16. VISUAL LITERACY

Roberts A. Braden
CALIFORNIA STATE UNIVERSITY AT CHICO

There are two major impediments to research on visual literacy. The first is a lack of a widely accepted definition of the term *visual literacy* itself. The second, perhaps a consequence of the first, is a lack of a cohesive theory. We must confront the ever-present problem of identifying visual literacy itself before we can identify the body of visual literacy research. The visual literacy concept as an area of study has been plagued by an identity crisis from the outset. Skeptics doubt that visual literacy really exists.

16.1 DEFINITION

For one group of advocates, a literal definition of the term has led to investigation of visual languages with a one-for-one analogy with the reading and writing aspects of verbal literacy. For others, more inclusive definitions have led to the study of visualization in all of its aspects of communication and education. The definitional controversy has been so much a part of visual literacy that Cassidy and Knowlton wrote a major paper in 1983 entitled "Visual Literacy, a Failed Metaphor?" and in 1994 Moore and Dwyer included in their book a chapter titled "Visual Literacy: The Definition Problem" (Seels, 1994). Cassidy and Knowlton (1983) may have had trouble with the term because Knowlton (1966) had set for himself an *exclusive* definition. Seels and most others at this time favor a more *inclusive* attitude toward what constitutes the area of visual literacy.

As evidence that there is no common definition, we merely need to look at the titles of six recent books: *Visual Literacy: Image, Mind, & Reality* (Messaris, 1994); *Visual Literacy: A Conceptual Approach to Solving Graphic Problems* (Wilde & Wilde, 1991); *Introduction to Visual Literacy* (Curtiss, 1987); *Visual Literacy Connections to Thinking, Reading and Writing* (Sinatra, 1986); *Visual Literacy: A Spectrum of Visual Learning* (Moore & Dwyer, 1994); and *Art, Science & Visual Literacy* (Braden, Baca & Beauchamp, 1993).

Each of these books contains the term *visual literacy* in the title, but, how different are their basic assumptions. Messaris (1994) approached the subject—and thus defines and delimits it—from the communications field and particularly from the perspectives of film, television, and advertising. Wilde and Wilde (1991) have written a basic textbook for graphic artists that contains 15 graphic design exercises and 4 illustration exercises, with each exercise followed by examples of how the authors' students have solved those problems. Like the work of Curtiss, the Wildes work relates visual literacy more to art than to communication, and except in the graphic-design world, nobody would accept their assumed limited definition of *visual literacy* Curtiss (1987) took a wide-ranging look, but primarily from the viewpoint of the fine artist. Sinatra's (1986) title includes the term, but his book is more about the acquisition of verbal literacy (reading). Moore and Dwyer (1994) have compiled an eclectic, comprehensive text, covering 22 aspects of visual literacy. Their particular delimiter (definitional bias) is *learning:* the ways that visuals and visualization affect the learning process. Finally, the Braden, Baca, and Beauchamp (1993) volume is just one of more than a dozen annual books of readings published by the International Visual Literacy Association. Similar to proceedings, these edited compilations include articles that have only one unifying thread: they all have something to do with seeing.

This chapter will attempt to deal with so-called *visual literacy research* that includes widely diverging topics of interest. With such an expanded conception of visual literacy, to describe all of the relevant research and to present all of the findings would take an entire volume, not a chapter. Thus, the thrust of this chapter will be to identify and categorize a large portion of the related literature and to elaborate on only selected studies.

16.2 THEORETICAL FOUNDATIONS OF VISUAL LITERACY

The concept of visual literacy was crystallized by John Debes (1968, 1969, 1970), but as Jonassen and Fork noted, "Visual literacy is eclectic in origin" (1975, p. 7). Debes (1970) may or may not have coined the term *visual literacy,* but indeed he did provide its longest (and perhaps longest lasting) definition:

> Visual literacy refers to a group of vision competencies a human being can develop by seeing at the same time he has and integrates other sensory experiences. The development of these competencies is fundamental to normal human learning. When developed, they enable a visually literate person to discriminate and interpret the visible actions, objects, and/or symbols, natural or man made, that he encounters in his environment. Through the creative use of these competencies, he is able to communicate with others. Through the appreciative use of these competencies, he is able to comprehend and enjoy the masterworks of visual communication (p. 14).

In that early visual literacy work, "The Loom of Visual Literacy," Debes flirted with the idea of a visual language, and referred to the even earlier work of Chomsky (1957) on syntactic structures and the work of Paul Wendt (1962) who had written about the language of pictures. Colin Turbayne, an early visual literacy theorist (1962, 1969, 1970a, 1970b), explored the syntax of visual language (1 970b) and concluded that, "Unhappily the code of visual language is chaotic" (p. 24). He was concerned that "Words are often ambiguous" (1970a, p. 115) and that for an object or image to have language utility, it must ". . . always suggest things in the same uniform way.. ." (p. 115). Turbayne, more than any other, laid the groundwork for an analogy of a visual language to verbal language. He wrote, "Just as a large part of learning to understand words consists in learning how to respond to them, so is it the case in learning how to see" (1970, p. *125).* The notion that human beings can be taught (thus learn) "how to see" has been central to visual literacists ever since.

16.2.1 Dual Coding

In 1971, Paivio published his book, *Imagery and Verbal Processes,* In that work he introduced in print what has come to be known as the Dual Coding Theory (DCT) of memory and cognition (see 26.3, 29.2.3). Later, Paivio (1991) said that DCT evolved from his specific experiments on the role of imagery in associative learning (e.g., Paivio, 1963, 1965). Paivio isn't easy reading, and he is prone to take many pages to explain his theory, but nowhere does he state it simply. The closest that he comes is within a summary table (Paivio, 1991) where parsimony is essential:

> Cognition is served by two modality-specific systems that are experientially derived and differentially specialized for representing and processing information concerning nonverbal objects, events, and language (p. 258).

Not all theorists agree with the basic tenets of dual-coding theory. Miller and Burton (1994) characterize those who argue that imaging is encoded as neutral abstract propositions (as opposed to spatial and modality-specific encoding) as the "anti-image group" (e.g., Pylyshyn, 1981). Although there has been no direct conflict between cue summation theory (see 29.4) and dual coding theory, neither has there been any concerted attempt to reconcile the two theories into a more encompassing theorization.

Although dual-coding research is primarily within the province of the field of psychology, the implications for visual literacy are obvious. If, in fact, we do encode both visually and verbally, and if, in fact, the conceptual-peg hypothesis is true [an oversimplification of the hypothesis that verbal concepts are hung on nonverbal pegs in memory, that imagery is the effective variable in recall of concrete verbal information], then the visualization, visual thinking, and visual-verbal connections aspects of visual literacy are theoretically supported.

16.2.2 Theoretical Foundations

Hortin has done the most intensive study of the theoretical foundations of visual literacy. His dissertation (Hortin, 1980a) was subtitled *An Investigation of the Research, Practices, and Theories* [of visual literacy] . In that document and subsequent writings (Hortin 1980b, 1994; Braden & Hortin, 1982), he has agreed with Jonassen and Fork (1975), emphasizing the eclectic nature of the origins of the field of visual literacy and of the range of interests that find a common bond under that rubric. Like the pseudopod metaphor advanced by Debes (1970) as a description of the parameters of visual literacy, Hortin has portrayed visual literacy as a confluence of thought—incorporating linguistics, art, psychology, philosophy, and more.

Incidentally, the first researcher to characterize visual literacy as "a confluence of theories" was Johnson (1977). In his doctoral dissertation he wrote:

> I was disappointed to discover that visual literacy is really nothing more than a "confluence of theories," brought together to form a vague, unorganized concept that tries to explain the notion of "visual sequencing" (p. 141).

Visual sequencing is only one narrow aspect of visual literacy as it is viewed today. The point of view of the researcher is critical, of course. Hortin was fascinated by the metaphor of parallel languages, and concentrated much of his focus on the contributions of linguist Noam Chomsky (1957, 1964, 1968, 1975). However, Hortin's primary research interest was with "visual thinking," and therefore his interpretation of what constituted a confluence of theories was much broader than that of Johnson whose field was the English language.

While Johnson (1977) was delving into the nature of visual literacy as an approach to English instruction, Hocking (1978) was exploring the wider issue of the parameters of visual literacy. His study at the University of Colorado sought to determine visual literacy goals. The paper by Braden and Hortin (1982) also explored the boundaries of the field. Braden and Hortin also offered a shorter definition than that of Debes's. They refined Hortin's own earlier definition (Hortin, 1980a) and came up with this definition:

> Visual literacy is the ability to understand and use images, including the ability to think, learn, and express oneself in terms of images (p. 169).

Seels (1994), in her chapter on the "visual literacy definition problem," uses the Braden-Hortin definition in her glossary, giving current support to defining the field in broader terms. Many other attempts have been made to examine the nature of visual literacy and to define the concept. Notable among them are the work of Case-Gant (1973), Lamberski (1976), Fork and Newhouse (1978), Sucy (1985), Sinatra (1988), Whiteside and Whiteside (1988), and the participants at the Twenty-second Annual Lake Okoboji Educational Media Leadership Conference (Cureton & Cochran, 1976).

Baca (1990) did the most recent and most comprehensive study to date, a delphi study in which visual literacy professionals collectively helped identify what is and what is not a part of visual literacy. After years of quibbling about the nature of visual literacy, Baca found that "There is a great deal of agreement regarding the basic tenets of visual literacy among the scholars who study it" (p. 74). Baca listed 186 accepted constructs of visual literacy. Those regarding definition included: "Visual literacy refers to the use of visuals for the purposes of communication, thinking, learning, constructing meaning, creative expression, [and] aesthetic enjoyment" (p. 65). Earlier, Baca and Braden (1990) had pointed out regarding the Braden-Hortin definition that "even that definition fails to directly address design, creativity, and aesthetics as they apply to visualization." The delphi study acknowledged the additions.

The primary contribution of the Baca study was that it affirmed the broad scope of interests that are subsumed under the visual literacy umbrella. The study also provided an organizational scheme for categorizing the constructs of the field, but it did not identify all of the legs of Debes's pseudopod. That is one objective of this chapter: to organize the research of the field into the subfields of visual literacy. Such a framework will help to clarify the focus of future visual literacy research and will aid future fledgling researchers to select an area for study.

A host of theories and diverging areas of specialization emerged in the dozen years immediately after the visual literacy movement was set in motion. Braden and Hortin (1982, p. 164) compiled a short list:

> Some of the theories have dealt with: visual languaging (e.g., Ausburn & Ausburn, 1978; Debes, 1972, 1974: Turbayne, 1970b); visual thinking (e.g., Arnheim, 1969; Haber, 1970; Wileman, 1980); visual learning (e.g., Dwyer, 1978; Jonassen & Fork, 1978; Randhawa, Back & Meyers, 1977); hemispheric lateralization of the brain (e.g., Bogen, 1979; Ragan, 1977; Sperry, 1973); mental imagery (e.g., Fleming, 1977; Kosslyn & Pomerantz, 1977; Pylyshyn, 1973); levels of abstraction (e.g., Clark & Clark, 1976; Clark, 1978); cultural interaction (Cochran, Younghouse, Sorflaten & Molek, 1980); and the interactive theories dealing with symbol systems and dual coding (e.g., Levie, 1978; Levie & Levie, 1975; Paivio, 1971, 1975, 1983; Salomon, 1972, 1979a).

The list was not meant to be all inclusive then, and certainly is incomplete another dozen years later. Clearly, there are many theories relevant to the area loosely called *visual literacy.* No one theory comes even close to encompassing all (or even one) of the others.

