CHAPTER 1

Introduction

Research which explored the utilization of graphics or pictures in instruction/learning began at least as early as the late 1960's. Studies by Paivio and Csapo (1973), Sampson (1970), Cole, Frankel and Sharp (1971) and Horowitz (1969) provided early evidence for the superiority effect of pictures. Thus, they provide perhaps the strongest evidence in support of a dual-coding model, which proposes that separate memory systems exist for verbal and non-verbal information (Paivio, 1971).

Between 1975 and 1990, a series of studies were conducted to assess the interactive effects of color and visual complexity and learners' traits which include cognitive style factors, specifically field dependence/independence, impulsivity / reflectivity, and leveling /sharpening. Berry (1991b) in his review of these studies, noted that the majority of this research focused on the role of color and specifically color realism, in relation to pictorial recognition performance. Studies by Berry (1977), (1982), (1983), (1984), (1990); Lertchalolarn (1991); El Gazzar (1984); Gubriyal (1984); Waltz (1990) focused on the comparative effects of different color presentation formats as one of their primary research questions. The collective results of all these studies indicate significant differences in favor of color over black and white format in both realistic and nonrealistic colors.

During the past several years, numerous studies have addressed the effects of variations in color realism on visual recognition memory and a few focused on the effects of these color factors on pictorial recall memory (Berry 1991b).

Another group of studies (Denis, 1976; Loftus & Bell, 1975; Nelson, Metzler, & Reed, 1974; Peeck & van Dam, 1978; Peeck, van Dam & Uhlenbeck, 1977; Ritchey & Beal, 1980) focused on the effect of pictorial detail on recall memory. Results from these studies provide some evidence on the effect of pictorial detail on recall. However, there were some contradictory findings.

Among the studies which focused on pictorial detail, a secondary variable, mode of presentation, was also involved. Nelson et al. (1974), Peeck and van Dam (1978) and Ritchey and Beal (1980) looked at pictorial detail in both categorized and uncategorized lists. Pictures were presented in categorized and uncategorized lists. However, the effect of both types of lists on recall was not emphasized in the discussions. Thus, the effect of the format of presentation was not confirmed during this period..

The present study attempts to provide clearer clarification about the effects of pictorial details, specifically the effects of color realism on pictorial recall memory. It also attempts to explore the effect of format of presentation of the pictorial information, i.e. when the pictorial information is presented in categorized list and in uncategorized list.

Need for the Study

The present study is important for two main reasons. First, previous studies which have explored color realism, clustering, and age or any combination of these variables have yielded inconsistent and varying findings (Jesky, 1991; Maisto & Queen, 1992; Plummert, 1994; Ritchey, 1982). A sizable number of studies has explored the interactive effects between color realism and/or pictorial complexity, pictorial recognition memory and pictorial recall memory and cognitive styles. The majority of these studies focused on color realism and pictorial recognition task. The most popular cognitive style factors are field dependence / independence, impulsivity / reflectivity and leveling / sharpening. A few studies have explored color realism and hemisphericity (Berry, 1990; Berry & Waltz, 1991; Gadzella et al., 1991). Most studies on pictorial recall have yielded results which indicate that picture information is recalled better than words especially among children. With regard to adults there seem to be contradictory results. In Ritchey's study (1982), adults were observed to recall better than children, while in Maisto & Queen's study (1992), adults' recalls deteriorated in word only, picture-plus-word and picture only categories.

In studies on both words and pictures, categorized lists have been proven to produce better recall among both children and adults. Studies on color realism have provided us with findings that confirm the superiority of color when color is important in the content. When the content is not color-based, there seem to be some contradictory findings in the previous studies. However, there does not seem to be any studies which have focused on the interaction between the format of presentation (categorized and uncategorized) and color realism (color, black and white, and line drawing). Findings on the interaction between the two would provide a useful insight in the use of picture information in instruction in term of level of realism and how they should be presented. The two factors under consideration in the present study, color realism (color, black and white pictures and line drawings) and clustering or format of presentation (categorized and uncategorized lists) seem to exhibit their own strength and advantages. However, between the two, there is no indication as to which one is more powerful or effective than the other on recall of picture information. This study will attempt to determine the strength of each on recall controlling for the other. Previous studies also indicated contradictory findings

on whether the degree of realism and the format of presentation are affected differently by age. Thus, this study will also attempt to determine if age affects the two variables and for the same purpose confirm findings from previous studies. Findings will be very valuable in determining the level of color realism of pictorial information and the format of presentation and the combination of both when instruction involves visual information.

The present study will explore the interaction among three factors: color realism, clustering, and age. Pictures will be presented in two formats: categorized and uncategorized, i.e. random order. Thus, this study will also attempt to determine if the concept of "categorical clustering" (Bousfield, 1951,1953) occurs in pictorial recall task as occurred in the recall of words. In his study, learners were found to recall words in categories even though they were presented randomly.

Another importance of this study is the fact that most studies on the effects of color realism, clustering, and age on pictorial recall memory have been conducted only with children and adults in the U.S. This study will be the first attempt to investigate if there exists any differences in the effects of the three factors on pictorial recall on children and adults in a geographic location outside the U.S., specifically Malaysia. If any differences exist, it is hoped that the findings will help teachers in term of designing effective instruction for different age groups when instruction involves pictures.

With the rapidly increasing use of computers in schools and universities in Malaysia, there is an urgent and necessary need to explore this area. Visual literacy will become an important literacy because visuals play an important role in the teaching and learning process at all educational levels. The use of visualization in all phases of instruction will continue to increase and therefore, continues to be an important instructional variable. Joseph and Dwyer (1984) however, have asserted that the vital question for practitioners is determining what kinds and combinations of visualization are most effective in facilitating student achievement of different educational objectives. This study will attempt to make a starting point for research of this nature on students in Malaysia at various educational levels in order to produce more accurate description and explanation about their learning styles, needs, and characteristics.

Purpose of the Study

The present study involved three main factors: color realism, clustering (format of presentation), and age. The main purpose of the present study was to attempt to investigate whether pictorial recall memory is affected by the three factors mentioned. Do different levels of color realism of the picture information affect recall among children of three age groups in Malaysia? In addition, does the format of presentation affect the recall of picture information? In this study, the pictures were presented to the children in two different formats of presentation. The first group of pictures were presented as a categorized list of common nouns. A list of nouns belonging to seven categories: animals, fruits, vegetables, insects, vehicles, musical instruments, and clothes are used. Each category consisted of seven items belonging to that particular category. The second list of pictures consisted of the same items from the categorized lists but were presented in random sequence so as to create uncategorized list.

At another level, the pictures in each list were presented in three different levels of realism: color, black and white, and line drawing. This was to determine the level of realism which was better recalled, and whether its interaction with the format of presentation produced differences in recall. The third factor, age, which is the between-subject variable, determined whether age affected both the levels of color realism and format of presentation (clustering).

Another purpose of the study was to determine whether learners recalled picture information using strategies they were presented to them. This was to determine if the concept of "categorical clustering" which occurred in Bousfield's study (1951,1953) on recall of words would occur in the recall of picture information. Findings from the study also would confirm findings from previous studies on the three factors under consideration.

Review of Literature

Major Theories of Human Visual Information Processing

Two major theoretical orientations deal with the question of realism and complexity in learning from visual materials. The first one, a group of theories collectively referred to as "realism theory" by Dwyer (1967) include the iconicity theory of Morris (1946), Dale's (1946) Cone of Experience, and the sign similarity orientation of Carpenter (1953).

Dale's (1946) Cone of Experience is a visual analogy which shows the progression of learning experiences from direct purposeful experience to pictorial representation and on to purely abstract verbal symbols. The degree of concreteness decreases as the experience moves from the bottom to the top of the cone. It is intended as a practical guide for the various kinds of audiovisual materials that can be used in teaching. The cone is divided into separate bands that are used to organize instructional materials according to the kind of experience each provides.

