

**The Effect of Attribute Emphasis in Photographic Illustrations  
for Concept Attainment by Learners having Varying Degrees of  
Field Dependence**

by

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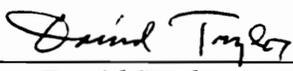
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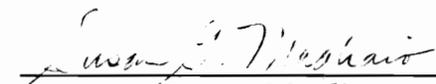
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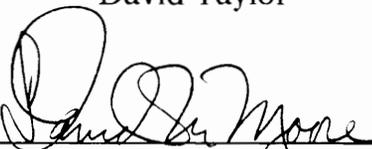
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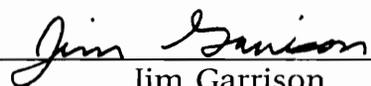
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(ABSTRACT)

The purpose of this study was to determine whether modifying photographic illustrations used for concept-learning by emphasizing defining attributes improves learning by individuals exhibiting various degrees of field-dependence. Concept-learning in this instance refers to identifying objects based on visual characteristics. The specific questions addressed were:

- 1) Does emphasis of attributes improve concept attainment in general? and
- 2) Does attribute emphasis provide a differential advantage to field-dependent students, who generally do not perform as well on visual tasks?

The relative levels of field-dependence of 115 participants, recruited from the university and surrounding community, were assessed using the Group Embedded Figures Test (GEFT). Three levels of field-dependence were identified: an "indeterminate" level centered on the mean GEFT score for the group; field-dependent, those scoring more than 1/2 standard deviation below the mean; and field-independent, those scoring more than 1/2 standard deviation above the mean.

Participants partook of one of two computer-based lessons on the identification of four maple tree species based on the appearance of leaves. One lesson (the control condition) was illustrated with plain photographs, the other with photographs which had been modified using digital image editing to emphasize the critical attributes of each leaf. Following the lesson, each participant took a computer-based, 15-item multiple choice

test on identification, and then a second 20-item test requiring identification of mounted leaf specimens.

Bartlett's test for homogeneity of variance revealed that the values in the six cells were not equal. Therefore, the test scores were analyzed using two-way t-tests for samples with unequal variances. All analyses were performed at the 0.05 significance level. Results of the analyses suggest that attribute emphasis does improve learning by individuals in general, particularly when considering transfer. However, no evidence of specific benefit for field dependent learners was revealed by the results. The author concludes with suggestions for further investigation of the benefits derived by various types of attribute emphasis and also the extent to which attribute-emphasis techniques may improve learning for tasks other than concept attainment.

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## Introduction

One type of learning task individuals face throughout their lives is the classification of objects or ideas based on specific characteristics. Examples of this activity include distinguishing the letters of the alphabet, recognizing various geometric figures, identifying different species of plants and animals, and naming the bones of a skeleton. This type of task has been called *concept learning* (Bruner, Goodnow & Austin, 1956; Mayer, 1977).

Concept learning which involves concrete categories, such as plant species, is intrinsically a visual task. Ideally, it would seem best to use genuine instances of the concept under study to teach learners how to distinguish new categories. However, presenting learners with real examples of a concept may prove impractical for a variety of reasons: physical examples may be unavailable, unwieldy, unsafe, or any combination of the three. Consider for instance the difficulties of using real physical examples to teach the concept *tiger*. Consequently, concept learning often must occur with the assistance of illustrations or models which substitute for physical examples.

Issues surrounding the use of illustrations used in learning have been studied at length, with the considered questions ranging from Miller's (1938) examination of the extent to which pictures enhance ability to read accompanying text, to more subtle research addressing the suitability of different levels of realism in images for various types of tasks and learners (for instance, Dwyer, 1967a). Research on instructional illustrations typically has focused on the level of complexity of the image and general learning tasks, such as comprehension and recall. Croft and Burton (1995) have suggested the use of concept attainment theory, as outlined by Bruner, Goodnow, and Austin (1956), to guide the selection of illustrations, and in addition have suggested the use of enhancements to illustrations to emphasize important features for concept learning.

Another factor implicated both in general visual learning tasks and concept learning is the learner's degree of field-dependence. This individual trait represents a continuum which is reflected in a person's

ability to impose structure on a perceived field (Witkin, 1950). Those individuals who are easily able to restructure are said to be field-independent; those who exhibit difficulty, accepting the organization as presented, are said to be field-dependent. Individuals who are field-dependent tend to perform less well on visual tasks than those who are field-independent. For this reason, considerable work has taken place to determine which illustration styles, if any, assist field-dependent learners to improve performance. There is also some evidence that field-dependent learners perform less effectively on concept-learning tasks, even those which do not rely on visual characteristics.

The evidence of studies of concept learning, instructional illustration, and the interactions of these with a learner's degree of field dependence suggest the need for an examination of the effectiveness of instructional illustrations which have been modified for the specific purpose of concept learning for individuals having different degrees of field-dependence. The research effort described in the following pages examines whether emphasizing important features in photographs used for concept learning results in improved learning and transfer, particularly for field dependent individuals.

## Related Research

The primary elements of this study are concept learning, instructional illustration, and interactions of field-dependence with concept learning and illustration style. The ensuing sections will address significant research in each of these domains: concept learning; illustrations for instruction; and field dependence and its interactions with concept learning and illustration treatment.

### **Concept Learning**

Bourne (1970) provides a succinct definition of *concept*: “A class concept is a principle which describes a partitioning of a stimulus population.” (p. 546). Bruner, Goodnow, and Austin (1956) define *concept attainment* as “...the process of defining attributes that distinguish exemplars from non-exemplars of the class one seeks to discriminate.” (p. 22). Mayer (1977) states that “...*concept attainment* [takes place when] the subject must learn a rule for classifying objects into mutually exclusive categories.” (p. 32). Whether we call the process concept learning or concept attainment, it involves the learner acquiring the ability to categorize a novel stimulus according to rules dictated by convention.

The rules for identifying a concept describe specific characteristics which set members of that concept apart from stimuli which are not members. Bruner, Goodnow, and Austin (1956) call the important characteristics *attributes*, and state that an attribute is “any discriminable feature of an event that is susceptible of some variation from event to event” (p. 26), meaning that if the feature is constant between classes, it is not a meaningful attribute for the task at hand. Trabasso (1963) refers to the defining characteristics of a concept as *cues*. Examples of attributes (or cues) might be “red,” “striped,” or “large.” Each attribute represents a value in a specific *dimension*. For the three examples just mentioned, the dimensions would be “color,” “fill pattern,” and “size.” A concept may be defined by its value in only one dimension (anything red belongs in the category) or many attribute dimensions may be necessary for classification.

Several investigators have studied the process of concept learning, the factors which contribute to the difficulty of concept learning tasks, and measures which may reduce the difficulty of learning concepts.

### **The Process of Learning Concepts**

Learning what places a given stimulus in a concept category involves viewing one or more examples of category members and identifying which traits are necessary for category membership. In experimental settings, the learner is typically presented with several training examples and asked to guess to which category the examples belong. The researcher confirms or infirms each guess. Gradually, the learner correctly recognizes which features characterize the concept. Success is measured by the number of instances the learner can correctly classify after the training.

Heidbredder (1947) performed a series of experiments which offer insights into both the process of concept learning and the characteristics of visual concepts. In her experiments, participants learned to identify nine concepts with nonsense syllable names. The concepts fell into three general categories: familiar concrete objects (for instance, human faces, birds, trees); shapes (such as a circle); and number (3, 5, 6). Stimuli were drawings which represented each concept. Heidbredder found that the number of trials necessary for participants to identify the category for a novel stimulus depended on which of the three general types of concept was involved.

Following a number of trials in which the learner viewed nine training drawings and attempted to correctly identify each by the assigned nonsense syllable, Heidbredder (1947) introduced similar (but new) drawings for the learner to categorize. Heidbredder observed that at some point, each learner would “suddenly” recognize the novel stimulus as having sufficient similarity to one of the training stimuli to warrant giving it the same name. Heidbredder describes this as the transition from memorization to conceptualization.

In addition to making a fundamental distinction between simple stimulus-response behavior and the act of conceptualization, Heidbredder (1947) observed that learners reacted differently to the three categories of concept. Correctly identifying stimuli representing new instances of a

shape category required significantly more trials than identifying members of concrete concepts, and numbers required significantly more trials than either of the other two types of concepts. Based upon these results, Heidbredder suggested that there is a “dominance hierarchy” of cues which influences their apparent importance to a person learning a concept. Concepts which resemble something familiar and concrete—having “thing-character”—are more readily conceptualized.

Dattman and Israel (1956) expressed some concern that the materials used in Heidbredder’s (1947) experiments may have induced the observed hierarchy. They noted that the illustrations for the concrete concepts were very plain and recognizable, while the illustrations for shapes included many distracting elements. For instance, one of the pictures for the “circle” concept was a wreath of leaves. The number concepts included the correct number objects, but arrangement was random, and the types of objects varied. Dattman and Israel repeated the experiment using modified pictures. They added distracting elements to the concrete concept illustrations and simplified the shapes and numbers. Their results show no significant difference in the number of trials necessary for learning the concepts as represented by the modified materials.

Although the results obtained by Dattman and Israel (1956) appear to suggest that the dominance hierarchy posited by Heidbredder (1947) is insignificant or nonexistent, we must consider that the modified stimuli used by the later researchers made the concrete examples *less* familiar and the abstract examples *more* familiar. In this case, we may still conclude that stimulus materials which resemble the known are generally easier to conceptualize than those which are abstract, a point with which Mayer (1977) concurs.

### Concept Learning Strategies

Investigations subsequent to the efforts of Heidbredder and Dattman and Israel focused on the strategies individuals use when learning concepts under various conditions. Bruner et al. (1956) conducted a series of experiments to determine factors influencing the approach individuals use in learning concepts and to identify specific strategies employed under

various conditions. Their results suggested that five general conditions affect the way individuals attain concepts:

- (1) the type of task (what do you need to do? Distinguish tree from animal, evergreen from deciduous, maple from oak, or sugar maple from red maple?);
- (2) the nature of instances encountered (how many attributes do they show? How many are distinguishing?);
- (3) nature of feedback (is there immediate information whether the attempted categorization was correct?);
- (4) the consequences of specific categorization (what is the cost of an error? What is the gain if correct?); and
- (5) the nature of imposed restrictions (how much time is available; are learning examples presented simultaneously or in sequence?).

Having identified the factors governing a person's choice of strategy, Bruner et al. (1956) describe *selection strategies* and *reception strategies*. Selection strategies are methods for concept attainment when the learner is able to choose the order of instance (in other words, all the examples are available simultaneously). Reception strategies are methods for use in the more realistic instance of unpredictable, random instance presentation. Bruner, Goodnow and Austin used experiments involving participants trying to learn a concept represented by a specific pattern of shapes, borders, and colors on cards were used to test the effectiveness and frequency of strategies in situations permitting selection and situations which dictated reception.

### *Selection Strategies*

Bruner et al. (1956) outline four hypothetical "ideal" strategies for selection. ("Ideal" in this case refers not to effectiveness but to the hypothetical purity. This is acknowledgment that humans are unlikely to always use the same machine-like approach to a task.) The first strategy is "simultaneous scanning," in which the individual generates all possible hypotheses (combinations of relevant attribute values) and eliminates hypotheses as evidence arises. In "successive scanning," the second strategy, the individual chooses a single hypothesis and then selects examples to test that hypothesis until accepting it or having to reject in favor of another

hypothesis. The third strategy is “conservative focusing,” and involves finding a single positive example of the concept, and then varying only single attributes in successive instances. If the variation results in a negative instance, then it is one of the defining attributes. A focusing strategy allowing more than one attribute to change between instances is “focus gambling,” the fourth strategy.

The first experiment involved showing each participant a card which exemplified a concept. The viewer could then select a card from an array of 64 displayed on a board, and learn whether it also was an instance of the concept. Observation of the types of choices participants made allowed the experimenters to classify the strategy in use as a “scanning” or “focusing” strategy. Each participant solved three “concept problems;” two in the manner described above, and the third with no array of cards from which to select. The third problem provided a variance in the demand on memory. The individuals who used the focusing strategy were able to solve the third problem in an average of five trials. The scanners required thirteen. This experiment showed that the focusing strategy is more effective in general. It also revealed that under the conditions of the experiment, humans without prompting adopt strategies akin to the ideal strategies presented, although the strategies generalize to just “scanning” and “focusing.”

A second experiment suggested that the choice of strategy may vary depending on the presence of order in the selection of cards. If the array of cards was well-ordered, so as to encourage systematic testing of attributes, more of the students involved in the test used a focusing strategy. If it was totally random, more used scanning.

