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**Drawing/Writing: A brain research-based writing program
designed to develop descriptive, analytical and inferential
thinking skills at the elementary school level**

Sheridan, Susan Rich, Ed.D.

University of Massachusetts, 1990

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DRAWING/WRITING:
A BRAIN RESEARCH-BASED WRITING PROGRAM
DESIGNED TO DEVELOP
DESCRIPTIVE, ANALYTICAL AND INFERENTIAL THINKING SKILLS
AT THE ELEMENTARY SCHOOL LEVEL

A Dissertation Presented

by

SUSAN R. SHERIDAN

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

February 1990

Education

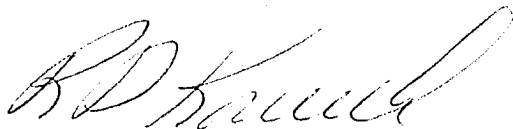
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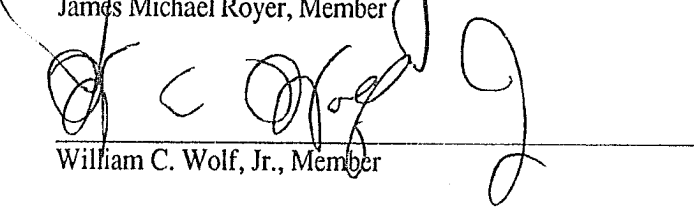
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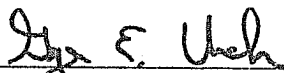
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My thanks to my mother, VIRGINIA, for her example.

To the Children

ABSTRACT

DRAWING/WRITING:
A BRAIN RESEARCH-BASED WRITING PROGRAM
DESIGNED TO DEVELOP
DESCRIPTIVE, ANALYTICAL AND INFERENCEAL THINKING SKILL
AT THE ELEMENTARY SCHOOL LEVEL

FEBRUARY 1990

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The research and the study focus on the problem of dissociated learning. Why do students fail to connect with knowledge?

The purposes of the study are: to summarize research pertaining to brain growth; to describe educational approaches and tactics consistent with this research; to test a brain research-based program designed to connect children to knowledge.

The study rests on two research-based assumptions: strategies that connect dysfunctional or developmentally delayed students with thinking and learning will connect children in general with thinking and learning; educational activities integrating spatial information processing with linguistic processing will develop thinking skills more effectively than programs that do not.

The apparent reason for the success of a spatial/linguistic program is that cross-modal activities mirror, or model, the integrated processes of the brain, impacting attention, emotion and logical operations.

Increasing numbers of students fail to connect with writing. Many of these students can draw. Can drawing be used to connect these students to writing as thinking?

The hypothesis is that a cross-modal activity combining drawing (a spatial activity) with writing (a linguistic activity) will develop descriptive, analytical and inferenceal thinking skills more effectively than a writing program that does not. The study targets children who receive special services, including those with language- and attention-related problems.

To test the hypothesis, a quasi-experimental/control study was designed, involving 200 students in grades K, 3, 4, 5 and 6 in intact classrooms in two elementary schools. Approximately 2,000 pieces of data revealed a significant effect for the treatment, Drawing/Writing, on writing and thinking skills in the experimental group, including students who receive special services.

