. Therefore, a second variation shape would appear more similar to a prototype shape than would a fourth variation shape.
Figure 1. Generating shape variations from an original random shape -- Arrows refer to randomly chosen directions of displacement (ranging from 1 through 360 degrees).
Each prototype shape may be used to generate a number of different shape continua. Different continua are constructed by selecting a different set of directions for deflecting each point of the prototype shape. A continuum is a series of variation shapes created by moving points the same set of directions, but for progressively greater distances. The present study employed a collection of shapes consisting of a prototype and four different continua extending from this prototype, as shown in Figure 2. The prototype and fourth variations served as primary training and testing stimuli, due to their "formal similarity." As can be seen in Figure 2, Ap is more visually similar to any fourth variation, which is formally four steps removed, than any fourth variation is to another fourth variation, formally eight steps removed.

**Experiment I**

The main objective for Experiment I was to determine if qualitative changes in memory for form can occur during memory storage. The experiment served as a basic replication of the study by Daniel and Toglia (1976), with the inclusion of a delay factor in recognition testing. It was hypothesized that shifting between same-labeled shapes would occur during memory storage, as evidenced by changes in recognition gradients obtained after various retention intervals.
Figure 2. A depiction of four A-shape continua, based on the prototype shape, Ap.
Method

Stimuli and Apparatus. Stimuli used in Experiment I consisted of the main prototype shape, Ap, and its four associated continua of shape variations. Each continuum contained six equally spaced shape variations. In addition, one continuum was generated for each of three other prototype shapes, Bp, Cp, and Dp. Shapes from these continua were employed as distractors and as supplementary control tests for the main effects investigated with the A shapes.

The verbal labels used were common color names: red, blue, brown, green, yellow, purple, orange. All shape and label stimuli were individually mounted on 35 mm transparent slides. Slides were presented with a Kodak Carousel projector from behind a rear view screen placed 2 m in front of the subjects. Slide exposure times and the intervals between slides were controlled by two Hunter timers.

Subjects. Nine volunteer subjects from introductory psychology classes at The University of Arizona were randomly assigned to each of six experimental groups, requiring 54 subjects for Experiment I.

Experimental Design. Experiment I involved a 2 x 3 x (2 x 6) factorial design. Two levels of labeling (same and different labeling) were crossed with three levels of recognition test delay (immediate test, 2-day delayed test,
1-week delayed test), defining six independent experiment groups. Within-subject variables were continuum and distance from Ap. Two levels of continuum consisted of variation shapes on "trained" continua (pretraining shapes from three continua), or "untrained" continuum (the set of test shapes completely unfamiliar to subjects). Distance from Ap consisted of the distance (formal number of steps) from each variation test shape to the prototype shape.

**General Procedure.** The experiment was run in three stages: pretraining, target designation, and recognition testing. During pretraining, subjects learned to associate color labels to shapes from A, B, C, and D continua. The A prototype and the fourth variations from three of the A continua were chosen as training shapes. Four other shapes were selected from B, C, and D continua. In a paired-associate procedure, subjects learned to associate color name labels with the shapes. Immediately following verbal label pretraining, subjects were required to identify the pretraining stimuli with their appropriate color labels. During this aided recall test, shapes were presented one at a time, and subjects were instructed to write the corresponding color names for each shape. In target designation, subjects were shown only one of the pretraining shapes, which in all conditions was the A prototype. The
experimenter instructed subjects to remember only that shape for the subsequent recognition test.

Recognition testing consisted of a single-stimulus shape recognition test. All of the shape variations from the three A-continua from which training shapes were extracted, as well as shape variations from the B, C, and D continua, were presented. Subjects indicated, using a rating scale, their degree of certainty that each shape presented was or was not exactly like the shape they had been told to remember during target designation.

Pretraining. In each condition of Experiment I, subjects were run three at a time, and randomly assigned different sets of three of the four A-continua as main training continua. In same-labeling conditions, the A prototype shape and variation four from one A continuum (e.g., $A_p$ and $A_4^4$) were associated with the same color label (e.g., red). Two other randomly chosen fourth variations from A continua (e.g., $A_2^4$ and $A_3^4$) were associated with different names (e.g., purple and orange). Additional pretraining shapes were chosen from B, C, and D continua. In same-labeling conditions, the B prototype and its fourth variation ($B_4^4$) were associated with different color labels, as were the C and D continua sixth variations. In different-labeling conditions, $A_p$, three randomly chosen A fourth variations, $C_6^6$ and $D_6^6$, were associated with different
color labels. The B prototype and \( B^4 \) were associated with the same color label in different-labeling conditions.

Table 1 presents the basic format of shape-label pretraining for Experiment I. In all conditions, eight different shapes were associated with seven color labels. Shape-label association training was accomplished with 15 paired-associate study trials. Each shape was presented for 3 sec, followed by presentation of its label for 3 sec. The eight shape-label pairs were randomly ordered for each of the 15 presentation trials. In pretraining, subjects were instructed to study and learn the shapes and labels, without making any overt responses.

Immediately following pretraining, subjects were given an aided recall test for labels. Each training shape was presented for 3 sec, followed by a 3 sec interval during which subjects wrote down the label associated with the shape. Each of the eight training shapes was presented twice, and each set of eight shapes was randomly ordered. A total of 16 recall responses was required from all subjects.

**Target Designation.** Immediately following the aided recall test, all subjects in Experiment I were shown the A prototype shape for 3 sec, after being instructed to remember only that shape for a subsequent recognition test.
Table 1. Shape-label pretraining format for Experiment I and Experiment II —
Note: The orders are not randomized.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Same Label</th>
<th>Different Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ap</td>
<td>RED</td>
<td>blue</td>
</tr>
<tr>
<td>A₁⁴</td>
<td>RED</td>
<td>yellow</td>
</tr>
<tr>
<td>A₂⁴</td>
<td>yellow</td>
<td>orange</td>
</tr>
<tr>
<td>A₃⁴</td>
<td>green</td>
<td>brown</td>
</tr>
<tr>
<td>Bₚ</td>
<td>purple</td>
<td>RED</td>
</tr>
<tr>
<td>B⁴</td>
<td>orange</td>
<td>RED</td>
</tr>
<tr>
<td>C⁶</td>
<td>blue</td>
<td>green</td>
</tr>
<tr>
<td>D₆</td>
<td>brown</td>
<td>purple</td>
</tr>
<tr>
<td>8 shapes</td>
<td>7 labels</td>
<td>7 labels</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Shape</th>
<th>Same Label</th>
<th>Different Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁⁴</td>
<td>RED</td>
<td>orange</td>
</tr>
<tr>
<td>A₂⁴</td>
<td>RED</td>
<td>purple</td>
</tr>
<tr>
<td>A₄⁴</td>
<td>RED</td>
<td>green</td>
</tr>
<tr>
<td>B³</td>
<td>blue</td>
<td>RED</td>
</tr>
<tr>
<td>B⁶</td>
<td>brown</td>
<td>RED</td>
</tr>
<tr>
<td>B⁹</td>
<td>yellow</td>
<td>RED</td>
</tr>
<tr>
<td>C⁶</td>
<td>green</td>
<td>blue</td>
</tr>
<tr>
<td>D₆</td>
<td>purple</td>
<td>yellow</td>
</tr>
<tr>
<td>8 shapes</td>
<td>6 labels</td>
<td>6 labels</td>
</tr>
</tbody>
</table>

Note: The orders are not randomized.
Recognition Memory Test. All subjects were given a single-stimulus recognition memory test either immediately following target designation, two days later, or one week later, depending on the experimental condition to which they were assigned. In all cases, the order of test shape presentation was randomized for each set of three subjects. Shapes were presented for 3 sec, followed by a 3 sec blank interval, during which subjects made their responses. Subjects rated on paper their degree of certainty that each test shape presented was or was not exactly like the target shape, Ap, previously designated by the experimenter as the shape they were to remember. The rating scale ranged from a value of 1, "absolutely certain, no," to 10, "absolutely certain, yes." A sign depicting the rating scale was hung above the viewing screen for reference during recognition testing.