According to Dwyer (1972), the basic assumption of each proponent of the realism theories is that learning will be more complete as the number of cues in the learning situation increases. According to the theory, the higher the degree of realism in the existing cues in a learning situation, the higher the probability that learning will be facilitated (Dwyer, 1972). In addition, Finn (1953) contends that the basic underlying concept of the realism theories is the concrete-to-abstract dimension of learning. It has been recommended by both Finn (1953) and Dale (1946) that for instructional purposes, a "more realistic or lifelike" stimulus will increase its probability for facilitating learning. This basic concept is supported by other similar theories - Gibson's projective-conventional continuum (1954), Osgood's more detachable-less detachable continuum (1953), and Knowlton's transparency-opacity continuum (1964).

Dwyer (1972) proposes a visual realism continuum which extends from the object or situation itself to a very simplified line representation. He added that the visual is said to be more realistic if it possesses more qualities which are "in harmony" with the object or situation it denotes. In a continuum of illustrations, Dwyer claims that color photographs provide the most realistic impression of the object and simple black and white line representation is at the lowest

end of the realistic continuum. A visual which is at the highest end of the realism continuum could not be differentiated from the object because it would possess exactly the same qualities possessed by the object (Dwyer, 1972, p. 5).

It is the contention of this orientation that adding visual cues will increase the ability of the persons who view the pictures to store and retrieve visual information. This position suggests that instructional materials become more effective as the degree of realism or overall number of visual and contextual cues is increased. It means that the more realistic an instructional device is, the more effective it will be in facilitating learning. This assumption is based on the notion that the more realistic materials will present more visual cues to the learner and thus, give him/her more information with which to work. This hypothesis which is referred to as "cue summation" has two distinct interpretations (Berry, 1991b). According to Berry (1991a), the inclusion or absence of color information can be regarded as one dimension of visual complexity, which is one aspect of the larger theoretical debate regarding visual complexity and human information processing. Color can function in a dual role when used in visual displays. First, it can serve as a coding function where it provides additional information but does not provide any realistic description of the display. In this case, the effectiveness of color can be predicted by cue summation theory but not by the "realism theories." Alternately, color can be used to present a more realistic version of the visual display. In this instance, besides providing a greater number of overall cues, it provides the viewers with more realistic attributes or "handles" with which to store and retrieve information. When color is used in this fashion, its value could be predicted by both theories (Berry, 1991a). Moore et al. (1996) concluded that research on the cue-summation have produced opposing results. However, they also content that there appear to be some evidence that cue-summation is superior to single-channel presentation when cues are summed across channel.

On the other side, other theorists and researchers (Broadbent, 1958, 1965; Travers, 1964) have suggested that the "realism theories" do not accurately describe how visual instructional materials function in learning, and in fact, may be in direct contradiction to the true situation. They argued that the human information processing system is limited in capacity and in times of rapid information reception, irrelevant information may block the processing of other relevant

information. Broadbent (1958, 1965) has described the human information processing system as a single-channel, limited capacity system which he refers to as the P-system. Jacobson (1950, 1951) further supported this contention and indicated that only a small percentage of all information perceived is effectively stored and utilized by the nervous system.

Working from the theory of Broadbent, Travers (1964) focused specifically on the question of realism in instructional materials. He suggested that to deal with a complex environment, the nervous system must simplify inputs and perceptions. To achieve this, Travers described a process known as "compression." He indicated that to maximize the instructional effectiveness of visuals, it may be necessary to discard some elements of a visual which contain little information. His position was supported by empirical research by Attneave (1954), Cherry (1953), Dwyer (1972), Gorman (1972) and Spaulding (1956). Among these studies, Dwyer's study was the most comprehensive group of studies in this area. He found strong evidence to indicate that the most realistic visuals are not the most effective in promoting student learning. He said that the relevance of color realism to the use of color is readily apparent, and that color in a great many visual illustrations can represent a significant contribution to the realism depicted in those visuals (Dwyer, 1972).

In addition, Dwyer (1978) also noted that there is literature available that contents that "an increase in the amount of information presented in a visual will not add proportionately to the amount of learning achieved by the student". He added that despite having a high amount of realistic detail, some visual illustrations may be more effective than others in facilitating student achievement of different types of educational objectives. As a result of the realism continuum, he contends that visual illustrations which range from colored photographs to black and white line representations, may vary in their ability to facilitate student's learning achievement of specific educational objectives.This is what Lordahl (1961) and Walker and Bourne (1961) found in their studies. They found that an increase in the amount of irrelevant detail in the visual illustration decreases student performance.

The second major theory which underlies human visual information processing system is the dual-coding theory (Paivio, 1969, 1971, 1978). According to the hypothesis, pictures are more easily remembered than words because " pictures are more likely to be encoded as images

and as verbal traces". Paivio and Csapo (1973) explain the picture superiority effect in terms of the dual-coding hypothesis. This explanation assumes independence and interconnectedness of the codes. According to them, the codes must be at least partially independent so that encoding could be in terms of one code or the other, or both. If encoding involves both, one code presumably could be forgotten and the verbal response could still be retrieved from the other; hence, the two codes would have additive effects on recall probability. (Paivio & Csapo, 1973, p. 179). Moore et al. (1996) stated that distinction is made by imagery theorist between the codes used for images and verbal information, and that the two systems are assumed to be structurally and functionally distinct.

Paivio (1971) claims that the theoretical assumptions are concerned with the differential availability of images and verbal processes as a function of the concreteness dimension, analyzed in term of levels of meaning. He adds that familiar and easily named pictures are meaningful both at the representational and the referential levels. They arouse both a concrete memory representation (imagery) and a verbal label. However, the verbal code is available less than the imagery code; its availability is even lesser if the pictures are unfamiliar or ambiguous. For concrete and abstract words, the verbal code is directly and equally available but concrete words are more likely to evoke images because their referential meaning is higher (Paivio, 1979, p.179).

Visual Realism and Pictorial Recognition

Research related to the use of color during this period have produced contradicting results. In a number of studies investigating the use of color in visual instructional materials, (Katzman & Nyenhuis, 1972; Kanner & Rosenstein, 1960, 1961; VanderMeer, 1952) it was found that color has no significant effect on learner achievement. The studies revealed no significant differences in learning outcome between groups learning with color versus black and white graphics. The same studies, however, did reveal a consistently higher learner reaction to color graphics than to black and white graphics. It is proposed that color would more directly affect learning outcomes (as measured by learner performance) in those cases where the color is directly related to the subject matter/skills being taught (Baek & Lane, 1988, Mitchell, Scriven & Wayne, 1995). Moreover, studies by Berry (1975), Bourne and Restle (1959), Dwyer (1972), Saltz (1963), and Underwood (1963) showed that color was a significant factor in design. Berry (1975) further concluded that realism in a visual display is a factor which should be considered in addition to the total number of visual cues presented.

In his observation, Berry (1991a) also noted that past research which studied color and monochrome visuals failed to take into account the fact that realistic color visuals contain more information and consequently require more processing time. In 1974, he conducted a study to compare realistic and nonrealistic instructional materials on the human heart developed by Dwyer (1967). Data suggested that in those learning tasks where visual materials contributed significantly to the improvement of instruction, realistic color materials were more effective. Later research (Berry, 1977, 1982, 1983, 1990) which investigated the color realism/complexity question in relation to pictorial recognition memory found both realistic and nonrealistic color materials superior to black and white visuals. Berry (1977) also found that the nonrealistic color visuals were recognized the most in the delayed test. He attributed this to the uniqueness of the cues. He added that the nonrealistic cues would appear to provide unique associations and were therefore easier to retrieve from the memory store. These findings suggest that cue summation theory may provide an accurate description of how color functions in basic information processing tasks such as picture recognition. At the same time, the data from the studies do not support the contention of Broadbent (1958, 1965) and Travers (1964).

Visual Realism and Pictorial Recall

In spite of numerous research related to the use of color in instructional materials, Berry (1991a) noticed that almost all these studies focused on pictorial recognition memory, and that limited research has addressed the effects of color realism on recall memory. Ritchey (1982) reported an advantage in recall for outline drawing over detailed drawings. Jesky (1984) conducted a study and found that color is superior over black and white and both color and black and white are superior over line drawing in recall task. Alfahad (1990) confirmed these findings. Berry's (1991a) study produced results that confirmed the findings of Jesky (1984) for the line drawing, black and white and realistic color treatments. Nonrealistic color materials were found to be recalled less often than all other treatments. These results would indicate that the nonrealistically colored materials were substantially more difficult to recall eventhough they were systematically as visually complex as the realistic color treatment. Rather than aiding recall by adding additional cues, they interfered with it by providing irrelevant , and possibly distracting information. This is contradictory to what happened in the delayed recognition test in which the nonrealistic color visuals were found to be superior to all other treatments (Berry, 1977). These results also do not support the generalized theory of cue summation which predicts that learning will be increased as the total number of cues increases. In this case, the addition of nonreal cues interferes rather than facilitates recall of the information (Berry, 1991a).