The conclusions of the research are that brain research has relevance for education and that cross-modal activities provide antidotes to dissociated learning. The conclusion of the study is that, as a writing program, Drawing/Writing has broad usefulness and appeal.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	iv
ABSTRACT.....	vi
LIST OF TABLES.....	xiv
LIST OF ILLUSTRATIONS.....	xv
 CHAPTER	
1. PROBLEM STATEMENT AND BACKGROUND.....	1
1.1 Statement of the Problem.....	1
1.2 Background of the Problem.....	2
1.3 Development of an Idea	4
1.3.1 Phase 1, Teaching.....	7
1.3.2 Phase 2, Research	9
1.3.3 Phase 3, The Study.....	10
1.3.4 Phase 4, On-Going Teaching and Research.....	10
1.4 Purposes of the Study.....	11
1.5 Definition of Terms.....	12
1.6 Significance	16
1.7 Methodolgy.....	18
1.8 Limitations	18
1.9 Delimitations	20
1.10 Summary of the Chapters.....	21
2. REVIEW OF THE LITERATURE.....	22
2.1 Introduction: Attention, Memory, Language.....	22
2.2 Research in Neurobiology.....	23
2.2.1 The Brain as a Cross-modal Connection System.....	24
2.2.2 Sensitive Periods and the Uses of Immaturity	27
2.2.3 Vision, Attention, Memory and Learning	29
2.2.3.1 Vision.....	29
2.2.3.2 Vision and Attention.....	29
2.2.3.3 Vision, Attention and Learning.....	31
2.2.4 Mental Representations.....	36
2.2.5 Hemisphericity.....	40
2.2.6 The Social Brain.....	40
2.2.7 Research Speculations and Recommendations.....	41

2.2.7.1	The Magical Mirror of Thought.....	41
2.2.7.2	Thirteen Research-Based Recommendations.....	42
2.2.7.3	Four Tactics to Facilitate Brain Growth.....	45
2.2.7.4	A Model Learning Activity.....	46
2.3	Introduction to Research in Education.....	48
2.4	Research in Education.....	49
2.4.1	Connection through Action and Language	49
2.4.2	An Overview of Theories of Early Childhood, Early Education, and Intelligence.....	52
2.4.3	Early Experience and Language Acquisition.....	56
2.4.4	Multi-Sensory Remedial Language Programs.....	57
2.4.5	Vision, Attention, Memory, Learning and Language Acquisition from the Point of View of Art Education	62
2.4.6	Symbolic Representation.....	65
2.4.6.1	Piaget: Symbols and Operations.....	65
2.4.6.2	Symbols and the Arts.....	66
2.4.7	Theories of Drawing.....	68
2.4.7.1	Children's Drawings as Measures of Developing Abilities or Intelligence.....	72
2.4.7.2	Speculations about Children's Drawings.....	74
2.4.8	Theories of Writing.....	75
2.4.9	Speculations on the Relationships between Drawing and Writing.....	77
2.4.10	Constructivism.....	78
2.4.11	Research Speculations.....	83
2.4.11.1	Dyslexia Revisited	83
2.4.11.2	Parallel Understandings.....	85
2.4.11.3	Profile of a Theory of Education Designed to Develop Attention, Memory and Logical Operations within the Context of Language Acquisition.....	86
2.5	Integration of the Combined Research.....	91
3.	METHODOLOGY.....	92
3.1	Introduction.....	92
3.2	Drawing/Writing, The Experimental Treatment.....	92
3.2.1	Steps One through Seven.....	93
3.2.2	Socio-Moral Ramifications of "Neither Too Much, nor Too Little"....	97
3.2.3	The Cognitive Ramifications of Drawing/Writing including Remedial Spin-offs.....	98
3.2.4	Step Eight.....	98

3.3	Research Population and Setting	99
3.4	Procedure of the Study.....	99
3.4.1	History	99
3.4.2	Mode of Inquiry.....	100
3.4.3	Teacher Training.....	100
3.4.4	Schedule	101
3.4.5	The Tests.....	101
3.5	Sample.....	102
3.6	Study Design	103
3.7	The Hypotheses, General and Specific.....	103
3.7.1	The Spatial/Linguistic Hypothesis	103
3.7.2	Drawing/Writing as a Spatial/Linguistic Activity.....	103
3.7.3	The Six Specific Hypotheses.....	104
3.8	The Variables	104
3.8.1	Holistic Dependent Variables	104
3.8.2	Rescore Dependent Variables	105
3.9	Methods of Evaluation.....	105
3.9.1	Evaluation, Holistic	106
3.9.2	Evaluation, Rescore	108
3.10	Summary, Evaluation Methods.....	109
4.	DESCRIPTION AND ANALYSIS OF THE DATA	110
4.1	Description of the Data	110
4.1.1	Overview.....	110
4.1.2	Review Study Design.....	111
4.1.3	Significant Interactions.....	114
4.1.4	Overall Results.....	114
4.1.5	Results by Scoring Methods.....	115
4.1.6	Kindergarten Results.....	120
4.1.7	Analysis of Table 4.....	123
4.1.8	Analysis of Table 6 using Rescore Means by School, Child Type, Sex..	127
4.1.9	Analyses, Drawing.....	129
4.1.10	Analyses, Escher Prints.....	130
4.2	Multivariate Analyses by Hypotheses, Holistic and Rescore.....	131
4.2.1	Hypothesis #1: Drawing/Writing Affects Descriptive and Inferential Writing about Objects.....	131