### *Reception Strategies*

The conditions of the experiments used to test scanning strategies were somewhat unrealistic—humans usually have to take concept instances as they come, and do not have the luxury of modifying attributes to see if they are important. Bruner et al. (1956) devised a second series of experiments to test strategy choice in the reception condition—when the learner must make the most of each instance as it presents itself in an arbitrary fashion.

The expected strategies were the “wholist” strategy and the “partist” strategy. The wholist strategy is similar to focusing: the learner formulates an idea of the concept by using the entire first instance, and modifies it only when subsequent positive instances vary. The partist strategy is akin to scanning: the learner chooses a single attribute from the first instance, and adds to it as subsequent examples warrant. If the single attribute chosen is ruled out by a negative example, then the learner reviews in memory all previous examples to formulate a new hypothesis.

The experiments testing these strategies were similar to the ones used for selection strategies. A little more than half the participants used a wholist strategy (and half of these adhered to it faithfully). When time was a factor, the wholist strategy proved vastly more effective, but both strategies worked equally well when there was no time pressure. For both strategies, as the number of attributes (complexity) increased, the percentage of problems solved decreased.

### Transfer

Most of the studies described so far investigated factors involved in learning pictorial concepts. Di Vesta and Peverly (1984) examined learners' ability to apply their new knowledge in a variety of contexts. Their experiment used concepts represented by nonsense verbs. For instance, the verb “lem” was defined as “to use something for a different purpose than it was originally intended” (p. 112). Instances of the concepts were illustrated by example sentences using the words, rather than pictorially, for instance “The old milk can was painted a bright color and sold as an umbrella stand” (p. 112).

One of the hypotheses Di Vesta and Peverly (1984) tested was that individuals learning a concept in a narrow context may be unable to recognize it in a novel context—in other words, that non-criterial contextual information may become bound in the learner's rules for a concept if that information does not vary during learning. To examine this question (among others) the researchers recruited 180 participants who were taught six different nonsense concepts under varying circumstances. Two days later the learners returned for a test to determine retention and

ability to recognize a wide variety of appropriate uses of the words. Those individuals who had learned the concepts using a wide variety of examples were able to identify significantly more instances of the concepts in novel contexts. These results imply that learners may indeed include unimportant contextual information when learning concepts, with the result of impaired transfer to new situations.

### **Concept Learning Difficulty**

In studies of concept learning, a number of factors have emerged which influence the relative difficulty of learning specific concepts. The difficulty of learning a concept is generally determined by the number of trials a learner requires to correctly identify all members of a concept in a set of training stimuli. In addition to Heidbredder's (1947) finding that more abstract concepts are more difficult to learn, these include the complexity of the task, success or failure in a previous task, and the degree to which a new concept appears familiar when the important attributes are not in accordance with experience.

### **Task Complexity**

The relative complexity of a concept-learning task is dependent upon the complexity of the concept(s) to be learned and the degree of similarity between members and non-members.

The complexity of a concept is determined by the number of characteristics necessary for identification and also the amount of irrelevant information present in the examples learned. For instance, the concept *quadrangle* is defined by the number of line segments forming a closed figure. This is the single characteristic necessary to differentiate a rectangle from a triangle. However, the accurate identification of the concept *square* requires the consideration of two additional dimensions: the relative lengths of the line segments and the angles formed by the corners. However, for these simple geometric concepts, the color of the line segments, the background, and the fill, are irrelevant characteristic dimensions.

Several studies have shown that the numbers of both relevant and irrelevant attributes affect the difficulty of learning concepts. Bourne and

Haygood (1959, 1961) performed an experiment to study the effect of number of relevant and irrelevant attribute dimensions on concept learning. The experimental stimuli included six dimensions, each having two possible attribute values. Participants faced one of six learning conditions representing a variety of combinations of relevant and irrelevant dimensions in the concepts learned. The simplest condition involved stimuli which exhibited one relevant dimension (such as shape) and one irrelevant dimension (color). More complex conditions included one with four relevant and three irrelevant dimensions and one with two relevant and five irrelevant dimensions. Fifteen participants were assigned to each learning condition.

The number of errors participants made before successfully completing the task increased dramatically with the number of irrelevant dimensions present. The conditions with greater numbers of relevant dimensions also required more trials to successful completion. Finally, a strong interaction between the numbers of relevant and irrelevant dimensions appeared. Mayer (1977) suggests that any increase in the number of irrelevant dimensions results in a greater likelihood of the learner selecting a worthless hypothesis. In addition, it seems that any increase in the number of possible factors, relevant or otherwise, that a learner may have to consider in learning a concept results in a considerable increase in the number of hypotheses the individual must test prior to determining the correct set of rules.

In a similar experiment using geometric figures having from one to three relevant and one to three irrelevant dimensions, Walker and Bourne (1961) found a significant increase in the number of errors to task completion with increased number of both relevant and irrelevant dimensions. This effort also revealed an interaction between the numbers of relevant and irrelevant dimensions, with the number of errors to task completion increasing geometrically with the combined number of dimensions. Battig and Bourne (1961) drew similar conclusions from the results of a study of the influence of variability in the values within and between attribute dimensions.

Bulgarella and Archer (1962) obtained similar results in a study of the effect of relevant and irrelevant information in an auditory concept attainment task. In this experiment, the attribute dimensions included tone frequency, pulse rate, and volume. The experimenters found significant increases in the number of errors to task completion with increased numbers of relevant and irrelevant dimensions. However, unlike the two previously-described efforts, this experiment revealed no interaction between the amount of relevant and irrelevant information. These authors offer no explanation for this difference in their results and those of researchers conducting similar investigations.

Concept learning becomes increasingly difficult with the greater amounts of information; there is also evidence that a concept attainment task may become harder if the distinctions between concept categories are subtle. Dattman and Israel (1951) found that in their experiment using Heidbredder's (1947) materials, participants were more likely to make errors in identification if a problem set included multiple concepts of the "number" type. Baum (1954) performed a test, also using Heidbredder's materials, with the specific purpose of analyzing the numbers of errors resulting from confusion between similar concepts. Baum's results showed a strong statistically significant relationship between the similarity of two concepts and the number of times learners mistook one for the other.

Battig and Bourne (1961) examined the effects of increasing the number of possible values in each of the dimensions in a concept learning task using geometric forms. For instance, instead of the color dimension having only "red" and "green," there were up to three shades of each color possible. The results suggested a linear relationship between the number of attribute values within a dimension and the difficulty of solving the problem. In addition, certain dimensions contributed more to the error rate. Figures could have one to three stripes placed either horizontally or vertically; only seven percent of the errors resulted from a failure to notice the number and orientation of stripes. Another dimension, width, accounted for one-third of the errors. Evidently differences in width were much more difficult for the learners to discern.

The effect of similarity of concepts on the difficulty of a task becomes apparent when one considers that should similar concepts differ by only a single attribute value, an individual must process more information to distinguish between them. On the other hand, an individual may discriminate between widely-divergent concepts (such as “face” and “two”) without knowing the full set of rules for either.

#### Previous Success or Failure

Pishkin (1965) examined the influence of antecedent success or failure on a concept learning task. His experiment took place in two phases, each of which presented learners the challenge of dividing geometric forms into two classes. In the first phase, half of the participants received feedback which indicated a single relevant dimension for the categorization. The other half received random feedback, making impossible the formation of any correct categorization. During the second phase, all participants faced a new problem, once again involving categorization of geometric forms. The individuals who in the first phase had the unsolvable problem took significantly longer to solve the second problem. Pishkin’s results suggest that the individual’s expectations of success or failure play a meaningful role in concept acquisition.

#### Apparent Familiarity of Concept Domain

In an experiment involving thematic material within the realm of experience of all the students participating, Bruner et al. (1956) noted some interesting differences in behavior compared with that exhibited by students learning abstract concepts. The experiment included two groups. One (the thematic group) used cards depicting an adult figure and a child figure. The attributes which varied were affect of each figure, gender of each, and mode of dress for each (night or day). The second group’s cards had the same number of varying attributes, but the figures were triangle or rectangle, and could be yellow or black, bordered or un-bordered. This group represented served as control.

The average number of trials for the control group to correctly ascertain the concept was 6.1; for the thematic group it was 9.7, The ranges for the two groups were similarly disparate. Arithmetically, the two groups

were solving the same problem—why should they differ so? Bruner, Goodnow, and Austin (1956) submit that

*...the problem solver is likely to fall back upon reasonable and familiar hypotheses about the possible groupings. In so doing, he may be led into a form of successive scanning: the strategy par excellence for going through a list of hypotheses. ...thematic material will, more readily than abstract material, lead certain attributes to have nonrational criteriality: the subject will “hang on” to these and will formulate hypotheses around them.* (p. 111; authors’ italics)

This effect may appear to contradict the Heidbredder’s (1947) findings that concepts in familiar domains are more readily learned. However, note that Bruner et al. (1956) dealt with concepts which only seemed familiar. The familiar aspects of the stimuli were misleading. Had Heidbredder’s “face” concept required attention to a particular detail, such as the curve of the lip or shape of the hairline, the other familiar aspects of the drawings might have resulted in a greater learning time than Heidbredder observed by drawing attention away from the criterial attributes.

### **Efforts to Reduce Task Difficulty**

With so many factors which may interfere with learning concepts—even the simple concepts used in experimental situations—it would be desirable to identify methods to reduce the difficulty of concept learning. Gagné (1962) offers a good starting point for facilitating concept attainment in learning settings. He recommends that instruction begin at a simple level, with the gradual addition of further detail as learners master the material. Reigeluth (1983) describes a similar general approach, “successive differentiation,” submitted by Ausubel (1968). Reigeluth outlines an “Elaboration Theory” of instruction, which includes specific means of decomposing tasks in a fashion fitting the recommendations of Gagné and Ausubel, and calls for the use of elaboration to make concepts more attainable.

The methods offered by Gagné (1962), Reigeluth (1983), and Ausubel (1968) are all applicable for consideration in a long-term lesson or curriculum design. Other efforts have examined influences on a “micro” scale, more similar to a single lesson or experimental setting. Researchers have examined the effects of presentation modes and alterations to training stimuli.

### Presentation Modes

As revealed by Bruner et al. (1956), an individual can learn to identify a concept by examining several examples at once or by encountering them in succession. Gorman (1973) conducted an experimental comparison of these two approaches. His stimulus materials were simple drawings representing three meaningful architectural concepts. Each of his 150 participants were trained and tested on each of the three concepts in turn. The test on the first concept preceded any exposure to the second. Learners participated in one of two conditions: the control group viewed training instances in succession; the treatment group viewed all training instances together. The post-test scores of the simultaneous (treatment) group were significantly higher for the *first concept only*. Gorman suggests that both groups benefited sufficiently from practice to “wash out” any differences on the subsequent tests.

Others have examined the effects of various sequences of presentation of rules and examples. A learner may either be told what rules define a concept prior to viewing training examples, or be allowed to examine the training examples before learning the defining rules. Indeed, the learner may never receive any explicit instruction whatsoever regarding the definition. The findings from this body of research are somewhat varied.

Di Vesta and Peverly (1984) found that learners who were given the definition of a verbal concept before viewing the examples performed better on a recognition post-test than those who viewed the examples before learning the definition. Di Vesta and Peverly suggest that learners viewing examples with knowledge of what is important are less likely to include irrelevant information in their model of the concept.

Koran, Koran, and Freeman (1976) also found a significant difference in the performance of learners depending upon mode of concept learning. The purpose of the experiment was to compare “inductive” and “deductive” presentation modes. The inductive approach involved giving the name of the concept and then giving examples; the deductive mode involved giving the name and also the defining characteristics before showing the examples. With a sample of 339 secondary students trying to learn the concept “monocot,” the researchers found that students who received the lesson in the deductive mode performed significantly better on a twenty-item post test.

Not all research on presentation mode has supported giving the rules before the examples. Park (1984) evaluated two methods of presenting the concepts “positive reinforcement,” “negative reinforcement,” “positive punishment,” and “negative punishment.” The twelfth-grade participants were given instructional booklets which included instruction designed following one of two methods, and a set of practice questions. Immediately after completing the instructional booklet, each participant took a post-test, and a week later took a second post-test as a measure of retention.

For both conditions, the instructions included detailed definitions of the terms. Each group’s booklets included a page to be removed for reference while working the practice problems. For one group, the reference page included only one “best example” of each concept. For the other group, the page included a terse technical definition of each of: “reinforcement,” “punishment,” “positive,” and “negative.” The instructional strategy for the first group was what Park (1984) calls “Example Comparison Strategy,” and is intended to encourage the learner to develop a personal idea of the concept based on similarities between the “best example” and subsequent instances. The second strategy examined is an “Attribute Identification Strategy,” which provides the learners with rules in advance.

