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Crossing Bridges that Connect the Arts, Cognitive Development, and the Brain

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Abstract:
Crossing high bridges offers the opportunity to ponder views from a distance: to see connections between places at the ground level or ideas that are familiar, and to capture an overview of places or ideas that are yet to be explored. The purpose of this essay is to explore the figural bridges that connect the arts with cognitive development and the neurosciences. More precisely, the essay considers the role that visual images and sounds play in early life and in the arts, then turns to neurological understandings of cognitive development, and finally focuses on these bridging relationships to teaching about the arts. More broadly, this essay is part of the author's effort to create a framework for understanding the social construction and neurological organization of cognitive development.

The first view explores our human attraction to visual images in response to the environment and to the arts. This view considers prehistoric, early historic, and recent examples of humankind's contructed visual images. A second view explores our response to sounds in the environment and sounds associated with the arts. The connections that link our auditory perception with our visual memory are also given consideration. Music and literature serve to illustrate the significance of these auditory-visual connections. A third view explores neuroscientists' discoveries of how our brain processes and integrates the information we take in, and considers the contribution of the neurosciences to our understanding of cognitive development. A final view from the bridge explores the potential contribution of the arts toward enhanced cognitive development. This view is framed in terms of future research and an analysis of the implications for those who teach the arts.

Crossing Bridges that Connect the Arts, Cognitive Development and the Brain

Rita W. Peterson

Overview

Crossing high bridges offers the opportunity to ponder views from a distance: to see connections between places at the ground level or ideas that are familiar, and to capture an overview of places or ideas that are yet to be explored. The purpose of this essay is to explore the figural bridges that connect the arts with cognitive development and the neurosciences. More precisely, the essay considers the role that visual images and sounds play in early life and in the arts, then turns to neurological understandings of cognitive development, and finally focuses on these bridging relationships to teaching about the arts. More broadly, this essay is part of the author's effort to create a framework for understanding the social construction and neurological organization of cognitive development.

The first view explores our human attraction to visual images in response to the environment and to the arts. This view considers prehistoric, early historic, and recent examples of humankind's constructed visual images. A second view explores our response to sounds in the environment and sounds associated with the arts. The connections that link our auditory perception with our visual memory are also given consideration. Music and literature serve to illustrate the significance of these auditory-visual connections. ***.*** *A third view explores neuroscientists' discoveries of how our brain processes and integrates the information we take in, and considers the contribution of the neurosciences to our understanding of cognitive development. A final view from the bridges explores the potential contribution of the arts toward enhanced cognitive development. This view is framed in terms of future research and an analysis of the implications for those who teach the arts.*

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View 1: Our human attraction to visual images.

Visual images are such an important part of our daily lives that we rarely distinguish between what we see before us and what we see reproduced as pictures on television screens or in the printed media, and create as mental representations of things we have seen. In this essay a distinction is made: *visual images are distinct from the act of seeing*. The visual images that are the focus of this essay include all of those images that are represented in our imaginations or our minds, along with the images that are created by hand, camera, or machine. The theme underlying the discussion is what Martin Kemp (2000) calls "our human quest for visual understanding."

A brief glance backward, to the early history of humankind, reveals that visual images are at least as old as the images of animals that were drawn on the walls of caves in France and Spain. The masterful cave drawings of antelope and bison, and a caribou wading in a salmon-filled stream, look very much like animals seen today (See Figures 1and 2, page 17; from Roos,1953).

A continent away, early inhabitants along the southeastern coast of Alaska were creating petroglyphs, stone carvings of animals common in their environment and people who were prominent in traditional stories. A petroglyph depicting a salmon is still located by a river mouth and thought to have served as a marker to locate a stream where salmon entered to spawn. Other images are thought to have represented ancient tales of admirable and foolish behavior. Some of Alaska's petroglyphs are estimated to be between five and twelve thousand years old (Whitmore, 2002).

The animals represented in the cave drawings in Spain and France, as well as those in Alaska's petroglyphs, are assumed to have existed as visual memories in the minds of the artists, on two continents. This seems likely because these early artists would not have been able to draw living animals in the way Renaissance artists painted portraits of living persons. If the animals in pictures created by these ancient artists existed as visual representations in their minds, then those visual memories represent a kind of communication across thousands of years, since they have now become a part of our own visual memories in the 21st century.

Egyptian hieroglyphs emerged as a somewhat more recent example of the use of visual images to communicate important information. The earliest hieroglyphs are estimated to have been created five thousand years ago. Their evolution into an eloquent written language provides a powerful example of the bridge between visual image and written language.

Interpreting Egyptian hieroglyph picture-phrases is now relatively easy with a practical step-by-step picture-phrase guide designed by Kamrin (2004) to explain the meanings of hieroglyphs that decorate tombs and other architectural structures in Egypt. (See Figures 3 and 4 on page 17.)

The Indus civilization which at one time spanned the area now occupied by India, Pakistan, and Afghanistan, is now the site of the most recent controversy. Linguists, archaeologists, and other scholars are actively debating the meaning of nearly 4,000 Indus inscriptions found on tablets, pots and stamp seals discovered in the 1870s. The debate involves the meaning of the tablets and stamp seals: whether the inscriptions form a system of script alone, or a system of combined symbol-and-picture-writing that differs in a significant way from hieroglyphics. (See Figure 5 on page 17.)