4.2.1.1	Girls, Rescore Analysis, Word-Numbers and Uses	133
4.2.2	Hypothesis # 2: Drawing/Writing Affects Drawing Skills.....	134
4.2.3	Hypothesis # 3: Drawing/Writing Affects Descriptive and Inferential Writing about Seasons.....	135
4.2.4	Hypothesis # 4: Drawing/Writing Affects Descriptive and Inferential Writing about Escher Prints.....	136
4.2.5	Hypothesis # 5: Drawing/Writing Affects Descriptive and Inferential Writing to a Greater Extent in Child Type 2, or the Referred Child, rather than in Child Type 1, the Non-Referred Child	136
4.2.6	Hypothesis # 6: Drawing/Writing is Taught Better by the Regular Classroom Teacher than by the Researcher/Teacher	137
4.2.7	Analysis, Three Sets of Scores.....	139
4.3	Summary, Both Scoring Systems.....	140
4.3.1	Analysis of Percents Gains and Losses, Both Child Types, Both Scoring Systems, Writing Only.....	142
4.4	Summary, Holistic Analysis.....	142
4.5	Individual Cases that Demonstrate Errors in the Holistic Method of Evaluation....	143
4.6	Summary of Rescore Analysis.....	144
4.7	Ipsative or Descriptive Case Studies, 1-12.....	145
4.8	Conclusion.....	167
5.	DISCUSSION.....	168
5.1	Overview of the Chapter: Discussion, Speculations, Recommendations.....	168
5.2	Discussion of the Results by Hypothesis.....	169
5.2.1	Hypothesis # 1: Drawing/Writing will Increase Descriptive and Inferential Writing.....	169
5.2.2	Hypothesis # 2: Drawing/Writing will Increase Drawing Skills.....	171
5.2.3	Hypothesis # 3: Drawing/Writing will increase Descriptive and Inferential Writing about the Seasons.....	171
5.2.4	Hypothesis # 4: Drawing/Writing will increase Descriptive and Inferential Writing about Escher Prints.....	171
5.2.5	Hypothesis # 5: Drawing/Writing will Increase the Referred Child's Abilities to Draw and to Write to a Greater Extent than those of the Non-Referred Child.....	172
5.2.6	Hypothesis # 6: Drawing/Writing will be Taught Better by the Regular Classroom Teacher than by the Researcher/Teacher.....	173
5.3	Discussion of the Results.....	174
5.4	Limitations of the Study.....	175
5.5	Plan for Future Research.....	176
5.5.1	Design Changes.....	177
5.6	Recommendations	179

5.7	Conclusions from the Research and from the Study	179
5.8	The Problem and the Purpose Revisited: Review of the Tactics.....	181
5.9	How Drawing/Writing Jibes with the Research.....	181
5.10	Predictions.....	186
5.11	Profile of a New Approach: "Neuro-Constructivism".....	187
5.11.1	Tenets of Neuro-Constructivism.....	188
5.11.1.1	Active Problem-Solving Causes Brain Growth.....	188
5.11.1.2	Attention is Both Automatic and Self-Regulatory.....	188
5.11.1.3	Children Move In and Out of Risk.....	188
5.11.1.4	Learning is Lifetime Possibility from a Neural Point of View	188
5.11.1.5	The Immature Human Central Nervous System is Plastic.....	188
5.11.1.6	The Young Central Nervous System Represents Thought Using Symbols.....	189
5.12	Theory of "The Thinking Child"	189
5.13	Conclusions.....	193
5.14	Speculations	195
APPENDICES.....		201
A. ESCHER PRINTS.....		202
B. LETTERS OF RELEASE.....		204
BIBLIOGRAPHY.....		206