Park’s (1984) results showed no significant difference between the learners in the two conditions when they took the immediate post-test; however, on the delayed measure, the students in the Example Comparison condition (ECS) scored significantly higher than the Attribute

Identification (AIS) group. The two groups also differed somewhat in their performance on the instructional task, although in this case the AIS group completed the task with fewer errors. Park concludes that while simply identifying critical attributes “is not the best form for teaching concepts, understanding the concept definition in a contextual form still seems important because it may serve as a conceptual base for deriving meaningful dimensions of the best examples.” (p. 159). Because the students in the each of two learning conditions performed well on certain aspects of the task, Park recommends further investigation of the effect of a strategy including both attribute identification and best examples. This in fact appears to describe the “deductive mode” which Koran et al. (1976) found to be effective in their work, discussed earlier in this section.

#### Alterations to Examples

One has another choice for influencing concept-learning besides that of altering presentation mode. Altering the type of examples used for the lesson offers another avenue for influencing learner success. Trabasso (1963) tested the effects of various types of emphasis on the defining attributes of examples used to teach a simple concept. His stimulus materials were line drawings of flowers on stems. Available attribute dimensions were flower shape (4 values), leaf position (two values), leaf shape (2 values), and angle of leaf to stem (2 values). Of all dimensions, the leaf-to-stem angle was definitive for most of the experimental groups; other dimensions were irrelevant. Trabasso’s participants learned the concept in one of nine conditions. One group solved a problem in which all irrelevant attributes were held constant; five groups faced conditions in which the leaf angle was emphasized either by exaggeration (doubling the angle) or by coloring. When colored, the angle was either: always red; always green; red or green, but with color uncorrelated with the angle; or red or green, with color correlated with angle.

Trabasso (1963) measured the number of errors to satisfactory learning and then repeated the exercise with a new set of stimuli which had no attribute emphasis. The intent of the second trial was to measure transfer. On the training measure, learners in the conditions which used

color emphasis which allowed the color to become significant (always red for a small angle, always green for a large angle) performed much better than any other group except those who face no irrelevant dimensions or for whom the irrelevant dimensions remained fixed. However, this group did very poorly in the transfer exercise. Participants in conditions which used exaggerated angle as emphasis, or in which color was used as an emphasize without correlating with angle, made more mistakes in the training exercise but made virtually none (mean = 0.00 to 0.20) on the transfer exercise. The greatest number of errors in training occurred when color emphasis was random, apparently because learners were inclined at first to attend to the different colors instead of the angle. It appears that emphasizing attributes may improve transfer, but it is important not to select a method of emphasis which itself, in the learner's eyes, becomes the defining attribute.

Turner (1983) examined the effect of color emphasis on defining attributes on concept attainment by learners with different levels of anxiety. The learning tasks were to identify visual concepts defined by small geometric forms embedded in a field of overlapping, larger geometric forms. The forms for the first task were "lightly-embedded;" for the second task they were "heavily-embedded." Based on their scores on the State-Trait Anxiety Inventory, participants were partitioned into groups of high- and low-anxiety students. For half of the participants in each group the forms were presented with no emphasis. The other half viewed training stimuli in which the embedded forms were outlined in red. The differences in scores on the test for lightly-embedded figures were minimal. On the "heavily-embedded" task, the mean score for the control group was 22.29, while the treatment group's mean was 25.75. Although Turner (1983) does not state whether this difference is significant, a *t*-test reveals that the treatment did yield significantly higher scores ( $p < .05$ ). The results obtained by Turner, and Trabasso (1963), suggest that emphasizing subtle attribute values in concept attainment lessons may offer a decided advantage to learners.

## Key Points about Concept Learning

A review of concept-learning literature suggests several considerations relevant to the design of an illustrated concept lesson.

- 1) Individuals are more likely to pay attention to familiar aspects of a conceptual problem. If the familiar aspects are relevant, this effect improves learning (Heidbredder, 1947). However, if the definitive aspects of the problem are not what the learner anticipates from previous experience, the problem may be more difficult than a totally unfamiliar one with the same number of relevant attribute dimensions (Bruner et al., 1956).
- 2) The more attribute dimensions, relevant or irrelevant, that are present in a conceptual task, the more difficult the task becomes.
- 3) Reducing the number of irrelevant attribute dimensions in training examples speeds learning, but may impair transfer (Di Vesta & Peverly, 1984; Trabasso, 1963).
- 4) Providing a definition (description of relevant attribute values) prior to training examples may improve learning and transfer (Di Vesta & Peverly, 1984; Koran et al., 1976). However, providing learners *only* with the rules appears to diminish their retention compared with a situation in which they have a “best example” but no formal definition (Park, 1984).
- 5) Emphasizing relevant attribute dimensions in the training examples appears to enhance learning and transfer (Trabasso, 1963; Turner 1983). Such emphasis must not be correlated with the specific values, or the learner will focus on the emphasize instead of the attribute (Trabasso, 1963).
- 6) Previous success or failure on a similar task seems to affect learner performance on a concept learning task (Pishkin, 1965). How similar the previous task must be to have an effect must be is not certain.

## Instructional Illustration

Many of the efforts described in the preceding section involved pictures used to convey conceptual material. However, the focus of the research was the ability of the learner to form conceptualizations from the pictures, and not the effects of different types of illustration. Among the questions we might ask regarding images used for instruction are: “Does the use of illustration improve learning,” “What types of illustration are

most easily remembered,” “Does the presence or absence of color affect learning,” and “What pictorial detail is appropriate under different circumstances.” A number of researchers have addressed these and other issues which revolve around the use of illustrations in learning.

### **Usefulness of Illustration for Instruction**

Miller’s (1938) examination of the effect of illustrations in primary readers exemplifies early research in the usefulness of illustrations. Miller’s study included six hundred first-, second- and third-graders whose reading abilities were assessed by standardized test before and after they read three stories. For half the students, the stories included pictures; for the other half the stories were unillustrated. Miller’s results did not support the use of illustration in primary readers as a means of improving reading ability. However, considering the nature of the task, and the stories generally included in primary readers, these findings are not surprising. Furthermore, Miller does not comment on the relevancy of the illustrations to the content of the reading material.

Whether illustrations prove useful in improving learning depends on the type of learning objectives involved. A task which is intrinsically visual seems the one most certain to benefit from illustrated instruction. Dwyer (1967a) performed a test of different types of illustration for a lesson of the anatomy and physiology of the heart. The effectiveness of the lesson was measured using four criteria tests: a drawing test in which the learner drew a rough sketch and labeled structures; an identification test in which the learner examined a detailed drawing and identified tagged structures; a multiple-choice terminology test; and a multiple-choice comprehension test. Illustrated lesson materials yielded the best results on the drawing and identification tests—both of which are visual tasks—but illustration did not improve scores on the terminology and comprehension tasks. These results have been supported by many replications of this experiment, including Acevedo and Lamberski (1982), Berry and Dwyer (1982), Canelos, Taylor, and Dwyer (1985), Dwyer (1967b), and Joseph and Dwyer (1984). Regarding the instruction of tasks which are assessed visually, Canelos, Taylor, and Altschuld (1983) state that “...if instruction is completely verbal,

requiring the learner to transfer this instruction to a visual testing condition is not appropriate!" (p. 9). A corollary conclusion is that instruction for visual tasks should include visual components.

### **Factors Influencing Illustration Choice**

Given that visual instruction is favorable for at least some tasks, it is desirable to determine what makes a fitting illustration in various circumstances. One may divide most of the applicable research into two categories: investigations of the properties which maximize recognition and recall of images and investigations of the effects of image realism on learning.

#### **Immediate Recall of Image Content**

Whether a person is aided by illustrations which accompany instruction in part depends on the extent to which that person attends to and recalls the illustration. If we allow a person to briefly view a series of images, we may test the memorability of the images by determining how many the person recognizes from a second series of pictures which includes a combination of novel pictures and images from the original set. We can determine the amount of information the person derived from images by asking questions about the contents of the pictures. Fleming and Sheikhian (1972) tested the influence of image detail, presence or absence of color, inclusion or exclusion of verbal elements, and length of viewing time on the recognition of images by first-grader, sixth graders, and graduate students. The levels of detail included in the study were low (no interior or background detail), medium (reduced interior detail, little background detail), and high (complete interior and background detail). Participants in the study viewed images for either two or four seconds.

Fleming and Sheikhian (1972) found that when exposure time was two seconds, recognition was highest for low-detail pictures and lowest for high-detail pictures. However, when exposure time was increased to four seconds, while the percentages of recognized images at all levels of detail increased, high-detail images showed the greatest gain. At the longer exposure time, more high-detail images were recognized. Fleming and Sheikhian attribute the disproportionate improvement to the added

opportunity for viewers to process the information available in the complex images. This study revealed no significant effect of color on recognition of images at any level of detail.

Although Fleming and Sheikhian (1972) found no influence of color on recognition, Berry (1983) determined that images which included color, even non-realistic color, were more likely to be recognized in an immediate-recall situation. Berry used as stimulus materials 150 projected slides which either retained their natural color, were converted to black and white, or had the colors reversed (50 of each). His participants, 74 university students, recognized significantly more of the color stimulus images when shown a random selection of distracters and the original stimuli. This experiment showed no difference in recognition for realistic color or non-realistic color, although an earlier experiment (Berry, 1982) suggest that realistic color resulted in greater recognizability. Later repetitions of this experiment (Berry, 1991) support the conclusion that color, whether realistic or not, improves recognition.

The preceding results offer insights into the elements which contribute to an image's recognizability. However, for instructional purposes, we are interested in more than merely making the illustration memorable—we also need the learners to notice the content. Berry (1991), Katzman and Nyenhuis (1972), and Moore and Sasse (1971) have performed experiments which required the learners to remember information contained within images.

Moore and Sasse (1971) examined the effects of different types of projected still images on the ability of learners to recall the image's content. The images used all portrayed realistic scenes, but were rendered either as detailed line drawings, paintings, or photographs and reproduced on black-and-white film. Participants from grades 3, 7 and 11 viewed nine projected images (three of each format) for 15 seconds apiece. After each image, the students answered five multiple-choice items about the factual content of the image.

The results revealed that for all age groups, the lowest mean score was for photographs. For students from grades 7 and 11, line drawings yielded the highest mean score, while the grade three group performed

best using paintings. Curiously, the grade 11 participants had the lowest mean score for all three image types. Moore and Sasse (1971) report the differences to be significant. This study suggests that immediate recall of image content is generally highest for images with less detail.

Katzman and Nyenhuis (1972) also examined immediate recall of image content. For their study, however, the independent variable of interest was not the style of illustration, but whether it was rendered in color or grayscale. The experiment used projected images of a series of six posters and a sequence of 10 comic book pages, with the viewer controlling the pacing. Half of the undergraduate participants saw black-and-white renditions of the images, and the other half saw the original color image. After viewing the entire series of images, the students completed a questionnaire designed to assess interest value of the posters. Following this, they completed a multiple choice recall test about the comic book pages. The questions fell into four categories: material which was central to the plot and conveyed by text on the pages; material which was central to the plot and conveyed by the illustrations; "peripheral" information conveyed by text, (for instance, a nameplate on a door); and peripheral illustrated information. The experiment was repeated twice; once with 26 male undergraduates and a second time with 34 female undergraduates.

In both iterations of the experiment, the only significant difference in recall scores between the color and black-and-white treatments was in the realm of peripheral non-verbal information. The students who viewed the color images recalled significantly more than the students who saw the black-and-white version. Analysis of the questionnaires suggested that the students regarded the color renditions as more interesting and attention-getting. Katzman and Nyenhuis (1972) conclude that the presence of color may improve the viewer's impression of the image, but it contributes only to recall of non-central information.

One question which lingers regarding both of the previous studies is the conversion of color pictures to black-and-white. An image designed to be viewed in color may prove unsatisfactory as a grayscale image, for aesthetic reasons if not because some distinctly different colors look very similar when recorded on black-and-white film.

Berry (1991) outlines the results of a series of tests, performed at the University of Pittsburgh, of the effect of color and black-and-white images on both recognition of images and recall of picture content. For the two of the three experiments which tested recall effects, the stimulus materials were images which showed arrangements of common household items, rendered either as line drawings, as black-and-white images, or as color pictures. A third study included a fourth category: non-realistic (reversed) color picture. Participants viewed the slides for 20 seconds, and were then asked to list as many of the items portrayed in the image as possible. In all three studies, recall was significantly higher for realistic color images than for both other formats; black and white was superior to line-drawings. When non-realistic color was included, participants remembered fewer details than with any of the other three formats. Based on the series of results, Berry concludes that for recall tasks, realistic color is the most effective treatment, followed by black and white and then line-drawings.