Art historians and anthropologists recognize the importance of prehistoric and early historic visual images as indicators of respect for animals, as ways of honoring individuals and acknowledging worthy behavior, as warnings and as ways to locate important resources. Similarly, when we examine coins, paper money, and postage stamps from the present and past century we find visual images of esteemed animals or persons (such as eagles and presidents), important landmarks (including tall buildings and first bridges), and valued modes of transportation, representing our American cultural values.

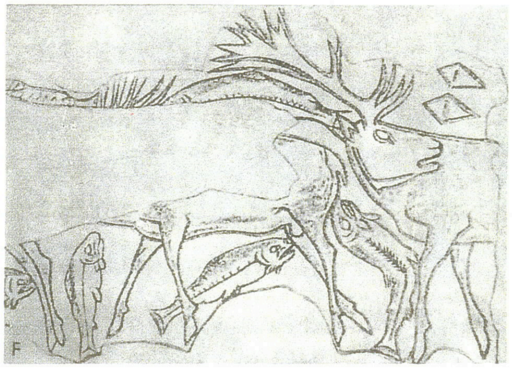
As the 21st century begins, electronic media in the form of motion pictures, television, and computers have catapulted humanity into a world where visual images are available 24 hours a day, across time zones. In technologically enriched nations, visual images are generated and transmitted at greater speeds, to far larger audiences around the world than at any previous time.

The arts have emerged as significant beneficiaries of the electronic media revolution. The public now is able to enjoy centuries of creative expression. Knowledgeable scholars appear on television to discuss visual arts presented in special programs. The level of analysis provided by such experts has greatly enhanced the general public's understanding and appreciation of the visual arts.

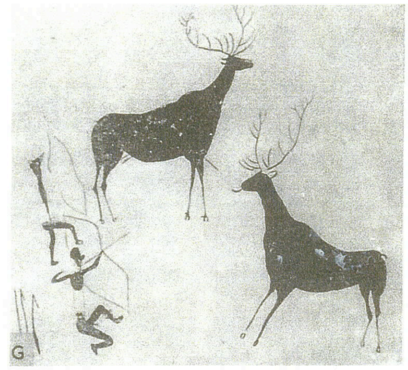
Artists have created visual images for thousands of years. They selected scenes from nature and daily life and represented them in new forms. Without these artists, we would not have the classic Greek statues, Roman pottery, or paintings like Fra Filippo Lippi's *Madona and Child,* Hall's *Portrait of a Girl*, Gauguin's *Tahitian Women,* Grant Wood's *American Gothic*, or Ansel Adam's collection of black and white photographic scenes from *Yosemite*.

Figures 1, 2. PREHISTORIC ART

BEFORE 20,000 B.C.



Reindeer and Salmon. Engraving in Reindeer Horn, from Lorthet, in the Pyrenees. Magdalenian. (American Museum of Natural History)



Stag Hunt. From cave at Alpera. (American Museum of Natural History)

Figures 3, 4. Egyptian heiroglyphs

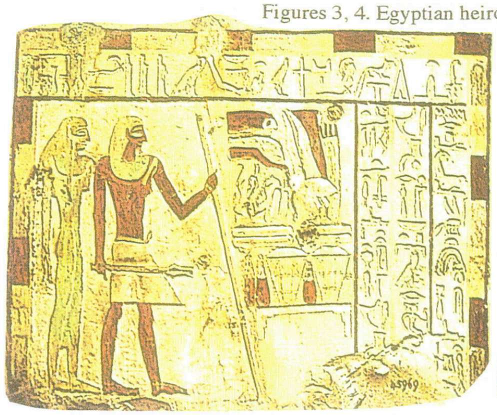


Figure 5: Indus inscriptions

View 2. Sounds in nature and the arts add to our cognitive development.

The sounds associated with nature and the arts reflect the regional and cultural environments in which they occur. Gradually these sounds become part of each individual's cognitive development. Early in life infants learn to associate sounds with visual images in their immediate environment. Most toddlers develop a repertoire of paired associations between animal sounds and animals or animal pictures before they form sentences. Young children associate sounds of music with specific objects, scenes and events. Adolescents who might listen to Tchaikovsky's *1812 Overture,* with the sounds of cannons roaring at the conclusion of the music, may visualize images of war when learning that the music portrays Russia's victory celebration at the end of a battle between Russia and the French army led by Napoleon. Adults who might attend the opera *The Tales of Hoffman* and see a gondola on stage, gliding through simulated waves as the orchestra plays *Barcarolle*, are likely to visualize a gliding gondola whenever they hear the *Barcarolle* in the future. The connections between the sounds of nature, daily life, and music can either be subtle or obvious to listeners.

Sounds associated with the language of poetry can also evoke visual images. Like music, the sounds of poetry may also stir our emotions. As sounds remind us of scenes and experiences we have enjoyed, we gradually grow to value the creators of these works as much as we value the images and the sounds themselves. Consider the subtle differences in the effect that the following poetry passages have on you as a reader, eliciting vivid images of "the sea-breeze damp and cold" pervading the atmosphere in the first excerpt, while the north-wind roars in "baffled rage at pane and door" in the second.