A total of 26 shapes was presented in random order during recognition testing in Experiment I. Test shapes for all subjects consisted of the A prototype, variations one through six from the three pretraining A-continua employed, variations one, three, and five from the remaining untrained A-continuum, Bp, B⁴, C⁶, and Dp.

Results

Recall. The overall score for aided recall of labels was 91% correct, indicating that pretraining subjects
had learned the names of the shapes and could discriminate between training shapes. No other analysis was done with these data.

**Recognition.** Three analyses of variance were performed on recognition test data from Experiment I to determine labeling and test delay effects on recognition memory. All analyses included the two levels of labeling and three levels of delay as between-subject variables, but differed in the within-subject variables considered. All results reported fell within an acceptable alpha level of .05. ANOVA's were not performed to determine any significance between responses to "correct" vs. "incorrect" test shapes. Rather, the question of interest was the degree to which each test shape was found acceptable by subjects. For this reason, the analyses incorporated all rating responses obtained for all shapes from Ap through A^6.

The first within-subject variable considered was distance from Ap, the degree of variation of test shapes from the Ap prototype that had been designated as the target shape to be remembered for recognition testing. Figure 3 depicts mean confidence ratings for A shape variations in same- and different-labeling groups after the three delay intervals. The different-label groups clearly rated variation shapes further from Ap lower than did same-label subjects. An apparent labeling x distance from Ap interaction
Figure 3. Experiment I: mean ratings for A-shape variations -- Arrows refer to gradient modes.
was found to be significant ($F [6,288] = 2.80, MSe = 26.14$). Visual inspection of Figure 3 indicates that all subjects rated $A_p$, the target shape, relatively high. Different-labeling subjects became increasingly more certain over the one-week retention interval that $A_p$ was the target shape, as indicated by the recognition gradients. Same-labeling subjects also tended to rate $A_p$ relatively high, especially in comparison to variations at the end of the continua ($A^5$ and $A^6$). However, same-label subjects increasingly generalized between shapes ranging from $A_p$ to $A^4$ as the retention interval increased. Thus, different-label subjects evidenced progressively sharper discriminations over the delays tested, while same-label subjects increasingly generalized recognition responses to variation shapes more distant from $A_p$.

Inspection of Figure 3 reveals that the modes of the same-label gradients progressively shift from $A^1$ in the immediate condition to $A^2$ after 2 days delay, then to $A^3$ after one week. Individual distributions were visually inspected to confirm that the mean ratings on gradients accurately reflected individual performances. Same-label subjects consistently rated $A^1$ as the most familiar shape at the immediate test delay, $A^2$ as most familiar after 2 days delay, and $A^3$ as most familiar after one week delay.

An analysis of variance was performed to assess response differences for $A$ shape variations from trained and
untrained continua. During pretraining, Ap and fourth variations from three of the four A-continua were presented; subjects had no experience prior to testing with any shapes from the single "untrained" A-continuum. During recognition testing, only variations one, three, and five from the untrained continuum were presented, therefore, the ANOVA for trained/untrained A-continua took into account only these variations.

The distance from Ap x trained/untrained continua interaction was found to be significant \( (F_{2.96} = 6.45, \ MSe = 51.40) \). Greater generalization occurred with trained continua than with the untrained continuum; ratings for trained-continua variations ranged from a mean of 6.2 at \( A^1 \) to 3.6 at \( A^5 \), whereas ratings for untrained-continua variations ranged from 6.9 at \( A^1 \) to 1.7 at \( A^5 \). Subjects showed response generalization to untrained-continuum first variation shapes, then began to differentiate between continua they had prior experience with and the continuum whose shapes they had never seen. By variation five, there was very evident differentiation between trained and untrained shapes. The distance from Ap x labeling interaction was also found to be significant in the trained/untrained analysis \( (F_{2.96} = 3.57, \ MSe = 34.76) \). Subjects in the same-labeling conditions showed more generalized responding to all shape variations (trained and untrained continua data collapsed) than different-labeling subjects, especially
between variations one and three. This finding is consistent with predictions based on Ellis' (1973) conceptual coding hypothesis that associating common labels to distinctive stimuli encourages attention to common features of the stimuli, resulting in a less distinctive encoding of the stimuli and poorer recognition performance.

Experiment II

Experiment II was an attempt to investigate further the effects of verbal labeling on shape memory. In particular, the experimenter sought to determine whether or not same-labeling of different, but related, shapes would result in a memory representation (a "schema") that was a compromise among the experimenter-labeled shapes. The hypothesis of interest was: can same-label training with variations from three different A-continua lead to recognition gradients whose peaks merge toward Ap, a shape comprised of features common to all of the same-labeled shapes?

Method

General Procedure. Experiment II was run in two stages: pretraining and recognition testing. Pretraining consisted of shape-label association training, followed by a label recall test, as in Experiment I. Stage two consisted of a single-stimulus shape recognition test comprised of thirty items. Subjects were instructed to rate their degree
of certainty that each test shape was or was not exactly like any shape they had previously seen during training.

**Pretraining.** Subjects were randomly assigned three A-continua as main training continua. In same-labeling conditions only the fourth variations from these three continua (e.g., $A_1^4$, $A_2^4$, $A_3^4$) were associated with the same color label. In different-labeling conditions, these shapes were associated with different color names, while three B control shapes ($B^3$, $B^6$, $B^9$) were associated with the same color name. In all conditions, eight shapes were associated with six color labels. Table 1 presents the basic format of same- vs. different-label training for Experiment II. Shape-label pretraining was accomplished in 15 paired-associate trials, exactly as in Experiment I. Pretraining was followed by an aided recall test, as in Experiment I.

**Recognition Memory Test.** All subjects were given a single-stimulus recognition memory test either immediately following pretraining, after two days delay, or after one week delay. The only difference between recognition testing in Experiment I and Experiment II was that subjects in the second experiment were instructed to rate their degree of certainty that the test shapes presented to them were or were not exactly like any shape seen during pretraining.

Thirty shapes were presented in random order during recognition testing. Test shapes for all subjects consisted
of the A prototype, variations one through six from all three "trained" A-continua, variations one through four of the "untrained" A-continua, Bp, B\textsuperscript{6}, B\textsubscript{12}, Cp, C\textsuperscript{6}, Dp, and D\textsuperscript{6}.