The studies of recall memory and illustrations have not yielded entirely conclusive results. Moore and Sasse (1971) submit that simpler treatments lead to better recall, although their examination did not include color as a variable. Katzman and Nyenhuis (1972) found that students who viewed color or black-and-white versions of the same materials tended to find the color more favorable, but the only difference in recall was for peripheral information. Berry's (1991) analysis suggests that color offers a distinct advantage for recall, and furthermore that color photographs are favorable over line drawings. Much of the disparity between these results may be due to the ages of the participants or the specific nature of the materials used.

### Image Detail and Learning

Experiments on the effects of different image characteristics on recognition and recall offer insights of factors which may influence the degree of attention a learner may give an illustration, and those which help the individual to gain information from the image in an undirected setting. However, the selection of pictures which are to be used for specific instruction requires additional information. Determining how different

types of illustrations influence what a person can learn from a lesson requires examining how well people learn from a lesson accompanied by a variety of illustrations. The research discussed in this section follows this line of inquiry.

Dwyer (1967a) conducted a test of different levels of realism in illustration using a 2000 word lesson on heart anatomy and physiology, administered as a tape/slide presentation. Learning was evaluated using four criteria: a drawing test which required the student to draw a sketch of the heart and label 18 structures; an identification test in which the student named 20 structures on a shaded drawing; and two non-visual tests of terminology and comprehension. The experiment included four conditions: a lesson with no illustrations (control); and lessons illustrated with either black and white renderings of simple line drawings, realistic shaded drawings, or realistic photographs. The results of 108 college freshmen taking part in this study suggested that for the visual criteria, the treatment with simple line drawings was most effective; for the terminology and comprehension criteria, no illustrations offered any benefit. Overall, the treatment with photographic illustration yielded no better results than the lesson with no illustration.

Dwyer (1968) repeated the experiment, adding color versions of each of the illustrated treatments. The participants in the second study were high school students in grades 9, 10, 11, and 12. The results showed that the black and white line drawing was most effective for the ninth, tenth, and eleventh graders (using the total score on the four criteria). However, the twelfth-graders who received the black-and-white shaded drawings outperformed the twelfth-graders in other treatments. When Dwyer (1971) repeated the experiment again, with 261 college students as participants, the students who received the lesson accompanied by the color version of the shaded drawings scored best on the identification criterion. The results of these two studies suggest that the best choice of illustration style may rely not only on the instructional objectives, but also the age group or experience of the learners.

### *Effects of Lesson Pacing*

The three studies described in the preceding paragraphs all used an externally-paced lesson format. Dwyer (1967b, 1968) adapted his lesson materials to a self-paced, programmed instruction format for further investigation. In an experiment using the modified materials with monochrome versions of line drawings, shaded drawings, and realistic photographs, or (as a control) plates which had only the labels but no accompanying illustration, Dwyer (1967b) found that college students achieved the highest mean scores (overall) with instruction including realistic photographs. A repetition of this experiment (Dwyer, 1968), with ninth-grade participants using the programmed-instruction treatments, showed that for the drawing and identification criteria, photographic illustration resulted in the greatest performance. For the overall scores, however, the instruction without visuals was more effective.

### *Effects of Learners' Prior Knowledge*

In addition to learning objectives, age of learner, and pacing, another factor which may influence the effectiveness of various types of illustration is the extent of the learner's prior knowledge. Dwyer (1975) used the heart lesson materials, in programmed instruction form, to examine the relative performance of college students with low, medium, and high levels of prior knowledge of human physiology. Although students in the high prior-knowledge group consistently outperformed the others, the differences in performance were significantly smaller when the lesson was illustrated using line drawings or shaded drawings. Dwyer observed that as illustration detail increased, the difference in time required for students with varying levels of prior knowledge also increased. Students with less prior knowledge required longer to complete lessons illustrated in greater detail than did the high prior knowledge students.

Joseph and Dwyer (1984) also tested for interaction between the degree of prior knowledge and the level of detail in instructional illustration. For this experiment, the instructional material was once more the heart lesson, and was given in a both self-paced and externally-paced formats. The variations of "realistic shaded drawing" were omitted, and a

new category, “hybrid illustration” was added. The hybrid illustration was half line drawing and half photograph of model.

The researchers divided the 374 participating grade 10 students into categories of low, medium, and high prior knowledge, based upon their performance on a physiology pretest. From this point, the experiment proceeded as did the previous ones. The experimenters concluded that:

- 1) using visualization was effective in reducing differences in achievement between students with low and medium pre-test scores;
- 2) Illustrations did not enhance externally-paced instruction;
- 3) Medium and high-level students may benefit from the use of realistic illustration, depending on pacing and type of objective.

These conclusions offer further evidence that instructional pacing and the extent of the learner’s knowledge influence the choice of illustration, with greater available time and greater prior knowledge resulting in gains from higher realism in the pictures.

#### *Effects of Learners’ General Intelligence*

Dwyer (1968, 1971) found evidence that learners in more advanced levels of school were more likely to benefit from the detail in realistic illustrations. Dwyer (1975) and Joseph and Dwyer (1984) obtained results which suggest that a higher level of subject-specific previous experience also tend to lead to greater ability to benefit from realism. The trend appears to be that individuals with an advantage in knowledge or development are better able to process the information available in detailed illustrations. Further evidence suggests that the same holds true when general mental ability is taken into consideration.

Berry and Dwyer (1982) and Parkhurst and Dwyer (1983) performed tests using variations of the Dwyer (1967a) materials and students divided into three levels of general intelligence based on standardized IQ scores.

Berry and Dwyer (1982) included slide/tape treatments with no illustrations, with monochromatic shaded drawings, with realistic color shaded drawings, and with non-realistic color shaded drawings. The university students who participated took the Otis Mental Ability test, and

based on their scores were rated as average, above average, or below average ability. ("Average" included the mean score plus-or-minus 1/2 standard deviation). Students were randomly assigned to one of the treatments, and then completed the four criterion tests. Based on the results which were statistically significant, Berry and Dwyer submit that low-ability students do not benefit from the use of higher levels of realism, and that the use of non-realistic color serves as an interference for average students.

Parkhurst and Dwyer (1983) used a self-paced, programmed instruction version of the heart lesson to test the effects of level of illustration detail on achievement by students of varying levels of ability. Treatments (all monochrome) were illustrated with line drawings, detailed shaded drawings, photographs of a realistic model, or were unillustrated. The university student participants were divided into three ability groups, as with the Berry and Dwyer (1984) study, and completed the lesson materials prior to taking the four criterion tests. Under this self-paced condition, low-ability students showed gains on all criteria when administered the photographically-illustrated treatment. Even so, the difference between high and low ability students was greatest with this treatment, because the high-ability learners demonstrated an even greater gain from the use of realistic detail. These results imply both that increased available time improves opportunity to benefit from realism in illustration and that students having a "cognitive edge" can make greater use of realism in a variety of settings.

#### *Effects of Special Illustrations*

The use of the hybrid illustration type for the heart lesson introduced by Joseph and Dwyer (1984) raises the question of whether illustrations which incorporate the simplifying aspects of line drawings and the context offered by realistic images might offer specific advantages. Joseph (1983) modified the experimental materials by including both the hybrid illustration already described and a treatment which placed the line drawing and photographic illustration side by side. He used these materials in both self-paced and externally-paced formats to present the lesson to tenth-graders with various reading abilities. Overall, the highest

achievement resulted in the groups using the lesson illustrated with the hybrid pictures. In the condition using the externally-paced lesson, students with low reading ability performed better with simple line drawings; middle- and high-ability students achieved better using the hybrid illustration. Low reading ability students using the self-paced lesson performed best when the illustrations included both the simple line drawing and the photograph. Medium ability readers in the self-paced condition scored highest when presented photographic illustrations, and the best treatment for high ability readers, as in the externally-paced condition, was the hybrid illustration. Although students with low reading ability apparently were unable to benefit from extra information provided by more realistic treatments unless they were given time to deal with the written material, the use of simple illustrations augmented by realistic contextual information appears to have offered genuine benefit.

Lamberski and Dwyer (1983) tested the effectiveness of two methods of focusing learners' attention on important aspects of line drawings. Their materials were programmed-instruction versions of the heart lesson prepared with line drawings which were either color-coded or coded in black-and-white. They found that the color-coded materials led to significantly better performance on all criteria, both for immediate and delayed post-tests.

Dwyer and Moore (1992), Dwyer and Moore (1995), and Moore and Dwyer (1991) also tested the effectiveness of color-coding versus black-and-white coding on line drawings illustrating the heart lesson. The result of these studies also suggested that color coding was the superior treatment. As with Lamberski and Dwyer (1983), these studies were concerned with a comparison of the two formats of coding, and consequently did not compare a treatment which had no coding whatsoever. However, based on the results obtained by Trabasso (1963), presented in the review of concept learning research, it seems probable that coding should offer an advantage over uncoded materials.

### **Illustrations for Instruction: Concluding Remarks**

The results of research report in the preceding sections suggest several general conclusions regarding the use of illustrations for learning. First, the inclusion of illustrations with instruction for visual tasks generally improves learning. However, the type of image which is most beneficial depends on a variety of factors. The amount of benefit from increased realism generally rises with the learner's age, previous experience in the subject domain, and mental ability. Students who are allowed to proceed through instructional materials at their own pace are able to derive more information from detailed illustrations, while simpler illustrations are more appropriate for externally paced instruction. Detailed, realistic images seem to take longer to understand. Combining simplified and detailed images with instruction appears to offer the learner an opportunity to see important details and also the general context, leading to improved learning. If emphasis is provided by coding important aspects of an image, color coding seems more effective than monochromatic coding.

In terms of recognition and recall without specific learning objectives, color seems to improve recognition, but may increase recall only for peripheral material. Viewers seem to find color images more pleasing, at least as compared with monochromatic renderings of color originals. For learning tasks in which color is not an important attribute dimension, the value of color in instructional images is uncertain.

### **Field Dependence-Independence**

Asch and Witkin (1948, cited in Witkin and Goodenough, 1981) conducted studies into the means individuals use for maintaining upright posture. The measure employed was the Body Adjustment Test (BAT), and required individuals seated in an adjustable chair in an skewed room to adjust the chair's position themselves to the upright, regardless of the room's orientation. The experiments investigated this question unveiled an issue that continues to reveal profound effects in education. The results of the studies suggested that while some individuals were able to orient themselves spatially in the absence of meaningful visual referents, others

could not. Subsequent experimentation revealed that, when placed in a darkened room, those individuals unable to orient themselves without visual cues also failed to position a luminescent rod in an upright position within a luminescent rectangular frame which was tilted away from the conventional square orientation. Persons who succeeded on this task (the Rod-and-Frame Test, or RFT), ceased to perform well when lying on their backs. The differences in behavior suggested that some people consistently rely on external, visual information for spacial orientation while others consistently depend on internal (vestibular) cues. When deprived of accurate inner-ear signals, the second group of individuals ceases to enjoy an advantage on an instrument such as the RFT. Witkin and Goodenough described the two extremes of a continuum reflected by the extent that individuals rely on the visual field as “field-dependent” and “field-independent.”

Witkin and Goodenough (1981) and Witkin, Oltman, Raskin and Karp (1971) present a summary of research efforts which followed the initial studies of physical orientation. Both sources cite the works of Witkin (1950), Witkin, Dyk, Faterson, Goodenough, and Karp (1962), and Witkin, Lewis, Hartzman, Machover, Meissner and Wapner (1954) as demonstrating the relationship between an individual’s performance on the BAT and RFT and the ability to disembed figures in complex drawings. The instrument used to measure disembedding ability was the Embedded Figures Test (EFT). What the three tests (BAT, RFT, and EFT) share in common is the ability to detect to what extent an individual is dominated by the surrounding visual field (Witkin, Oltman, Raskin & Karp, 1971).

The following sections outline the effects that field dependence manifests in individuals’ performance of a variety of learning tasks and the efforts taken in visual learning to reduce these effects.

### **Effects in Learning**

Simply on the basis that performance on a visual task such as the embedded figures test is a common measure of an individual’s degree of field dependence, we may expect field dependence to be reflected in performance in any visual learning task. However, investigators have found

connections between field dependence and a wide variety of learning factors, many of which are not strictly visual. Effects noted include the learner's ability to: detect subtle signals (Moore & Gross, 1973); selectively attend to a specific task (Avolio, Alexander, Barret, & Sterns, 1981); automatize simple sequences (Jolly & Reardon, 1985); and write coherently (Williams, 1985). In each of these arenas, those persons whose scores placed them toward the field dependent end of the continuum showed significantly poorer performance on the task at hand.