The Fire of Driftwood by Henry Wadsworth Longfellow

We sat within the farm-house old,
Whose windows, looking o're the bay,
Gave to the sea-breeze damp and cold,
An easy entrance, night and day.
Not far away we saw the port,
The strange, old-fashioned, silent town,
The lighthouse, the dismantled fort,
The wooden houses, quaint and brown, …

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Snow-Bound by John Greenleaf Whittier

Shut in from all the world without,
We sat the clean-winged hearth about,
Content to let the north-wind roar
In baffled rage at pane and door,
While red logs before us beat
The frost-line back with tropic heat;
And ever when a louder blast
Shook beam and rafter as it passed….
The mug of cider simmered slow,
The apples sputtered in a row,
And close at hand, the basket stood
With nuts from brown October's wood….

View 3: Neuroscientists' discoveries of how the human brain processes and integrates information add to our understanding of cognitive development.

How does the brain process the visual images that we see and the sounds that we hear? We begin with the big picture and later consider the details of neuroscientists' discoveries. We now know that the brain processes what we see, hear, taste, smell, and feel with our senses, by storing the details of these experiences in different regions of the brain. There are no single complete traces of individual visual images existing in one place in our mind, even though we can visualize them in our mind's eye. We also know that a part of our brain monitors our incoming experiences for their emotional content and puts in boldface those that are worrisome and important to our survival so that we remember their details. Further, we know that the brain's communication network to every region of the brain is so sophisticated that we can instantaneously integrate our experiential information, form new ideas, and tell others about them. We can even describe our thought processes to others. We understand that our brain has the metaphorical capacity of a high-speed computer's *search engine* that is architecturally housed in the area behind our skeletal forehead. This search engine allows us not only to access what we know, but also provides enough working memory space to consider several ideas at the same time.

How then does our brain actually store visual images and sounds related to the arts? The visual images that we see and the sounds that we hear occur in specific places; they exist within social contexts. The social context becomes part of the information that is stored with each visual image and each sound. By way of example, imagine you are using the Internet to look at famous paintings, and you are attracted to a particular painting that is currently exhibited at the New York Museum of Modern Art (NY MoMA). As you study the painting, your brain registers each of the details involving the content, colors, textures, shapes, and sizes of areas within the painting, and stores them, along with the place where you saw the painting, in a wide variety of brain regions. Your attention to the number and specificity of details in the visual image and its social context influence how easily you will be able to recall the painting, the artist or its location in the future.

Retrieving a memory of the painting at the NY MoMa involves a process of pattern completion in which a few details of the past experience are activated, and in turn trigger or reactivate the remaining regions of the brain where the details of the past experience are stored. This is a description of perfect storage of a visual memory and perfect recall of the same visual memory in its social context. But recall is not always perfect. It improves with intentionally focused attention for details. An exception is described below.

Many neuroscientists have studied exceptions to what is thought of as normal memory storage and retrieval. In other words, when individuals try to recall a specific event, face, or name, they typically search for clues that start the chain reaction of retrieval of the complete memory. However, whenever we witness a serious accident or other events that have personal relevance related to danger or threat to survival, our brain appears to record the details of such events with unusual detail and accuracy. The emotional significance of such experiences affects storage and recall of the details of these memories long after the events have passed. Most of us remember with exceptional clarity the televised picture of planes flying into towers on a previous September 11, and we most likely remember exactly where we were and what we were doing at that moment we saw the first pictures. Neuroscientists have discovered that memories of devastating events remain with individuals for a very long time. Individuals directly involved in these events, such as the firemen who worked on the ground in an effort to save the lives of those escaping from the burning buildings on September 11, were undoubtedly troubled deeply by these memories for a long time afterward, and are perhaps even now. The human brain's capacity to vividly recall traumatic events resumably increases the likelihood that we will recognize clues that help us to avoid such incidents in the future.

Neuroscience

Many of the major advances in understanding the human brain have been driven by medical needs to treat brain diseases, such as schizophrenia and Alzheimer's, to treat patients suffering from strokes and cancer affecting the brain and to treat brain injuries caused by accidents. Brain imaging technology has developed rapidly over a thirty year period from the first CAT scans, to PET scans, then MRI, to the current *f*MRI (functional magnetic resonance imaging) which now allows neuroscientists to capture human thinking in action. With each improvement in brain imaging technology neuroscientists have been able to continuously refine maps of the brain's architecture and to incorporate their growing knowledge of the brain's biochemistry (Andreasen, 2001).

Early on, neuroscientists recognized the need for a reference collection of brain images of healthy individuals free from known brain diseases, disorders or injuries, essentially a collection of *normal profiles* that could be compared with the growing library of profiles depicting some sort of brain damage. A few neuroscientists turned to psychologists who were known for their expertise and research in the use of assessment measures of cognitive development among populations with normal intelligence. The collaboration between neuroscientists and psychologists was successful in creating collections of normal brain-imaged profiles.