Results

Recall. Identical to the recall data of the first experiment, subjects from Experiment II averaged 91% correct recall of color labels. On the basis of these data, it was concluded that subjects had adequately learned the names of the shapes and were able to discriminate between the training shapes.

Recognition. Five analyses of variance were performed on recognition data from Experiment II. In all analyses, labeling and delay factors were treated as between-subject variables; within-subject factors varied with different analyses.

Table 2 presents ratings of prototype shapes from Experiment II, tabled across recognition test delays and labeling conditions. As shown in Table 2, Ap received high confidence ratings over all conditions. It is interesting to note that no prototype shapes were presented during training, therefore all prototypes should have received very low ratings, since subjects were instructed to give high ratings only to shapes they had seen during pretraining. This expectation is met only by B, C, and D prototypes.
Table 2. Mean confidence ratings for prototype test shapes in Experiment II.

<table>
<thead>
<tr>
<th></th>
<th>Same-labeling Conditions</th>
<th>Different-labeling Conditions</th>
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<tbody>
<tr>
<td><strong>Immediate</strong></td>
<td>Ap 9.22</td>
<td>Ap 9.44</td>
</tr>
<tr>
<td>Recognition Test</td>
<td>Bp 4.44</td>
<td>Bp 3.89</td>
</tr>
<tr>
<td></td>
<td>Cp 4.67</td>
<td>Cp 1.00</td>
</tr>
<tr>
<td></td>
<td>Dp 3.89</td>
<td>Dp 3.56</td>
</tr>
<tr>
<td><strong>2-day</strong></td>
<td>Ap 7.56</td>
<td>Ap 8.78</td>
</tr>
<tr>
<td>Delayed Test</td>
<td>Bp 5.44</td>
<td>Bp 3.44</td>
</tr>
<tr>
<td></td>
<td>Cp 3.67</td>
<td>Cp 2.00</td>
</tr>
<tr>
<td></td>
<td>Dp 3.33</td>
<td>Dp 3.11</td>
</tr>
<tr>
<td><strong>1-week</strong></td>
<td>Ap 6.33</td>
<td>Ap 7.33</td>
</tr>
<tr>
<td>Delayed Test</td>
<td>Bp 3.22</td>
<td>Bp 6.78</td>
</tr>
<tr>
<td></td>
<td>Cp 3.67</td>
<td>Cp 3.33</td>
</tr>
<tr>
<td></td>
<td>Dp 3.67</td>
<td>Dp 3.89</td>
</tr>
</tbody>
</table>
These results are supported by an analysis of variance of labeling x delay x prototype shapes, which indicated a significant prototype shapes effect ($F_{[3,144]} = 23.48$, MSe = 280.39).

An analysis of variance of labeling x recognition test delay x control shapes produced a significant control shapes effect ($F_{[6,288]} = 66.53$, MSe = 532.21). As expected, all control shapes employed during pretraining ($B^6, C^6, D^6$) received very high ratings, over all test delay intervals. Since no delay effect was obtained, there was apparently no forgetting of control shapes over testing delays. An unexpected finding is noted with ratings for $B_p, B^12, C_p, D_p$ control shapes. During training, shapes $B^3, B^6, B^9$ were presented, along with $C^6$ and $D^6$. $B_p$ and $B^12$ test shapes are only three steps removed from $B$ training shapes ($B^3$ and $B^9$), whereas $C_p$ and $D_p$ test shapes are six steps removed from $C^6$ and $D^6$ training shapes. Nevertheless, $B_p, B^12, C_p, D_p$ test shapes were all given essentially equal low ratings.

Figure 4 presents mean ratings for all $A$ variation test shapes over labeling and delay variables. Referring to the trained continua gradients, it is clear that some discrimination between shapes has occurred, in that $A^5$ and $A^6$ shapes invariably received low ratings. If the $A^4$ training continua shapes are considered as an axis, all shapes moving toward $A_p$ receive high ratings in comparison to those moving
Figure 4. Experiment II: mean ratings for A-shape variations from trained and untrained continua -- Note: Arrows refer to A^4 pretraining shapes, the only shapes which should have been "familiar" to subjects.
away from \( A^4 \). A labeling x test delay x distance of test shapes from Ap ANOVA resulted in a significant distance from Ap effect (\( F[6,288] = 66.71, \text{MSe} = 225.47 \)), as well as a significant delay effect (\( F[2,48] = 4.27, \text{MSe} = 63.59 \)). The delay effect is shown as a progressive decline in confidence ratings over delay intervals.

Great distinction is made by subjects between shapes belonging to continua with which they had pretraining experience (designated "trained" continua) and the single "untrained" continuum with which they have had no pretraining experience. All subjects, regardless of label training, appear to respond almost identically to all A test shapes, as seen in the similarity between same- and different-labeling gradients at each test delay in Figure 4. The general tendency is for subjects to give high ratings to all training continua A-shapes between Ap and \( A^4 \), then rate \( A^5 \) and \( A^6 \) progressively lower. The untrained continuum shapes are consistently rated lower than trained continuum shapes, except for \( A^2 \) untrained-continuum shapes at one week delay. Here, subjects show generalized responding to first and second variations, from trained and untrained continua, appearing not to discriminate between continua until shapes are three steps removed from Ap.

A labeling x delay x distance from Ap x trained/untrained continua shapes interaction was found significant (\( F[3,144] = 20.67, \text{MSe} = 90.91 \)). Figure 4 indicates that
subjects effectively discriminated between the three familiar training continua and the single unfamiliar, untrained continuum. This becomes especially evident as variation shapes move away from the A prototype shape.

It may now be apparent that no labeling effects were obtained from analyses of Experiment II data. Subjects in Experiment II received label training identical to that employed in Experiment I; the only difference between training procedures was the actual training shapes employed. Experiment II consisted of same- or different-label training of shapes essentially eight steps removed from each other, whereas only a four-step difference occurred in Experiment I.

Label training seemed to make little difference, in that all subjects accepted all shapes between and including Ap and $A^4$ as "remembered" or familiar shapes, as shown by the high ratings these shapes received. By one week delay, both same- and different-label gradients suggest that subjects are looking at the first variation training continua shapes as the most familiar shapes of all.

Table 3 shows the highest mean ratings occurring for shapes between Ap and $A^4$ over labeling conditions and test delays. Following immediate testing, $A^3$ variations received the highest ratings for both same- and different-labeling conditions. At two days delay, this changes to $A^1$ for the same-labeling subjects and $A^2$ for different-labeling subjects. This change continues with both same- and
Table 3. The highest mean ratings occurring between Ap and $A^4$ shape ratings in Experiment II.

<table>
<thead>
<tr>
<th>Recognition Test Delay</th>
<th>Immediate</th>
<th>2-Day</th>
<th>1-Week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.78</td>
<td>9.22</td>
<td>9.11</td>
</tr>
<tr>
<td></td>
<td>9.78</td>
<td>9.44</td>
<td>9.22</td>
</tr>
</tbody>
</table>
different-labeling subjects producing the highest mean ratings for shape $A^1$ after one week. Although this effect is not statistically reliable, there appears to be a tendency for all subjects to give the highest ratings to variations progressively more similar to $A_p$, as pretraining-testing intervals increase.