### Concept-learning, Context, and Transfer

Some evidence has emerged that an individual's degree of field dependence may affect concept learning. We may expect a person whose perception is to some degree dominated by the entire visual presentation to have greater difficulty articulating a stimulus into its component attributes than someone who can impose structure on the field. Goodenough (1976) offers the results obtained by Dickstein (1968) as evidence that in concept-attainment environments, field-dependent learners tend to be dominated by the most noticeable cues, regardless of the relevance of those cues.

The difficulty of the field-dependent learner in articulating a stimulus appears to lead to the use of different approaches to learning conceptual material. Kirschenbaum (1968; cited by Goodenough, 1976) analyzed the error patterns in students of varying degrees of field dependence as they solved abstract conceptual problems of the kind used by Bruner, Goodnow, and Austin (1956). The patterns revealed that as field independent students repeated the task, nearly all adopted the more efficient wholist strategy (as described by Bruner, Goodnow, and Austin). Field dependent students, however, tended to continue using the partist strategy even after practice. The partist strategy involves fixing a single attribute at a time to construct hypotheses, and while effective is more time-consuming than the wholist strategy. The wholist strategy requires the learner to discern all attribute values present in a stimulus for construction of a hypothesis.

Park (1984) also examined the effects of field dependence and concept attainment. Park's results indicated that field dependent learners presented the concepts "positive reinforcement," "negative reinforcement," "positive punishment," and "negative punishment" did not succeed as well on post-tests as field independent learners. His conclusion is that field-dependent learners rely heavily on external examples while field-independent learners organize and use their own examples based on a few training instances.

Based on findings, including those discussed in the preceding paragraphs, which link individual differences in field dependence with performance ability on a variety of activities involved in learning, Davis and Cochran (1989) suggest that instructional designers develop strategies for accommodating individual differences, including provision of organizational aids and arriving at techniques to focus attention on critical attributes.

In addition to affecting the individual's approach to concept acquisition, a person's degree of field dependence may influence ability to transfer certain types of knowledge to novel contexts. A context different from the learning environment may offer a host of irrelevant information, which can result in retroactive interference. Frank (1983) exposed field dependent and field independent learners to a paired association task. Each stimulus word, presented in uppercase, was a homograph (a word with two or more distinct meanings). Learners were presented the stimulus lists with an adjacent list of lowercase words, each of which was one possible interpretation of the stimulus word beside it. During the recall test, students were presented either the same list of cues (context) or a list composed of other meanings for the stimulus words. For instance, if the stimulus was "TEMPLE" and learned with the context cue "forehead," the cue presented for the recall task might be "forehead" or "church." Field dependent and field independent students recalled the same number of stimuli when the recall context was the same as the learning context. Under conditions of free recall, there was no significance in the difference of recall between field dependent and field independent students. However, when the alternate context was presented, field independent

students recalled a significantly greater number of the words than their field dependent counterparts. Frank submits that the difference in performance results from greater rigidity in the field dependent's information processing. Goodenough (1976) offers an alternate explanation based on similar work by Gollin and Baron (1954)—that field independent learners can impose an appropriate organization on the lists.

### **Interactions with Illustration Types**

The effect of field-dependence on the individual's ability to distinguish embedded features coupled with the tendency of field-dependents to focus on single prominent features rather than the articulated set of attributes represented has prompted an extensive quest for ways to improve learning for field-dependent students on assorted visual learning tasks.

One body of work has addressed the influence of illustrating with varying degrees of realism on the performance of field-dependent students using materials based on Dwyer's (1967a) heart lesson. In a test for interaction between illustration complexity and field dependence, Canelos and Taylor (1981) used three types of color illustration: simple line drawing, shaded illustration, and realistic photograph. The undergraduate participants viewed a slide/tape version of the lesson and their performance was evaluated using the drawing, terminology, and comprehension criteria. Scores on the three criteria indicated no interaction of image complexity and level of field dependence. Canelos, Taylor and Altschuld (1983) replicated these results using the same materials.

Wise (1984) also investigated the possibility of interaction between image complexity and field dependence. He suspected that on a drawing test, field dependent and field independent learners would perform at the same level if they learned from line drawings, but that field independent learners would outperform field dependents on the same task if the illustrations were a realistic photograph. His learners, 40 raw recruits at the Navy Hospital Corps School, all performed at about the same level when presented instruction accompanied by realistic photographs. Both groups

of learners performed better on this task when their lesson was illustrated with simple line drawings. Wise's suspicions were not confirmed. Given the setting of the experiment, there may have been a number of factors operating which are not usually present in a traditional learning setting.

Image complexity does not seem to interact with field dependence; however, Moore and Dwyer (1991) examined the effect of color coding on student performance by level of field dependence. Their hypothesis was that the addition of color cues would aid field dependent learners in picking out significant information in the illustrations. Using a version of Dwyer's (1967a) heart lesson illustrated by either black-and-white or color-coded line drawings, they found "nonsignificant interaction...between treatment and the three levels of interaction" (p. 614) on performance as measured using the terminology and comprehension criteria. However, the results using a visual criterion (Dwyer & Moore, 1992) revealed a greater improvement in the performance of field-dependent learners when the lesson was color-coded. The improvement placed the achievement of field-dependents very near that of field independents. Results for the groups which used the lesson illustrated with monochromatic line drawings showed a wide gap in performance, depending on level of field-dependence. Although color-coding does not seem to influence achievement on non-visual learning objectives, for a visual task color emphasis on important parts of the drawing appears to provide meaningful assistance in articulation.

The results obtained by Canelos and Taylor (1980), Canelos, Taylor and Altschuld (1983), Moore and Dwyer (1991), Dwyer and Moore (1992) and Wise (1984) were all obtained using variations of Dwyer's (1967a) heart lesson. Although these materials cover several types of learning objectives, none of them is exemplary of the concept attainment task—learning to categorize stimuli based on defining attributes. French (1984) used a real-life concept attainment task to examine interactions of illustration type and level of field-dependence. With a learner population of 492 trade apprentices, she examined the effects of detail in illustration on the ability of field-dependents and field-independents to learn to identify five types of diesel fuel injectors. The illustrations were either color-coded or black-and-white,

simple or complex line-drawings. The presentation of material was by an externally-paced audio tape and filmstrip. Criteria for performance were first a task of identifying (classifying) an assortment of drawings of fuel injectors, and a second task in which the learner classified *real* fuel injectors.

French's (1984) results suggest that simple color-coded line drawings provided learning assistance for field dependent students, although color-cueing did not confer any advantage in general. This agrees with the findings of Dwyer and Moore (1992). In addition, French states that increased complexity resulted in loss of performance in all groups, a finding which is in agreement with the results of other researchers examining illustration in externally-paced instruction (Dwyer, 1967a, 1967b, 1968; Joseph, 1983; Joseph & Dwyer, 1984).

### **Related Research: Conclusions**

Studies of concept learning have revealed that as the number of attribute dimensions in a problem increase, the difficulty of learning the concept also increases. Even if the number of relevant attribute dimensions is small, if there are many other irrelevant dimensions, the problem becomes more difficult. Another factor which influences the relative difficulty of a concept-attainment task is the amount of variation possible in an attribute value. If a range of subtly-differing values are acceptable for category membership, the length of time for accurate learning increases. To an extent, these findings are recapitulated in the research on the effect of different types of illustration on learning. The general results obtained in a number of studies suggest that more detailed illustration requires greater time and/or knowledge to interpret, and may result in confusion when time is limited or the learners lack experience or mental ability.

Some results (Di Vesta & Peverly, 1984) have also suggested that diminished detail may inhibit transfer of the learned material to settings outside the learning environment. If this is the case, a person trying to present conceptual material is torn between the need to reduce irrelevant dimensions in order to speed learning, and the need to maintain contextual information to promote transfer. One compromise is to preserve

the presence of irrelevant dimensions but make the defining characteristics accessible. Trabasso (1973) demonstrated the effectiveness of using color or exaggeration to emphasize the single definitive attribute dimension of a problem with five irrelevant dimensions. Lamberski and Dwyer (1983), Moore and Dwyer (1991), Dwyer and Moore (1992), and Dwyer and Moore (1995) found that color coding proved more satisfactory than black and white coding when used in a sample lesson. Joseph (1983) and Joseph and Dwyer (1984) showed that integration of pictures which included both line-drawing simplicity and photographic realism improved learning in some cases.

Individuals of varying degrees of field dependence perform differently on both concept attainment tasks and in interaction with illustrations. Persons described as field dependent have difficulty articulating complex images, and are less likely to perceive significant details. Due to their tendency to fixate on salient irrelevant cues and the possibility that they employ less efficient concept attainment strategies, field dependent learners may require additional time for success in concept acquisition, and may demonstrate greater difficulty transferring learned knowledge to new contexts. The use of color-coding appears to assist field-dependent learners to properly articulate visual stimuli and attend to appropriate details when they are performing visual tasks.

In experimental situations, concept learning usually involves concepts defined by relatively few attribute dimensions, and portrayed with fairly simple drawings. Outside the laboratory, concepts may be extremely complex, involving any number of relevant and irrelevant dimensions. The tasks faced in day to day life may mandate transfer to a variety of situations rife with potentially-confusing irrelevant information. Unlike experiment participants, persons attempting to learn categories in school or at work may have limited time and feedback. At the university level, the only definitive feedback may be a final exam.

Consider the mature students in a university course faced with the problem of quickly learning to categorize a large number of plant or animal species, and then applying this knowledge in the field. If we wish to illustrate instructional material for such students, the research in concept

attainment and illustration suggests that for the benefit of transfer, the images be realistic. However, to prevent the learners from being distracted by irrelevant attribute dimensions, the important features of each concept illustration should have some kind of emphasis. An issue of further interest is whether such emphasis will result in differential improvement of learning by field dependent students. . The results described in the preceding pages suggest that emphasizing the important attributes in photographic illustrations accompanying a concept-learning task should improve learning and transfer. Furthermore, such emphasis should assist field-dependent learners to focus on important information rather than the most salient cues present. The following experiment is a test of photo realistic illustrations with attribute emphasis for use in learning concepts in a natural science domain.

### **Hypotheses**

- 1) Learners presented a lesson on tree identification illustrated with photographs having emphasized critical attributes will score higher on the post-tests than learners presented a similar lesson that uses unmodified photographs.
- 2) Field independent learners will score higher on the post tests than field dependent learners, regardless of the type of illustration.
- 3) Field dependent participants in the treatment group will demonstrate a greater increase in performance than will their field-independent counterparts.

## **Research Methodology**

The purpose of this experiment was to determine the relative effectiveness of attribute-emphasis for photographic illustration used in a concept attainment task for learners having different degrees of field dependence. The experimental task was a computer-based lesson on the identification of four species of maple trees based on the appearances of their leaves. Students' success in the task was evaluated by two criteria: a computer-based multiple choice test using digitized photographs and a second multiple-choice instrument using real leaves. Independent variables were type of illustration (plain photograph or photograph with emphasized attributes) and degree of field dependence (field-dependent, indeterminate, or field-independent). The two post-tests provided two dependent variables, with a third composed of the total obtained on both tests.

### **Materials Used**

The Group Embedded Figures Test (GEFT) was used to assess each participant's relative degree of field-dependence. The GEFT is a form of the Embedded Figures Test (Witkin, 1950) designed for administration to several individuals at a time. It is a timed instrument including 18 disembedding problems, and has a reliability of 0.82 (Witkin, Oltman, Raskin, & Karp, 1971).

An audio recording of the instructions for the GEFT, as presented by Witkin et al. (1971) was used for administration of the test in order to assure that each group of participants received the same instructions.

A questionnaire about trees (see Appendix I) provided information about each individual's existing knowledge of tree identification. The lesson was delivered using 6 Apple Macintosh IICx and 3 Apple Macintosh IISI computers, equipped with 13-inch color monitors. The lesson itself was a program written in AuthorWare, and included directions for the lesson and also the first post-test of fifteen multiple choice items. A single version of the program contained both versions of the lesson. Images for the lesson

presentation and quiz were photographed by the investigator against gray or black card stock.

The second post-test required real leaves; 28 specimens (seven from each tree species) were collected from the Montgomery County, Virginia region, and mounted on paper or railroad board using a laminating press. The leaves included specimens displaying a variety of colors and size, but each exhibited the characteristic attribute values of its parent species. John Peterson, an Urban Forestry expert employed by Virginia Tech's College of Forestry and Wildlife, confirmed the species identity for each leaf and photograph used.

### **Experiment Design**

Because participation was voluntary and not compensated, the procedure was prepared to minimize each participant's time investment. It was necessary to select a task and criteria which could be completed by the participant in less than one hour. To determine success of learning, an immediate post-test was necessary. In addition, to ascertain whether the treatment influences transfer, a post-test in a different medium was also desirable. Although a delayed test of retention would be valuable, since participants would not be compensated it did not seem realistic to anticipate a large percentage of them returning at a later date for a post test. Furthermore, owing to the nature of the concepts presented, such a test may not be meaningful, as some participants may elect to "cram" prior to the test for retention.