The reference collection of brain images grew rapidly to form libraries that have led to major discoveries. For example, when the new neuroscientist-psychologist teams realized that no two human brains were identical, the discovery changed the way some pediatricians and educators think about normal cognitive development. Variations in brain images may suggest a neurological basis for variations in students' special talents and affinities, and also in some of their academic difficulties. It is important to emphasize, however, that the overall similarities among brain profiles are generally greater than the differences. That is, human brains are more nearly alike in terms of the organization of functions within the brain's architecture than they are different. A second and more important discovery made by neuroscientist-psychologist-psychiatrist teams concerns the finding that various mental illnesses are characterized by significant differences in brain and blood chemistry. These latter discoveries have led to the formulation of new drugs that help to alleviate some of the symptoms associated with mental illnesses.

Collaboration between psychologists and neuroscientists led psychologists to realize that brain imaging was a valuable tool that could provide them with the first brain images of cognitive processing among average adults, adolescents and children. Thus, the collaboration led the way to the creation of new fields of research called neuro-psychology and cognitive neuroscience. Figuratively, new bridges now connect psychology and the neurosciences.

A New Bridge: Cognitive Neuroscience

Cognitive neuroscience emerged as a new field of research as advances in the neurosciences accumulated. With the use of *f*MRI scanners to study the brain, cognitive neuroscientists have been able to document and describe the thinking processes of ordinary people who have served as subjects in research. Increasing numbers of studies in the field of cognitive neuroscience now focus entirely on healthy individuals. These studies contribute to our understanding of how the brain organizes information and how these organizational processes are related to normal cognitive development.

Educators are beginning to discover the relevance of the cognitive neuroscience literature that focuses on how the brain organizes new information and retrieves new and old information when needed. Since the early 1990s the University of
California, Irvine has presented three annual public lectures each year, designed to advance the public's understanding of new discoveries in the neurobiology of learning and memory, organized by McGaugh (1995-2005). Most, if not all of the lectures in this series, now are available on audiotape. Many of the lectures have some direct implications or relevance for education.

Cognitive Development

A brief look backward is useful to set the stage for more recent developments. Cognitive development as an area of study has a long history that for the past fifty years has focused on two dominant theoretical perspectives. One perspective is referred to as a *global view of cognitive development.* The other perspective is referred to as a *domain-specific view of cognitive development* (Kail, 2004).

The global view is best represented by the work of Jean Piaget, a genetic epistemologist who formulated a general conception of the mind in growth. In *Six Psychological Studies,* Piaget offers a comprehensive formulation of the process of cognitive growth (Piaget, 1968). Translations of Piaget's work have allowed Americans to understand his work as a theory of cognitive development that explains the child's changing view of the world as the child interacts with the environment from early childhood through adolescence. Piaget's books have inspired educators for decades, both because his interviews with children and adolescents are replicable in regular school classrooms, and teachers are able to gain insights into the cognitive development of many of their students. This global view of cognitive development that was dominant during the 1960s through the 1980s continues to attract followers today, because it looks at the child's cognitive development as a whole rather than a child's performance in each of seven or eight areas of the curriculum. Howard Gardner brought a new vision to the global view of cognitive development with his proposal for a theory of multiple intelligences, which was enthusiastically received by teachers (Gardner, 1986).

The domain-specific view of cognitive development is best represented by Noam Chomsky's work. Chomsky (1988) and others with this view have argued that children learn specific bodies of knowledge on their own and in schools. The fact that children acquire language rapidly, easily, and with relatively little environmental support suggested to Chomsky that language is a modular cognitive system; language acquisition can be said to operate according to a unique set of principles not shared with other realms of cognitive development, according to Kail (2004). During the 1970s and 1980s, researchers searched for the principal structures that characterized various disciplines. Today many schools still feel the impact of the domain-specific view of cognitive development, since school districts are held accountable for students' acquisition of bodies of knowledge, which can be viewed as domain-specific knowledge instead of global cognitive development.

Some researchers in the field of cognitive development have moved away from the either-or theoretical approach that is either global or domain-specific, and are attempting to incorporate both global and domain-specific processes and models in their studies that focus on basic human cognitive processes (Kail, 2004). Other psychologists have moved into the new field of cognitive neuroscience described next. The cognitive-neuroscience bridge has served as a model for spawning other new bridges.

Building bridges

In 1982 an experiment in cross-disciplinary communication was organized by six representatives from the National Institute of Education, the National Science Foundation, and the Alfred P. Sloan Foundation. The experiment was to bring together a small group of 18 researchers representing the fields of neuroscience, cognitive psychology and education. These three fields shared a common interest in how people acquire and use knowledge. Invited participants were chosen for distinguished research in their fields and for their willingness to explore connections among the three fields of research. Each was expected to prepare and present a paper that could be understood by the entire group. The papers that were presented and discussed at the meeting, were subsequently published as a book: The Brain, Cognition and Education (Eds: Friedman, Klivington, and Peterson,1986). This book led to major new funding from several agencies and private foundations that supported promising research that could contribute to improving communication among these three fields. Many of the projects, programs and books that emerged from the 1982 experiment have influenced current views of cognitive development today.