Table 3 also presents mean ratings for $A_p$ and $A^4$ shapes, separated by labeling conditions and test delays. Comparisons of ratings for $A_p$ and $A^4$ in either labeling condition at any test delay show great similarities. The same amount of forgetting occurring with $A^4$ training shapes appears to occur with the $A$ prototype shape, although the $A$ prototype shape was not presented during training.
DISCUSSION

Experiment I was designed after the study by Daniel and Toglia (1976), in an effort to replicate and further verify a same/different labeling effect. The test delay factor was included to assess whether recognition memory performance would show progressive and systematic changes; specifically, if the modes of the recognition gradients would progressively shift over time.

The labeling effect was obtained as expected. Subjects were requested to remember the prototype shape, and recognition gradients reflected this instruction. Ap consistently received high ratings, regardless of label training. Different-labeling subjects differentiated all other shapes from Ap, as would be expected considering the nature of their label training. Same-labeling subjects showed generalization in rating variations one, two, and three as high as they rated shape Ap. These results closely match those obtained by Daniel and Toglia.

This labeling effect was exerted on untrained continuum shapes, as well as trained continua shapes. All subjects rated the untrained $A^1$ shape relatively high. Same-labeling subjects also considered the untrained $A^3$ variation as relatively familiar, although different-labeling subjects
rated it low. In both conditions, the untrained $A^5$ was
given low ratings.

The lack of a significant delay effect throughout
Experiment I appears to be a contradiction to the hypothesis
that memory storage should be characterized as a dynamic
process. However, the action apparent in Figure 3 should be
carefully considered. Graphic representation of mean con­
fidence ratings for $A$ variations, separated into the three
test delay intervals, leads to the nagging question of
whether a delay effect may be operative, although embedded
and disguised due to label training. One might postulate
that a delay effect would produce a same-labeling gradient
following an immediate test exactly like gradient (A) in
Figure 2. Gradient (B) would provide a convincing portrait
of a delay effect, if ratings for $Ap$ and $A^1$ were ignored, as
would (C), if $Ap$, $A^1$, and $A^2$ were ignored. In other words,
high ratings for the prototype and its closest variations
tend to mask the fact that the highest ratings (gradient
modes) consistently and systematically shift away from the
targeted prototype toward the equally familiar fourth varia­
tion. Subjects generalize over all variations between the
pretraining stimuli $Ap$ and $A^4$, a convincing same-labeling
effect, but they shift their highest certainty further and
further away from the prototype over one-week delay.

The different-labeling gradients can also be viewed
as reflecting a delay effect by shifting in an opposite
fashion. Gradient (D) in Figure 3 shows more generalization than would be expected from different-labeling subjects, in that Ap, A₁, and A² all received similar, somewhat low ratings, reflecting a measure of uncertainty in subjects' responses. After two days, however, Ap is definitely and appropriately the most familiar stimulus. A one-week test delay merely intensifies this certainty. Different-labeling subjects would be expected to differentiate between shapes and rate Ap highest, due to their label pretraining. This expectation is more strongly realized, the greater the interval of time between training and testing. Again, the possibility of progressive changes occurring in memory appears plausible.

Experiment II was designed to test the strength of the effects obtained in Experiment I, by employing more disparate shapes as critical shapes, using essentially the same experimental procedure.

Quite surprisingly, results from Experiment II did not conform to expectation: unlike Experiment I, no labeling effects were obtained, either singly or in interaction with other variables; delay effects, not apparent in Experiment I, surfaced as a significant main effect in analysis of Experiment II.

A question arises as to why no labeling effects were obtained in Experiment II. Perhaps the pretraining variations (fourth variations from three training continua) were
perceived as being so different from each other that label training could not exert an influence; i.e., providing the same name for three disparate shapes did not make the shapes functionally equivalent, and different names certainly would not make them equivalent. The significant distance from Ap effect obtained from the labeling x delay x distance from Ap analysis lends credence to this idea. Subjects apparently could discriminate between A-shapes equally well, given same- or different-label training. A-shapes verging upon and including the prototype shape were all considered equally familiar, compared to shapes moving away from the A^4 pretraining shapes.

A main delay effect was obtained from the labeling x delay x distance from Ap ANOVA. The point was previously made that perhaps no delay effects were obtained in Experiment I because they were masked by the labeling effect. It is tempting to suggest that the delay effect from Experiment II was allowed to surface because the labeling effect was inoperative. A more conservative approach would be to consider the delay effect as merely representing changes due to simple forgetting; uncertainty increases over time, leading to lower certainty ratings for A shapes at each test interval. This is shown in Table 3, with Ap and A^4 shapes.

The delay effect obtained in Experiment II supports the hypothesis that memory can be characterized as a dynamic process. Table 3 is an illustration of this, in
that the highest mean ratings given to test shapes shifts from variation three at the immediate test delay to variation one after one-week delay, in both same- and different-labeling conditions.

Why should all subjects, regardless of label training or test delay, respond so similarly to shapes ranging from $A^4$ to $Ap$, after having pretraining experience only with $A^4$ variations? The concept of a schema may serve here as a comprehensive explanation for these results of Experiment II.

During pretraining, subjects were presented with three shapes of similar appearance, accompanied by several obviously different distractor/control shapes. These similar shapes might be considered as belonging to the same "family" of shapes, in contrast to the control shapes. This could be described as a shape schema, a classification of particular shapes, whose single member best representing the entire class is the prototype shape $Ap$. Subjects were not instructed to respond positively during recognition testing to any shapes but $A^4$ variations presented during training. Yet, all shapes between and including $Ap$ and $A^4$ were considered functionally equivalent. It is as if $A^4$ variations defined the boundaries of a shape schema, as illustrated by the darkened area in Figure 5. Any shape within these boundaries is recognized as familiar and given a high confidence rating. This includes variation one, and possibly two, of the
Figure 5. Model of a shape schema — Darkened area indicates the area of the schema, stippled area indicates an extended area of influence.
untrained continuum, for the schema should exert some influence on shapes in close proximity, although not belonging to, the schema itself (stippled area, Figure 5).

This schema concept may account for the lack of a labeling effect in Experiment II. Possibly, schemas are developed when a broad enough range of stimuli are available to define a set of similar stimuli. These disparate stimuli may be too different to sensibly be labeled with the same name. They are highly discriminable, therefore common labeling is a senseless manipulation. Perhaps a rule is in order here; if schema, no labels; if labels, no schema.

The results of this study indicate clearly that the old Gestalt notion of memory is highly plausible. Memory storage should be characterized as a dynamic process, capable of producing changes over time that cannot be attributed merely to encoding or retrieval difficulties. By implication, the majority of current processing models are inadequate, in that no consideration is given to dynamic changes occurring in storage.