16.3 ESTABLISHING A VISUAL LITERACY RESEARCH AGENDA

In the past, others have attempted in sundry ways to facilitate the research of the visual literacy area. The first authors to undertake the task of building a framework for visual literacy research were Spitzer and McNerny (1975). Their emphasis was on operationally defining visual literacy so that others could proceed with research to support the operational definitions. An extensive study was made by Hocking to determine visual literacy goals, which in turn could become the basis for research (Hocking, 1978). At about the same time, Levie (1 978a) offered the field a prospectus for instructional research on visual literacy. The link of instruction to visual literacy was important, and *the bulk of all visual literacy research has been done with learning and instruction in mind.*

Lida Cochran and her associates took a more pragmatic approach. The Cochran team held seminars and meetings with aspiring visual literacists and examined the possible avenues of visual literacy research. A direction for the field was recommended and possibilities were outlined for a broader audience in their *Educational Communication and Technology Journal* article (Cochran et al., 1980). For those with a greater interest in the linguistic aspects of visual literacy, Hennis (1981) pointed out the need for research in the area of visual language. More recently, other authors have provided their conceptions of an agenda for visual literacy research. For example, Hartley (1987) addressed the role of print-based research in an era when we must accommodate to changes brought about by the emergence of electronic text.

Gnizak and Girshman (1984) turned the entire process on its head. Rather than concern themselves with doing research about visual literacy, they undertook an experiment in visualizing during the research process. They encouraged students to "define a pressing social problem in visual terms and thereby develop student abilities to analyze, to criticize, and finally to synthesize" (p. 207).

16.3.1 Levie's "Islands"

Levie (1987) lamented the fact that research on pictures was done in small topical islands, barely connected. He said that "an additional approach that brings together data and ideas from separate contexts could contribute much to our understanding of this pervasive, versatile mode of communication" (p. 27). *A list of Levie 's "islands" is an outline of much of the research in visual literacy.* His selected bibliography to accompany that list is broken into categories and is exceptional, including sections for:

- Picture perception (6 bibliography entries)
- Theoretical approaches to picture perception (21 entries)
- Attention and scanning (40 entries)
- Interpreting figures and pictorial cues (40 entries)
- Perceiving global meaning (25 entries)
- Memory for pictures (6 entries)
- Memory models (25 entries)
- Recognition memory (44 entries)
- Recall (20 entries)
- Other types of memory research (27 entries)
- Learning and cognition (7 entries)
- The acquisition of knowledge (48 entries)
- Problem solving and visual thinking (26 entries)

- Acquisition of cognitive skills (32 entries)
- Media research (39 entries)
- Affective responses to pictures (95 entries; broken down further as follows: arousal and emotional impact, 17 entries; preferences, 22 entries; attitudes, 25 entries; and aesthetic responses, 31 entries)

Obviously, many of the topics above are included in the research agendas of other fields. What is remarkable is that so much research in sundry fields has been found to have visual literacy implications.

16.4 VISUAL VOCABULARY

Although Levie's summary of the research on pictures covers much of the research relevant to visual literacy, Baca's study reminds us that the use of "visuals" touches other areas, including thinking and learning, and constructing meaning. To construct meaning from visuals implies that in some way the constructed meaning can be "read" by persons who view it. The notion that images can be "read" implies the existence of at least a rudimentary visual language made up of vocabulary components.

16.4.1 Reading Pictures

Some authors have addressed the encoding of pictorial information directly. Stewig (1989) even titled his article "Reading Pictures." In Stewig's study, 28 fifth-grade students listened to the reading of three different versions of *The Three Little Pigs,* each version with a different set of illustrations. A rather complex 3-day procedure was adopted which involved letting students ask questions, having students make comparisons, and encouraging other interactions with the pictures and the stories. On the fourth day, students wrote what they liked best and why. Only 15 comments of 83 related to the story: content, plot, and book design. The other 68 comments referred to the pictures: color, style, detail, brightness, medium, and size. One student wrote: "The pictures told the whole story themselves because they were so clear" (p. 79).

Other research has been done to examine how children interpret pictures (interpretation in this sense is a measure of how the students read the picture). Leslie Higgins has done three notable studies in this area (1978, 1979, 1980). The studies were based on her own model which posits that ". . . picture interpretation consists of two related and interdependent forms of behavior: observation and inference drawing" (Higgins, 1978, p. 216). She goes on to explain that "Inferring in the picture interpretation context carries understanding beyond an awareness of what is seen (p. 216). In her first experiment with 95 fifth- and sixth-graders, Higgins (1978) found that picture interpretation ability correlated highly with only one factor: *operational facility,* a characteristic that reflects Piaget's operational stages. In her second study, she set out to determine whether children can be taught to draw inferences from pictures (Higgins, 1979). Students who were given "thinking guides" prior to the picture interpretation tests did significantly better at making inferences. However, the guides did not help the students to better evaluate their inferences. In four experiments to assess literalism in the interpretation of pictures by children, Higgins (1980) found that many children in the 4- to 7-year-old range gather information that the pictures were not intended to convey. For example, in a picture in which only half a dog is shown (the other half being out of the frame), the child may conclude that the character (dog) has no head and only two legs. This phenomenon was found to be a maturational attribute that does not occur in older children. No evidence was given to indicate whether children grow out of this mistake-prone behavior simply by aging or whether learning is the change factor.

Ramsey (1989a, 1989b) suggests that "Artistic style may also be a powerful pictorial variable which primary-age children utilize as a yardstick in predicting the reality or fantasy of accompanying text content." She reports two of her own studies, done in 1982 and 1989, that demonstrate the wide range of interpretation skills already possessed by children that age.

Pettersson (1984, 1993) has approached the matter of reading pictures from the standpoint of picture readability. He first created a picture readability index called BLIX (a Swedish acronym) based on 19 picture variables that were ultimately collapsed into five rating (indexing) factors. Then he validated the index experimentally:

> Experiments with ranking and rating of test-pictures showed that pictures with high BLIX-values were ranked and rated better than those with lower values by children as well as adults. Experiments with the actual making of pictures showed that despite detailed instructions on the execution of the visuals, there was still plenty of scope for individual creativity. It was also shown that informative pictures drawn so that their BLIX-ratings were high (more than 4.5 on a scale of *5.0)* were to a large extent rated as aesthetically pleasing, rated as "suitable" or "very suitable" for teaching, and did not take more time to make than pictures with lower BLIX-ratings (1993, p. 158).

16.4.2 Visual Representation

The study of *visual representation* has generally fallen into five distinct areas of inquiry: (1) semiotics and film/video conventions; (2) signs, symbols, and icons; (3) images and illustration (including the survey by Levie discussed above); (4) multi-image; and *(5)* graphic representation. Each of those areas has its own growing research literature.

16.4.2.1. Semiotics and Film/Video Conventions. The literature of film is voluminous. Arnheim (1957) theorized about the nature of images in film and about film structure. He made popular the idea of film as art. Metz (1974), on the other hand, was concerned with the linguistic attributes of film and the sign language (semiotics) used by filmmakers. He identified and categorized the visual building blocks of film imagery into a notational scheme that has since become the basis for reader theories. In that sense, semiotics has become the basis for analysis of "the language of film."

The educational media field was introduced to the concept of analyzing film by Pryluck and Snow (1975). Theirs was the linguistic approach. Corcoran (1981) was one of the first to deal with semiotics and film/video conventions in a way that is related to visual literacy. He pointed out that there are problems in the use of linguistic models or reader theories as they apply to reading the images of screen media. Others who have focused on the relationship of semiotics to visual literacy are Muffoletto (1982), Metallinos (1982, 1995a), and Gavriel Salomon (1979b, 1982, 1983, 1984). In his earlier work, Salomon (1979b) indicated that different symbol systems are employed by different media. Jack Solomon (1988) extended Salomon's logic by interpreting hidden signs within the environment at large.

The vast majority of the scholarly work in semiotics is theoretical and analytical-interpretive rather than experimental. Thus, Salomon (1979b) speaks of the differences between notational symbol systems and nonnotational ones, but research on labeled and nonlabeled illustrations is done by people outside the semiotics area, like Mayer (1989).

Monoco (1981) popularized the idea of interpreting film symbols as "reading" film. The latter research by Salomon (1983, 1984) has focused on demonstrating experimentally that it is much easier in terms of mental effort for an individual to view television than it is to read text. He characterized television as easy, and print as tough. This conclusion was consistent with his earlier lament (Salomon, 1979b), based on his interpretation of Samuels' (1970) study of children reading illustrated text: "Specifically, the employment of charts, graphs, or pictures could save mental effort and make the acquisition of knowledge more effective, but it will impede [reading] skill development" (p. 83). The implication that the availability of visuals and film may make learners lazy is obvious.

The primary scholarly interest in film semiotics has been directed toward film criticism. While many approaches to film criticism have evolved, each with its advocates, it was not until 1994 that *a visual literacy approach to film criticism* was introduced (Metallinos, 1995). Whether the underlying theory of that approach will lead to supportive research is not yet clear.

Hefzalla (1987) has taken the position that the principle of visual primacy in film has led to the use of the visual element of film as a tool for communicating more than is actually shown. Thus film has an implying power [his term] more powerful than simple, literal linguistics. Related research has disproportionately focused on cinematic production variables: lighting, focus, shot selection, camera angle, image placement, camera movement, and such (e.g., McCain, Chilberg & Wakshlag, 1977; Metallinos & Tiemens, 1977; Kaha, 1993; Kipper, 1986). While many of these results are of interest to the visual literacy and instructional technology fields, the research is the primary province of those doing encoding research in the fields of mass communication and film studies.

Goodman (1968, 1977, 1978) contributed basic theory about symbol systems that had an influence on semiotics (Salomon, 1979a) and also added a cognitive (as contrasted to an aesthetic) dimension to the interpretation of art. In his "theory of symbols," he created a taxonomy of the major symbol systems used by human beings, including gestural and visual graphics systems. The theoretical literature on semiotics and symbol systems is rich. The research to validate the theories is, as yet, not so rich.

16.4.2.2. Signs, Symbols, and Icons. Scholarship concerning signs, symbols, and icons is interwoven with that of semiotics, but it also stands apart. The concepts are easily confused, and frequently the terms are used and misused interchangeably. Thus, to define *symbol,* Salomon (1979b) indicated that "most objects, marks, events, models, or pictures that serve as bearers of extractable knowledge are symbols" and that "Symbols serve as characters or coding elements . . .' (p. 29). By Salomon's definition, symbols subsume both signs and icons, which are at opposite ends of a continuum of abstractness and resemblance.

Historically there has been much disagreement over the nature, meaning, and definition of symbols (Sewell, 1994). Semiotic theorists have considered *sign* to be the more inclusive term, subsuming symbols, signals, indexes, and icons. Sewell (1994) helped bring focus to the *functional* nature of symbols this way:

> Symbols are classified into a three-tiered hierarchy along a concrete to abstract continuum as *pictorial symbols* that include 3-D models, photographs, and illustration drawings, *graphic symbols* that include image-related graphics, concept-related graphics, and arbitrary graphics, and *verbal symbols* that are the most abstract, since they have no graphic resemblance with the object to which they refer (p. 137).

Eisner (1970), too, was concerned with the element of resemblance of symbols to their referents. However, his taxonomy classified symbols into four classes that reflect more than the simple polarity of the continuum. His classes of symbols are: conventional symbols (abstract signs/symbols with finite referents), representational symbols (iconic symbols that faithfully depict their referents), connotative symbols (those that distort the image of the referent), and qualitative symbols (those that are neither signs nor icons per se, but rather are images that establish an atmosphere or evoke feelings). Theorists have quibbled over how and why symbols represent referents and over such points as the functional imperatives of symbols as either descriptive or depictive (Goodman, 1968; Salomon, 1979b). However, these issues have not been an object of research, and the categorization schemes serve research only as obvious variables to be used in all manner of visual representation studies.