Ritchey and Beal (1980) propose that picture detail provides more information and thus participants could recall the pictures better. They call the concept "within-item elaboration." In 1982 Ritchey conducted a study to investigate recall in relation to age and stimulus format (categorized and uncategorized). The most interesting finding in his study is that outline drawings were better recalled than detailed drawings. This finding did not confirm Ritchey and Beal's (1980) concept of within-item elaboration. They concluded that greater picture detail did not lead to better recall. However, it interferes with the recall by providing additional irrelevant detail.

Recall of Words versus Pictures

Numerous studies have been conducted to assess the superiority of pictures over words. Shepard (1967) reported an experiment he performed in 1959 that provides one of the earliest evidence for the superiority of pictures over words and sentences in recognition memory. Similar studies by Nickerson (1965, 1968), and Standing, Conezio and Harber (1970) also yielded comparable results for the superiority of pictures in recognition memory.

To date, all studies in recall memory also have proven that picture information is recalled better than verbal information. Research by Paivio (1971) and Bevan and Stegar (1971) concluded that recall for pictures is generally higher than recall for their printed verbal labels. Paivio and Csapo (1973) explain this picture superiority effect in terms of a dual-coding hypothesis, which was described in earlier section. According to the hypothesis, pictures are more easily remembered than words because " pictures are more likely to be encoded as images and as verbal traces". The two codes, imaginal and verbal, would have additive effects on recall probability. (Paivio & Csapo, 1973, p. 179). Following Paivio, many studies have attempted to confirm his findings (Keitz & Gounard, 1976; Park, Puglisi & Sovacool, 1985; Winograd, Smith, & Simon, 1982).

More recent studies have provided more evidence to this issue. Ritchey (1982) conducted a study in which both children and adults recalled pictures (detailed drawings and words and outline drawings with words) and words only in categorized and uncategorized lists. The results reveal that both detailed drawings and outline drawings were recalled significantly better than words only. That pictures are recalled better than words is further confirmed.

Gadzella et al. (1991) conducted a study to determine the differences in recall of pictures and words as a function of hemisphericity. The study produced interesting results in relation to hemisphericity, gender, age and the visual stimuli. There was a significant difference on recall of information between left hemispherics who saw pictures and left hemispherics who saw words. Also, there was significant difference between right hemispherics who saw pictures when compared with right hemispherics who saw words. In each case, more picture information was recalled than information presented in words.

In more recent study, Maisto and Queen (1992) investigated if age and stimulus type (word only, picture only and picture and word) affect recall. They found that pictures were

recalled better than words among their participants, with significant increase of recall for pictures among young children.

Pictorial Recall and Clustering

Miller (1956) claims that the short-term memory in the human memory system can hold up to only 7 plus or minus 2 units of information. However, the term "units" is determined by the person and the situation involved. Each unit can range from a single item or a few items within a specified category and having common attributes. Thus, a unit can be several items which have been grouped together using some common characteristics. This regrouping process called "recoding" or "chunking" is a powerful device to overcome the limitation of "bottleneck" which permits only a relatively few items or units of information to be held in short-term memory. This concept is basically similar to the clustering process whereby stimulus items are presented to a person an item at a time where each item belongs to a single distinct category. For example, a monkey, a book, a television, an eye, an orange, a doctor, and a truck belong to seven distinct categories. They all form seven individual units of information. The following items are 21 individual items of information; however, they are grouped into seven distinct categories with some common characteristics. For example, lion, elephant, deer, hand, foot, nose, pear, apple, mango, airplane, train, ship, teacher, lawyer, mailman, telephone, computer, radio, turnip, cabbage and lettuce all belong to animals, body parts, fruits, transports, occupation, electrical appliances, and vegetables categories. Eventhough the second group contains 21 items, they still form the basic 7 units of information with 3 individual items in each unit. In the first group, there are 7 small "chunks"; the second group contains 7 larger "chunks". The items in each unit can be selected using very general or very specific characteristics.

The terms clustered / unclustered and categorized / uncategorized have been used as variables in many studies which involved recall and recognition of words. However, not many studies have attempted to investigate the phenomenon in relation to recall of picture information. Bousfield (1951, 1953) first used categorical structure in free recall with four categories containing 15 items in each. Eventhough the words were presented randomly, he found that subjects recalled members of the same category together; thus he called the concept "categorical

clustering". The question is whether what happens in the recall of verbal information happens in the recall of picture information as well. Thus, this is what the present study intends to investigate. Bousfield and Cohen (1953) further explain that, in the learning of categorized list, "all instances of a given category will become associated to a higher order structure representing the category itself ". Later on, the superordinate structure is activated when one of the instances is recalled; as a result, this will facilitate the recall of other instances of the category. Those instances will be recalled together, yielding a cluster. For example, if a list contains several animal names,
remembering *lion* may activate the category *animal*, leading to recall of *dog*, *zebra*, etc.

In Ritchey's (1982) study, both children and adults recalled pictures (detailed drawings with words and outline drawings with words) and words only better in the categorized list than in the uncategorized list. The clustering of picture information in one common group seemed to have facilitated the recall.

In term of the structure of the clustering, Ritchey (1982) used six categories with nine items in each for the categorized list and the uncategorized list contains 54 items which were chosen to minimize common categorical origin. Ritchey however, did not report whether the 54 items in the six categories were recalled in categories as reported by Bousfield (1953).

So far, no studies on pictorial recall have attempted to investigate the occurance of Bousfield's "categorical clustering" (1951) concept. Thus, this study also attempts to determine whether categorical clustering applies as well to pictorial information.

Most of the studies involving students' recall strategies, may it be categorical clustering or associative relatedness or use of mnemonic concentrated on the recall strategies utilized by the students themselves when recalling the information. However, the format of presentation of the information to the students was not the focus of the studies and thus was not taken into account. According to Eysenck (1974), the degree to which one remembers verbal material is a function of the manner it was processed when it was initially presented. In his study, which involves two age groups (18-30 and 50-65 years old), participants recalled words after they were presented and asked to remember them in five different ways (counting, rhyming, using adjectives, using imagery and intentionally asking them to recall) which increases in the level of

processing. Findings revealed that both young and old people recall the words the most when they were intentionally asked to recall, followed by when they were asked to form vivid images of each word compared to when they used the three lower levels of processing. It was also noted that the young participants performed better than older participants at the two highest levels of processing (imagery and intentional).

By presenting the pictures in two ways (categorized and uncategorized), the subjects will be forced to recall the information according to experimenter-prescribed categories rather than subject-defined ones. This will provide proof whether subjects process the pictorial information according to the manner they are presented as they do with verbal information in the study by Eysenck (1974).

Studies also have been conducted to determine the strategies utilized by people to recall pictorial information. Bjorklund and Zeman (1982) in their experiment found that older children and adults used more general organizational schemes based on categorical relations. They believe that this is presumably more efficient in mediating memory, and with development, replaces the use of associativity as a 'strategy' for organized recall. In addition, in their 1984 study, Bjorklund and de Marchena found that seventh graders used categorical grouping strategy far more than associative and combined categorical/associative grouping strategies in sorting tasks. On the other hand, the first graders used more associative grouping than categorical grouping strategy. In fact, the use of associative strategy over categorical strategy by the first graders was almost five-fold. The fourth graders were found to use approximately equal level of both strategies. In their

studies, Bjorklund and de Marchena (1984) determined only the strategies utilized by the children and compared specifically the use of categorical grouping strategy, associative grouping strategy and combined categorical/associative grouping strategies in recall and sorting tasks. However, the degree or amount of recall in relation to each strategy was not determined.