LIST OF TABLES

TABLES	Page
1 The Study Populations.....	111
2 Comparison of Groups, Means and Standard Deviations, Outset.....	117
3 Comparison of Groups, Post- and Follow-up Tests.....	118
4 Means and Standard Deviations, Both Scoring Systems.....	121
5 Gains and Losses, Sex and Child Type	124
6 Rescore, Means and Standard Deviations.....	125
7 Means and Standard Deviations, Drawing Scores.....	128
8 Means and Standard Deviations, Escher Scores.....	130
9 Comparison by Percentages, Gain and Loss, Both Groups, Drawing and Writing Scores.....	137
10 Comparisons, Gain and Loss, Pre- and Post-Tests.....	138
11 Percent Gain and Loss by Group and Child Type.....	139
12 Percents, Gains and Losses.....	140

LIST OF ILLUSTRATIONS

		Page
	ILLUSTRATIONS	
1	Bones.....	146
2	Geode.....	148
3	Hose Sprayer.....	150
4	Garden Clippers.....	152
5	Hammer.....	154
6	Roller Skate.....	156
7	Rose Clippers.....	158
8	Mussell, Hammer.....	160
9	Whisk, Cork Screw.....	162
10	Parsley Grinder, Mallet.....	164
11	Vertebra, Shell.....	166

CHAPTER 1

PROBLEM STATEMENT AND BACKGROUND

1.1 Statement of the Problem

NOTE: In this paper, the words "brain" and "mind" will be used interchangeably. Although this paper takes the position that the mind is the brain, the researcher is aware of difficulties with the reductionist position. This paper suggests that the brain is at least largely, if not entirely, responsible for thought. Surely, how the brain develops impacts how the mind grows. "Mind/brain" might provide a more precise descriptor, but the combined word is somewhat cumbersome, and it, too, may be unsettling. Whether the words "brain" or "mind" or "mind/brain" are used, the phenomenon under discussion in this paper is the human central nervous system.

The major problem addressed in these papers is dissociated learning in general (Papert, 1980) and inappropriate elementary curricula in particular, especially in connection with the use of symbols, including words and numbers (Montessori, 1912; Elkind, 1974; Papert, 1980). Some time-honored approaches to developing skills with symbols may be more damaging than useful (Liebermann, 1984; Ferreiro & Teberosky, 1979). Children need to be physically and emotionally invested in the learning process.

Are there antidotes to dissociated learning, particularly in connection with the use of symbol systems? One of the major antidotes to a lack of connection is active involvement; children themselves must learn to construct relationships between things and ideas. Both brain research (Rosenzweig & Bennett, 1978; Changeux, 1985; Gazzaniga, 1985; Kosslyn et al., 1984) and educational research (Piaget, 1960; Arnheim, 1969; Adler, 1984; Devries, 1987) suggest that effective thinking and learning take place when children are involved in active ways.

It appears that the field of research that focusses on the brain can impact and enrich educational theory and practice in connection with interactive learning and effective thinking skills. What emerges from the brain research is an understanding that all children have special needs and that all children are at risk at one time or another. The following research suggests that both neurobiology and the larger field of cognitive science, including artificial intelligence (A.I.) can be mined for information useful to educators who are eager to design programs appropriate to a broad range of children to develop skills in symbolic representation, particularly in connection with writing.