Salomon has linked his interest in codes and symbols system with his concern for cognition and learning (1 979a). In generalizing the results of four coding experiments, he reported "that at least three kinds of covert skills—singling out details, visualization, and changing points of view—can be affected by filmic coding elements" (Salomon, 1979b, p. 155).

Almost anything can be a *sign,* depending on how one defines the term. However, the common lay uses of the term have driven the research. Dewar and Ellis (1977) studied the perception of, and understanding of, traffic signs. Makett-Stout and Dewar (1981) evaluated the effectiveness of public information signs. They concluded that such signs communicate as individual symbols, but that they do not constitute a visual language. They also found that the proliferation of safety signs and symbols has resulted in the creation of several signs with identical meanings.

In a related analysis, Yeaman (1987) investigated the functions and content of signs in libraries. His taxonomy was austere, establishing only three basic categories of library signage: directional, locational, and informational. While his analysis included legibility concerns, font selection, and location considerations, it did not consider the use of symbolic, nonverbal signs.

Three recent studies have investigated how well people are able to read and interpret graphic signs, symbols, and icons (Griffin & Gibbs, 1993; Griffin, 1994; Griffin, Pettersson, Semali & Takakuwa, 1995). In the first of these studies (Griffin & Gibbs, 1993), subjects from the United States and Jamaica were asked to identify 48 widely used symbols. Subjects from both countries found some symbols to be confusing. Some symbols, though widely used, were found to be not widely understood. And there were significant differences in the recognition patterns between subjects of the two cultures. The study verified that signs are culture related. In a study that drew symbols from street signs, computer notation, and clip art, Griffin (1994) found that symbols used in business presentations were often misinterpreted or not understood. He found that image perception and understanding is relevant to context (verbal context can make visual symbols easier to interpret correctly). He also found that subjects make rapid judgments about the meaning of symbols because:

> They often do not look at the visual in great detail . Rather, they take a superficial look at the symbol and then make a determination of the meaning. Visual experts should not rely on symbols to convey in-depth meaning or ideas which are critical to an outcome. *Symbols do not convey accurate meanings"* (p. 44, emphasis added).

The third study (Griffin, Pettersson, Semali & Takakuwa, 1995) was performed on subjects in four different countries, each country with its own distinct culture. The methods and results paralleled those of the 1993 Griffin and Gibbs study. The evidence of American culture was evident in the responses in other countries, particularly in Japan regarding computer-related symbols, but the overwhelming evidence was in favor of cultural differences being the predominant variable when symbol understanding was measured. An international symbol system based on intuitive interpretation of symbol meanings may not be possible until the world shares a common culture.

16.4.2.3. Images and Illustration. In the area of images and illustration, including pictorial research, we find important contributions by Alesandrini (1981, 1984), Duchastel (1978, 1980), Duchastel and Waller (1979), Knowlton (1966), Levie (1978, 1987), Levie and Lentz (1982), Pettersson (1989, 1993), and the text *The Psychology of Illustration, Volume 1, Basic Research,* by Willows and Houghton (1987).

First Knowlton (1966), then Alesandrini (1984), offered classification schemes for illustrations. Their categories are conceptually quite similar. Knowlton proposed three categories: realistic, analogical, and logical. Alesandrini also offered three categories: representational, analogical, and arbitrary. These categories have been useful tools for the field. Realistic or representational illustrations share a physical resemblance to the referent object or concept. Analogical illustrations show something other than the referent object and imply a similarity. Logical or arbitrary illustrations bear no resemblance to the referent object or concept but rather offer some organizational or layout feature that highlights a conceptual or logical relationship of the illustration's components to each other.

While *the results of research relevant to images and illustration are spread throughout this chapter,* special notice should be made of two chapters in the Willows and Houghton book that deal with the use of illustrations in children's learning. In one chapter, Pressley and Miller (1987) have reviewed the research on "Effects of Illustrations on Children's Listening Comprehension and Oral Prose Memory." In the other, Peek (1987) has brought together the research on 'The Role of Illustrations in Processing and Remembering Illustrated Text." The information being too voluminous to be included here in toto, these chapters can only be touched on briefly, with closer examination commended to readers.

Pressley and Miller (1987) have explicitly written their review of the effects of illustration on children's memory as a reflection of Paivio's dual-coding theory. That theoretical bias reflects Pressley's (1977) own conclusion that enough research evidence had been gathered regarding illustrated text, so that "No more experiments are required to substantiate the positive effect of pictures on children's learning" (p. 613). In a summary and analysis of the issues related to research on illustrations in text, Duchastel (1980) agreed with that general conclusion.

Most of the research on illustrations has involved text-illustration relationships and comparisons or other linkages of visual to verbal material. Pressley and Miller (1987) point out that verbal cues have a greater effect on memory than visual cues, but:

> There can be little doubt from the available data, however, that if the picture and verbal cues [both] can be activated, they promote children's learning of stories relevant to verbal codes alone (p. 89).

Peek (1987) has reviewed the research on illustrated text regarding the role of illustrations in mental processing and remembering. She cites numerous authors who have made claims about the beneficial affective-motivational roles and functions of illustrations in texts. Pictures have been said to arouse interest, set mood, arouse curiosity, make reading more enjoyable, and to create positive attitudes toward subject content and toward reading itself. While acknowledging that a few studies support such claims, Peek's overall judgment is that:

> Although the proposed roles sound quite plausible, educational research has not come up with much evidence in support of these claims—perhaps because researchers consider the interest and enjoyment effects too obvious for serious investigation (p. 117).

Regarding cognitive effects of illustrations in text, Peek has concentrated on studies of retention effects. Her general conclusions are that "retention of depicted text information is facilitated, whereas unillustrated text is not," and "with growing delay, subjects tend to base their retention-test responses on what they have seen in the pictorial supplements" (p. 128). In other words, when pictures and text are used together, retention is facilitated, and pictures help delayed recall more than immediate recall.

Levie and Lentz (1982) have provided an outstanding review of the research on effects of illustrated text on learning. They summarized the results of 155 experimental comparisons of learning from illustrated versus nonillustrated text. Forty-six of those studies compared learning from illustrated text material versus from text alone:

> In all but 1 of these 46 cases, the group mean for those reading illustrated text was superior to that of the group reading text alone. . . . In 39 of the 46 comparisons, the difference was statistically significant . . . and the average group score for the illustrated-text groups was 36% better than for text-alone groups (p. 198).

The Levie and Lentz review also analyzed as a group those studies that dealt with learning a combination of illustrated and nonillustrated text information from illustrated text versus text alone. The studies included the earlier works prior to 1970 that had led many to conclude that pictures do not facilitate comprehension of text (see Samuels, 1970). However, when all of the studies were considered together, Levie and Lentz concluded:

In summary, the diverse group of studies indicates that when the test of learning is something other than a test of only illustrated text information or only nonillustrated text information, the addition of pictures should not be expected to hinder learning; nor should pictures always be expected to facilitate learning. Even so, learning is better with pictures in most cases (p. 206).

A third aspect of the Levie and Lentz review is its coverage of "some closely related research areas" (p. 214). Accordingly, theirs is the most comprehensive review available of the research on learning from illustrated text in all of its aspects. For that reason their nine conclusions are particularly noteworthy:

1. In normal instructional situations, the addition of pictorial *embellishments* will not enhance the learning of information in the text [emphasis added].
2. When illustrations provide text-redundant information, learning information in the text that is also shown in pictures will be facilitated.
3. The presence of text-redundant illustrations will neither help nor hinder the learning of information in the text that is not illustrated.
4. Illustrations can help learners understand what they read, can help learners remember what they read, and can perform a variety of other instructional functions.
5. Illustrations can sometimes be used as effective/efficient substitutes for words or as providers of extralinguistic information.
6. Learners may fail to make effective use of complex illustrations unless they are prompted to do so.
7. Illustrations usually enhance learner enjoyment, and they can be used to evoke affective reactions.
8. Illustrations may be somewhat more helpful to poor readers than to good readers.
9. Learner-generated imaginal adjuncts are generally less helpful than provided illustrations (pp. 225—26).

16.4.2.4. Multi-Image. Multimedia is an area whose current popularity has spurred both articles in the popular press and research interest. Romiszowski (1994) lauds "the motivation-enhancement role of multimedia that is a result of providing appropriate information through impactful presentations" (p. 12). However, multimedia has not yet become a research interest of visual literacists.

Before there was multimedia, there was multi-image, which was inadequately researched, although there was enough published over 30 years for it to be reviewed as a body of research by Burke and Leps (1989). Jonassen (1979) noted that "Research on multi-imagery generally has focused on the linear versus simultaneous presentation issue" (p. 291). The presentation of two or more images simultaneously (multi-image) has obvious implications on perception, encoding, and many other issues that remain areas of popular visual literacy concern.

Perrin (1969) provided a theory of multiple-image communication that posited that more information would be assimilated by viewers when multiple images were presented simultaneously on multiple screens. Perrin's theory was based on the assumption that viewers would mentally combine the images and consequently be able to make more and better comparisons. Perrin did not address the issue of information overload, which other scholars have considered to be either positive or negative, depending on the purpose of the multi-image presentation: positive when affective responses are sought, negative when cognitive learning is the purpose (Goldstein, 1975).

Goldstein (1975) reconsidered the relevant research on perception and applied those findings to the perception of multiple images. He cited Haber (1970) as concluding that "recognition memory for pictures is essentially perfect" and linked that to the findings of fixation studies:

> We know that once a picture receives only a few fixations, that the picture will be recognized later. The presentation should be slow enough to allow the necessary fixations, but, since our memory for pictures is excellent, overly long exposures are not necessary (p. 59).

Whiteside (1987) reviewed the four multi-image dissertations of Didcoct, Ehlinger; Tierney, and Toler. The studies covered single-image versus multi-image comparisons, picture recognition following a multi-image presentation, physiological and intellectual effects on subjects viewing multi-image, perception questions, and, of course, the effects of simultaneous versus sequential presentation on learning. Whiteside generalized that the majority of the studies (three of four) had not revealed significant differences. The other study (Toler, n.d.) found the effect of simultaneous presentation on visual discrimination tasks to be significantly higher scores than when the presentation was sequential. She also confirmed that "visuals" (visual learners) would outperform haptics, but that haptics would benefit most from multi-image presentation.

Like film, much of the scholarly writing in regard to multiple imagery has been devoted to aesthetics and criticism. Burke (1977) offered a scheme for multi-image criticism that considered the unique characteristics of the medium. In contrast, Seigler (1980) drew directly from film theory when he theorized about the montage effects of multiple images.

Although it would seem natural that multi-image would be the stage on which the competing cue summation and dual-coding theories would be compared, that has not happened. Jonassen's (1979) study comes close. In an experiment with seventh-grade students, one-screen, three-screen, and four-screen presentations were made of the same content. All treatment groups achieved substantial improvement on the criterion task, confirming the instructional effectiveness of the slide-tape medium. The one-screen presentation was a basic linear slide-tape. The three-screen presentation was a duplication of the one-screen presentation, except that additional examples of the concepts were shown concurrently alongside the basic set of slides. The four-screen presentation proved to be significantly more effective than the other treatments. That treatment used only the basic set of images, but kept previously shown slides in view as new images were introduced. The four-screen treatment was the only one that provided concurrent projection of both examples and nonexamples for the students to compare visually.

The paucity of multi-image research may be a function of a lack of a unifying theory of multi-image (Burke, 1991 a). In two recent articles, Burke (1991a, 1991b) has provided a new theoretical framework for the study of multi-image that is consistent with classical film theory. His theory accommodates the differing spatial emphasis of painting, photography, cinema, video, and multi-image. With theory in place, perhaps elaborating research will follow.