In a more recent study, Plummert (1994) reported that 10 year old children use categorical clustering strategy more often than 16 year old children and adults in recalling picture information, and hence recalled more information. However, Plummert believes that by age 16, children begin to recall less picture information with this strategy and thus they resort to spatial

clustering. This study shows that young children recall picture information better than older children and adults when the categorical clustering strategy is utilized. Similar to Ritchey, Plummert also did not analyze whether items of the same categories were recalled together as happened in verbal recall in Bousfield's study (1951).

The present study also attempts to determine whether children's recall of picture information indeed decreases by age when categorical clustering strategy is used. As a result, it will also attempt to determine whether the categorized lists of picture information are recalled better than the uncategorized lists.

Recall and Age

In the early 1990's, new literature was developing that examined age-related declines in memory for nonverbal information, particularly pictorial material. Winograd and Simon (1980) noted that this new interest in memory imagery grew from attempts to reduce memory problems in elderly by training them in imagery-based mnemonic techniques.

Studies in this area have yielded contrasting results. Early studies by Laurence (1966) and Howell (1972) indicated a decline with age in both recall and recognition of pictures. In both Winograd et al.'s (1982) and Keitz and Gounard's (1976) studies, comparable picture superiority was found in both young and old subjects. Park, Puglisi, and Sovacool (1985) also yielded similar findings in recognition memory test.

In Gadzella's study (1991), both age groups (21-29 and 30-34 years) recalled more picture information than words. The older age group recalled slightly less picture information than the other group. According to Gadzella, the data may indicate specific characteristics of aging.

Ritchey (1982) conducted a study to determine recall of pictures (detailed drawings with words and outline drawings with words) and words only between adults and children. The results indicate that adults recalled much better than children (both 3rd and 6th graders) in both categorized and uncategorized lists. In fact, the mean number of recall among adults almost doubled the amount of recall among children. Ritchey suggests that for both categorized and uncategorized lists, the recall advantage for the outlines may have increased by age.

In a more recent study, Maisto and Queen (1992) found that young subjects recalled better than old subjects in word only, picture only and picture-plus-word category. In fact, the old subjects' recall decreased significantly in the picture-plus-word category, while young subjects recorded gradual increase in recall from word only to picture-plus-word category. The decrease was attributed to the bimodal presentation of picture-plus-word category, which according to them "tax the processing capacity of older adults considerably more than individuals in other age groups."

In another similar area which involves categorical and spatial clustering, children and adults have been found to utilize different strategies in recalling objects. Plummert (1994) conducted two studies to investigate the development of flexibility in children's use of spatial and categorical organizational strategies. In the first study, she found that at younger age (10 years old), children use categorical clustering strategy more often than spatial clustering. The 12 and 14 year old children use approximately equal levels of both strategies when recalling the objects. On the other hand, 16 year old children and adults use more spatial clustering strategy than categorical clustering strategy. It shows that by age 16, children begin to develop and exhibit their high degree of spatial organization in their recall. Overall, 16 year old children and adults recalled the objects better than the younger age groups. To summarize, studies which attempt to determine the effect of age variable in relation to recall of picture information seem to have produced contradictory results. Thus, further attempts should be made to determine whether age has significant effect on recall of picture information.

Summary

From the studies which have been reviewed, there are a lot of contradictory findings with regard to the different variables on the effectiveness of visual instructional materials. It can be concluded from these studies during the 1970's, 80's and 90's that visual materials with realistic colors seem to be more effective than non-realistic and black and white ones. Color seems to provide a greater level of realism and complexity to the visual materials by adding more visual cues. In term of the degree of realism, we could conclude that color visuals would possess higher degree than black and white visuals, which in turn higher than line drawings.

With regard to the mode of presentation, categorized and uncategorized lists, studies reviewed seem to support that categorized lists are recalled better than the uncategorized ones (Ritchey, 1982). In addition, children recall picture information better when they utilize categorical clustering strategy; however, the strategy begins to diminish as they reach 16 years old, and thus, they resort to spatial clustering strategy (Plummert, 1994). On the other hand, a contradicting finding reports that children were found to resort to categorical clustering strategy in recall tasks as they grow older (Bjorklund & Zeman, 1982).

Of all the studies which investigated the mode of presentation (categorized and uncategorized lists), only a few studies (Peeck & van Dam, 1978; Ritchey, 1982) have attempted to determine its effects on the visual materials with different degrees of realism, specifically among color, black and white and line drawing. The focus has been between visual and verbal information, with visual information being recalled significantly better than the other. The superiority of pictures has been confirmed repeatedly beginning with Paivio and Csapo (1973) with the support of the dual-coding hypothesis. The present study tries to cross analyze the two variables, color realism and mode of presentation in an attempt to determine the strength of the two combined on recall task of picture information. On another level, age is used as between-subject variable. Early studies indicated that recall of picture information decreased with age (Howell, 1972; Laurence, 1966). However, Ritchey (1982) reported adults' superiority in recall of picture information over children. In addition, in Gadzella's study (1991), older subjects were found to recall slightly better than their younger counterparts. In a study by Maisto and Queen (1992) however, younger subjects were reported to recall better than older ones. Based on the

findings of these studies, it is uncertain whether children and adults have equal or different capacity to recall picture information. Thus, this study also attempts to determine if different age groups will perform differently when the earlier two variables (color realism and mode of presentation) are combined.

Research Questions

The followings are research questions for which this study attempts to seek answers and explanation. They concern relationships among color realism (A), clustering (B), and age (C).

1. Is there a difference in the effect of color realism (color, black and white and line drawing) on pictorial recall memory among Malaysian students? (A)
2. Is there a difference in the effect of clustering (categorized and uncategorized lists) on pictorial recall memory among Malaysian students? (B)
3. Is there a difference in the effect of age (10, 16 and adults) on pictorial recall memory among Malaysian students? (C)
4. Is there a difference in the effect of color realism (color, black and white and line drawing) on pictorial recall memory among Malaysian students when picture are presented as categorized and uncategorized lists? (AXB)
5. Is there a difference in the effect of color realism (color, black and white and line drawing) on pictorial recall memory among Malaysian students of 10, 16 and adults? (AXC)
6. Is there a difference in the effect of clustering (categorized and uncategorized lists) on pictorial recall memory among of 10, 16 years old and adult Malaysian students? (BXC)
7. Is there an interaction effect between color realism, clustering, and age on pictorial recall memory among Malaysian students? (AXBXC)

Research Hypothesis

Based on the research questions and findings from previous research in the areas discussed earlier, it is hypothesized that:

1. H#1 Color pictures will be recalled better than black and white pictures and line drawings across all age levels and clustering (Jesky, 1984, Alfahad, 1990, Berry 1991a).
2. H#2 Pictures in the categorized lists will be recalled better than the pictures in the uncategorized lists across all levels of color realism and age levels (Ritchey, 1982; Plummert, 1984).
3. H#3 Younger age group will recall the pictures better than the older groups across all levels of color realism and clustering (Gadzella et al., 1991; Maisto & Queen, 1992).
4. H#4 Color pictures in the categorized lists will be recalled better than the other combinations across all age levels (Ritchey, 1982).
5. H#5 Color pictures will be recalled better than black and white pictures and line drawings by the younger age groups across both clusters.
6. H#6 The categorized lists of pictures will be recalled better than the uncategorized lists by the younger age groups across all levels of color realism (Ritchey, 1982; Plummert, 1984).
7. H#7 The younger age groups will recall more color pictures than black and white pictures and line drawings in the categorized lists, and color pictures, black and white pictures and line drawings in the uncategorized lists.

CHAPTER 2

Methodology

Research Design

This study employed a 3 x 2 x 3 experimental design. The main effects were color realism (color pictures, black and white pictures and line drawings), clustering (categorized and uncategorized), and age level.

Participants

A stratified random sampling technique was used to account for the age groups. A total of 360 students participated in the study. One hundred twenty (120) students for each age group were selected randomly from representative sites. For the age group of 10 years old, children were selected randomly at an elementary school in the district of Kubang Pasu in the state of Kedah in Malaysia. For the age group of 16 years old, children were randomly selected from two secondary schools in the same geographic location. Table 1 shows the treatment groups which were created for the experiment.