Final view from the bridges

The intent of this final discussion is to consider the potential contribution of the arts toward enhancing cognitive development. The discussion is framed first in terms of research that *seeks to reveal elements of cognitive development, and second, in terms of the potential value and usefulness of the proposed "elements of behavior associated with cognitive development" to teachers of the arts.*

Research: a search for evidence of cognitive development

Researchers and teachers are faced with the same challenge, that of gathering evidence of students' cognitive development, whether the expected result derives from classroom or laboratory experiences in the arts or other academic subjects. Although brain-scanning technology captures cognitive processing in action, the task for educational researchers and teachers is to recognize cognitive development as it occurs within individuals and classrooms. It is a challenge not unlike that faced by Aristotle who wrote that we remember information by forming images of it and retrieve these images from memory by associating them with one another in order, according to the principles of similarity, contrast, and contiguity. We are indebted to Wittrock (1986) for reminding us of Aristotle's great influence on ancient Greek and Roman teachers and students as they followed Aristotle's model of imagery in memory.

Faced with the challenge of collecting indirect evidence of cognitive development as it appears to result from experiences in school settings, the author reviewed research reported by neuroscientists, cognitive psychologists and educators in *The brain, cognition, and education* (Friedman, Klivington and Peterson, 1986). The goal was to capture both the natural kinds of cognition described by Gardener (1986) and the fluid nature of cognitive development implicit in research described by Friedman and Cocking (1986) and Wittrock (1986). The operational question that drove the search was "How does one describe a student who is turning something over in his/her mind?"

To achieve this goal, the author formulated a short list of generic behaviors that might be required frequently by students responding to challenges given to them in school or lab settings. It is a modest initial step to describe a series of behaviors that capture the fluid nature of cognitive development. The resulting behavioral descriptions are called ***Elements of Behavior Associated with Cognitive Development***. The list of *Elements* on the next page includes sixteen behaviors that are consistent with research findings in the mind-brain sciences; they are indicated with references in endnotes. It goes without saying that the *Elements* are provisional examples, certainly not a complete inventory of behaviors that are estimated to be representative of cognitive development.

The list of *Elements* lends itself to both research and the development of teaching strategies. Both require validation as representing cognitive development observed in research and teaching situations, whether one is observing cognitive development in the arts or in other academic disciplines. Both uses of the list of *Elements* are demonstrated by example in the remainder of this paper. As a researcher, the author experimented with using two of the *Elements* to interact with children and adults in several classrooms.

Elements of Behavior Associated with Cognitive Development

1. Interest in expanding a single view of the world[i]
2. Active consideration of essential features of new experiences[ii]
3. Conscious comparison of new experience with past experiences[iii]
4. Willingness to revise and reinterpret original perceptions[iv]
5. Automatic integration of new information with existing knowledge[v]
6. Conscious effort to integrate information from several new sources[vi]
7. Capacity to see things from different points of view[vii]
8. Capacity to look for and see the big picture[viii]
9. Conscious search for new insights from new and past experiences[ix]
10. Reflection on others' learning from their important experiences[x]
11. Search for new ways to remember what has been seen and heard[xi]
12. Ability to recall accurately large amounts of information[xii]
13. Tendency to remember details of highly emotional or traumatic events.[xiii]
14. Ability to retrieve complex information from multiple sources in long term memory and to organize it in a new way.[xiv]
15. Selection of visual images in nature and daily life to create new art forms.[xv]
16. Selection of sounds in nature and daily life to create new art forms.[xvi]

Research

To explore use of *Elements of Behavior Associated with Cognitive Development* for research purposes, two case studies are described briefly below. The first case study focused on *Element 14* and used children's drawings to assess this element. The second case study focused on *Element 13* and used young adults' drawings.

Case Study 1: "Children's long term visual memories of favorite animals"

Case Study 1 research features:

- *Cognitive Behavior-Element 14:* Ability to retrieve complex information from multiple sources in long-term memory and to organize the information in a new way.

- *Neuroscience Component*: Visual images are stored in different areas of the brain. Working memory is required for memory search and drawing task.

- *Experimental Modification*: The protocol for Case Study 1 requests children to recall seven (7) features about their favorite animal. Generic prompts are given to the entire class to aid all children's searches of their long-term memories for visual images of the animal they select for their drawing.

Sample. Twelve elementary school classrooms, including 12 teachers and 250 students, participated in this experimental lesson.

Method. The experimental lesson involved the following steps: (1) Reading the protocol; (2) distributing paper and a colored pen set to each student; 3) maintaining quiet during drawing time; (4) circulating among children as they finished their drawings; (5) asking if children wished to describe for the visiting teacher/researcher (i.e., the author) any information they didn't show in their animal pictures; (6) recording each student's comments, name and age on the back of each picture.

The protocol below was intended to enable children to form mental visual images of the animals they would choose to draw. To this end, the protocol was designed to provide generic prompts that would stimulate each student to think about and recall the specific features of the animal each child was likely to choose and portray in a picture. The same protocol was given in all classes, and children were treated identically in terms of the generic prompts they received, regardless of the differences in the ages of the students. Since the author was exploring the use of generic prompts with all children before they chose the animal they wanted to draw, children were asked to close their eyes throughout the instructions, while they thought about "their animal." One last point, the drawing task was not related to any classroom instruction about animals.