16.4.2.5. Graphic Representation. Spread across several disciplines are many papers on graphic representation, such as those of Jonassen, Beissner and Yacci (1993), Bertoline, Burton, and Wiley (1992), Braden (1983), Whiteside and Whiteside (1988), Griffin (1989), Macdonald-Ross (1977a, 1977b, 1979), Moxley (1983), Pruisner (1992), Winn (1980, 1981, 1982, 1983, 1986, 1987), and Winn and Holiday (1982).

16.4.2.5.1. Graphics. Saunders (1994) identifies nine categories of graphics: "symbols (pictographic or abstract), maps, graphs, diagrams, illustrations or rendered pictures (realistic to abstract), photos (still or moving), three-dimensional models, graphic devices and elements (may also be considered as symbols, and composite graphics made up of two or more of the other types)" (p. 184). At first glance, two of those categories seem questionable, those of photos and 3-D models. However, Saunders explains that she refers to photos that have been digitized and are capable of artistic manipulation and to models constructed through computer graphics and animation. These then all fit within her definition: "Graphics may be simply defined as a *prepared form of visual message or a visual form of communication"* (p. 184). As noted previously, Alesandrini (1984) classified graphics much differently under three rubrics: representational, analogical, and arbitrary. Her classification has been widely used in the research literature.

Graphics have also been categorized according to instructional applications. Reiber (1994) classified graphic applications as cosmetic, motivation, attention gaining, presentation, and practice. He further noted that cosmetic and motivation applications served affective functions, and that the other three applications served cognitive functions.

Research on graphics is heavily interwoven with research on pictures, as reviewed by Levie (1987). Accordingly, most of Levie's "picture" conclusions are applicable to graphics. Thus, we might read his conclusions as follows:

> Overall, research on interpreting pictorial cues and features [graphic cues and features] demonstrates that although some fundamental skills such as object recognition are essentially innate, young children and adults without ample picture-viewing [graphics-viewing] experience have trouble decoding pictorial [graphic] information that is abstract, complex, or represented in culture-bound conven-

> tions-especially when the objects and concepts shown are unfamiliar (Levie, 1987, pp. 7, 8; brackets added).

However, this expansion of Levie's conclusions must be taken with a grain of caution. When the purpose of the visuals is exclusively to support *reading to learn,* the effects of pictures and representational illustrations are more effective than those of graphics (Levin, Anglin & Carney, 1987).

16.4.2.5.2. Charts, Graphs, and Diagrams. For a more extensive review and discussion of research on charts, diagrams, and graphs than is provided here, readers are referred to the chapter by Bill Winn in Houghton and Willows' *The Psychology of Illustration: Basic Research* (1987). In that review of research on charts, graphs, and diagrams, Winn (1987) summarized that usually, but not always, graphics have done more to improve performance of students with low ability than those with high ability. Studies that supported that conclusion included the study of the effects of complex flow diagrams on 10th-grade science learning by Holliday, Bruner, and Donais (1977) and the study of elementary and secondary school students solving illustrated math story problems by Moyer, Sowder, Threadgill-Sowder, and Moyer (1984). Both of those studies are "diagram" studies.

16.4.2.6. Diagrams. According to Saunders (1994), diagrams "include those visuals drawn to represent and identify parts of a whole, a process, a general scheme, and/or the flow of results of an action or process" (p. 185). Winn (1987) points out that:

> There is a disproportionate amount of research on what we have defined as "diagrams." There is very little on the instructional effectiveness of graphs, and not much more on charts (p. 168).

Diagrams have proved particularly effective in science instruction when used to show processes (Winn, 1987).

In a study that examined the effectiveness of two mathemagenic activities, study questions, and diagrams, Buttolph and Branch (1993) found a weak effect in favor of diagrams, but no significant difference between the treatment groups. However, their post hoc comparison led them to "suggest that diagrams have the potential to be more effective mathemagenic aids to learning than study questions (p. 25). Since the subjects in this study created their own diagrams with prompts, the results should be compared to those of Alesandrini's (1981) study that involved student creation of mathemagenic material. In that study, college students were given a science chapter to read and were assigned one of two study strategies. Students who wrote paraphrases were compared to students who drew pictures of the material. Alesandrini, too, found only weak (not significant) effects in favor of the drawing strategy.

16.4.2.7. Charts. As a graphic form, charts are characterized by the organization of information on the page in groupings that are set apart from each other by columns and rows (Winn, 1987). Thus defined, charts will be used with increasing frequency in the future due to their ease of creation with the spreadsheet and tables functions of modern computer software. The term *chart,* however, is used incorrectly to refer to many other graphic forms such as posters, pie *graphs,* bar *graphs,* and line *graphs,* as wall *charts,* pie *charts,* and so forth.

Winn (1987), in reviewing the studies of Decker and Wheatley (1982) and of Rabinowitz and Mandler (1983), concluded that students improve free recall if they take advantage of spatial grouping, and that this free recall is further facilitated if the cognitive elements are grouped according to a conceptual structure. Considering an even wider body of research, Winn (1987) said, "We can conclude from this research that even the simplest spatial organization of elements into meaningful clusters has the potential for improving learning" (p. 177).

16.4.2.8. Graphs. Graphs are used to show quantitative relationships. Different types of graphs show different functions; e.g., line graphs show sequence and trends, pie graphs show portions of a whole, and bar graphs show quantitative comparisons (Fry, 1983; Macdonald Ross, 1977b; Pettersson, 1993; Winn, 1987). A form of bar graph that is of particular interest to visual literacists is the isotype graph, wherein quantities are represented not by bars but by series of small representational drawings (Winn, 1987). The isotype is thus visually a combination of the graph and the illustration.

More than any other of the graphic forms, graphs are governed by design conventions, and organizations such as the American Statistical Association have gone so far as to prepare style sheets to codify those conventions (ASA, 1976; Tufte, 1983). Research to substantiate the unique teaching values of graphs, even the highly pictorial isotype graphs, is lacking.

16.4.2.8.1 Graphic Organizers. Closely related to the effects of graphic materials are the effects that occur when they are used in special ways. Early research on graphic organizers showed "little or no effect" (Levie & Lentz, 1982, p. 215). Therefore, it will not be discussed here. Bellanca (1990, 1992) has proposed two dozen graphic organizers as tools for teaching thinking. The organizers all have two things in common. First, each has a visual (or graphic) component. Second, each graphic component is meant to be the structural background for the display of words, phrases, or other verbal information. Unfortunately (for our purposes), the Bellanca works are trade books, written for elementary and secondary school teachers. No research evidence is presented to validate the effectiveness of these graphic patterns, although each is recommended for use in a particular type of learning situation. Black and Black (1990) also have written a trade book that suggests that thinking can be organized with graphic organizers. Again, there is no substantiating research evidence. Does this mean that scholars have no interest in this issue? Not at all. If we accept what Bellanca classifies as a *graphic organizer,* then we can say that some, not all, of the graphic organizers have received limited research attention.

In early studies that measured the effect of graphic organizers when used as teacher-directed, prereading activities, graphic organizers failed to significantly facilitate learning of content material (Smith, 1978). Moore and Readance in the first of two meta-analyses (1980) reported more positive results, indicating that there was, in fact, a small overall effect of graphic organizers on learning from text. They also noted a strong effect when graphic organizers were used as student-constructed postorganizers rather than preorganizers. The second Moore and Readance meta-analysis (1984) confirmed the results of the 1980 study and found that adults benefit more from graphic organizers than do children.

Moore and Readance (1984) also analyzed the affective effect on teachers. Teachers were reported themselves to be more confident, better organized, and more in control when they had prepared themselves to use graphic organizer strategies. "In essence, teachers believed that graphic organizers prepared them to help students cope with particular pieces of content" (p. 15).

Johnson, Toms-Bronowski, and Pittelman (1982) found semantic maps to be superior to traditional teaching methods when used to teach vocabulary. Sinatra, Berg, and Dunn (1985) used a graphical outline with learning-disabled students, with positive effects on learning comprehension.

Sinatra, Stahl-Gemake, and Berg (1984) presented vocabulary concepts through graphic networking to 27 disabled readers. Results were compared against a verbal-oriented readiness approach, yielding significantly higher comprehension scores in favor of the mapping approach. Sinatra (1984) introduced four different types of network outlines in an attempt to increase reading and writing proficiency. Using these semantic mapping techniques had no significant effect on quality of writing but did have significant effects on improving reading comprehension.

In a fourth study, Sinatra demonstrated that these same semantic mapping techniques could render significant improvement in writing over a short period of time when the graphic outline is used to help the student organize thoughts prior to writing.

Jonassen, Beissner, and Yacci (1993) take a narrower view of what constitutes a graphic organizer, limiting the category to structural overviews. As such, graphic organizers are visual aids that function as "organizers" in the sense of what Ausubel (1978) termed an *advance organizer* So defined, the graphic usually takes the form of labeled nodes connected to unlabeled lines. Jonassen, Beissner, and Yacci recommend using graphic organizers with good or more mature students. They cite examples of graphic organizer research with significant increases in learning effects for science learning (Amerine, 1986), and for recall of social science passages (Boothy & Alvermann, 1984).

Eggen, Kauchuk, and Kirby (1978) examined the effects of graphic organizers on comprehending and producing hierarchies. They found a significant increase in comprehension for fourth-, fifth-, and sixth-grade students asked (and able) to draw a hierarchy of the information in a text. The ability to create hierarchical drawings was not a metacognitive skill possessed by all students at that developmental stage.

16.4.3 Color

Although color could be a subtopic of any or all of the five categories of visual representation above, the topic generates so much interest that it will be covered here separately. Dwyer and Lamberski (1983) reviewed the research literature on the use of color in teaching. Their reference list includes 185 items, most being reports of research. Their general conclusion was that "The instructional value of color appears highly dependent upon the complexity of the task in the materials and perceived response requirements by the learners" (p. 316). More specific conclusions were that:

- Color was found to be of value in nonmeaningful tasks, especially if other perceptual cues lacked physical form differences or were low in associative value.
- The application of color to meaningful tasks appeared related to the interaction between learner and materials.
- In externally paced materials (passive), color appeared to be secondary to other salient features.
- If the task in passive materials became confusing, especially in simultaneous audio and visual materials, the learner selectively attended to a preferred mode as the functional stimulus. However, in most adult learners, this preferred mode is verbal, though in some incidences an integrated verbal and visual strategy may be used.
- If color was central to the concept being presented and if students focused their attention on it, color facilitated learning.
- In unstructured situations, older learners . . . disregard… the potential contribution that could have been made by the relevant visual code.
- In structured situations . . . older learners appeared to have the encoding and rehearsal strategies necessary to use an integrated code system like color.
- Younger learners generally have been found to benefit from color cues in passive materials, due more to their motivational characteristics rather than to their identified cognitive functions.
- Color codes have been found to be ineffective in passive materials, apparently due to insufficient learner-material interactive time.
- Color codes have had more success in facilitating verbal performance in self-paced (active) materials.
- The value of color in retrieval tasks appears highly task related.
- Color cues appeared to facilitate recall of low-perceptual

tasks which are highly visual [but not of more verbal tasks] .

- Color codes have been found to facilitate achievement in complex self-paced tasks, particularly with criterion tasks that are visual in nature (p. 317).

There is continued interest in color. See, for example, the recent work of Pruisner (1992, 1993, 1994). Pruisner (1994) concluded that students *prefer* color-cued text, and that the use of color in graphics enhances learning. Pett (1994) reviewed the research on the use of white letters on colored backgrounds. Preferred background colors for both slides and CRTs were found to be blue and cyan. Medium-density backgrounds were found to provide greater legibility than either high or low density. Green and cyan provided high legibility with slides, but not on a CRT.

None of the research cited above has resulted in major new theory or in revelations of such a magnitude as to cause paradigm shift. Rather, the studies have resulted in the revelation of principles for image design and for instructional applications.