The following research and study suggest that what binds children to learning is personal knowledge. Bodily, concrete exploration and manipulation of the world lays the foundation for habits and strategies of powerful abstract thought, when the world will be explored and manipulated symbolically. The arts provide young children with accessible symbol systems, useful in their quest for world-knowledge. It follows, then,

that the arts are appropriate to developing mind most particularly at the pre- and peri-literate (elementary) level of education. The pedagogical question is whether the arts can be paired with academic activities in ways that will be effective to develop a spectrum of symbolic skills and abilities, including the weakest and the strongest of these representational skills? The research and the study suggest that the arts can be used in concert with academics in this way.

1.2 Background of the Problem

Children see and hear before they speak, and they speak before they read and write. Seeing, hearing, speaking, reading and writing engage childrens' brains. Many people have attempted to understand how the young brain works. Their work has influenced general knowledge about the mass of cells that are responsible for physical and mental coordination. At this time, more is known about brain physiology than about two of its primary functions - thinking and learning. Even less seems to be known about how to nurture the young brain's thinking and learning capabilities.

Neurobiologists, psychologists, cyberneticists and others interested in the brain's functions have provided a wealth of information over the last two decades that is relevant to the education of young minds. Their work is an important resource that is accessible to those who are responsible for the education of the nation's children and youth. Accessibility, however, has not facilitated widespread utilization of the combined brain research. There appear to be two reasons for this: Firstly, most educators are simply unfamiliar with the outcomes of brain research. Secondly, as a direct outcome of this lack of exposure, curriculum materials and instructional methods that find their way into the mainstream of practice aren't based upon and do not reflect these research outcomes often enough.

Brain researchers agree that children command powerful thought processes. They agree that children think symbolically in a variety of ways, and that children make marks intended to have meaning. Researchers agree, furthermore, that children's marks not only intend to communicate but do act as transmitted and received messages. Children are clearly able to reflect upon what they see, hear, say, read and write.

Unfortunately, translating these understandings about children's minds into viable instructional methods and curriculum materials is a complex process. While the technical know-how may be currently in place, the will to translate theory into practice is generally not. Once there is precedence for brain research-based educational theory and practice, this reluctance to integrate seemingly disparate but mutually enhancing bodies of information may be dispelled. This occurrence would be appreciably facilitated by an easy-to-model program. This paper will attempt to provide the theoretical and practical guidelines for such a program in which one activity in the arts, drawing, is successfully integrated with one academic activity, writing.

Drawing is a natural mark-making activity for most young children. Most children, given the chance, do draw, like to draw, and - with practice and minimal instruction - become competent at drawing. Writing appears to be a somewhat less natural activity for children. Even with the advent of an approach to teaching

writing which assumes that writing is a natural skill (Graves, 1979, 1983; Calkins, 1979, 1986), some children still find writing difficult.

In traditional writing programs, children master a battery of skills before they start writing. Children who learn to write in this way may not use writing as a way to think as they progress through the educational system (Holt, 1967; Zinsler, 1988), and they may not use writing later in life as a way to think.

There is an appreciable number of children who have trouble acquiring written language. Either the number of children who have trouble with writing may be increasing, or the early detection of language-troubled children may be making society more aware of writing and reading problems. Whatever the reasons for the apparent increase in the numbers of children who have trouble with language, educators are focussing energy and resources on children with language-related problems.

The problem in the most general sense may have to do with children's acquisition and effective use of increasingly abstract symbol systems. In this acquisition process, drawing appears to be developmentally accessible first.

Even though very young children appear naturally to engage in both kinds of mark-making - a drawing kind, and a writing kind, as early evidence of developing symbolic thinking (Grinnell & Burris, 1983; Schickedanz, 1986)- educators do not encourage nor train the mark-making that is called drawing, as thinking. Even though drawing is a skill that most children feel they can use to think with, and which they like to think with, drawing is more often thought of as a time-filler than as a substantive activity. Many children who were confident, or who might have been confident and fluent thinkers as draw-ers, become, during the elementary school years disfluent not only as draw-ers, but as writers. In addition, many children become increasingly insecure and ill-practiced as thinkers.

The marks we use for writing appear to be more abstract than the marks we use for drawing. It is possible that the degree of level of abstraction and the degree of difficulty of instruction are related. It may take more teaching to teach writing than it does to teach drawing.