Protocol. "Today you will explore how many pictures your brain stores in your mind. I will ask each of you to close your eyes while you think about an animal that you know a lot about, maybe from books or television or movies. Maybe it is an animal you have or once had as a pet. Try to picture the animal in your mind. (Pause.) Once you have chosen your animal, still keep your eyes closed while I ask you to think about special parts of the animal, and what the animal is doing. Afterward, I will give you paper and a set of colored pens to show what you remember about the animal you choose. Now listen to what I say."

"Again, close your eyes and think of an animal that you can easily imagine with your eyes closed. (Pause.) Think about the animal you want to draw. Think about its size and shape. How big is it? (Pause.) Still keeping your eyes closed, what color is the animal? Is it one color or more than one color? (Pause.) Can you see its texture? How would it feel to touch? (Pause.) What is the animal's environment? Where does it live? (Pause) Can you picture what the animal eats? (Pause.) Are there plants or other animals that live nearby? (Pause.) Still keeping your eyes closed, how does the animal look when it is resting? (Pause.) Once you can picture your animal in your mind, raise your hand and I will bring paper and a set of colored pens to you to draw the picture in your mind."

Discussion of Result. Children's drawings varied in complexity and amount of detail. Talking with children after they completed their drawings gave a more complete profile of children's recalled visual memories of the animals they chose to draw. Older children, ages nine to twelve years, were expected to recall and represent more complex visual information in their pictures, but the complexity of children's recalled visual images appeared unrelated to their age. *The Shark* (Figure 6) created by a five-year old boy illustrates the surprising level of detail in many young children's drawings. Note all of the plants and animals in the shark's environment and the marginal notes of the boy's explanation of what each animal ate. A second drawing, *The Elephant* (Figure 7) was created by a seven-year old girl, shows a remarkable similarity between current child's drawing and the 20,000 year old cave drawing of a reindeer shown earlier in Figure 1, p. 17). Both *The Elephant* and *The Reindeer* show animals walking in streams filled with fish around their legs.

Figure 6

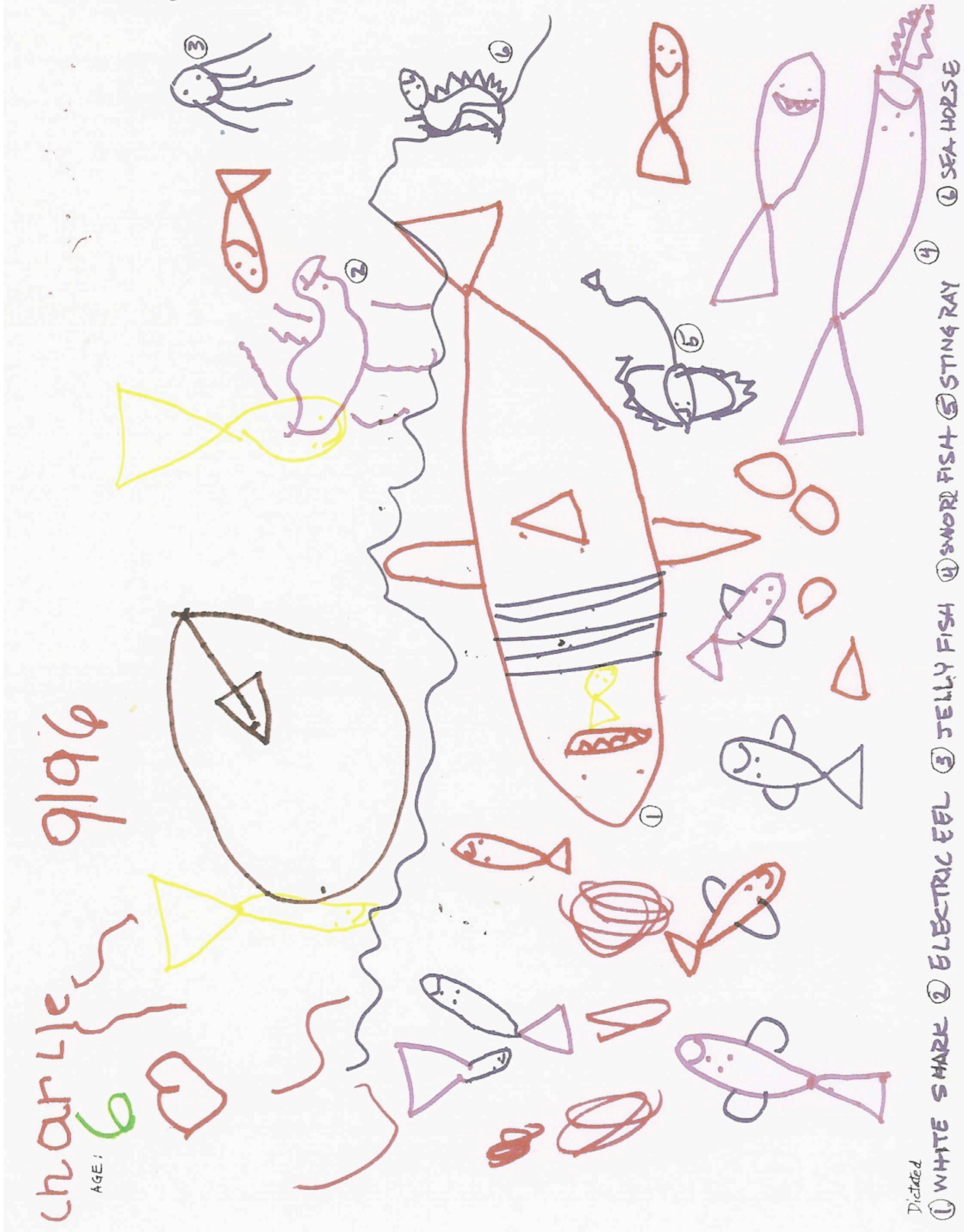
charlie
AGE: 6
9196
Dictated
① WHITE SHARK ② ELECTRIC EEL ③ JELLY FISH ④ SWORD FISH ⑤ STING RAY ⑥ SEA HORSE