Prior arrangement was made with Malaysia's Ministry of Education to obtain the permission to get the 10-year old and 16-year old students in the geographic area mentioned above to participate in the study. Official application was sent to the ministry's Educational Planning and Research Division, and state's Department of Education. The official permission from the ministry was obtained on October 17 1997, and from the state's Department of Education on October 25 1997. For the adult group, undergraduate students at Universiti Utara Malaysia were randomly selected. The sample for the adult students was selected randomly from English Language classes which were conducted at the School of Languages and Scientific Thinking at the university. Permission was obtained from the instructor of each class. The undergraduate students ranged from 19 years old to 35 years old. All the participants were given

keychains as a token of appreciation for their participation. The experiments were conducted from November 4 to November 9 1997.

Table 1

Experimental Treatment Groups

	Number	Age	Presentation Format	Color Realism
1.	20	10 years old	Categorized	color pictures
2.	20	10 years old	Uncategorized	color pictures
3.	20	10 years old	Categorized	black and white pictures
4.	20	10 years old	Uncategorized	black and white pictures
5.	20	10 years old	Categorized	line drawings
6.	20	10 years old	Uncategorized	line drawings
7.	20	16 years old	Categorized	color pictures
8.	20	16 years old	Uncategorized	color pictures
9.	20	16 years old	Categorized	black and white pictures
10.	20	16 years old	Uncategorized	black and white pictures
11.	20	16 years old	Categorized	line drawings
12.	20	16 years old	Uncategorized	line drawings
13.	20	adults	Categorized	color pictures
14.	20	adults	Uncategorized	color pictures
15.	20	adults	Categorized	black and white pictures
16.	20	adults	Uncategorized	black and white pictures
17.	20	adults	Categorized	line drawings
18.	20	adults	Uncategorized	line drawings

Instruments/Materials

The stimulus materials used in this study consisted of six sets of visuals, which were produced as slide presentations. All the six sets of visuals were produced in three different levels of color realism: two as color pictures, two as black and white pictures (grayscale) and two as line drawings produced from the color pictures. For each level of color realism, the slides were presented in two different formats: one containing categorized list of pictures and the other containing uncategorized list of pictures. The three categorized lists of pictures each consisted of 49 pictures (seven for each category) from seven (7) specified categories of common nouns - animals, fruits, vegetables, clothes, vehicles, insects, and musical instruments. The sequence of the seven categories as well as the seven items within a category were randomized for the three categorized lists. The three uncategorized lists of pictures consisted of the same 49 items, which were randomized in the sequence of presentation so as to create uncategorized lists. A white background was used in each slide. All six sets of materials were produced using Microsoft PowerPoint to create color and black and white overhead slides, which were projected using an overhead LCD projector. Table 2 shows the sequences of the 49 items and the 7 categories for the categorized lists, which were randomly selected. Table 3 shows the sequence of the 49 items for the uncategorized lists, which were randomly selected.

Pilot Study

A pilot study was conducted with eight Malaysian students. There were three, 21- year old, one 15-year old, one 14-year old, one 10-year old, and two 8-year old students. The 21-year olds were undergraduate Malaysian students at Virginia Tech while the 8, 10, 14 and 15 year old were children of Malaysian students at Virginia Tech. The children were students at Harding Avenue Elementary School, Blacksburg Middle School, and Blacksburg High School in Blacksburg, Virginia.

As a result of the pilot study, several procedural modifications were made to increase the control of extraneous variables and to increase the instrument reliability. The first modification was to add a blank white slide at the beginning of each treatment condition to avoid participants

Table 2

Sequence of 49 items in 7 categories in categorized lists

Fruits	**Insects**	**Musical Instruments**	**Vegetables**	**Vehicles**	**Animals**	**Clothes**
Durian	Ants	Guitar	Tomatoes	Car	Lion	Cap
Orange	Bee	Drum	Carrots	Van	Cow	Pants
Mangosteen	Butterfly	Recorder	Cabbages	Airplane	Rhinoceros	Shoe
Papaya	Dragonfly	Violin	Onions	Canoe	Horse	Shirt
Banana	Grasshopper	Keyboard	Chilies	Motorcycle	Tiger	Tie
Apples	Beetle	Piano	Corns	Train	Cat	Belt
Melon	Spider	Trumpet	Cucumbers	Helicopter	Zebra	Socks

Table 3

Sequence of 49 items in uncategorized lists

1	Durian	18	Rhinoceros	35	Cucumbers
2	Cat	19	Grasshopper	36	Cow
3	Horse	20	Drum	37	Socks
4	Motorcycle	21	Belt	38	Carrots
5	Car	22	Beetle	39	Pants
6	Cap	23	Van	40	Keyboard
7	Trumpet	24	Onion	41	Cabbage
8	Chilies	25	Butterfly	42	Tomatoes
9	Piano	26	Canoe	43	Melons
10	Shoe	27	Spider	44	Recorder
11	Mangosteen	28	Papaya	45	Shirt
12	Bee	29	Ants	46	Tiger
13	Dragonfly	30	Zebra	47	Helicopter
14	Apples	31	Lion	48	Airplane
15	Guitar	32	Oranges	49	Banana
16	Tie	33	Train		
17	Violin	34	Corns		

from seeing any picture before the presentation began. In addition, the 50 boxes provided in the recall form were replaced with horizontal lines to avoid from having students know the total number of names they had to recall.

Task Procedures/Experiment

The three age groups (4^{th} grade, Form 4 or American 10^{th} grade, and adults) were assigned randomly to the six sets of stimulus slides. In a dimmed room, each group was shown the

slides at a 6- second duration each and 1-second interval between each slide. The 6-second duration was adopted based on the study by Whitley and Moore (1979). The participants were informed that they would be asked to recall by writing the names of the pictures they were shown. They were also asked to provide personal information before the slide show. After all the 49 slides were viewed, the lights were brought up. The participants were then asked to write in either the native language (Bahasa Malaysia) or English, the names of as many objects as they could recall from the slide show in any sequence they like. Assistance was provided (especially to the fourth graders) if they needed assistance in spelling the names of the pictures. The same procedure were repeated for each treatment group.

Instructions

Standardized instructions in Bahasa Malaysia for the slide presentations were prepared and read in all the presentations to ensure consistency in the instruction. The size of the projected image was made approximately the same for every slide show, and participants were seated within 15-20 feet from the screen to ensure similar effect for all the learners and groups. Standardized paper forms and pencils were provided.

Data Analysis

A three-way analysis of variance (ANOVA) was used to determine if there were statistically significant differences in the main effects ofcolor realism, presentation format, and age groups, and the interactions among the three on recall.

CHAPTER 3

Results

The main purpose of this study was to determine the interactive effects of color realism, clustering (format of presentation), and age on the pictorial recall memory among students in Malaysia. A 3 X 2 X 3 factorial analysis of variance (ANOVA) was employed to interpret the data. Simple main effects tests and Tukey pairwise comparisons were used to make post-hoc comparison between the means as required [family error rate for Tukey set at 0.05]. Table 4 shows the means and standard deviations associated with the treatment combinations of cluster, color realism, and age. Table 5 displays the summary of the 3-way ANOVA between color realism, clustering, and age on recall. The magnitude of each effect is also given in Table 5 under the heading eta-squared. These values indicate the proportion of variability in recall scores associated with each of the effect tested.

Analysis of the Data

The results of ANOVA indicate that the main effects of cluster, color realism, and age are significant, , F (1, 342) = 19.35, $p < .0001$, F (2, 342) = 11.85, $p < .0001$ and , F (2, 342) = 95.19, $p < .0001$ respectively. For the main effect of cluster, the mean number of pictures recalled in the categorized lists was significantly higher than the mean number of pictures in the uncategorized lists. The main effect of age was also significant; 16-year-olds recalled more pictures than either adults or 10-year-olds. The main effect of color realism was also significant with higher mean associated with color pictures than for black and white pictures and line drawings.

The interaction between cluster and color realism was not significant, F (2, 342) = 0.77, $p < 0.465$. However, the interaction effects between age and cluster, was significant, F (2,342) = 9.07, $p < .0001$, as was the interaction between age and color realism, F (2, 342) = 2.93, $p < .021$. Tables 6 and 7 provide means and standard deviations for the interactions, and Figures 1

and 2 provide graphs of the cell means to illustrate the interactions. The three-way interaction of cluster, color realism and age was not significant, $\underline{F}$ (4, 342) = 0.93, $\underline{p}$ < 0.447.