Future research must address itself to the problem that cognitive processes are not necessarily rooted in peripheral events. This problem has continued to be the single largest, long-standing problem of this field--its solution continues to be the crucial task of psychology.
Gestalt Psychology

Investigations of human memory are most often conducted with the assumption that memory is comprised of three basic processes: encoding, storage, and retrieval. The bulk of recent investigation has been dedicated to processes of encoding and retrieval. Research on memory storage has emphasized the structure of memory storage and the mechanics of placing information into storage. Little consideration has been given to processes operating on information already placed in storage. In contrast, the early Gestalt psychologists gave very serious consideration to the notion that distortions in memory might be attributable to changes which occur during the actual storage of information.

In its original form, Gestalt psychology emphasized that an understanding of perceptual principles is preliminary to understanding psychological functioning. Perception is not equivalent to sensation; what is presented as a stimulus can be transformed in perception, as is evidenced by optical illusions. Dynamic laws of organization impose structure upon the elements of a perceptual field. Hypothetical forces in the cortex act to simplify perceptions by
transforming them into better organized figures (i.e., simpler, more regular, more symmetrical). Over time, incoherent or poorly organized perceptions, which endure in a subdued form as memory traces, are transformed into better organized traces. Complete forgetting occurs when this transformation is so extreme, a retrieval cue cannot contact the trace. Distortion in memory occurs when the change is less extreme. In theory, recall should show progressive distortion toward better organization over time delays (Koffka, 1935).

In 1922, Friedrich Wulf conducted one of the first experiments seeking to determine whether progressive changes in memory occur over time. Wulf presented line drawings of geometric figures to subjects, then had them draw the figures from memory following various time delays. His analysis of subjects' memory reproductions emphasized figural characteristics that were exaggerated, minimized, or unchanged. Wulf found that 392 out of 394 subjects showed changes in their reproductions of the figures. Furthermore, these changes progressively increased over time. He claimed that these demonstrated changes were consistent with the Gestalt account of memory. Although Wulf's study triggered a long line of experiments attempting either to support or refute his results (e.g., Gibson, 1929; Carmichael, Hogan, and Walter, 1932; Brown, 1935; Zangwill, 1937; Hanawalt,
1937), conclusive evidence was never obtained that pro-
gressive changes can occur during memory storage.

A modern interpretation of Gestalt theory can be
formulated, based on these early notions of memory. The
modern interpretation would give little, if any, considera-
tion to dynamic, organizational forces in the cortex moving
perceptions toward better organized figures. Rather, the
important idea would be that storage of information is a
continuing process, not necessarily a static event.
"Assimilation" between items encoded can occur, and dis-
 distortions in memory can be shown to occur not only because of
selectivity in encoding, or inaccuracies in retrieval, but
because memory storage itself is an active process which,
systematically and progressively alters information that
has been stored in memory.

Numerous interesting implications arise when this
"dynamic change" concept is applied to existing concep-
tualizations of memory. Consider, for example, Anderson and
Bower's (1973) account of human associative memory, based on
the model of a propositional tree or network. The proposi-
tional tree represents the organization of memory—a bit
of information supplied to the system is fitted into the
memory network, based on connections it may have with other
information of similar meaning, syntactical function, and
grammatical form already in the system. Information is
stored in memory, in the sense that it occupies a certain
location on the tree, in relation to other information. Bits of information may have many intricate connections with other bits of information, and the shape of the organizational network may change as more information is encoded. However, the implicit assumption remains that once information is encoded, it retains its same location within the tree. In other words, memory storage in this model is viewed as a static process.

It may be reasonable to postulate the existence of a testing capacity within memory which considers each bit of stored information to determine a better fit for it within the organizational network. The constant input of more information could create a situation where another location within the tree would provide a better organized representation in memory. Locations would constantly change, as more and more information enters the system. A reconsideration of memory storage, unrestricted by preconceived notions that it must be a static process, may prove valuable; it is possible that several types of memory storage processes may be differentially active, depending on what is encoded. The possibility that on-going organizational processes operate during storage signals a different direction for studying memory. That is, investigations into memory storage processes should be designed to assess the nature of dynamic changes occurring during storage of information.
Labeling Effects on Encoding

Several studies have been conducted whose results indicate that the effects of labeling on memory for random shapes takes place during encoding of information. These studies employ shape stimuli consisting of prototype shapes, and variations generated from prototype shapes. A prototype shape can be thought of as an abstract polygon created by connecting a number of randomly placed points with straight lines. A first degree variation shape is generated when each point from the prototype shape is moved from its origin a set distance in a random direction, then the points are re-connected with straight lines. Prototype shapes are designated P; a first variation shape is designated as $V^1$. Further variations are generated from the preceding variations in the same fashion and designated $V^2$, $V^3$, $V^4$, etc., respectively. A $V^1$ shape would be visually more similar to the prototype shape than a $V^2$ shape, which in turn would be more similar than a $V^3$.

Malloy and Ellis (1970) assessed the effects of labeling 6-point random shape stimuli on the acquired equivalence of cues, and the acquired distinctiveness of cues (Miller and Dollard, 1941). The acquired equivalence of cues hypothesis predicts that associating the same cue-producing response to different stimulus objects facilitates a learned equivalence to the objects, resulting in generalization of instrumental responses between stimuli. The
acquired distinctiveness of cues hypothesis predicts the opposite effect: a decrease in generalization will occur when distinctive responses are associated with distinctive stimuli. Malloy and Ellis (1970) attempted to distinguish between generalization effects that could be ascribed to the mediational functions of response-produced cues and generalization effects due to attentional functions, where response-produced cues facilitate attention to attributes of the pretraining stimuli.

Malloy and Ellis (1970) conducted their experiment in three stages: mediation pretraining, irrelevant label training, and generalization testing. During mediation pretraining, all subjects were given a paired-associate task consisting of four sets of shapes, each set made up of one prototype shape and a second degree variation constructed from the prototype. A common CVC was associated with the first set of stimuli to establish acquired equivalence of cues. Acquired distinctiveness of cues was established with the second set of stimuli by pairing the prototype with one CVC, and the second degree variation with a different CVC. An observation-observation control was established with the third set of stimuli by having subjects merely observe both stimuli. For the fourth set of stimuli, an observation-distinctiveness control was obtained by pairing the prototype with a CVC, but observing the variation shape. A final
control set of shapes was not employed during mediation pre-training, but was used in the other two stages of the study. During irrelevant label training, a paired-associate procedure was employed to teach subjects an irrelevant noun label for the prototype shape from each of the four pretraining sets, as well as for the fifth prototype not presented during pretraining. This stage was designed to establish a new instrumental response to one member of each of the stimulus sets.

Generalization testing consisted of showing subjects each of the five prototypes and a family of five variations generated from each prototype. Subjects had to identify the shapes learned during irrelevant label training (all prototype shapes) with the associated noun, when they thought that one of these stimuli appeared.

In the acquired equivalence condition, the per cent of noun identification responses incorrectly given to second degree variations was almost as high as the per cent of identification responses given correctly to the prototype shapes. These results supported the acquired equivalence of cues hypothesis, in that labeling two distinctive stimuli with one verbal response during pretraining served to increase the strength of generalized responding. Malloy and Ellis concluded that attentional processes could not account for the greater generalization following equivalent training, since significantly fewer identification responses
were made to $V^2$ shapes in the observation-observation control group. It is unlikely that equivalent label pretraining forced subjects to attend to particular cues, since subjects in the observation pretraining condition were also forced to attend to the stimuli.