Figure 7

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Case Study 2: "Student teachers' prior knowledge of earthquakes"

Case Study 2 research features:

- *Cognitive Behavior Element 13:* Tendency to remember details of highly emotional or traumatic events
- *Neuroscience Component:* Traumatic events increase the sharpness and amount of detail in images stored and recalled in long term visual memory.
- *Experimental Modification*: None

Sample. Two classes of university graduate students (N=70) who planned to be future elementary school teachers.

Method. The experimental lesson involved the following steps:(1) Reading the protocol; (2) providing paper and colored pen sets for all student teachers; 3) maintaining a quiet environment during drawing time; (4) circulating among student teachers as they constructed their drawings; (5) asking student teachers to place their names on the backs of their pictures, and to add any comments about the contents of their drawing they wished to have me know.

Protocol. "Today the first lab activity is designed to demonstrate a technique for assessing children's prior knowledge about science topics you will be teaching. Some science topics may have touched your students' lives in ways that are connected to emotional or traumatic events. Soon you will be teaching a science unit about earthquakes in your school. Some students in one of your classes might actually have had a traumatic experience with an earthquake. You would want to know that before you begin to teach your science unit. Why? Neuroscientists have found that the details of traumatic events remain in long-term memory for a long time, and cause unusual stress to the person who has experienced a traumatic event. One way to find out if someone in your class has experienced such an event related to a subject you will be teaching; is to ask students to draw pictures that show what they already know about the subject, in this case, earthquakes. Then assure students that their pictures will not be shared in class. Your assurance protects students who might worry that they will have to tell about their picture or show it to the class. Incidentally, an unexpected value of this activity is that students with limited language ability often show they know much more than you might expect.

"During this first lab, I want each of you to draw a picture that shows what you know about earthquakes. The paper and colored pens are on the counter at the back of the lab. You will have 20 minutes to complete your drawing. I will come around to look at your drawings, talk briefly with each of you, and collect them. This time, we won't share them in class."

Result. During this exercise, I walked around the room quietly and saw a drawing which suggested a personal trauma. The picture showed a small cottage whose door was perched at the edge of a wide, very deep trench. Behind the cottage was a row of burial mounds with rough stone markers. It was a picture which I would later name ***Visual Image of Major Guatemalan Earthquake***. When I saw the drawing I whispered to the student teacher who was from Guatemala, "That earthquake must have been very severe." She whispered that she had never been able to talk about the Guatemalan earthquake before today, because her home was on the very edge of the earthquake fault that had opened a trench by their front door, and her family had to crawl out a back window to get out of the house. She explained that all of her childhood friends had died in the quake. Now that she had drawn the picture, she wanted to talk about it. The student teacher then asked if she could share her picture with the class. I explained to the class that I was making an exception to the procedure I had described earlier. "One student teacher has asked to share her picture for personal reasons." The class of student teachers immediately became silent as their classmate told them about the Guatemalan earthquake that had erupted along a fault that ran through their village. The graves shown in the picture were those of her best friends. No one else in the class could talk about the event.

Discussion of Result. The student teachers appeared to be "living the Guatemalan earthquake" in their minds. They had never been so quiet in any previous class meeting. At the end of the course, weeks later, the student teachers rated that particular lesson more highly than any other class for the term, suggesting students were still reviewing the traumatic event in their minds. In terms of the *Elements of Behavior Associated with Cognitive Behavior,* the behavior of the student teachers toward their Guatemalan classmate's story suggested two other elements of behavior associated with cognitive development: *Element 7, Capacity to see things from different points of view, and Element 10, Reflection on others' learning from their important experiences*.

<u>Conclusions regarding the research</u>. The two case studies described above provide examples of studies that explored the use of *Elements of Behavior Associated with Cognitive Development* as a research tool. The combination of drawings by 250 K-6 students and 70 graduate students, and talking with them about their drawings, provided evidence that one can assess students' abilities to recall large amounts of visual information and to organize the information in new ways. It is premature to draw general conclusions about the usefulness of *Elements* for comparing students' cognitive development, beyond the limited contexts described. Since it was possible to recognize similarities and differences among students, the tool looks promising for additional experimentation. The distinguishing difference among students at each grade level was in the amount of information they included in their drawings versus the amount of information they voluntarily told the teacher-researcher as she went from desk to desk. This result points to the importance of talking with students about their pictures. However, no claim can be made at this time that the author has assessed the cognitive development of the students who participated in the drawing activity . Further studies will begin the task of establishing validity and reliability for the approach described here. One last point, the *Elements* lend themselves to observations in many settings. Researchers and teachers interested in assessing student behaviors may use a variety of methods, such as 1) observing or listening to students/subjects in natural settings like classrooms, museums, or labs, 2) analyzing a variety of samples of students'/subjects' written work, and 3) asking students/subjects to represent their thinking through drawings.