### **Selection of the Task**

The object of this study was to test the effect of modifying photographs used for a concept-attainment task similar to those faced by university students. A difficult classification task—one in which the most obvious characteristics are not necessarily the most important—would satisfy this need. The investigator chose the task of distinguishing between four species of maple trees because of personal experience, acquired as an undergraduate student and as the developer of a multimedia course supplement for the dendrology lab taught at Virginia Tech, with the difficulty of learning to identify trees.

With the general task determined, it was necessary to select specific concepts from the domain to use for the lesson. It was necessary that each concept be genuinely distinct, and yet not identifiable by the most obvious attributes. Many trees, such as Yellow Poplar and Sweetgum, have distinctly unique leaves. The leaves of others (most oaks for instance) vary so greatly that leaves are not a reliable method for distinguishing species. Maples, however, have similar leaves which are nonetheless sufficiently distinct to serve as a method of accurate identification most of the time.

Leaves are familiar everyday objects, but the distinctions between the leaves of the selected tree species are not obvious at first glance. Therefore the problem should prove similar to that described by Bruner et al. (1956) of learning concepts in a seemingly-familiar domain. The learner in this case is likely to rely on the most obvious attributes of the leaves rather than those which are truly diagnostic. For instance, many Red Maple leaves have reddish stems, which the investigator has heard others offer as a method of identification. However, some Silver Maple leaves also have reddish stems. Furthermore, not all Red Maple leaves exhibit this trait. The task of acquiring the four presented concepts in a limited time should therefore prove sufficiently difficult to allow determination of the instructive value of modified images.

### Preparation of Procedure

#### *Program Behavior*

In order to ensure consistency of delivery and pacing, the investigator elected to use computer-mediated instruction as the vehicle for the experimental lesson. The program, written in AuthorWare 2.01e, first solicits an ID number which is used to tag the results. The program then presents a black screen with the phrase “Experimental Lesson—Press any key to begin” centered on the screen in large type. At this point, the computer assigns the lesson format (treatment or control) based on random number generation. Once the learner presses a key, the program displays the instructions (see Appendix Two) for the lesson. While the user reads the instructions, the program generates a list of 15 random numbers, without repetition, which indicates the choice and sequencing of the

images used for the first post-test. When the list is finished (four to seven seconds), the computer displays “Press any key to continue” at the bottom of the screen, below the instructions.

The lesson format is simple: on the right-hand side of the screen appears a text description of the name of the leaf and its defining attributes, on the left appears a picture of the leaf (either a plain or a modified photograph). The display remains for a set period time, and is replaced by the next leaf. The order of presentation is Red Maple, Silver Maple, Norway Maple, Sugar Maple. After the last leaf has been displayed, the computer displays an image of all four pictures side-by-side, with the name of each tree appearing above the appropriate leaf. This image remains on the screen for 20 seconds, and is then erased.

After the lesson terminates, the computer displays the instructions for the first post test and an example of the “button panel” used for answering. The panel consists of four rectangles arrayed on the right side of the display, each bearing the name of one of the four trees and a number from one to four. The user may choose an answer either by pressing a number key or by directing the cursor to the “button” and clicking the mouse. The user presses any key to proceed after reading the directions, at which time the computer displays a clock icon and counts thirty seconds before beginning the quiz. The purpose of the delay is to diminish the likelihood of recency effect on the initial questions.

The quiz proceeds by displaying a plain picture of a leaf, chosen from a pool of 24 as indicated by the first random number generated for this session. The image remains on display until the user chooses an answer, and then the next image appears. This process continues until the user has identified fifteen images, and then the screen blanks, displaying a message instructing the participant to report to the experimenter for the next phase of the test. The program then appends the participant’s identification number and scoring information to a file of results.

### *Pilot Studies*

A pilot study was necessary not only to test the general procedure, but to determine appropriate pacing for the lesson materials. Given

sufficient time, even a person using a very inefficient concept attainment strategy may successfully learn a concept. Since one of the considerations of this study was to determine the effectiveness of the treatment when learners face time pressure, the lesson must be appropriately paced.

The first pilot used only the computer-based lesson and test, with the lesson option forced to be the control condition. The object was to select a length of exposure which would yield a mean score of forty to fifty percent for individuals in the control group. The rationale was that with four-choice items on the post-test, random selection could account for a score of 25 percent. If the average score were in the range of 20–30 percent, the lesson may be paced too quickly for the person to have learned anything. Average scores over fifty percent may not leave sufficient “room for improvement” to detect any benefits conferred by the treatment. After 15 trials, using volunteers at home and from the Instructional Technology program, the investigator determined pacing of 7.5 seconds per image, with 15 seconds for the recap picture.

During the experiment sessions including the first 13 volunteers some problems emerged which required modification to the procedure. Several of the participants complained that they did not have enough time to read the text and look at the picture. The alert sounds on several of the computers were set to be a “quack” at maximum volume. AuthorWare plays the alert sound at completion of a timed pause, and pandemonium erupted as the relative quiet of the lab was intermittently broken by one loud “quack” after another. Finally, the original answer sheets for the second post-test appeared to be inadequate, for several people wrote two answers for one question while omitting the answer for the next.

Owing to the described problems, the investigator elected to regard the first thirteen data points as a second pilot study and make corrections to the procedure. The time per image was increased to nine seconds, with 20 for the recap; the alert sounds on all nine machines were adjusted to be a simple beep at the lowest volume, and the investigator redesigned the answer sheets for the second post test.

### Preparation of Attribute-Isolation Images

The modifications to each image were intended to make explicit the defining characteristics of each leaf, while leaving the context (the suite of irrelevant dimensions) visible. Park (1984) suggests that providing learners with only the rules for concept definition diminishes retention; others (Di Vesta & Peverly, 1984; Koran et al., 1975) submit that presenting the rules in the presence of exemplars and in broad context enhances transfer. The attribute-isolation images are an effort to serve both purposes with one illustration.

The leaf images used for the lesson were photographed on thirty-five millimeter color film by the researcher and stored on a Kodak PhotoCD by the developing lab. The PhotoCD format was selected for the lesson images because it offers higher resolution than standard scanning. High resolution is necessary for the types of manipulations the researcher wanted to test. Images used for the control group were prepared first and modified for the treatment, so that the only differences between the two would be the intended modifications. In accordance with Trabasso (1963) the two values in each of the three attribute dimensions were emphasized in the same manner, so that the emphasis itself would not become a relevant attribute. The researcher used Adobe PhotoShop 2.51 and an Apple Macintosh IIfx to prepare the images as follows.

The first attribute of importance in distinguishing the four leaf types is the leaf margins, which are serrated on Red and Silver Maple and smooth on Sugar and Norway Maple. This characteristic was emphasized by using the highest-resolution image (288 dots-per-inch, 9 x 12 inches) and then selecting a circle including part of the leaf's edge. The selected circle was copied to the clipboard. The selection was outlined in yellow, and then the image resolution and dimensions reduced to appropriate screen resolution (72 dpi). The copied circle was then pasted onto the image and offset to an area with no detail. The resulting image has an effective enlargement of the edge of the leaf. A descriptive phrase ("Smooth edge" or "Toothed edge") was added.

The distinction between Red Maple and Silver Maple is the depth of the inter-lobe sinus. This attribute dimension was emphasized by the

addition of an arrow pointing into the sinus labeled “Deep notch” or “Shallow Notch.”

Norway Maple and Sugar Maple leaves are most easily distinguished when freshly plucked from the tree—Norway Maple leaves exude a milky sap from the base of the petiole when it is squeezed, while Sugar Maples have clear sap. This particular trait is not practical for a situation using photographs and mounted specimens for evaluation. Therefore, a more subtle, but entirely visual attribute dimension was selected: aspect ratio of the leaf. Norway Maple leaves are usually broader than they are long; Sugar Maple leaves are no broader than they are long. To emphasize this characteristic, the leaf in each picture had a circle drawn around it which was the same diameter as the leaf’s larger dimension; the image of the Sugar Maple leaf does not reach across the circle in the horizontal dimension, and the image of the Norway Maple leaf does not span the circle in the vertical dimension. As with the other attribute dimensions, these were annotated with “Broader than high” or “Not broad.”

All images were stored as 256-color PICT files. The backgrounds were solid black and the annotations and drawn elements were all white or bright yellow. A reduced-size version of all four images was prepared showing the four leaves side-by-side for the “recap” image at the end of the lesson. See Appendix Two for monochrome renderings of the images as used in the lesson.

## **Participants**

A total of 132 volunteers participated in the study. Participants were recruited by posting signs around Blacksburg and the university campus. All participants were adults over 18. Most were undergraduate students, but many were adults of many ages from various walks of life. Five were attendees for a national convention hosted at the university. About twenty percent were personal acquaintances of the researcher. Given the pool of participants, results may generalize to a typical university community.

The first thirteen volunteers (as previously noted) were excluded from the analysis. Four other data points were discarded; one because the individual left the lab in the middle of the computer-based lesson and the

other three because their introductory surveys indicated knowledge of the lesson material.

### **Procedure**

Experiment sessions included from one to nine participants at a time, with the number determined by the number of individuals who volunteered for a given session.

Prior to each session, the researcher first powered on all the computers and launched the lesson software, then shuffled (face down) the mounted leaves. After shuffling, he counted off the first twenty specimens, numbering them as they were “dealt.” The twenty selected leaves formed the second post-test for the session. The experimenter then prepared the following materials: consent forms, GEFT booklets, tree-identification questionnaires, and post-test forms. Each paper item (except the consent form) bore an identification number, and each participant received materials with the same number.

When all participants for a session were assembled, they first read and signed the consent form. When all had done this, the experimenter distributed the tree-identification questionnaires and asked the participants to complete them as fully as possible.

Following the above preliminaries, the experimenter distributed a GEFT booklet and two pencils to each participant, and started the audio tape of the directions. During administration of the GEFT, the investigator reviewed the tree-identification surveys to ascertain whether any of the data points should be excluded due to prior knowledge. After the group had completed the test and the mandated time had elapsed, the booklets were collected and the participants led to the computers. As each participant sat in front of a machine, the experimenter entered the identification number for that individual. Once all the group members were seated, the experimenter offered these vocal directions:

“These computers have a program that will teach you how to identify four trees. When you press any key, the lesson directions will begin; you can take your time reading the directions, but once you indicate that you’re finished, the

lesson will proceed at the machine's pace. When the lesson is over, the computer will give you a short quiz on what you've learned."

The investigator then left the room and arranged the twenty mounted specimens in preparation for the second post-test.

As participants completed the computer-based materials, they were handed an answer sheet and shown to the area where the mounted leaves were arranged. When they were finished marking their answers for the second post-test, the participants were free to leave. After all participants had left, the investigator scored the GEFT and the second post-test, and accessed the scores on the computers. Each individual's group assignment (Control or Treatment) and all scores were recorded on the tree identification questionnaire for later analysis.

## Results and Analyses

The study accumulated 115 data points for analysis. The design for the experiment called for a factorial analysis including two independent variables: treatment group and level of field dependence. In order to assure detection of differences between field dependent and field independent participants, the investigator divided this dimension into three categories. The average GEFT score was 12.77; the mean was 4.76. Any score in the range of the average plus and minus 1/2 standard deviation (10–14) was regarded as indeterminate; all scores below this range were classified field dependent (0–10) and all above the range were field independent (15–18). Consequently, the data fell into six cells. Because the distribution of field dependent and field independent volunteers was uneven, and the random assignment to treatment group was controlled by a random number generator, distribution in the cells was uneven. Table One shows the results for the three criteria; Table Two shows the total for each test and treatment.

**Table One:** Results by treatment and field dependence.

Test One	Field Dependent			Indeterminate			Field Independent		
	n	mean	s.d.	n	mean	s.d.	n	mean	s.d.
Control	16	8.50	2.58	18	9.39	2.28	15	11.07	3.11
Treatment	15	8.27	3.06	20	10.60	2.91	31	11.84	2.16
Total	31	8.38	2.77	38	10.03	2.67	46	11.59	2.50
Test Two									
Control	16	10.88	4.35	18	12.28	3.25	15	13.80	4.38
Treatment	15	11.93	3.99	20	14.55	4.17	31	16.10	3.57
Total	31	11.39	4.15	38	13.47	3.89	46	15.35	3.96
Total Score									
Control	16	19.38	6.29	18	21.67	4.55	15	24.87	6.37
Treatment	15	20.20	5.78	20	25.15	6.38	31	27.94	5.18
Total	31	19.77	5.97	38	23.50	5.79	46	26.94	5.71

Table Two: Criteria results by treatment.