Results obtained after distinctiveness pretraining were not consistent with predictions based on the acquired distinctiveness of cues hypothesis. There was no evidence of lessened generalization following acquired distinctiveness training.

Although the acquired distinctiveness of cues hypothesis was not supported, Malloy and Ellis' results were consistent with the position that associating common verbal responses to distinctive stimuli generates common response-produced cues which serve to increase the functional equivalence of the stimuli.

An investigation was conducted by Ellis and Daniel (1971) to determine if recognition of visual stimuli is attributable to retrieval of labels at the time of recognition testing, or if the effects of verbal labels on recognition take place during encoding. They assumed that memory for verbal codes should be longer-lasting than memory for specific visual forms, if labels serve a mediational function during recognition testing. Alternatively, the rate of forgetting of labels in a recall test should be faster than the rate of forgetting of stimulus forms in a recognition
test, if representative verbal labels direct attention to distinctive features of the stimuli during acquisition. Ellis and Daniel found that representative verbal labels exert their effect on recognition of visual stimuli during stimulus selection and encoding. This conclusion was based on the lack of variability found in correct-recognition curves obtained over seven days delay. It was found, in a subsequent experiment, that while visual stimulus recognition remained stable over a span of 28 days, both free and aided recall of labels decreased over the same temporal delay. According to Ellis and Daniel, there is virtually no forgetting in stimulus recognition over test intervals, although there is a weakening in the associative strength between shapes and labels. In general, the results from these experiments supported the view that representative verbal labels facilitate recognition performance by fostering attention to distinctive stimulus features during training.

The results of an experiment by Daniel and Ellis (1972) also indicated that the effects of labeling on random shape memory are operative during encoding or acquisition. This experiment investigated the effects of stimulus coddability (stimulus-encoding difficulty) and distinctive verbal label pretraining on recognition memory, tested either immediately, after a 15-minute delay, or one week following training. According to the investigators, increasing difficulty in encoding a shape should force subjects to rely more
heavily on associated verbal labels. Reliance on verbal labels as mediators for shape recognition should maximize the necessity for label availability at the time of testing in order to obtain correct shape recognition performance.

The stimuli used by Daniel and Ellis (1972) were 24-point prototype shapes scaled for codability. Codability scores were obtained by measuring the mean latency of the first associative response made by subjects who had been instructed to provide a name for each shape as rapidly as possible. The shapes with shortest latencies were designated as high-codability shapes, and those with longest latencies were designated as low-codability shapes. Modal verbal labels were selected as the labels to be used during pretraining.

Subjects were given either observation pretraining or relevant verbal label (the modal association labels above) pretraining with pretraining shapes. Half of the shapes were exposed for 0.5 sec and half for 6.0 sec. In the observation condition, subjects were instructed to observe and remember the pretraining shapes. In the relevant label condition, verbal labels were shown along with pretraining shapes, and subjects were instructed to associate the labels with the shapes to help remember the shapes.

Recognition testing was given either immediately, 15 min, or 1 week after training. The forced-choice
recognition task consisted of a series of five-stimulus sets, each set containing a pretraining prototype shape, and four random variations generated from that prototype. Subjects were required to identify which of the shapes they had seen before; correct identifications could only occur to prototype shapes. Immediately following shape recognition testing, subjects from the relevant label pretraining condition were required to write down as many pretraining labels as they could recall.

The main finding of the study was that shape recognition performance remained stable over the delay intervals employed, whereas recall of the pretraining labels declined significantly. Because high stimulus codability, distinctive label training, and longer stimulus exposure intervals (6.0 sec vs. 0.5 sec) independently facilitated recognition performance, Daniel and Ellis assumed that these variables had an effect during acquisition by affecting the level of original learning. They further suggested that the availability of a verbal code during testing is not required for correct recognition of shapes to occur. Low codability shapes and short stimulus exposure were employed to necessitate the use of labels; however, since recall of labels declined while recognition of shapes remained stable, verbal labels apparently do not effect retrieval of random shapes. As Daniel and Ellis (1972) stated, the effect that labels
exert on form memory apparently takes place during encoding rather than retrieval.

The conceptual coding hypothesis (Ellis, 1973) accounts for the results of these various studies of random shape recognition memory. Ellis proposed that the encoding of stimuli, especially highly complex, difficult-to-encode, stimuli, is affected by the type of verbal pretraining employed. When considering form memory, associating common responses to distinctive stimuli results in a less distinctive encoding of the stimuli, and subsequently poorer recognition performance. The use of common labels seems to encourage attention to common features of the stimuli. Distinctive labels have the opposite effect: subjects attend to distinctive features of the stimuli, and show superior recognition performance. Distinctive verbal labels, especially if they are representative of the abstract shape stimuli, apparently alter the encoded representation of the stimulus. This alteration explains the results of experiments such as that of Carmichael et al. (1932), where ambiguous stimulus figures are presented to subjects, preceded by the statement that the figures each resemble one of two plausible alternatives. For example, a stimulus figure consisting of two circles joined by a short horizontal line (0-0) could be presented to subjects as resembling either eyeglasses or dumbbells. Subjects asked to reproduce exactly the stimulus figures tend to produce
figures incorporating characteristics of whatever label has been associated with the stimulus figure. This altering of the encoded representation of the stimulus allows stable encoding of it, based on distinctive stimulus features, and facilitates recognition performance.

A study by Ellis, Tatum, Shaffer, and Malloy (1977) assessed the effects of verbal labeling on both recognition memory and discrimination of random shapes. The experiment was conducted in three stages: acquired equivalence training, unrelated noun association training, and recognition testing. Acquired equivalence effects were established through common labeling of similar random shapes, following the procedure reported by Malloy and Ellis (1970). Subjects learned to associate a common CVC to a prototype shape and its second degree variation during acquired equivalence training. An observation-observation control group was presented with a different prototype-second variation set, but was not required to learn a label for either shape. This group was considered to be an experimental condition in the sense that a common observation response was associated to each of the stimuli. A third group served as a no-pretraining control condition.

In the second stage of the experiment, subjects learned to associate an unrelated noun to all prototype shapes. This served to familiarize subjects with the target shapes they would subsequently have to recognize. The third
stage consisted of a recognition task employing all prototypes and a family of associated variations. Four variations were generated from each prototype stimulus for use during recognition testing. Subjects were instructed to respond "Yes" or "No" along a four-degree scale of certainty to indicate whether a test shape was or was not a prototype shape, as presented during unrelated noun association training.

Yes/No responses, when considered in terms of a signal detection analysis, provided data concerning the discriminability of test stimuli. Yes responses given to any prototype were defined as correct recognitions or hits. Yes responses to any other stimuli were considered as false alarms. Values of $d'$ indicated that the acquired equivalence condition produced the least sensitivity, while the no-pretraining condition produced greatest sensitivity in discrimination between stimuli.