Contributions of the arts toward students' cognitive development: thoughts about practical applications for teachers of the arts.

How can teachers of the arts contribute to cognitive development? In this final discussion, two ideas are discussed for their potential usefulness to teachers of the arts. The first idea relates to the significance of new discoveries about the brain which offer hints about teaching in the classroom or elsewhere. The second idea relates to ways teachers might modify one or more courses in the arts so that their teaching could contribute more directly to students' cognitive development.

Idea 1

Cognitive development is, first, a gradual process that proceeds on an enormous number of fronts simultaneously. As individuals explore their environments, each new experience is integrated into the network or sum total of all experiences that have preceded it. This integrated network of life experiences can be thought of metaphorically as each person's world view, which in turn influences his or her behavior and conscious view of the world. Although world views change very slowly, teachers are able to influence students' world views.

The arts taken as a whole have the potential to transform parts of each individual's world view. Music can not only connect students with their past and present condition, but it can change their emotional moods. Drama brings new insights to students' regarding their lives and allows them to feel the joy and pain of others. Literature and paintings connect them with worlds they may never have known existed. The exceedingly rich array of experiences within the arts have the potential to transform students' sense of themselves within the larger context of humanity.

Idea 2

What then are the roles of teachers of the arts? Teachers provide the language that connects each of the arts with the lives of their students. Language is the medium that makes transforming experiences with the arts possible for students. Through their choices of art to be presented, teachers connect the expressions of artists to the lives of students. Through their experiences with the arts, students have access to the possibilities of knowing what other minds have thought, and how people in other cultures and other centuries have viewed the world.

Can teachers connect the arts to students' lives in the ways described above when teachers are expected to meet state standards? Obviously it is important to distinguish between the requirements teachers must meet in terms of their contracts, and their goals as teachers of the arts. One can often accomplish both. By way of example, one can introduce the importance of *teaching students to think about their own thinking,* within the context of teaching one of the arts. Psychologists have a name for this process: Thinking about one's own thinking is called meta-cognitive behavior. (*Meta* in this sense means a comprehensive or transforming process of thinking or reflection, occurring later or after general thinking to complete an assignment.) How does one teach students to think about their own thinking? A relatively easy approach for teachers is to convert the *Elements of Behavior Associated with Cognitive Development* into teaching strategies. Consider the following example:

<u>Element # 1</u> Conscious comparison of new experiences with past experiences

<u>Teaching Strategy #1</u> Teach students to compare new knowledge in the arts with previous knowledge.

<u>Example</u> Teach students to compare the musical style, tempo, or instruments of a new music selection with a previous musical selection.

A second relatively easy approach to having students learn to think about their own thinking, is to "market" the idea as a way to improve their success in school or in their lives outside of school. In this approach, one renames the *Elements of Behavior Associated with Cognitive Development* so students will take a personal interest in their own cognitive development. One teacher might choose to rename the list to *Ways to Improve Your Mind***.** Another teacher might choose a title like *Steps to Becoming Smarter.* In this context, the list then becomes slightly transformed when it is placed on a classroom bulletin board.

The sixteen statements from the *Elements* chart below have been rewritten for adolescents.

Ways to Improve Your Mind.

1. Compare each new experience with similar past experiences.
2. Find a way to link new information to what you already know.
3. Try to gather and compare information from several new sources.
4. Ask yourself if you can see things from other people's points of view.
5. Look for the big picture. What is the most important main idea?
6. Search for new insights from new and past experiences.
7. Find the most important things about each new experience.
8. Think about what others have learned from important experiences.
9. Be willing to re-think and change your mind concerning an experience.
10. Think about ways you can enlarge your view of the world.
11. Ask others about new ways to remember what you have to learn.
12. Learn how to remember larger amounts of information.
13. Try to remember and describe the details of a specific event.
14. Think about a way you can reorganize large amounts of information.
15. Select visual images in nature and daily life to create new art forms.
16. Select sounds in nature and daily life to create new art forms.

Teachers who are excellent at teaching their course content often take time during their course, or a class, to talk with students about ways to improve the quality of their lives inside and outside of school. When teachers initiate such topics, their students generally listen closely to these shared moments.

Talking with students about ways they can improve their minds (cognitive development) and thereby, "have a better life" ranks high on the scale of students' descriptions of the high points in their high school experiences, which they associate with the teachers who have most influenced their lives.

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xv This element is based on the visual images in art produced by the French Impressionists including Cezanne, Gauguin, and Van Gogh who crated new forms of art from nature and daily events.

xvi This element is based on the music written by Copeland, Debussy and Gershwin among others who created music based on sounds in nature and daily life.