Four extraordinary books have been published which support research on illustration and graphic representation: the two books by Houghton and Willows/Willows and Houghton (1987) and the two books by Tufte (1983, 1990). While the latter are not research compendia, per se, Tufte's *The Visual Display of Quantitative Information* (1983) is scholarly, filled with principles drawn from the research, and is a definitive work on the subject. In a like manner, Tufte's *Envisioning Information* (1990) is a comprehensive, scholarly work that is a definitive book on how to use illustrations in support of concepts.

16.5 VISUALIZATION

Visualization is both something that we do for others and something that we do internally within our minds. The creative, do-it-for-others sense of visualization is covered in this chapter under other topics such as visual representation:

How do we "visualize" ideas for transmission to others? Most of the how-do-we-visualize questions had been answered to the general satisfaction of the field until new, computer-associated questions arose. Revived interest now expresses itself in terms of screen design, icon design, figure-ground, and similar look-of-the-tube issues. Friedhoff (1989) has commented that "visualization, because of the computer, is emerging as a distinctive new discipline" (p. 16).

The more abstract, more problematic concept of visualization is related to mental imagery ("picture that in your mind"), visual mnemonics ("visualize a duck with a yellow bill turning pancakes as a means of remembering the name Bill Turner"), mental spatial manipulations ("look at this picture of a polygon, then picture in your mind what it would look like from the back side"), mental rehearsal ("imagine yourself cutting out the letter A"), and mental recall ("visualize the face of Abraham Lincoln").

Visualization and other visual skills are widely considered to be innate. Salomon's (1 979a) study of the effects of television viewing on TV-naive children led him to conclude that visual skills will develop naturally as a result of exposure to visual media. However, there is no evidence that individuals will innately learn how and when to apply those skills or whether the skills will fully develop "naturally." Winn (1982a) concluded that:

> . . . imagery can be used in some shape or form by most people. However, only some learners can be said to be mentally skilled' in its use" (p. 4) and also that, "In general, any basic visual process can be developed into a visual skill through practice, and any visual skill can be developed into a useful learning strategy through training (p. 17).

16.5.1 Mental Imaging and Recall of Mental Images

Clark (1978) constructed a graphic model of the auditory and visual memory system. The model shows separate paths for coding and storing verbal and spatial representations in memory, following the dual-coding theory of Paivio (1971). In that model is a visual-spatial system that processes visual imagery (see 26.2). To test the model and the assumption that multichannel presentation of instruction with its dual-coding possibilities would be superior to single-channel presentation, Clark (1978) designed an experiment utilizing highly visual subject content to be learned by college students. The auditory-visual treatment group scored significantly higher than all others, and the visual-only treatment was second.

Under ideal conditions, mental imagery has been demonstrated to be effective as an aid to prose learning (Lesgold, McCormick & Golinkoff, 1975; Levin, 1973; Pressley, 1976). Pressley (1976) found that when eight-year-olds were instructed on forming mental images, given practice at imaging, and were provided separate times for reading and imaging (as opposed to simultaneous reading/imaging), their memory of story content was significantly improved. Lesgold, McCormick, and Golinkoff (1975) established an imagery training procedure for third- and fourth-graders. In the procedure, students read a passage, then drew stick figure cartoons illustrating the passage's content.

> After extended training in drawing adequate "comic strips" to illustrate prose passages, performance in a paraphrase-recall-task improved, but only when explicit imagery instructions were given with the task (p. 663). . . . The need for direct imagery instructions in order to get the effect is consistent with general paired-associate findings that even adults show substantially better performance when given explicit imagery instructions than when left to their own devices (p. 666).

Other early studies clearly established that when learners are told how to process visual information, their performance improves (Kosslyn, 1980; J. R. Levin et al., 1974; Paivio & Foth, 1970; Simon, 1972).

Several studies confirm the finding that imagery strategies particularly aid poor readers and poor-learning populations (Levin, 1973; Paris, Mahoney & Buckhalt, 1974; Pressley, 1976). Being *instructed to visualize* is a factor in these studies. *Age* is also a factor in the research associated with these findings. Rohwer (1970) demonstrated that children 5 and 6 years old do not benefit from visual imagery instructions. Levin et al. (1973) found that children have acquired the requisite internal elaboration ability by age 7. However, Shimron (1974) is cited in Lesgold et al. (1975) as having found 6- and 7-year-olds still not able to profit from imagery instructions in prose-learning tasks.

16.5.2 Mnemonics

For centuries, people have used mnemonic imagery as an aid to memory. The research doesn't go back that far. Atkinson (1975) wrote a seminal research paper that introduced the keyword *mnemonic strategy.* Atkinson's interest was in the value of mnemonic images to aid in learning second-language vocabulary. The keyword process is based on a simple two-stage process, First, a keyword is selected to represent the concept to be learned. Second, a visual image representing or using that keyword is created either by the student or the teacher to act as a mental proxy for the concept. Levin and Pressley (1978) used Atkinson's strategy, and it later became the focal point of a series of studies that demonstrated the effectiveness of the strategy for learning different kinds of subject matter (Levin et al., 1980, 1986, 1988; Pressley & Levin, 1981; Rosenheck et al., 1989). These experiments have demonstrated that the keyword technique is successful in aiding recall across a broad range of subject matter. Levin and Levin (1990), in discussing this series of studies, said that there is "a growing body of research that indicates that information acquired on the basis of mnemonic instruction is not just remembered better at the rote memory level. It is often applied better in a number of thinking contexts as well" (p. 315).

Another mnemonic technique that has proved to be useful for remembering people's names is the face-name mnemonic (Carney, Levin & Morrison, 1988). The process, developed by Carney in 1984, is similar to the keyword procedure in that it uses proxy images to stimulate recall, but it involves a third stage. First, a keyword is devised. Next, a prominent feature of the person's face is identified. Then, a visual image is generated which relates the facial feature to the keyword. Although Camey originated the procedure as an aid to remembering names, in the Carney, Levin, and Morrison (1988) experiments, the strategy was used to aid college students learn about art. The Carney team reported, "These three experiments demonstrate that the face-name mnemonic may be successfully extended to an ecologically valid task, the learning of artists and their paintings, such as one would find in an art appreciation class" (p. 120).

Still another derivative technique has been labeled by its creators as *mnemonomy* (Levin & Levin, 1990). The procedure combines the concept of figural taxonomy with that of visual mnemonics. That is, a scientific taxonomy is transformed into a "pictorial mnemonic (memory-enhancing) taxonomy" (p. 302). The Levins conducted three experiments using a botany mnemonomy. Subjects were college students. Mnemonomy students statistically outperformed their taxonomy counterparts in all experiments. The pictorial mnemonomy substantially enhanced students' ability to reconstruct the botany classification system. Mnemonic subjects were more fluent in their ability to navigate the plant classification system. Mnemonic subjects outperformed other subjects on tests of memory. In a surprise to the researchers, mnemonomy subjects statistically surpassed free-study students in related problem-solving ability.

16.6 VISUAL LEARNING/VISUAL TEACHING

The visual literacy movement has been tied to the field of education from the outset. While the research on visualization has demonstrated that visual skills can be taught (Winn, 1982a, and others), there has been no standard approach to teaching visual skills. Although visual skills and visual literacy instruction in the schools is the exception rather than the rule, in several instances visual literacy courses have been introduced. Dake (1982) reviewed 50 visual literacy curricula representing all education levels. He concluded:

> Programs that propose to promote visual literacy come in an amazing variety of formats with significantly different content. Each program seems to have been uniquely formed around existing conditions, the support and facilities available, and the knowledge and dedication of personnel already on hand (p. 2).

As to the significantly different content that he mentioned, Dake went on to list 20 topics that could be found in the various curricula. The list is interesting because of its diversity and because several topics seem only remotely related to communicating visually.

1. Developing an understanding of visual media
2. Development of an awareness of communications (mass media) technology and its pervasiveness
3. Technical information on photography, video, etc.
4. The psychology and physiology of vision (These are organized with various levels of analysis of specific behaviors as well as holistic subjective content.)
5. The analysis, evaluation, and interpretation of visual communication
6. Aesthetics
7. How visual literacy contributes to the development of general intellectual skills
8. Developing [visual] learning skills
9. Developing positive self-concept, autonomy, and self-esteem
10. Learning attentiveness to concrete experiences
11. The blending of vision with other senses
12. Developing self-knowledge (The selectivity that goes

into visual messaging reveals a great deal about the creator.)

13. Metaphoric thinking and language—development of meaning
14. The creative process
15. The nature of consciousness
16. Imagination
17. The relationship of visual literacy to concept development
18. Perception of patterns and classification (such as causation)
19. Body and object language
20. Exploring visual/verbal relations (p. 3)

Dake (1982) concluded that "the programs surveyed do not show a consistent relationship between visual literacy theory and research and the structure of the curricula." While he gathered and published information about 19 of the curricula, including evaluation information, no conclusive research conclusions can be drawn. (All of the programs were considered to be "successful," but evaluation evidence was more anecdotal than empirical.)

16.6.1 Realism and the Program of Systematic Evaluation

As noted earlier, Levie (1978) set a research agenda that had its focus on learning and cognition. Prior to that, Dwyer (1972) wrote his *Guide for Improving Visualized Instruction,* which made widely known that he and his associates had been involved in a series of related experimental studies employing similar instructional materials since 1965. That program of ongoing research came to be known as the Program of Systematic Evaluation (PSE), and the 1972 report covered the results of the first phase of that program. The second phase was reported in Dwyer's 1978 book, *Strategies for Improving Visual Learning.* In 1987, Dwyer edited a volume of more than 30 research papers selected from the then 150-odd PSE experiments (the number has since passed 200). Dwyer himself (1994) characterized the 1987 book as a report on phase 3 of PSE. *No other body of research rivals in size or scope the PSE series of experiments.* Recently, summaries of the PSE research have been made available (Dwyer, Dwyer & Canelos, 1989; Dwyer, 1994). The findings of PSE have resulted in dozens of principles for visualized instruction and for visual design. For example, here are 3 (of nearly 40) generalizations from Dwyer's latest overview (Dwyer, 1994):

- Boys and girls in the same grade level (high school) learn equally well from identical types of visual illustrations when they are used to complement oral instruction [a finding from phase 1 of PSE].
- The realism continuum for visual illustrations applied to externally paced instruction is not an effective predictor of learning efficiency of all types of educational objectives. An increase in the amount of realistic detail contained in an illustration will not produce a corresponding increase in the amount of information a student will acquire from it [a finding from phase 2 of PSE].
- Achievement is enhanced when embedded cueing strategies are integrated into computer-based instruction [a finding from phase 3 of PSE] .

16.6.1.1. Realism Studies. Other areas of study associated with visual learning and visual teaching have included *realism studies,* which are closely related to the PSE program in thrust but not in method. For a sample of this area of inquiry, readers are referred to Knowlton (1966), Levie (1978), Levie and Lentz (1982), Wileman (1980, 1993), Beauchamp and Braden (1989), and Braden and Beauchamp (1987).

The two Wileman texts (1980, 1993) have provided (and updated) a typology for the realism continuum that has been adopted by several other authors (e.g., Pettersson, 1993; Braden, 1994). Knowlton (1966) proposed that images be categorized for purposes of study and research. His categorization scheme was based primarily on degrees of realism. Levie and Lentz (1982), while concentrating on the effects of illustration on text, digressed to discuss providing additional pictorial information.