An analysis of recognition responses for the prototypes and second variations used during pretraining showed that the recognition gradient for the acquired equivalence condition was reliably broader and flatter than the slope of the no-pretraining condition. Visual inspection of gradients also showed the acquired equivalence slope to be broader and flatter than the observation-observation slope, although this was not supported statistically. These results indicated that making common responses to two
similar stimuli (in both acquired equivalence and observation-observation training) makes the stimuli functionally more similar, compared to the control condition receiving no prior experience with the two stimuli. Given the possibility that such changes in performance may be perceptual in nature rather than just mediated by associative and/or coding processes, Ellis et al. (1977) conducted a second experiment to determine if equivalence training produces perceptual-discriminative changes as well as recognition memory changes. In this second experiment, subjects were required to respond "same" or "different" to the simultaneous presentation of two stimuli. It was hypothesized that subjects would tend to call stimuli presented during acquired equivalence and observation-observation pretraining the "same" more frequently than stimuli presented in the no-pretraining condition. This hypothesis was based on the assumption that making common responses to two similar stimuli produces changes in discrimination.

The results of the second experiment indicated that subjects did not falsely judge stimuli to be the same more frequently following equivalence pretraining. In summary, making common responses to stimuli, either verbal or observational, affects recognition memory (Experiment 1) but does not affect same/different discrimination judgments (Experiment 2). The investigators concluded that verbal labeling effects operate during encoding and storage of random shape
information, but do not necessarily exert an effect during perception.

In addition, the authors reported that subjects tended to select first variation stimuli more frequently than they selected actual pretraining stimuli during recognition resting following equivalence pretraining. Apparently, making common responses to two similar stimuli influences the encoding of a representation serving as a compromise between the two original stimuli. This compromise is best represented during recognition testing by first variation shapes, which are considered by subjects as more familiar than actual training shapes with which they have had experience.

**Labeling Effects on Retrieval**

An alternative explanation of the effects of labeling on memory for form stresses the mediational function of labels during retrieval, rather than their effect in facilitating encoding.

Label relevance has been found to have some effect on the retrieval of form memory. The results of an experiment by Price and Slive (1970) indicated that, when labels are relevant to the stimuli they are associated with, their use increases the probability that the representation found and retrieved from memory during recognition testing will match the representation found previously during acquisition.
Price and Slive employed random shapes of high and low association value. High association value shapes were those shapes which reminded 85% or more pilot subjects of a familiar object or situation. Low association value shapes were given verbal labels by 40% or less of pilot subjects. Relevant labels were those labels most frequently applied to both high and low association value shapes. Irrelevant labels were obtained by randomly pairing low association value shape labels with high association value shapes, and vice versa. Association value and label relevance were crossed to define four independent experimental groups.

During acquisition, shapes were presented individually in a fixed random order at the same time the associated verbal label was presented by tape recording. Recognition testing consisted of presenting training shapes and an equal number of filler shapes in a single stimulus recognition test format. Subjects responded "Yes" or "No," depending on their decision as to whether or not a test shape had appeared during acquisition. Subjects were also required to record in writing if any test shape reminded them of a familiar object or situation.

Overall, recognition performance in the high association value-relevant label group was superior to all other groups. In several different analyses, both association value and label relevance were found to affect recognition performance.
Price and Slive presented an interpretation of recognition as a process involving two related processes: identification and recognition. Identification involves sensory processing of the stimulus, memory search for a symbolic representation of the stimulus as encoded, and verbal decoding of the representation should one be found. Recognition is initially identical to identification, in that sensory information from each test trial goes through the above processing. In addition, recognition involves evaluating the strength of a retrieved representation, then combining this evaluation with the subject's criterion to form the basis for yes/no recognition decisions. Retrieval can take one of three forms: (1) no representation will be found, (2) a representation different from that found during identification will be found, or (3) a representation the same as that found during identification will be retrieved. Whereas association value was found to increase the overall number of representations in memory, label relevance served to increase the probability that a representation, when found, will be identical to that occurring during learning.

The results of an experiment by Santa and Ranken (1968) indicated that verbalization of labels may affect retrieval. The main hypothesis investigated by Santa and Ranken was that verbal labeling serves to facilitate the development of integrated representations of abstract shapes. Stimulus shapes with irregular top and bottom
contours and straight sides were employed with two training conditions, Named (names were suggested by the outlines of the shapes) and Unnamed, and two test tasks, Redintegration and Recognition. In the redintegration test, a set of four top contours was presented, followed by a set of four bottom contours. Subjects were instructed to indicate which contours from the second set came from the same shape as the correspondingly-positioned top contour from the first set. In the recognition test, four top contours were presented, followed by another set of four top contours. Subjects pointed to each contour of the second set which was the same as the corresponding contour in the first set.

Santa and Ranken stated that naming facilitated redintegrative performance but did not differentially affect recognition performance. Performance on the recognition task for both Named and Unnamed conditions was superior to performance by the Named subjects on the redintegrative task. Unnamed subjects on the redintegrative task showed the poorest performance of all. The investigators did not attribute the results of the recognition test to a ceiling effect, pointing out that performance on the recognition task averaged only 74% correct responding. However, a ceiling effect should not be ruled out, as there was no indication made that an independent measure of subjects' acquisition had been obtained. Santa and Ranken stated that subjects in the Named condition had learned names for the
shapes, while subjects in the Unnamed condition had received equal practice in discriminating both top and bottom contours. However, there was no report that any measure had been taken to prove that subjects had really learned all of the shapes. According to the authors, the data supported the hypothesis that, in the naming condition, presentation of a single contour summons a representation of the corresponding shape, which provides information about all of the contours. In the Unnamed condition, the representation provides information about the contour that evoked it.

Santa and Ranken stated that the results of their study could be interpreted as due to the perceptual reorganization of the shapes which is induced by their association with meaningful, relevant labels. However, they indicate that the results of subsequent experiments, which they do not detail, suggest that the effect on redintegrative memory is due to verbalization of the labels during testing, rather than due to any perceptual changes. Although not specifically stated by the investigators, this could be interpreted as: a verbal label associated with a training stimulus facilitates the formation of an integrated representation--this integrated representation is retrieved during memory testing by reference to the training label.

Four experiments conducted by Santa (1975) investigated the influence of verbal labels on redintegrative memory tasks requiring the integration and retrieval of
visual information. Santa defined an integrated representation of a stimulus as one in which various portions of the representation are linked in such a way that the presentation of one part will evoke the rest of the representation. An integration hypothesis proposed by Santa (1975) holds that label training facilitates performance on a redintegrative task because the verbal name mediates or references the various attributes of a single abstract shape stimulus. The hypothesis asserts that subjects must use the labels during the redintegrative task in order to obtain the benefits of prior label training.

Eight stimulus shapes employed by Santa were the same as those used by Santa and Ranken (1968), with irregular top and bottom contours and straight sides. Labels associated with these shapes were meaningful words, and considered representative of the shapes to some extent. Subjects received one of three types of naming instruction: Unnamed; and Relevant Named-Verbal, a condition requiring subjects to verbalize aloud the names presented by the experimenter. Subjects were presented with a redintegration test in which a top contour was presented, followed by a bottom contour, under instructions to indicate whether the second contour came from the same shape as the first. A recognition test was also given, as a control for the effect of labeling on memory for specific contours. In this recognition test, a top contour was presented, followed by
another top contour, and subjects were asked to indicate whether the second contour was the same as the first. The test sequence for each subject consisted of a randomized mixture of both recognition and redintegration problems.