It is equally possible that drawing and writing are equipotential skills, and that the two are intimately related, and socially driven. Reading could be defined as what happens when children make marks that are intelligible to them. As may be the case with the force of gravity and a theory of unification, reading may not exist distinct from mark-making of significance, but may be inherent in the act of making them. It may be important to decode one's own marks before trying to read someone else's.

It is possible that there is something so abstract about writing for some children that disconnecting it from the system of marks that we call drawing may be doing them a disservice. It is possible that a lack of connection between drawing and writing may be responsible for some of the problems that some children experience with writing.

Children may be out of touch with their own thinking and learning abilities through no fault of their own. The way in which children learn in schools is often "dissociated" (Papert, 1980, p. 47). It may not connect in any meaningful way with children's lives. It is second-hand knowing. Children look at other people's pictures. They read other people's writing.

One way of interpreting some of the behavioral and learning problems encountered in schools, along with statistics on illiteracy and truancy is that young people are deeply, if unconsciously disaffected with this kind of disconnection. Rote learning holds students apart from knowledge (Papert, 1980). It neither engages, nor challenges them. Education may not be allowing students to do what their minds have evolved to do best, which is to make comparisons between systems of representation (Changeux, 1985; Gazzaniga, 1985, 1987).

Can children return to first-hand knowing? Can they get back in touch with inherent abilities to make meaning using symbolic languages? How can educators engineer a reconciliation between the child and knowledge in ways that society will find acceptable? Can curricula combine the ways in which children appear to learn naturally with what society expects of children educationally? Is it possible, for instance, to combine drawing with writing? Would such a combination allow a broad range of children to move more naturally and more effectively into the use of written language?

1.3 Development of an Idea

I grew up writing, and painting. I felt that writing and painting were two complementary ways of knowing. Each, to me, was distinctly different. Each, in its own way, was both a complete, and an incomplete statement.

Whenever I wrote or painted, I felt that my whole mind was engaged. I found books that dichotomized thinking skills in connection with brain function (Edwards, 1979) offensive, irritating, and frightening. How could a writer be using only the left side of the brain? How could a painter be using only the right side of the brain?

I was convinced that people who believed they were strictly left- or right- hemisphere thinkers were selling their minds short. Subsequent neurobiological research confirmed this suspicion. People had misunderstood the implications of the split-brain research of the 1950's (Gazzaniga, 1985; Gooch, 1980; Levy, 1985). It was true that in split brain studies, two somewhat distinct general functions, one spatial, one verbal, could be distinguished (Gazzaniga, 1985, 1987; Gardner, 1974). It was not true that these processes, in the intact brain, were divisible. Precisely because of dense interconnectedness, any thought, in an intact brain, is a global operation, involving, to some extent, both hemispheres (Levy, 1979).

Trying to define the usefulness of art to cognition, in terms other than those used by art education, was as challenging, as puzzling for me, as it was imperative. The arguments presented by art education - that art is production involving skill mastery, that art is cultural transmission, that art is aesthetics, that art develops something called creativity - have not caught the popular, nor the professional educational imagination. Somehow, an understanding of what the arts do for the mind remains unclear. The labels "frills," "elite," "effete" come to mind. The words "enrichment" and "remediation" come to mind.

The fundamental, everyday importance of the arts to knowledge continues to elude us. "Interest," "engagement," "involvement," "self-esteem"- even these words do not promote the cause of the arts as a part

of regular education. The words we need to associate with art are "relevant," "appropriate," and "integral." All other aspects of the arts to engage, to empower, to inform stem from the fact that the arts are an expression of how the mind learns through the body.

As an artist, and as a teacher of art, I have discovered that the arts are a powerful way to know. As a writer, and as a teacher of writing, I have learned that writing is a powerful way to know. Because I grew up drawing and writing, experience has led me to believe that both images and words are necessary to understanding and to expressing experience. Does this personal understanding generalize? I believe that it does.

I have observed two things about children and drawing; one is that young children like to draw, and they know they can do it; the second one is that older children lose interest in drawing, and they know they can't do it.