Braden and Beauchamp (1987) proposed a 2 X 2 matrix model for the concurrent study of the visual realism continuum and the audible realism continuum. The extremes of both continua were labeled *verbal* and *nonverbal.* Thus, four separate slide-plus-tape instructional presentations were prepared, each representing verbal and nonverbal extremes of visuals and sounds. Acknowledging that there is an aesthetic or affective component to interpretations at the abstract ends of both continua, they suggested an eclectic research approach to include both quantitative and qualitative methods in the investigation of the interactions of the two sets of variables. When the slide-plus-tapes were administered as instruction in a study with college students, significant cognitive and affective differences were found (Beauchamp & Braden, 1989). The following conclusions were drawn:

1. In a sight-plus-sound presentation, when verbal language is used to appeal to only one sense via either printed or spoken words, cognitive achievement is not significantly diminished.
2. Pictures used in a sight-plus-sound presentation prompt viewer recall from memory or experience of information not in the presentation.
3. Cognitive stimuli prompt immediate cognitive recall.
4. Visuals, especially photographs, prompt immediate positive affective responses to a presentation.
5. Music from a sight-plus-sound presentation, more so than visuals, prompts long-range, or delayed, positive affective responses.
6. Students are aware of "when" and *"if"* they are learning. Changing the delivery-of-instruction mode does not change this apparently innate sense of learning.

7. A desired change in attitude is prompted through the introduction of new concepts and ideas, not through the presentation itself (p. 38).

16.6.2. Perception and Critical Viewing Skills

16.6.2.1. Perception. Perception, narrowly defined, is awareness. Most of what we perceive is perceived visually—perhaps three-quarters or more (Barry, 1994; Hansen, 1987). Perception is sensing, and visual perception is seeing. Studies of perception at that level are beyond the scope of this chapter. Still, the relevance to visual literacy of perception more broadly defined is obvious. Barry (1994) defines perception as "the process by which we *derive meaning* from what we see, hear, taste, and smell" (p. 114, emphasis added). Seeing images and deriving meaning from them is both an act of perception and a necessary condition of visual literacy.

In his book on visual information, Pettersson (1993) includes a chapter on perception that assumes the broadest kind of definition of the term. Included in his chapter is a section on the physiological aspects of vision, including reference to studies of his own and of others about eye movements, fixations, and scanning as physical attributes of seeing-to-perceive. There is also a section on picture perception, again supported by reports of his own and others' research. In the smorgasbord of topics that he includes are subliminal reception, illusions, visual imagery, and a cognitive model of perception.

From the mass of research that Pettersson reviews and describes, he reached the following eclectic conclusions (among others):

- All visual experience is subject to individual interpretation.
- Perceived image content is different from intended image content.
- Even simple pictures may cause many different associations.
- A given set of basic elements can be combined to form completely different images.
- The design of a picture can be changed a great deal without any major impact on the perception of the image contents.
- Content is more important than execution or form.
- Picture readability is positively correlated with both aesthetic ratings and assessed usefulness in teaching.
- Legends should be written with great care. They heavily influence our interpretation of image content.
- To a large degree, readers see what they are told to see in an image.
- There seems to be no major difference between genders in interpretation of image contents.
- Students display poor pictorial capabilities.
- We must learn to read image content (p. 86).

Barry (1994) has written an elaborate piece on perceptual aesthetics and visual language. Although most of her chapter is expository and theoretical, she makes some interesting connections. For example, she brings together meaning and feeling and explains how the perceptual process serves as a link. She provides a useful conception of Gestalt psychology as a basis for aesthetic theory. Others who have concerned themselves with *visual aesthetics* are Arnheim (1979) and Curtiss (1987).

Winn (1993) has written a new two-part chapter on perception for the revised Fleming and Levie (1993) book of principles from the behavioral and cognitive sciences. In the Winn chapter, conclusions from the research are stated as principles, and each principle is then briefly explained. Many of the explanations cite the underlying research. In Part I, most of the 31 perception principles are generalized, but a few address visual perception directly. For example, these four *research-based principles* relate directly to visualization and visual literacy:

1.3. Distinguishing between figure and ground is one of the most basic perceptual processes. Early perceptual processes are active in figure-ground organization (p. 59).

1.5 b. Whether people see the "big picture" or details first depends primarily, in vision perception, on the size of the visual angle, that is, on the size of the image relative to the whole visual field (p. 64).

1.6. A horizontal-vertical reference system seems to be fundamental to perceptual organization. There is also a natural tendency for people to partition images into left and right fields (p. 65).

2.5. If none of these factors [sequence, organization, or composition] comes into play, there is a tendency for literate viewers to "read" visual messages in the same way they read text—for English speakers, that means from left to right and top to bottom (p. 70).

Part II of Winn's chapter on perception principles contains a section on "The Perception of Pictures," with 12 principles, and a section on 'The Perception of Diagrams, Charts, and Graphs," with 14 principles. All of these 26 research-based items are germane to visualization and visual literacy, and are commended to our readers.

16.6.2.2. Critical-Viewing Skills. The need for instruction in critical TV-viewing skills has been taken for granted. The Far West Laboratory for Educational Research and Development sponsored a national program of TV Viewing Workshops in support of Ned White's (1980) high school curriculum (and textbook) entitled *Inside Television: A Guide to Critical Viewing.* Lieberman (n.d.), in the trainer's manual for those workshops, offered a rationale for teaching critical-viewing skills: "Students do require training to develop the ability to analyze and evaluate these [TV] messages, know the capabilities and limitations of the medium, and make conscious decisions about when and what to watch" (p. 3). She did *not* cite any research to justify the need for or the effectiveness of critical-viewing skill instruction, and her extensive bibliography does not include any references to such research; either none exists or it is fugitive literature.

Minneapolis was the first American city to adopt a citywide program for teaching visual literacy skills across the curriculum, based on the assumption that to do so would develop creative and critical thinkers (Lacy, 1987). An 81-page curriculum document written by Lyn Lacy was published and distributed throughout the city (Lacy, 1989). The rationale stated in that document was not documented by research either, but its main points are of interest here. Regarding the teaching of thinking, the Minneapolis guidelines say that visual literacy and thinking:

1. Should both be taught throughout the curriculum
2. Should both be taught in relation to content
3. Should initially both be taught in sequential order but, once learned, neither are always used consciously and in sequence thereafter
4. Should both be taught as processes in themselves, so that students understand what they are doing and can apply processes elsewhere (Lacy, 1988, p. 34)

An.other program for teaching critical-viewing skills is sponsored by the Washington [D.C.] Association for Television and Children (WATCH). This small association published a critical-viewing guide (Banta & Creighton, 1985) and collaborated with a local television station in the production of a regional critical-viewing project (Sutton, 1987). Like the other examples given, the rationale for the WATCH critical-viewing project was based on *values* rather than on research.

To summarize on this topic, intuition that students will profit from critical viewing may well be sound. However, longitudinal research on the effects of these programs is needed. A number of authors have concentrated on perception and critical-viewing skills (Adams & Hamm, 1987; Baron, 1985; Finn, 1980; Hefzallah, 1986, 1987; Lloyd-Kolkin, 1982; Watkins et al., 1988; White, 1980).

A dedicated group of scholars has investigated visuals and visualizing as functions of *learning strategies and learner styles* (Ausburn & Ausburn, 1978b; Canelos, 1980, 1983; Dwyer & Moore, 1992; Moore, 1986; Moore & Dwyer, 1991; Moore & Bedient, 1986; Streibel, 1980; Ragan, 1978). Two approaches have been taken to investigating visuals as a function of learning styles. The first has focused on the differential effects when the learning style is based on the visual/haptic scale. According to Jonassen & Grabowski (1993):

> Visually oriented individuals acquaint themselves with the environment through their vision. . . . The individual with haptic tendencies is more concerned with body sensations experienced through a tactile and/or kinesthetic mode. . . . Visual and haptic learning styles are, theoretically, at opposite ends of a continuum of perceptual organization of the external environment (p. 177).

A much-used indicator of visual/haptic style has been field dependence. In 1991, Mike Moore reported the results of a program of eight research studies by him and his students at Virginia Tech involving field dependence-independence and a variety of media attributes. That program of research continues.

The other scale commonly used to identify individual differences involving visuals is that of visualizer/verbalizer. The important dimension used to identify the polarized ends of this spectrum is that visualizers are image oriented, whereas verbalizers are word oriented. Richardson (1977) established the link between the visualizer/verbalizer styles and brain hemisphericity and created the Verbal and Visual Learning Styles Questionnaire. The recent study by Kirby, Moore, and Shofield (1988) indicated that verbal ability as measured by Richardson's questionnaire was positively correlated with spatial relations and spatial visualization, but nothing else. Useful significant findings to date are few, the most important being that students whose styles are matched to the styles of teachers tend to do better (Moore, 1991), and when students' preferred learning mode is matched to the learning task, they also tend to do better (Riding & Burt, 1982).

While many individuals have shown an interest in teaching with visuals, only a few have chosen to explore the effects of both teaching with and testing with visuals. Most of the *visual testing* research has been done in conjunction with the PSE program (DeMelo, Szabo & Dwyer, 1981; F. Dwyer & DeMelo, 1983; Szabo, 1981; Szabo, F. Dwyer & DeMelo, 1981; DeMelo & F. Dwyer, 1983; C. Dwyer, 1984, 1985; C. Dwyer & F. Dwyer, 1985). In general the results of that research are that visualized testing provides better assessment and strengthens retention from visualized instruction.

16.7 VISUAL THINKING

Visual thinking is the most abstract concept that draws attention from researchers of visual literacy. Arnheim (1969) was one of the first to use the term. His theory of visual thinking has dominated the later work of such popular writers as McKim (1972), Dondis (1973), and Paivio (1971, 1975). Hortin (1982a) stretched the concept to add the dimension of visual rehearsal as a strategy for employing visual thinking in the learning process, and introduced the concept of introspection (is that a form of metacognition?) to the discussion of visual thinking (Hortin 1982b). Hortin also looked at the ways we use imagery in **our** daily lives (1983), connections of mental imagery to instructional design (1984), and the use of both internal and external imagery as aids for problem solving (1985). As noted earlier, the Minneapolis Public Schools have initiated a program that attempts to teach visual thinking (Lacy, 1989).

Since each individual's thinking is idiosyncratic, the teaching of thinking and thinking skills is problematic and controversial. Salomon (1979b, reprinted 1994) set a theoretical base for discussions of visual thinking in his comments on symbol systems: "Symbols serve as *characters or coding elements* . . . (p. 29), [and] . . . *some coding elements of symbol systems can become internalized to serve as vehicles of thought* (p. 84).

Conclusions about visual thinking evolve in strange ways. For example, Richard Mayer participated in two very different studies. One related to conceptual models for teaching computer programming (Bayman & Mayer, 1988). The other involved cognitive processing during reading (Mayer, 1987). From the two studies, he concluded that "Illustrations may help readers build useful mental models" (Mayer, 1989, p. 240).

16.8 VISUAL LITERACY AND VERBAL LITERACY

A natural outgrowth of the "literacy" metaphor has been the level of interest by teachers of reading and researchers in the field of reading in the relationship of visual literacy to the teaching of reading. Mulcahy and Samuels (1987) have written an extensive history of the use of illustrations in American textbooks over the last 300 years. They point out that only as printing technology has progressed has it been practical for publishers of textbooks to be concerned with semantic and syntactic text parallels between the illustration and the context to the text. Having the right images in the right places in a textbook is a concern that is as new as the visual literacy movement itself.

Scholars who have concerned themselves with visual literacy and reading include Sinatra (1987), who offered a technique to use pictures as tools to teach writing as well as reading, Haber and Haber (1981), whose primary interest was in the reading process, and Levie and Lentz (1982), who addressed the issue more directly as one of "pictures and prose."

Not all of the research concerning the effects of pictures on reading has favored the use of visuals. Early studies of the concurrent use of text and pictures focused on whether readers would attend to the text or to the pictures (Chall, 1967; Samuels, 1967, 1970; Willows, 1978). The emphasis of the research was to determine whether and to what degree the presence of pictures distracted beginning readers. Not surprisingly, Willows (1978) found that second- and third-grade readers read more slowly when the text was in the presence of pictures. Both background pictures and pictures on the periphery were shown to be distracting. Willows found that related pictures aided encoding, but reported that finding in a way biased against pictures: "Unrelated pictures produced more interference than related pictures" (p. 258). (An example of a "related" picture was of a dog on which the word *cat* had been superimposed.)