For the interaction between age and cluster, there was a difference in the mean number of items recalled between categorized and uncategorized lists across the three age groups. Tests of simple main effects showed that only for 10-year olds did the mean number of items recalled differ significantly between the categorized lists ($\underline{M}$ = 31.033) and the uncategorized lists ($\underline{M}$ = 25.700). For 16-year olds and adults, the mean obtained from the categorized lists and the uncategorized lists did not differ significantly (See Table 7 for mean associated with the interaction).

The significant interaction between color realism and age also required the use of simple main effects tests. These tests were used to analyze mean differences in color realism across age groups. Among 10-year olds, the mean number of items recalled differed significantly under each level of color realism. As shown in Table 7, the mean for color pictures was 31.050, for black and white was 27.400 and for line drawings the mean was 26.650. Pairwise comparison of these three means indicated that the mean for color pictures differed significantly from the other two types of pictures, but the difference between black and white pictures and line drawings was not significant. Essentially the same results were found for adults, but the mean differences were not as pronounced, as shown in Table 7. However, among 16-year olds, the mean number of items recalled under each level of color realism was not significantly different.

Table 4

Means and (Standard Deviations) of the number of items recalled associated with the treatment combinations of cluster, color realism and age

	Cluster								
	Categorized list				Uncategorized list				
	Age				Age				
Color realism	10	16	adult	ALL	10	16	adult	ALL	
color	34.70	38.80	35.65	36.38	27.40	35.80	37.00	33.40	**34.89**
(SD)	(5.12)	(4.91)	(5.86)		(4.85)	(4.23)	(3.45)		
black & white	30.10	38.80	32.60	33.83	24.70	37.00	32.05	31.25	**32.54**
(SD)	(6.71)	(4.21)	(5.34)		(4.80)	(3.40)	(4.93)		
line drawing	28.30	36.90	32.60	32.60	25.00	36.35	32.15	31.16	**31.88**
(SD)	(5.05)	(6.29)	(5.05)		(4.98)	(5.35)	(4.85)		
Mean	31.03	38.10	33.61		25.70	36.38	33.77		

Note: Number of subjects per cell =20

Table 5

Summary ANOVA Table of Color realism, Cluster and Age

SOURCE	DF	SS	MS	F	p	eta^2
Cluster	1	490	490	19.35	0.0001	.03
Color realism	2	600.24	300.12	11.85	0.0001	.04
Age	2	4819.87	2409.94	95.19	0.0001	.31
Cluster*Color realism	2	38.85	19.42	0.77	0.465	.0025
Cluster*Age	2	459.15	299.57	9.07	0.0001	.029
Cluster at 10 yr. old	1	853.30	853.30	33.70	*	
Cluster at 16 yr. old	1	95.40	95.40	3.76		
Cluster at adult	1	0.40	0.40	0.14		
Color realism* Age	4	296.98	74.24	2.93	0.021	.019
Color realism at 10 yr.old	2	443.30	221.60	8.75	*	
Color realism at 16 yr.old	2	32.50	16.30	0.64		
Color realism at adult	2	421.40	210.70	8.32	*	
Cluster*Color realism*Age	4	94.10	23.52	0.93	0.447	.006
Error	342	8658.80	25.32			.56
Total	359	15457.99				

* $p \leq .05$

Table 6

Means and (Standard Deviations) of the number of items recalled associated with interaction of cluster with age

Cluster	10 year old	16 year old	adult	Mean
Categorized	31.033	38.167	33.617	34.27
(SD)	(6.208)	(5.198)	(5.529)	(6.358)
Uncategorized	25.700	36.383	33.733	31.94
(SD)	(4.948)	(4.353)	(4.963)	(6.571)
Mean	28.37	37.28	33.67	
(SD)	(6.198)	(4.857)	(5.232)	

Note: Number of subject per cell = 60

Table 7

Means and (Standard Deviations) of the number of items recalled associated with interaction of color realism with age

Color realism	10 year old	16 year old	adult	Mean
color	31.050	37.300	36.325	34.89
(SD)	(6.155)	(4.767)	(4.795)	(5.916)
black & white	27.400	37.900	32.325	32.54
(SD)	(6.376)	(3.888)	(5.080)	(6.729)
line drawing	26.650	36.625	32.375	31.88
(SD)	(5.225)	(5.772)	(4.892)	(6.675)
Mean	28.37	37.28	33.67	
(SD)	(6.198)	(4.857)	(5.232)	

Note: Number of subjects per cell = 40

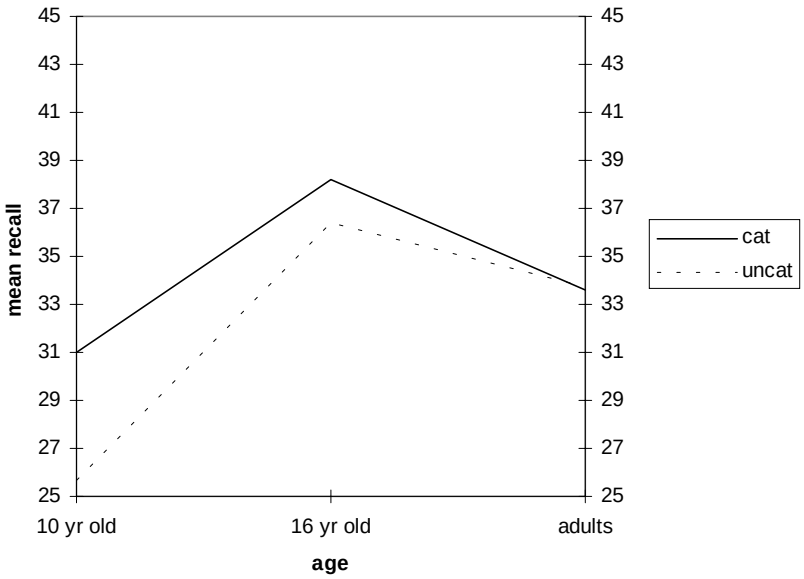

Figure 1. Plot of cell means of the number of items recalled for cluster by age

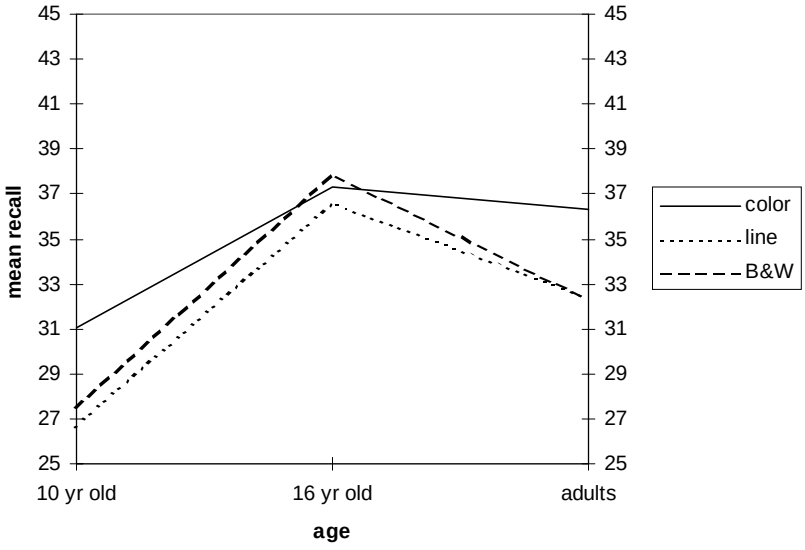

Figure 2. Plot of cell means of the number of items recalled for color realism by age

Research question # 1: Is there a difference in the effect of color realism (color, black and white and line drawing) on pictorial recall memory among Malaysian students?

It was hypothesized that color pictures would be recalled better than black and white pictures and line drawings across all age levels and presentation formats. The analysis of variance summary in Table 5 indicates that the main effect of realism (color, black and white, and line drawing) was significant, F (2, 342) = 11.85, p < .0001. The mean recall for color pictures of 34.89 is higher than for black and white pictures (32.54) as well as for line drawings (31.88). Students recalled more color pictures than both black and white and line drawings. The research hypothesis was confirmed. However, it must be qualified by the significant interaction of age and color realism.