Recognition errors were found more frequently in the Unnamed condition, less frequently in the Named condition, and least frequently in the Named-Verbal condition. However, this difference was not reliable, possibly because label training was identical for Named and Named-Verbal conditions.

In a second experiment from Santa's study, an attempt was made to create a more sensitive, statistically reliable naming effect by instructing subjects in the Named condition not to rehearse the names presented to them. Rehearsal of the names would confound the effects of the Named condition with those of the Named-Verbal condition, by essentially duplicating the Named-Verbal training procedure. The second experiment was designed to test the hypothesis that label facilitation depends to some degree on the extent to which names are used during testing, rather than to perceptual or attentional influences of name training.

A significant naming effect was obtained from the second experiment: subjects who verbalized names performed better than subjects instructed not to rehearse names, who in turn performed better than Unnamed subjects.
Santa devised a third experiment to determine if the effect of naming on redintegration might depend on perceptual reorganization, which is an encoding process. The third experiment was designed to determine if irrelevant labels (names appropriate for other shapes) or paralogs (pronounceable, low-meaningful words) arbitrarily assigned to the shapes should minimize perceptual reorganization. If the presence of a verbal code of any sort facilitates redintegration, the effect could be assumed to influence the retrieval process and should also be obtained with irrelevant words or paralogs used as names.

Four name training conditions were employed in Experiment 3: Relevant Named-Verbal, Paralog Named, Irrelevant Named, and Unnamed. Training and test stages were identical to those in Experiments 1 and 2. Santa found a trend, statistically unreliable, for relevant labels to facilitate redintegration, followed by paralog and irrelevant labels, respectively. He stated that these results support the hypothesis that the integration effect can be attributed to naming per se, rather than to perceptual reorganization.

A fourth experiment was designed to assess the differences between paralog and unnamed conditions, based on the possibility that paralog name subjects might have created spontaneous relevant names for the shapes. If the number of spontaneous names used by paralog subjects was
equal to the number used by unnamed subjects, then differ­
ences between the two conditions would constitute strong
evidence against an interpretation favoring perceptual
reorganization.

Training and testing during Experiment 4 was
essentially the same as that employed throughout the study.
Only two conditions were investigated, Paralog Named and
Unnamed. Following redintegration and recognition testing,
all subjects were tested to determine the level of spon-
taneous naming. The half shapes employed in recognition and
redintegration testing were presented to subjects, who were
instructed to report any names (other than paralogs) used by
them for the shapes during testing. The mean number of
spontaneous names was significantly greater in the Unnamed
condition than in the Paralog Named condition, indicating
that the effect of paralog names on redintegration was a
reliable one, not an artifact arising from greater spon-
taneous naming employed in the Paralog Named condition.

In summary, data from Santa's first two experiments
indicated that the extent to which names were used during
testing resulted in differential performance levels for
subjects. The last two experiments indicated that the type
of label employed was not essential to the facilitative
effect that labels exert on redintegrative memory, compared
to no-labeling control groups. Based on these findings,
Santa assumed that labels serve to integrate the parts of a
visual representation, which increases the retrievability of various stimulus features. The label mediates between stimulus features so that separate parts are remembered in relation to the whole integrated representation. Without denying that verbal labels affect the encoding and acquisition of visual stimuli, Santa proposed that names influence not just encoding, but retrieval as well.

Labeling Effects on Storage

The Gestalt/configurational approach to form memory (e.g., Gibson, 1929; Carmichael et al., 1932) suggests that verbal labels influence qualitative changes in memory during storage. Assimilation between representative labels and shape stimuli serves to generate a new memory configuration which affects recognition performance.

The process of assimilation, referring to qualitative changes occurring in form memory, is consistently reported in memory reproduction studies (e.g., Wulf, 1922; Allport, 1930; Perkins, 1932). Daniel (1972) investigated assimilation using a recognition memory paradigm. Daniel constructed shape continua ranging from a familiar form at the other extreme, following a procedure outlined by Ellis and Feuge (1966). In the pretraining phase, subjects were presented with a shape that was six variations removed from the original simple prototype shape, and told that the form resembled the original prototype shape. During the
single-stimulus recognition test, which employed the prototype and all eleven variations along the continuum, subjects were required to rate their degree of certainty that each test form was the form they had had experience with during pretraining. Subjects were tested either immediately after training, after 5 min, 20 min, or 2 days. Results indicated that, while overall mean ratings of the test variations were unchanged over time, the distribution of responses was changed. Data from the immediate test showed that subjects gave higher ratings to variations differing from the target shape in a direction away from the prototype shape. After the two-day delay, variations between the prototype and the training shape received higher ratings. In essence, stimulus preference was shifted toward shapes more like the prototype object stimulus which best depicted the assigned label. According to Daniel, the experimenter-assigned labels probably influenced encoding of the shape stimuli, but they also affected the storage stage. Variations differing from the training stimulus in the direction of becoming more similar to a form referred to by the pretraining labels apparently gained in memory strength. Those variations extending away from the form referred to by the label lost in strength.

In an experiment assessing the effects of distinctive and equivalent verbal label training on random shape recognition memory, Daniel and Toglia (1976) found
support for both a Gestalt/configurational interpretation and an interpretation based on Ellis' (1973) conceptual coding hypothesis. Polygons with 16 sides served as prototype shapes for continua extending to 12 variations, generated with the procedure described by Ellis and Feuge (1966). During pretraining, subjects were either presented with equivalent label training on two variations, or with distinctive label training on two variations. Following designation of one variation as the target shape to be remembered, subjects were given a single-stimulus recognition test in which they were shown all shapes, consisting of the prototype plus 12 variations. Subjects were asked to rate their degree of certainty that any one shape was exactly the same as the shape they had been told to remember. Daniel and Toglia (1976) found that recognition gradients differed between equivalent-label and distinctive-label trained subjects. Distinctive label training produced a symmetrical gradient with the mode at the correct designated target shape. Equivalent label training, on the other hand, produced an equally steep and symmetrical gradient, but this gradient was displaced with a mode over the first variation toward the prototype shape. The results of distinctive verbal label training can be accounted for by the conceptual coding hypothesis. Distinctive-label subjects encoded more distinctive features of the training shapes, whereas equivalent labeling encouraged the encoding of more
common features of the training shapes. However, the shape of the equivalent-label gradient was not consistent with Ellis' (1973) hypothesis. If equivalent-label training had influenced the encoding of common stimulus features, then the gradient should have been flatter, reflecting the generalizability of the test stimuli. Since the equivalent-label training gradient was just as steep as the distinctive label training gradient, equivalent-label subjects apparently felt as certain about their choices as the distinctive-label subjects did. These inconsistent results led Daniel and Toglia to suggest that the conceptual coding hypothesis be extended to incorporate these findings. Possibly, the old Gestalt notion of assimilation of items stored in memory could be a plausible explanation of the shifting found in the equivalent-label gradient.