Braun (1969) randomly assigned 240 kindergartners to picture and no-picture groups, with the subjects trying to learn sight vocabulary. In seven of eight comparisons, the no-picture group learned the vocabulary faster than the picture group. Samuels (1967) reported experimental results showing that poor beginning readers were distracted by pictures when trying to learn sight words as reading vocabulary. Samuels (1970), in a review of the research on the effects of pictures (in illustrated books), found that:

1. The bulk of the research findings on the effect of pictures on acquisition of a sight vocabulary was that pictures interfere with learning to read.
2. There was almost unanimous agreement that pictures, when used as adjuncts to the printed text, do not facilitate comprehension.
3. In the few studies done on attitudes, the consensus was that pictures can influence attitudes (p. 405).

In reaction to the notion that illustrations were not really very important in assisting instruction, both Denburg (1977) and Duchastel (1980) agreed that "it is not enough to examine whether illustrations can enhance learning; one must also examine why or how they can do so" (p. 283). Levin and Lesgold (1978) reviewed research on the effects of pictures on prose learning when the prose was presented orally. They concluded that 'There is solid evidence that pictures facilitate prose learning" (p. 233). Rohwer and Harris **(1975)** found that the media effects on prose learning correlated with socioeconomic status (SES). Black students from a lower SES benefited from pictures added to prose, while white students from a high SES did not.

Harming and Fry (1979) noted the contrast in the findings of Samuels and of Levin and Lesgold, and also noted that research since the Samuels review had been mixed on the effects of pictures on reading comprehension. They conducted four experiments with pictures and nonfictional text. They used single pictures to illustrate the main ideas in a newspaper article, and they used a group of pictures to illustrate each sentence. In all four experiments, the students who received the picture-supported information significantly outperformed students in the no-picture control group. Their broad conclusion was that "the pictures resulted in improved recall of both more and less important passage information" (p. 183).

Levin (1981) provided a theoretical structure for the study of prose-relevant pictures—one that went far beyond using pictures in basic reading texts. A year later, Levie and Lentz (1982) reviewed 46 studies that had compared learning from illustrated text to learning from text sans pictures. They reported "an overwhelming advantage for the inclusion of pictures" (p. 203).

Prose-relevant picture studies have addressed the question of long-term recall. These durability studies (Anglin, 1986, 1987; Peng & Levin, 1979) generally show that not only does the presence of pictures with prose aid in recall but also those effects endure over time. Peng and Levin used story-relevant pictures with second-graders and found persistent positive effects after 3 days. Anglin (1986, 1987) conducted similar experiments on adults. In his first study, significant durability effects were demonstrated after 24 days. In the second experiment, the durability of positive picture effects was shown to still exist after 55 days. The Levin and Berry (1980) study mentioned earlier also demonstrated that the effects of visual illustrations on children's recall of prose persisted 1, 2, and 3 days later.

Research has also been done on the recall effects of pictures that conflict in some way with the accompanying text (Peek, 1974; Pressley et al., 1983). Peek (1974) found that 7- to 9-year-old students who read stories with mismatched pictures did more poorly on a test of story content than did students who read the story without pictures. Pressley et al. found that "pictures mismatched with the prose content are unlikely to reduce children's prose recall substantially" (p. 141).

Brody (1981, 1982, 1983) has been concerned with pragmatic aspects of using pictures in textbooks. He conceded that his information was "pieced together from disparate studies which are only tangentially concerned with the picture-text relationship" (Brody, 1982, p. 315) when he made these suggestions:

1. Pictures should be referred to in the written narrative.
2. Captions can help students understand the relevance of the pictures.
3. Photographs and realistic detailed drawings are usually preferred to simpler formats such as line drawings. However, preference is not always related to student achievement.
4. Within limits, students will spend more time examining complex images.
5. Pictures containing dynamic images are generally more interesting than those which contain static images.
6. Placement of pictures should be based on the function the picture is to serve.

Hurt (1987) has also taken a pragmatic approach to visualization of texts. From his experiment with 180 undergraduate college students he concluded that:

> . . . illustrations possessing literal representations are more effective than illustrations possessing analogical representation when the instructional function to be served is identification of properties of phenomenal information, and that illustrations possessing analogical representation are more effective than illustrations possessing literal representation when the instructional function to be served is clarification of nonphenomenal information (p. 94).

Special recognition needs to be given to the comprehensive review of pictures-in-reading-to-learn research done by Levin, Anglin, and Carney (1987). Their chapter in the Willows and Houghton (1987) text provides extraordinary coverage of the topic. As the framework for a meta-analysis, Levin, Anglin, and Carney adopted five of Levin's (1981) 'functions" (decoration, representation, organization, interpretation, and transformation) that text-imbedded pictures serve in prose learning. Each function is explained and documented with numerous examples of the research relevant to that function. The meta-analysis covered 87 empirical studies, all of which are identified in a bibliographic appendix. Overall, the reported findings, based on average effect size, show positive effects for all functions except the decoration function. A comparison of the effectiveness of illustrations (pictures embedded in text) versus visual imagery (instructing students to visualize the text) demonstrated the greater strength of provided illustrations—again based on average effect size of the several studies. Levin, Anglin, and Carney (1987) supplement their meta-analysis with a set of "ten commandments of picture facilitation." These are a set of pragmatic suggestions and specific observations they have drawn from the review of the research literature. In spite of the stilted *shalt* and *shalt not* language, these prescriptions and proscriptions are valuable advice for producers of instructional text materials.

16.9 THE VISUAL-VERBAL RELATIONSHIP

When *visual literacy* was coined as a term, an early outcome was to suggest the existence or possibility of a visual language(s). From the beginning, comparisons have been made as if by second nature. Once we began to compare the communication aspects of imagery with written language, it was inevitable that the relationship between traditional verbal language and visuals would be explored. Sensory redundancy studies were one of the results of this natural progression of inquiry. Several researchers have explored the effects of visuals used alone and with written or spoken words. Some of the more interesting work along these lines has been done by Appelman (1993), Duchastel (1978), Braden (1983), Fleming (1987), and Dwyer (1988). A general conclusion would be that visuals and verbal materials when used together are in most cases stronger message carriers than when either is used alone.

Braden (1983) coined the terms *visual-verbal symbiosis* and *visual-verbal discontinuity.* Dwyer (1988) found a symbiotic relationship between verbal and visual literacy when the two were combined to facilitate student achievement. The concept of visual-verbal symbiosis is rooted in the idea that "visuals" support "verbals," and vice versa. Braden (1993, 1994) postulated that there are static and dynamic visuals and that they are found in 12 support relationships with each other and with static and dynamic verbal elements. Examples of each relationship are given in a 4 X 4 matrix (Braden, 1993, 1994) in what amounts to an expansion of the 2 x 2 audible-visual matrix of Beauchamp and Braden (1989). Research is needed to validate when, in the teaching-learning process, each of these relationships is most appropriate and to inform the field about the effects of altering the degrees of visualization or verbalization in each of the relationships.

Pettersson (1993) has taken a more definitional approach to visual-verbal relationships. In an explication of his model on linguistic combinations, he discussed visual languages in which symbols and pictures are both visual. He terms a combination of visual and verbal languages as *verbo-visual,* divided into *oral-visual* and *lexivisual.* The term *verbo-visual* has caught on in the European scholarly community and is now coming into use by North American scholars (e.g., Metallinos, 1994: Zettl, 1994).

16.10 VISIBLE LANGUAGE: TEXT AS VISUALS

The field of typography deals with the design and appearance of printed text. Typographical research has delved into such matters as readability of letterforms with resulting principles for using upper- and lowercase letters together, letter spacing, line length or column width, hyphenation, justified vs. unjustified margins, and so forth (e.g., Davenport & Smith, 1965; WaIler, 1979; McLean, 1980). Some of that research applies to visual literacy and its application to instruction and has been made widely available to the field by Hartley (1978, 1985) and Jonassen (1982, 1985). Misanchuk (1992) has shown how those same principles apply to amateur typography: desktop publishing. When visuals and verbal elements are used together, they become symbiotic (Braden, 1982), and in some forms the words or letters themselves become the visual message.

There is a distinction between text-as-visuals and text-in-visuals. Labels on diagrams, illustrations, or pictures are examples of text-in-visuals. Mayer (1989) conducted two experiments wherein effects of labeled illustrations on recall were compared to the effects of unlabeled illustrations. Students who read passages containing the labeled illustrations recalled more explanative information than did those who read passages with unlabeled illustrations. Mayer and Gallini (1990) found the use of visuals to be an effective presentation strategy when the visual material explains the information in the text. Mayer and Anderson (1991) conclude that "studies have shown that simultaneous presentation of illustrations and verbal labels in instructional texts resulted in better problem-solving transfer than did presenting illustrations without verbal labels" (p. 490).

16.11 ELECTRONIC VISUALS

16.11.1 Screen Design

Several studies have been conducted that investigated aspects of computer screen design. Grabinger has followed an ongoing line of research regarding display of text and other design elements on computer screens (1984, 1897, 1989, 1993). In 1989, he did a review of the research and provided guidelines that identified specific things that screen designers ought to do. His most recent work (Grabinger, 1993) investigated viewer responses to screen designs, finding that adult viewers of instructional screens judged them primarily on two dimensions: organization and visual interest.

Hannafin and Hooper/Hooper and Hannafin (1986, 1988, 1989) also published a series of papers about screen design and layout. While their papers, much like the Grabinger 1989 paper, were prescriptive, the most enduring contribution they make is less about screen design than about facilitating individual learning styles. The problem is that screens have changed since most of the research was done, e.g., that of Grabinger in 1984. Jones (1995) has stated the situation clearly: "Screen design literature is dated, and the existing guidelines do not allow for advances in computer technology" (p. 264). Jones went on to say, "there is a dearth of research into how the screen in a CBI program can incorporate a dynamic interface to promote the acquisition of knowledge to the end of promoting and improving human learning" (p. 266).

Duin (1988) followed the best guidance available at the time and created a "well-designed CAI program" that was tested against a poorly designed program and a control group that did not use CAI. While the experiment produced some positive results regarding student attitudes toward well-designed instruction, the resulting guidelines that emerged from the study seem more suited to monochrome screens than to today's high-resolution color monitors with powerful graphics capability.

Some research relevant to screen design, of course, will prove durable. For example, the study by Herbener, Van Tubergen, and Whitlow (1979) investigated the location of objects within the visual frame. That study only considered black-and-white images and did not include motion or attempts at three dimensionality, yet the findings are instructive:

> Subjects seem to consider images more active when the center of interest is higher in the frame. Subjects appear to rate images as slightly more potent when the center of interest is higher in the frame. When the center of interest is placed away from the geometric center of the frame, . . . subjects tend to rate the image more negatively. Not unexpectedly, ratings on the verticality scale are higher when the center of interest is higher in the frame; but there is also the hint . . . that a given vertical position is seen as higher when it is horizontally centered (p. 87).

16.11.2 Computer Graphics

An advantage of computer graphics is that they can be drawn either statically or dynamically. Moreover, they can be called or dismissed interactively. Alesandrini (1987) reviewed the research relevant to computer graphics in learning and instruction. She introduced her chapter with the following caveat:

> The effects of computer graphics on learning and motivation are only beginning to be explored. While many studies have investigated the use of graphics in traditional instruction, few studies have investigated graphics in CAI (computer-assisted instruction) or the instructional uses of graphics application software. Although the published

findings are limited, many projects are currently underway to field-test the variety of uses of computer graphics (p. 159).