	Control			Treatment			Total		
	n	mean	s.d.	n	mean	s.d.	n	mean	s.d.
Test One	49	9.61	2.80	66	10.65	2.94	115	10.21	2.91
Test Two	49	12.29	4.08	66	14.68	4.14	115	13.66	4.26
Total	49	21.90	6.04	66	25.33	6.39	115	23.87	6.44

The desire to test for interaction between the treatment and level of field dependence mandated the use of Analysis of Variance. Unfortunately, Bartlett's test for homogeneity of variance (Walpole & Myers, 1985) reveals that the variances of the six cells are significantly different, thus invalidating the assumption of equal variance necessary for reliable interpretation of ANOVA. Although hypothesis three could not be tested, other statistical methods allowed examination of the other two hypotheses. A version of the *t*-test exists for use with samples that do not have equal variances (Dixon & Massey, 1969). This procedure was used to test the first two hypotheses.

### Hypothesis One

The first hypothesis was that individuals who received instruction accompanied by images with attribute emphasis would score better on all post tests. Analysis of the average scores from the treatment and control groups indicates that for both tests the treatment group ( $M_1 = 10.652$ ,  $M_2 = 14.682$ ) scored significantly higher than the control group ( $M_1 = 9.612$ ,  $M_2 = 12.286$ ). Further analysis of scores within level of field dependence shows that on the second test, the indeterminate and field independent learners both scored significantly higher when given the treatment lesson; field dependents did no better in either condition. Additionally, analysis of test one performance reveals no significant difference at any level of field dependence. This difference from the result for the full sample may be due to the reduction in degrees of freedom resulting from dividing the data. Table Three shows mean scores by group and the computed values of *t* and degrees of freedom (the test for use with samples having unequal variances uses the sample sizes and variances for a calculation of degrees of freedom).

**Table Three: Tests of treatment effect. (\* significant,  $p < 0.05$ )**

		Control	Treatment	t	d.f.	
Post test 1 (computer) 15 items	F. D.	8.500	8.216	-0.228	29	
	Indeterm.	9.389	10.600	1.437	37	
	F. I.	11.067	11.839	0.867	22	
	Overall	9.612	10.652	1.930	108	*
Post test 2 (transfer) 20 items	F. D.	10.875	11.933	0.706	31	
	Indeterm.	12.278	14.550	1.882	37	*
	F. I.	13.800	16.097	1.767	25	*
	Overall	12.286	14.682	3.097	106	*

### Hypothesis Two

The second hypothesis was that field independent learners would perform better on all measures than those who were field dependent. A *t*-test made using the procedure described above supports this hypothesis for all comparisons at the 0.05 level. Table Four shows the compared means of field dependent and field independent participants in the two groups, and the computed *t* values and degrees of freedom.

**Table Four: FD vs FI. (\* significant,  $p < 0.05$ )**

		Field Dependent	Field Independent	t	d.f.	
Control	Test One	8.500	11.067	2.494	29	*
	Test Two	10.875	13.800	1.865	30	*
Treatment	Test One	8.267	11.839	4.060	22	*
	Test Two	11.933	16.097	3.431	27	*

### Hypothesis Three

As previously noted, a formal test of interaction was not possible because the data violated the assumptions required for reliable ANOVA. However, visual inspection of the results suggests that the anticipated

interaction was not present, and since the scores for field dependents are virtually the same regardless of treatment, we may conclude that hypothesis three is not supported by the data. Figures One–Three show graphical representations of the mean scores for each group on each measure.

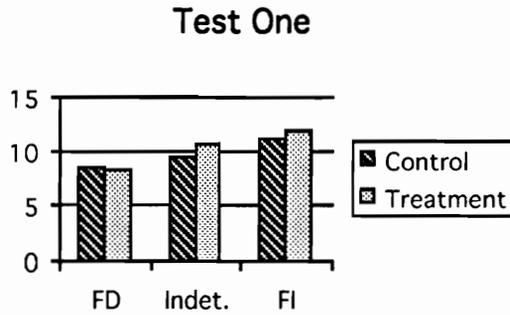


Figure One: Bar graph for first test.

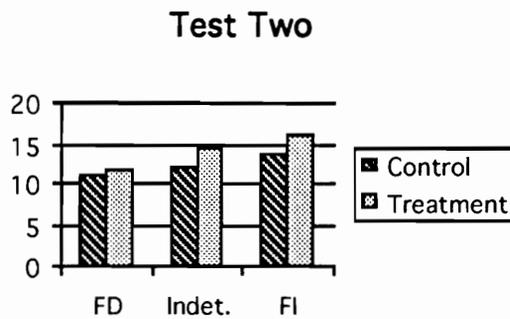


Figure Two: Bar graph for second test.

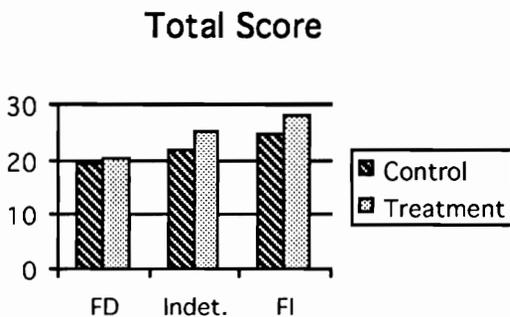


Figure Three: Bar graph for total scores.

## **Discussion**

One purpose of this study was to determine whether attribute emphasis in photographic illustrations used with lessons in concept attainment would improve learning. The results from an experiment including 49 individuals in a control condition and 66 who received the treatment suggest that while the special illustrations may not greatly enhance learning when tested in the same medium as the presented lesson, emphasizing important features in photographs appears to confer improved transfer to other contexts. The effectiveness offered follows the results obtained by Trabasso (1963) and Lamberski and Dwyer (1983): that emphasizing important aspects in images during instruction improves learning.

As has proven the case with previous research involving both concept-attainment tasks and learning including visual dimensions (for instance, Canelos & Taylor, 1981; Dickstein, 1968), field independent learners performed better than did field dependent learners. An anticipated interaction of the treatment with degree of field dependence failed to materialize, so we may not conclude that field dependent learners benefit differentially from the introduction of attribute emphasis. The analysis was confounded by erratic variance between cells.

### **Flaws in Instruments**

The difference in delivery between the two post-tests may have created some problems. Some participants mentioned that while taking the computer-based test, they had pressed the wrong key, and immediately wanted to change the choice. Unfortunately, the design of the test did not allow users to correct a mistake or to reconsider an already-made decision. The second test, on the other hand, was a series of specimens laid out on several tables. Individuals taking this test could change their answer for one item after seeing another and performing a mental comparison. When taking the second test the participants also had the benefit of practice on the first test.

Hindsight is always 20-20. A repetition of this experiment should include the following measures:

- 1) Means of correcting a mistake on the first test;
- 2) Means of tracking answers for each item to permit an item analysis;
- 3) An additional test requesting the learner to list the important attributes of each concept. This would allow evaluation of the extent to which learning the rules assists with a subtle perception task.

In spite of the described shortcomings, the results of this study suggest further investigation of the image modification techniques used.

### **Questions for Further Research**

Based on the statistical results and informal observation, the author feels that this study raises additional questions for investigation. First, a repetition of this experiment with changes to procedures and materials as described above is necessary to lend confidence to the findings. Second, the study should be repeated using some form of self-paced instruction. An additional realm of inquiry involves the types of emphasis used—if attribute emphasis is beneficial, then the effects of various methods of emphasis should be evaluated. Further study might involve the use of attribute emphasis in combination with brief practice and also with other types of learning objectives.

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**APPENDIX ONE**  
Pre-Test<sup>1</sup>

Introductory Survey

P# \_\_\_\_\_

This questionnaire is not a measure of intelligence or aptitude. It provides important information required for the experiment you are taking part in. Please answer these questions as accurately as you can.

1. Which of the following pairs of trees can you tell apart? Check the box next to each pair you believe you can distinguish from one another.

A.  Scarlet oak/Pin oak

E.  Red maple/Silver maple

B.  Burr oak/Black oak

F.  Sugar maple/Norway maple

C.  Pin oak/Burr oak

G.  Sugar maple/Red maple

D.  Scarlet oak/Black oak

H.  Red maple/Norway maple

2. For each box you checked for number one (above), please state how you would distinguish between the two trees. Please make your description as detailed as possible. If you would use multiple criteria, please state this.

A. Scarlet oak/Pin oak

B. Burr oak/Black oak

C. Pin oak/Burr oak

D. Scarlet oak/Black oak

E. Red maple/Silver maple

F. Sugar maple/Norway maple

G. Sugar maple/Red maple

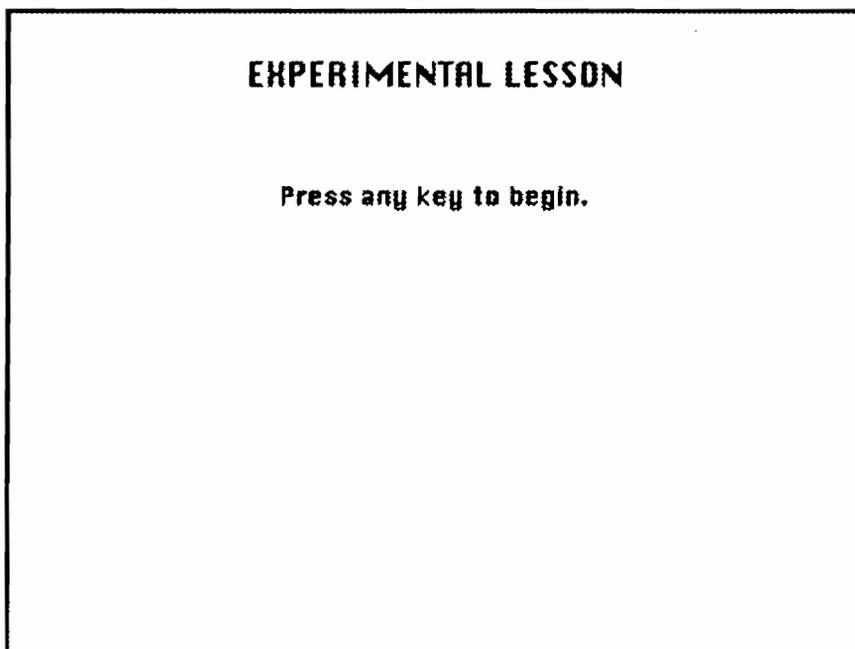
H. Red maple/Norway maple

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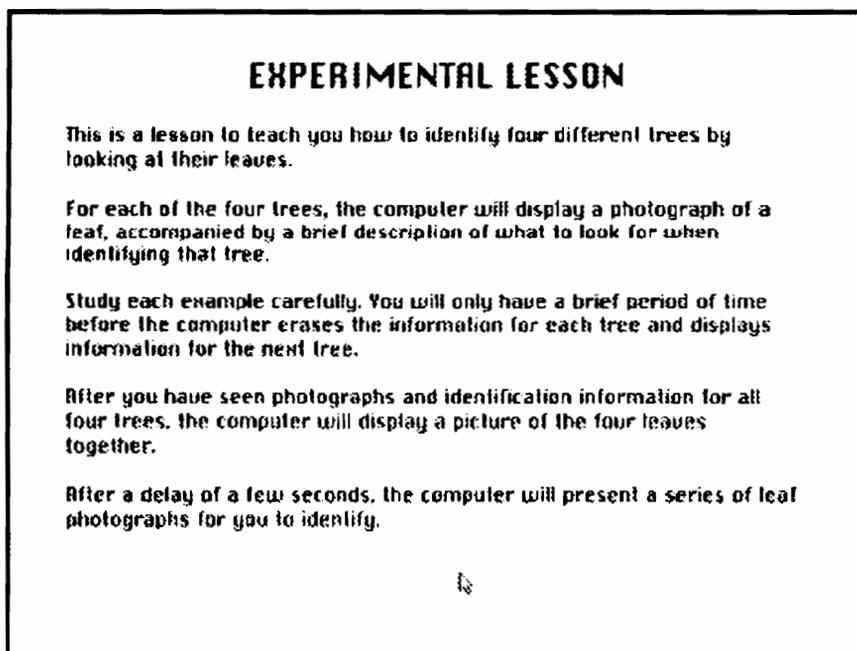
<sup>1</sup> Form shown reduced to fit in a bound volume.