Research Question # 2: Is there a difference in the effect of categorical clustering (categorized and uncategorized lists) on pictorial recall memory among Malaysian students?

It was hypothesized that pictures in the categorized lists would be recalled better than the pictures in the uncategorized lists across all levels of color realism and age level. The analysis of variance summary in Table 5 indicates that the main effect of cluster (categorized and uncategorized) was also significant, F (1, 342) = 19.35, p < .0001. The mean number of pictures for the categorized list was higher than the mean for the uncategorized list. The mean recall for the categorized list of 34.27, and the mean for the uncategorized list was 31.93. The research hypothesis was confirmed. However, it must be qualified by the significant interaction of age and cluster.

Research Question # 3: Is there a difference in the effect of age (10, 16 and adults) on pictorial recall memory among Malaysian students?

It was hypothesized that younger age group would recall the pictures better than the older groups across all levels of color realism and presentation formats. Sixteen year old students recalled more pictures than either 10 year old students or adults. As indicated in the analysis of variance summary in Table 5, the main effect of age (10, 16 year old and adults) was significant,

F (2, 342) = 95.19, p < .0001. However, it must be qualified by the significant interaction of age and color realism, and age and cluster.

Research question # 4: Is there a difference in the effect of color realism (color, black and white and line drawing) on pictorial recall memory among Malaysian students when picture are presented as categorized and uncategorized lists?

It was hypothesized that color pictures in the categorized lists would be recalled better than the other combinations across all age levels.

Analysis of variance summary as shown in Table 5 indicates that the interaction between cluster and realism was not significant, F (2, 342) = 0.77. p < .4651 It can concluded that there is not enough evidence to show that there is an interaction between realism and cluster. That is, there is a constant effect of cluster across all levels of color realism (and vice-versa) regardless of age.

Research question # 5: Is there a difference in the effect of color realism (color, black and white and line drawing) on pictorial recall memory among Malaysian students of 10, 16 and adults?

It was hypothesized that color pictures would be recalled better than black and white pictures and line drawings by the younger age groups across both presentation formats.

Interaction between color realism and age was found to be significant as indicated in Table 5, F (4, 342) = 2.93, p < .0209. Table 7 shows the mean number of items recalled for age and color realism. It can be concluded that there an interaction exists between realism and age. Specifically, color realism had a different effect within each age group. Ten-year olds recalled significantly more color pictures than both black and white pictures and line drawings. However, mean recall for black and white pictures was not significantly different from line drawings. For sixteen-year olds however, there was no significant differences in mean recall of color pictures, black and white pictures and line drawings. Similar to 10-year olds, adults recalled significantly more color pictures than both black and white pictures and line drawings. However, mean recall for black and white pictures was not significantly different from line drawings.

Research question # 6: Is there a difference in the effect of format of presentation (categorized and uncategorized lists) on pictorial recall memory among of 10, 16 years old and adult Malaysian students?

It was hypothesized that the categorized lists of pictures would be recalled better than the uncategorized lists by the younger age groups across all levels of color realism).

Table 5 shows that the interaction between cluster and age was significant, F (4, 342) = 9.07, $p < .0001$. Table 6 shows the means recall for both factors. It can thus be concluded that there is an interaction between age and cluster. Cluster had a different effect within each age group. Ten year old students recalled significantly more pictures in the categorized list than those pictures in the uncategorized lists. However, the mean recall of items between the categorized and the uncategorized list among 16 year old students and adults were not significantly different.

Research question #7: Is there an interaction effect between color realism, format of presentation, and age on pictorial recall memory among Malaysian students?

It was hypothesized that younger age group would recall color pictures more than black and white pictures and line drawings in the categorized list, and color pictures, black and white pictures, and line drawings in the uncategorized lists. Table 4 indicates that the 3-way interaction between realism, cluster and age was not significant, F (4, 342) = 0.93, $p < .4470$.

CHAPTER 4

Discussion

The present study investigated the effects of three levels of color realism, clustering, and age on the pictorial recall memory among students in Malaysia. Past studies which explored these factors separately or in combinations have yielded mixed and inconsistent results.

With regard to cluster, the results of this study support findings of previous studies that categorized lists are recalled better than the uncategorized ones (Ritchey, 1982). In Ritchey's study, the categorized lists of both drawings and outlines were recalled significantly better than the uncategorized lists by all third graders, sixth graders and adults. The only difference in the present study is that adults' recalls of categorized and uncategorized lists was not significantly different ($\underline{M}$ = 33.733) and $\underline{M}$ = 33.617). Regardless of whether the lists were categorized or uncategorized, adults seemed to have equal capacity for recalling picture information. Adults recalled better than 10-year olds in both lists, but not as well as 16-year olds. The strength of adult's recall compared to that of 10-year olds is in term of the amount of information presented rather than the format the items are presented. On the other hand, 10-year olds seemed to depend on the format of presentation as their strength. Categorized lists facilitate their recall even though not as well as 16-year olds and adults; however, uncategorized lists did not help their recall.

Plummert (1994) claims that younger children recalled picture information better when they utilized categorical clustering and that by 16 years old, this strategy begins to diminish. The results of the present study do not support nor reject the above claim. Although the pictures were presented in categorical clusters, there was no indication of whether the participants recalled the items using any particular strategy. Thus, this study does not provide any evidence to support Plummert's claims. However, if the categorical clustering strategy were used by the participants, Plummert's claim that the strategy diminishes by age sixteen is not supported. In the present study, 16-year olds recalled pictures in both categorized and uncategorized lists better than 10-year olds.

Even though both 10-year olds and 16-year olds recalled pictures in the categorized lists better than the uncategorized lists, 10-year olds' recall was adversely affected by the uncategorized lists. Sixteen-year olds were not affected as much, however. This finding supports finding by Ritchey (1982) that younger students were affected negatively by uncategorized lists. On the other hand, adults were not affected by the two different lists. They recalled both lists equally well. This finding contradicts Ritchey's finding in which adults' recalls for drawings and outlines decreased significantly in the uncategorized lists (Ritchey, 1982).

When presented with items by categories, recall for all the three age groups were facilitated. However, when items were presented in random or in uncategorized order, recall for 10-year olds were adversely affected the most, followed by 16-year olds. Adults however, did not suffer any reduction in recall due to uncategorized order. Even though the uncategorized lists were recalled less than the categorized ones, the mean number of items recalled in the uncategorized list by 16-year olds was still higher than the means of either the categorized or uncategorized list recalled by the other two age groups. Adults however, did not indicate any reduction in recall due to uncategorized order. The process of "chunking" (Miller, 1956) the items into units belonging to common categories facilitated recall of the items for both 10-year olds and 16-year olds. Presenting the forty-nine pictures in seven groups of seven items in each one benefited 16-year olds more than 10-year olds and adults. Ten-year olds' recall disadvantage could be due to their inability to store all the forty-nine items long enough in the short-term memory. They could not hold as much information as the 16-year olds but could hold as much as adults. The "chunking" process did facilitate their recall, as the mean recall for the uncategorized lists was reduced significantly. Likewise, the "chunking" process also facilitated the recall for 16-year olds; in addition to being able to hold more information in short-term memory than 10-year olds, the "chunking" process provides reinforcement and thus, the mean recalls for both lists were higher than for 10-year olds. Adults on the other hand, may have depended on the strength of the short-term memory alone; the "chunking" of items in categorized lists may have not been detected and thus was not utilized for recall. Both lists were treated similarly; thus, mean recalls are similar (33.617 for categorized and 33.733 for uncategorized).

However, when items were presented in random order without any indication of group origin, 10-year olds suffered the most; 16-year olds were not affected as much. Their developing short-term memory was not able to help facilitate their recall, and thus, 10-year olds recalled only 25.700 items on average. On the other hand, despite the absence of group origin in the uncategorized lists, 16-year olds recalled better than 10-year olds. Their powerful short-term memory may have compensated for the loss of group origin. In addition, 16-year old's advantage could also be due to their ability to detect the categorical grouping clue within the uncategorized lists. Eventhough the pictures were presented in uncategorized order, they were able to detect the categorical grouping clue, that the pictures were of several groups of common items. Analysis of the data indicates that more 16-year olds who viewed the three uncategorized lists indicated categorical clustering of the pictures when they recalled the pictures compared to 10-year olds and adults. Several items were recalled in groups of at least three items which belong to the same category. Among 16-year olds who recalled uncategorized lists, three (3) students actually provided the categories and wrote the items recalled under each category. Overall, there was no indication of any systematic arrangement of the categories and items recalled. Nevertheless, they recalled uncategorized lists as well as the categorized ones compared to other age groups.