Is art "outgrown" because schools do not recognize it as an initially and enduringly useful way to think? Or do the arts as symbolic languages outlive their usefulness in the course of most human being's cognitive development?

Anthropology (Gould, 1980), art history (Jansson, 1962/1967) art education (Eisner, 1982; Feldman, 1970; Project Zero, Harvard, 1966-present), developmental child psychology (Vygotsky, 1978; Kellogg, 1970; Koppitz, 1968; Goodnow, 1977; Freeman, 1980; 1985) suggest that pictorial representation has been and continues to be an important part of how human beings as a species, and as individuals, think about the world.

Despite the evidence from these fields, art is generally thought of, educationally, as an appropriate, but non-substantive activity for very young children. Art does not play an important role beyond preschool in most American elementary schools (Winner, 1988). The educational emphasis is quickly placed on verbal and mathematical reasoning. According to Elliot Eisner, this move away from art limits the notion of intelligence (Eisner, 1982).

Art is one of the universal languages. Most young children "speak" it; many older children don't. If art is inherently interesting and possible for most children as a language system, should we allow, or even encourage this discontinuity? If a discontinuity between the arts and what are called academics should be responsible, in part, for the disassociation children feel with learning, and if an association between the arts and academics proved to be in the best interests of a range of children who present a variety of learning styles, mightn't it be wise, educationally, to effect a reconciliation between the arts and academics?

The simplest, most accessible definition of art that I have come up with, after eight years of searching, and a lifetime of doing it, is that art is knowledge informed by touch. Art is intelligence informed by the senses. This kind of knowing, through direct interaction, is natural to children. This kind of sensory knowledge appears to be the bedrock of mature thought (Piaget, 1960; Montessori, 1912/1969; Papert, 1980; Arnheim, 1969; Lowenfeld, 1964).

Armed with this definition, that art is knowledge informed by touch, it can be inferred from the neurobiological research that examines the relationship of early sensory experience to brain growth that the

arts may be used to impact intelligence. The question for educational research is whether art as drawing may be used to impact writing as thinking in ways that are particularly effective for the young?

It is possible that the relationship between drawing and writing is effective because it is natural. This relationship may be not only of initial usefulness to the thinking of children, but a combination of pictorial and linguistic marks may have enduring usefulness for thought. For some young minds, whose language development is slow to develop, or which may be, for some reason, impaired, drawing (and the arts in general) may provide one of the only ways available to that child to express, and to drive his or her thinking skills in school, or for a lifetime.

If ontogeny recapitulates phylogeny, that is, if the embryo developmentally passes through the evolutionary stages of the species, and if this observation from biology is applied to the linguistic development of man, then the child learns to speak, to engage in symbolic play, to draw, and to write in the normal course of development, just as mankind has moved from speech to abstract symbolic expression in the course of human intellectual development.

It is possible that educators should deliberately devise teaching and learning strategies that mirror this development. Such mirroring might preclude, correct, or provide alternate strategies for the young mind that is at risk for language-related difficulties. It is possible, given an inadequate learning environment, that most minds are at risk for language-related difficulties.

Drawing skills develop with training and practice. Writing skills develop in the same way. No matter what the initial proclivity or level of competence, both skills need work to develop. Can the skills of drawing and writing develop together, to mutual advantage, within the educational environment?

Research suggests that language develops later than other information processing systems (Churchland, 1986, p. 388; Gazzaniga, 1985, p. 77; Minsky, 1985, p.270). In fact, language may not be the primary way much of the information used by the brain is stored and accessed (Kahneman & Treisman, 1984; Gazzaniga, 1985). However, it is certainly true that humans use words to think about things. Much of the information humans consciously use is tagged with language, and is retrievable through language (Gazzaniga, 1985).