Indeed some of those studies are beginning to appear, but advances in computer technology are outpacing research on computer utilization. Among other enhanced capabilities of microcomputers is the ability to portray with ease graphic representations of conceptual networks. Consequently, the research questions have changed with the emerging technology, and we see studies like that of Allen, Hoffman, Kompella, and Sticht (1993) that examine computer-based mapping as a tool for curriculum development.

We find current researchers turning back to basic graphing skills research as they consider the possibilities of computer-generated visualization. For example, Drahuschak and Harvey (1993) wrote an article on computer-based graphing that posed the problem this way:

The question we should ask now is this: Which instructional strategies will prove useful in developing critical thinking skills within this emerging discipline of visualization? Research performed by McKenzie and Padilla (1984), Mokros and Tinker (1987), Talley (1973), and Siemankowski and MacKnight (1971) has concluded that in order to be successful in science two critical areas must be mastered: graphing abilities and spatial abilities. Visualizing a data pattern in three-dimensional space once required a well-developed imagination. Fortunately, students today can augment their mental capabilities with the use of a computer system . . . (p. 3).

To place that quotation in context: McKenzie and Padilla (1984) found that formal operational thinkers tend to score higher in graphical achievement than concrete operational thinkers. Mokros and Tinker (1987) reported that experience in microcomputer labs enhanced children's ability to interpret graphs. Talley (1973) studied three-dimensional visualization, concluding that individuals who have better visualization skills perform at consistently higher levels of conceptualization. Siemankowski and MacKnight (1971) found science-oriented students to have greater three-dimensional visualization or spatial abilities than students who are not science oriented.

16.11.3 Animation

As computer technology advances and authoring systems become more friendly and powerful, computer special effects that were once esoteric are now becoming commonplace. As a result, computer animation, which has long been around in computer-based instruction (CBI), but only as a rarity, is now a pervasive reality. Just as the incidence of animated CBI has increased, so has the research about it. Rieber (1989, 1990a, 1990b, 1991a, 1991b; Rieber, Boyce & Assad, 1990; Reiber & Hannafin, 1988; Reiber & Kini, 1991) has generated a flurry of research. Many others have contributed also, including those whose interest preceded the new technologies (Alesandrini, 1987; Cambre, Johinsen & Taylor, 1985; King, 1975; Moore, Norwocki & Simutis, 1979; Rigney & Lutz, 1975), and others in more recent times (Baek & Lane, 1988; Mayer & Anderson, 1991; Torres-Rodriquez & Dwyer, 1991). Reiber (1990a) has promoted the appropriate use of animation, but cautioned that "CBI designers . . . must resist incorporating special effects, like animation, when no rationale exists . . ." (p. 84).

The findings tend to be related to narrow research questions. For example, the results of the Cambre, Johinsen, and Taylor study "indicated that children learned from and liked both serious and humorous animations, especially those animations designed for older audiences" (p. 111) Reiber, Boyce, and Assad reported that "although animation did not affect learning, it helped decrease the time necessary to retrieve information from long-term memory and then subsequently reconstruct it in short-term memory" (p. 50). Mayer and Anderson (1991) performed two experiments involving college students. In one experiment, instruction with an animation and a concurrent verbal explanation was compared to instruction where the narration was given first, followed by the animation. In the second experiment, the same comparison was made, and other treatments were added to include students who saw the animation only, students who heard the words only, or students who had no instruction (control). Students in the words-with-animation treatment performed better than students who received any of the other treatments. Reiber (1991), in an experiment with fourth-graders, "showed that students successfully extracted incidental information from animated graphics without risk to intentional learning, but were also more prone to developing a scientific misconception" (p. 318). In a study utilizing college students as subjects, Torres-Rodriquez and Dwyer (1991) set out to assess the relative effectiveness of animation, zoom-in, and a combination of animation and zoom-in. Students were grouped according to high or low prior knowledge of the content. The researchers reported that:

> . . . even though each treatment had been deliberately designed and positioned in the instructional sequence to instigate higher levels of information processing, when students were permitted to interact with their respective treatments for equal amounts of time insignificant results in student achievement occurred on the different criterion tests. Results also indicate that different visual enhancement strategies function differentially in reducing prior knowledge (high and low) between students within each group (p. 85).

While computer animation research can be covered in only a few paragraphs here, Reiber (1994) was able to devote an entire chapter to the subject. Considering the recency and thoroughness of his review, his conclusions are the best and latest word on the subject:

- Despite the popularity of animation among CBI designers and developers, little research is available on its effectiveness.
- Although animation can be a dramatic visual effect, research indicates that animation's effects on learning are

quite subtle.

- Early animation research was heavily prone to confounding.
- In order for animation to be effective, there must be a need for external visualization of changes to an object over time (motion attribute) and/or in a certain direction (trajectory attribute).
- Children and adults vary in the degree to which they benefit from animated displays.
- Learners may need to be carefully cued to information contained in an animated display.
- Young children seem able to extract information incidentally from animated displays, although they may form misconceptions without proper guidance.
- Animation, as continuous visual feedback, is an important part of visually based simulations, although the role that animation plays in such activities cannot be isolated and studied apart from the activity itself.
- Research indicates that visually based simulations can be effective practice strategies, as compared to traditional questioning activities.
- Visually based simulations have shown to be intrinsically motivating for children in intermediate grades.
- Early research on using visually based simulations as inductive learning strategies indicates that adults are frequently uncomfortable with open-ended, discovery-based activities, especially when they perceive the learning environment to be formal or "school-like" in other ways (p. 169).

16.11.4 Graphic User Interfaces and Graphic Browsers

The graphical user interface (GUI) is changing the way computers are used. Much has been written about it in the trade press and even in a few scholarly works (e.g., Reiber, 1994). However, in spite of the fact that the GUI represents a shift from verbal access to, and verbal manipulation of, computers, no visual literacy research has been reported. Macintosh mavens have heralded the fact that learning new Mac applications is easy because they all share a similar look (share a common visual language). Shneiderman (1987) indicated that students tend to reject the use of computer applications that do not have an interface (appearance) they can understand.

GUI conventions include the use of standardized icons such as the trashcan, folders, a printer graphic, a paint brush, and a magnifying glass. Emerging CBI standards for GUI include general acceptance of right and left arrow buttons that allow students to go to the next frame or to return to the previous one, hooked arrows that let users return to the previous menu, and the ubiquitous question mark that can be clicked for on-screen help. Screen geography (location of elements) is partially standardized. There are drop-down menus and roll-ups that are activated by a mouse-controlled arrow. And each individual program has the potential to be accessed by easily learned "buttons," the key aspect of which is their visual recognizability. While usage has tended to standardize these conventions, research has not played a significant role.

Limited research has been done on the effectiveness and acceptability of buttons. Egido and Patterson (1988) studied the effects of buttons as browsers. They found that buttons that combined icons and words were superior to word buttons. In corporate research reported by Microsoft (Temple, Barker & Sloane, 1990), picture buttons (icons) were found by adult users to be preferred to other types of buttons.

Lucas & Tuscher (1993) conducted a study to determine whether adult button preferences applied to adolescents. They found that, like adults, early adolescent students preferred buttons that contained both "pictures" and words, but that they were more accurate when using word-only buttons.

The button and drag features of the GUI have made possible interactive CBI. Mays, Kibby, and Watson (1988) reported the development and evaluation of hypermedia instruction on the Macintosh that featured *learning by browsing.* In an experimental study that assessed learning as measured in a posttest, Tripp and Roby (1990) found that induced visual metaphors did not significantly increase learning of foreign-language vocabulary (Japanese). There was functional similarity in their work and that of Mays, Kibby, and Watson (1988) in that the students had visual browsing capability. Jones *(1995),* whose criticism of current screen design guide-lines was mentioned earlier, has provided seven guidelines of his own for designing screens that facilitate browsing:

1. Provide selectable areas to allow users to access information.
2. Allow users to access information in a user-determined order.
3. Provide maps so that users can find where they are and allow provisions to jump to other information of interest from the map.
4. Provide users with feedback to let them know that they must wait when significant time delays are required for the program to access information.
5. Provide users with information that lets them know that they are making progress.
6. Arrange information in a nonthreatening manner so that users are not overwhelmed by the amount of information contained in a program.
7. Provide visual effects to give users visual feedback that their choices have been made and registered by the program (p. 267).

When the research catches up with the possibilities offered by the technology, these guidelines will have been empirically validated or rejected.

16.12 CONCLUSIONS

The research and scholarly literature of the field of visual literacy is voluminous. The bibliography of Clemente and Bohlin (1990), available from Educational Technology

Publications, is 37 pages in length and contains about 400 entries from sources who, by and large, are not part of the visual literacy movement. In an attempt to map the field of visual communication—which is even broader than the field of visual literacy—Moriarty (1995, Oct.) has evolved a taxonomy of the literature. She analyzed the input of 37 visual communication scholars in setting her 13 categories and 90 subcategories. These she has used much as one would use a key word classification system to classify the 1,600-plus books and articles in her ever-growing bibliography.

Two bibliographies by Walker (1990, 1994) contain nearly 500 entries from 11 of the last 14 International Visual Literacy Association's books of readings (Braden & Walker, 1982; Braden & Walker, 1983; Walker, Braden & Dunker, 1984; Thayer & Clayton-Randolph, 1985; Miller, 1986; Braden, Beauchamp & Miller, 1987; Braden, Braden, Beauchamp & Miller, 1988; Braden, Beauchamp, Miller & Moore, 1989: Braden, Beauchamp & Baca, 1990; Beauchamp, Baca & Braden, 1991; Baca, Beauchamp & Braden, 1992; Braden, Baca & Beauchamp, 1993; Beauchamp, Braden & Baca, 1994; Beauchamp, Braden & Griffin, 1995). The IVLA books are not widely disseminated, so most have been made available through ERIC.

16.12.1 Visual Literacy Research: Where to Start

There is much research yet to be done. As mentioned, the literature about visuals and visual literacy is overwhelming. This author is asked from time to time where a neophyte researcher interested in visual literacy should start. The temptation is to answer, "with the meta-analyses and reviews of the literature" (e.g., Levie, 1987; Levie & Lentz, 1982, Moore & Readance, 1984; Winn, 1987), but that is not a very helpful response. The best advice would be to read carefully three books: those of Moore and Dwyer (1994), Pettersson (1993), and Willows & Houghton (1987). Add to that list the dissertation of Baca (1990), if it is easily available. Another recommended early read would be Dwyer's 1987 book, with its 37 articles describing PSE research. Then the new researcher should select the meta-analyses and reviews of the literature relevant to his or her personal interests.

The best advice regarding research methods would be to design quantitative studies rather than qualitative ones. The aesthetic aspects of pictures, film, and television are real. They are also the bait to encourage qualitative methods. However, visual literacy is seen somewhat as a field of inquiry that lacks rigor, and even an excellent qualitative visual literacy study would be greeted with a general lack of respect. In terms of need, research is overdue that addresses longitudinal image effects, electronic imagery related to visual literacy constructs, and interaction of cue summation theory and dual-coding theory (as complementary or conflicting).

Those interested in finding a research topic, who don't have the time to read all of the recommended books, would be well advised to consider Baca's (1990) list. Visual literacy research is needed to:

- Identify the learnable visual literacy skills
- Identify the teachable visual literacy skills
- Develop implementation of visual literacy constructs
- Validate implementation of visual literacy constructs
- Provide a rationale for visual literacy implementation in our society
- Provide a rationale for visual literacy implementation in our educational system
- Supplement research conducted in other fields, including psychology, education, learning, visual perception and eye movement studies, print literacy (p. 70)

Baca also lists a dozen or so other possible research options. As an eclectic field, visual literacy provides many avenues of investigation. Fortunately, many resources are already available to facilitate future scholarly activity.

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