For instructional purposes, it is suggested that 10-year olds and 16-year olds would benefit if instructional materials were presented in categories or clusters. Grouping materials into some common characteristics would facilitate their learning. However, adults would benefit equally well regardless of whether materials were presented categorically or uncategorically.

The results of this study also provide further evidence for the superiority of color pictures over black and white pictures and line drawings. Findings by Jesky (1984), Alfahad (1990) and Berry (1991a) are thus supported. With meaningful additional cues, color pictures provide higher degree of realism, and thus facilitate their recall. Regardless of age and cluster, on average, color pictures were better recalled than black and white pictures and line drawings. Among the three age groups, 16-year olds did not seem to indicate any preference for any one level of color realism. They recalled all three levels equally well with each mean recall not significantly different from another. The amount of additional cues in each color format did not affect their recall of the lists. Despite not significantly different, one notable finding is that their

recall for black and white pictures is slightly better than color pictures. In fact, for age and color realism interaction, black and white pictures recalled by 16-year olds has the highest mean recall, 37.900.

On the other hand, 10-year olds and adults differentiated among the three levels of color realism; color pictures were recalled significantly better than both black and white pictures and line drawings. Despite showing higher recall for color pictures ($\underline{M}$ = 31.050) than for both black and white pictures and line drawings ($\underline{M}$ = 27.400 and 26.650), 10-year olds did not recall as well as the other two age groups in all three levels of color realism. In addition, line drawings recalled by 10-year olds recorded the lowest mean recall ($\underline{M}$ = 26.650) in the interaction of age and color realism. This finding supports Ritchey's (1982) claim that younger children do not benefit from outline (drawings) as much as older children and adults. In Ritchey's study, 8-year olds recalled outline drawings on average, lesser than 11-year olds and adults. On the other hand, 11 year-olds and adults recalled outline drawings better than drawings eventhough the difference was not significant. Despite having higher degree of realism (more details), drawings did not help the students to better recall them. Ritchey (1982) suggested that the recall advantage for outline drawings may have increased with age. However, the results of the present study do not support the idea.

With regard to both cluster and color realism, the mean number of items recalled by adults were not as high as for 16-year old, even though the former were assumed to be more mature and more proficient generally. This could be attributed to the lack of motivation due to the nature of the content, which was not interesting and too easy for them. Another factor involved could be the lack of enthusiasm and seriousness among them because the participation was voluntary despite of keychains given as a token of appreciation.

According to realism theories (Dwyer, 1972), the higher the degree of realism in the existing cues in a learning situation, the higher the probability that learning will be facilitated. Dwyer also proposed a continuum of illustrations which extends from the least realistic (simple black and white line representation) to the most realistic (color photographs). In general, the results of this study support Dwyer's claim. For both 10-year olds and adults, color pictures were recalled significantly better than both black and white pictures and line drawings. Thus, Dwyer's

claim for superiority of color pictures is supported. For 10-year olds, although not significantly different, black and white pictures were recalled slightly better than line drawings. This finding supports Dwyer's claim for superiority of black and white pictures over line drawings. For adults however, this claim is not supported. Line drawings were recalled slightly better than black and white pictures, though not significant.

For 16-year olds, on the other hand, Dwyer's claim is not fully supported. Black and white pictures were recalled slightly better than color pictures, which in turn were recalled better than line drawings. Even though the differences among the three were not significant, color pictures did not facilitate learning (recall) despite having the highest degree of realism. This could be attributed to the dependence of 16-year olds on the strength of short-term memory instead of the visual cues in the items. Regardless of the pictures' degrees of realism, 16-year olds did not appear to take advantage of it; instead they depended more or solely on the power of the short-term memory. With all of that, 16-year olds recalled better than both 10-year olds and adults in all three levels of color realism.

With regard to instructional purposes, it is suggested that 10-year olds and adults would benefit more if color pictures or illustrations were used instead of black and white pictures and line drawings. For 16-year olds, it makes no difference whether color pictures, black and white pictures or line drawings were used.

Conclusions

Based on the results and the discussion, several conclusions can be derived regarding the effects of color realism, clustering, and age on pictorial recall memory among students in Malaysia. Despite adults' recalling slightly more pictures in the uncategorized list than in categorized lists, categorized lists in general, do facilitate the students to recall the pictures regardless of whether the pictures are color, black and white or line drawings. Grouping items into smaller categories with common characteristics creates fewer chunks, and thus, facilitates recall of the items.

At the same time, the strength of the short-term memory also contributes to the ability to recall the pictures. With their short-term memory still developing, 10-year olds were not able to match 16-year olds who had far better developed short-term memory. Adults short-term memory fell between that of 10-year olds and 16-year olds. Regardless of whether the pictures were presented categorically or uncategorically, the strength of the short-term memory was not affected. Adults also may have not detected the categorical grouping clue within the uncategorized lists; thus, the recall for both lists were similar. Overall, 16-year olds received the most benefits from clustering. The ability to detect the categorical grouping clue also helped 16-year olds to recall the uncategorized lists in addition to the strength of their short-term memory. Ten-year olds however, suffered the most, especially when pictures were uncategorized. They were not able to detect the categorical grouping clue to help their recall. In addition, their developing short-term memory also did not help. It can be concluded that 10-year olds could benefit from categorized lists. Sixteen-year olds and adults however, could benefit from both lists.

With regard to color realism, sixteen-year olds recalled equally well regardless of the levels of color realism. Although not significantly different, black and white pictures were recalled slightly more than color pictures. Nonetheless, the three levels were not significantly different from each other. Ten-year olds recalled color pictures the least among the three age groups. Black and white pictures and line drawings were recalled the least as well; however, they were not significantly different from each other. Adults recalled color pictures as well as 16-year olds. On the other hand, they recalled black and white pictures and line drawings better than 10-

year olds but not as well as 16-year olds. Overall, it can be concluded that 10-year olds and adults could benefit from color pictures. Sixteen-year olds however, did not discriminate the three levels of color realism. They could benefit from them equally well.

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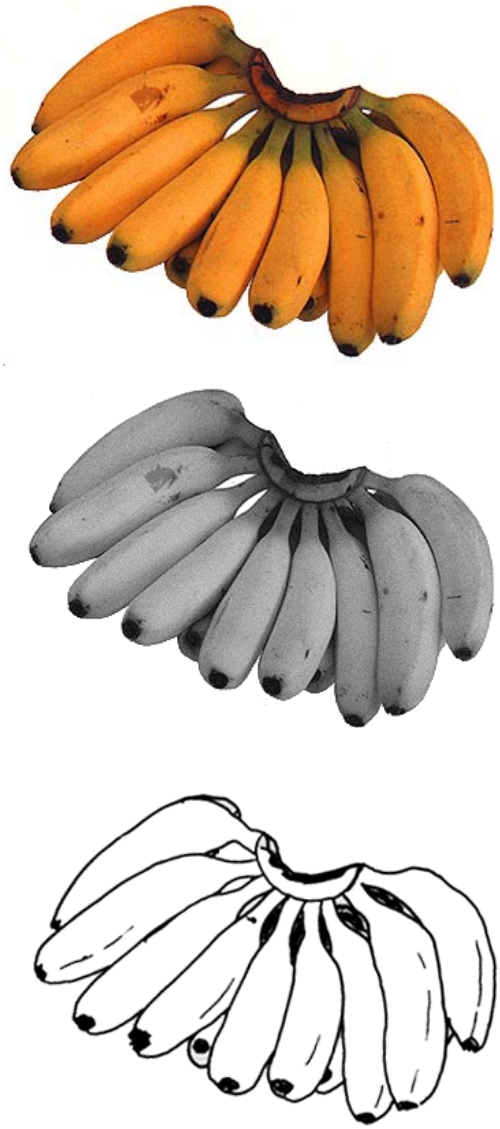
Appendix: A sample of an item for each level of color realism (color, black and white and line drawing)



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