## APPENDIX TWO

### Lesson Screens<sup>2</sup>



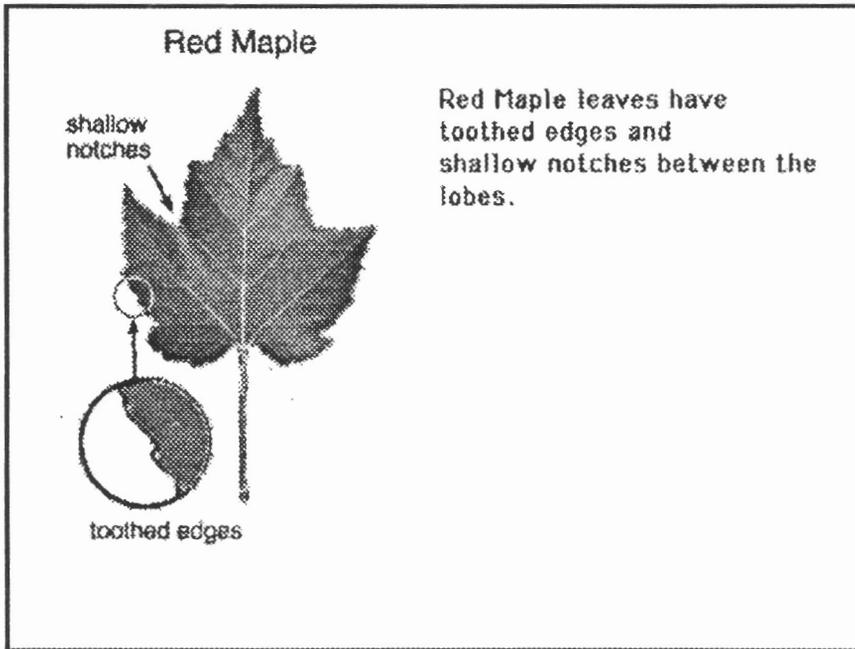
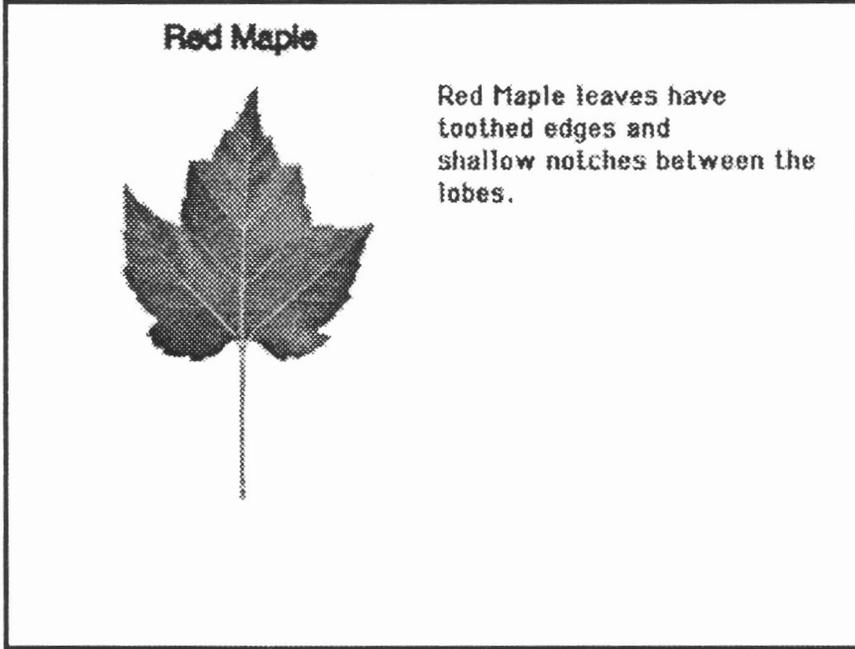
Initial Screen



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<sup>2</sup> Original screens were in full color. Backgrounds were black and lettering was yellow or white. Boxed area represents a full 13" diagonal screen. Downsizing resulted in considerable loss of image quality.

Directions Screen



First leaf. Control (top) and Treatment (bottom).

**Silver Maple**



Silver Maple leaves have toothed edges and deep notches between the lobes.

**Silver Maple**



Silver Maple leaves have toothed edges and deep notches between the lobes.

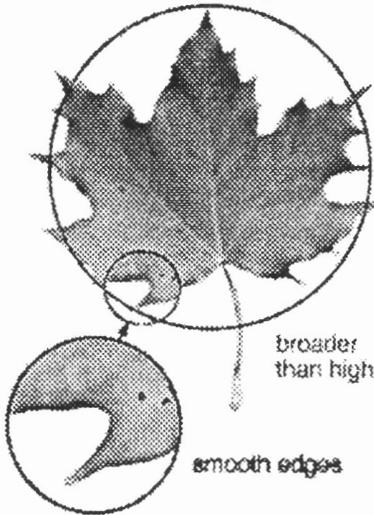
Second leaf. Control (top) and Treatment (bottom).

Norway Maple



Norway Maple leaves have smooth edges and are broader than they are high.

Norway Maple



Norway Maple leaves have smooth edges and are broader than they are high.

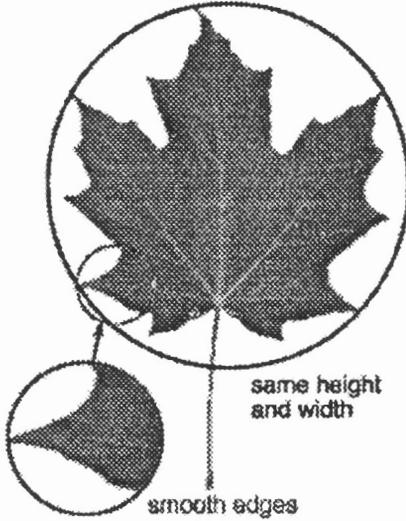
Third leaf. Control (top) and Treatment (bottom).

Sugar Maple



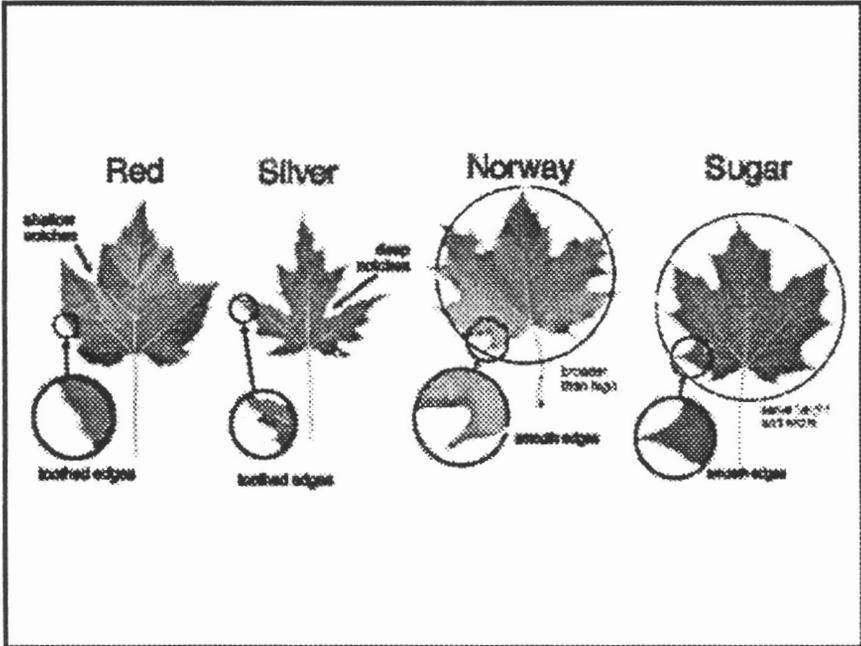
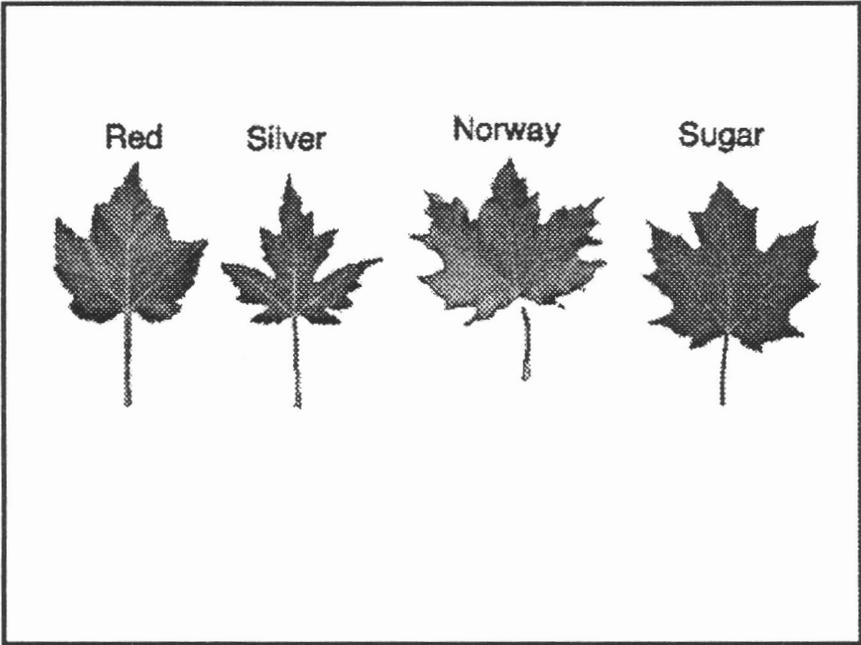
Sugar Maple leaves have smooth edges and are about as high as they are broad.

Sugar Maple



Sugar Maple leaves have smooth edges and are about as high as they are broad.

Fourth leaf. Control (top) and Treatment (bottom).



Recap Image. Control (top) and Treatment (bottom).

Think about what you have seen about identifying the four trees.

When you are finished reading these directions, the computer will present a series of leaf photographs.

For each photograph, use the mouse to select the name of the tree you believe the leaf belongs to...

**OR**

Press the number key on the keyboard which matches the number on the screen next to the tree's name.

The answer choices will look like the set of "buttons" to the right.

Press any key to begin. 

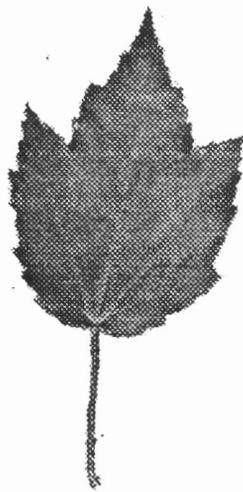
Norway Maple 1

Sugar Maple 2

Red Maple 3

Silver Maple 4

Quiz Directions.



Red Maple 1

Silver Maple 2

Norway Maple 3

Sugar Maple 4



Example Quiz Question.

You are now finished with part one of the experiment. You may now report to Richard Croft to proceed with the next phase.

Final Screen (Appears after 15 test items).

**APPENDIX THREE**  
**Answer Sheet for Second Post Test<sup>3</sup>**

Post Test Answer Form

P# \_\_\_\_\_

For this test you will examine twenty mounted leaf specimens and determine from which tree each came. Study the specimen, and circle the name of the tree in the list of choices next to the number which appears on the specimen.

1.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
2.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
3.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
4.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
5.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
6.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
7.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
8.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
9.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
10.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
11.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
12.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
13.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
14.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
15.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
16.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
17.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
18.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
19.	Red Maple	Silver Maple	Norway Maple	Sugar Maple
20.	Red Maple	Silver Maple	Norway Maple	Sugar Maple

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<sup>3</sup> Form reduced to 75% original size.

## Vita

Richard Scott Croft was born in Tampa, Florida on October 4, 1959. He attended public schools in Winter Haven, Florida, from 1965 until 1976. He graduated from Polk Community College, located in Winter Haven, in May 1977. During the following five years, he attended Virginia Polytechnic Institute and State University and also Florida State University. He was awarded a Bachelor of Science degree, *magna cum laude*, in Forestry and Wildlife in June 1982.

From 1982 until 1983, he taught math at Radford High School, located in Radford Virginia. From 1983 until 1986 he was a programmer-analyst at Radford Army Ammunition Plant. In 1986 he entered graduate school at Virginia Polytechnic Institute and State University to study computer science. After three years of graduate study of artificial intelligence and software engineering, he returned to Radford Army Ammunition Plant as a systems analyst.

In September 1992 Richard enrolled in graduate school once more to pursue doctoral study in Instructional Systems Development. During his enrollment he developed multimedia educational software for the College of Forestry and Wildlife and also for the Virginia-Maryland Regional College of Veterinary Medicine. He taught the undergraduate course in educational psychology and served as an assistant in the educational technology lab.

Mr. Croft is seeking employment as a university professor for an institution which will provide opportunities for him to continue his studies of the psychology of learning and the appropriate use of instructional technology, in addition to providing him opportunities to assist others in learning to learn.

A handwritten signature in black ink that reads "Richard S. Croft". The signature is written in a cursive style with a large, prominent 'R' and 'C'.