This study suggests that the arts provide a variety of ways to store and to access non-verbal information that are especially useful attentionally and affectively in childhood. The arts can be used in practical ways in the regular classroom to impact thinking skills in connection with what are described as academic subjects. The study suggests that art, as drawing, can be used to impact thinking skills in connection with descriptive, analytical and inferential writing. The study suggests that drawing impacts these kinds of writing for a broad range of children, including those who have trouble with writing. Parents and teachers and educators place a premium on writing skills (Zinsser, 1988; Graves, 1983; Calkins, 1986). If drawing should affect writing problems in a remedial or even in a preventative way, parents, teachers and educators would champion its use in writing programs.

There appears to be a connection between the kind of knowing that is informed by touch, and the cross-modal, comparative processes of the brain, and accurate and effective descriptive writing that reflects on drawing.

This study explores the connection between touch and knowledge and suggests the possibility of the practical application of art to education in the form of an activity called Drawing/Writing.

1.3.1 Phase 1, Teaching

Eight years ago, as a teaching assistant in the Masters of Arts and Teaching program at the University of Massachusetts, I taught basic drawing to non-art undergraduates. I tried to combine my understanding of my own drawing process with these students' needs as beginners in the mark-making system we call drawing. Anxious, assailed by doubts, I knew that my task was not to make artists. Artists, given the chance, make themselves. I knew that my task was to teach these students to see more carefully, and more thoughtfully. Haltingly, with the help of the students, I constructed the five-step drawing process that has become the operational foundation of the activity called Drawing/Writing.

The complete process of Drawing/Writing is described Chapter 3. Here, it is important to describe just one step, the last. The fifth-step in the drawing process is called the composite abstraction. This step was, and continues to be, what I call "the cognitive kicker." It is the step that introduces the young preliterate student to the idea that writing, just like drawing, will carry meaning. It suggests that the symbol that stands for a thing need not, in fact often will not, look like it. It is training in abstract symbol-making. It is training in putting old ideas together in new ways, a kind of thinking that is called recombinant. The composite abstraction is a straightforward, understandable way to get at what is sometimes dismissively, even perjoratively called creativity.

I was convinced, without knowing why, that I could not leave my college students stranded on the bright, illusive shores of realism. I had to drive them into abstraction in ways that we could all agree upon and respect. We had to have a way to create an abstraction that made sense, and that was consistent. Taking bits and pieces of the four previous drawings - pieces that were RELEVANT TO THE STUDENT - and combining them in new ways, was the strategy I devised for making an abstraction. As the Latin suggests, it was composite, or, "co," and "pono" - put together, using bits and pieces that were "ab" and "traho", or dragged from from other drawings.

As a way of getting at a new kind of representation that was no longer a literal translation of the thing being drawn, the composite abstraction made sense to college students then, and it still makes sense now, across ages, as a way to engage in inventive thought. It has become the lynch pin of the Drawing/Writing process as an activity that moves children through the use of drawing into the increasingly abstract mark-making system we call writing, where the symbol comes to stand for the thing itself in paradoxical way; the written word does not look like, and yet it is the thing itself.

As I worked out the five-step drawing process with college undergraduates, my additional intuition was that the fourth step, the realistic drawing which I called the "Perfect Whole" was no more real, in the final analysis, than the abstract drawing. An innate appreciation for the approximate nature of any one symbol system to tell the whole story of anything is natural to the minds of children. Drawing the thing, dancing it,

singing it, telling about it - all of these forms of expression conspire to provide completer understanding in children's minds. The playing of children is exploration in symbol systems. I knew that, whatever else I might be teaching in the Basic Design course at the University of Massachusetts, the students were learning thinking skills. Their drawings proved it, to them and to me. As they produced accurate copies, and aesthetically pleasing abstractions, the students were learning to look carefully, and to reflect thoughtfully. This growing ability to observe and to reflect in a literal, and in an inventive manner had implications for the ways in which Drawing/Writing would later drive levels of thought.

Moving from the university to a middle school art room, I made another observation about children and art; so-called "dyslexic" students did it better. I decided to try an experiment. Would the five-step drawing process, if it were linked to writing, ease writing for children who had trouble with it?

Working with an identified population of dyslexic boys, I began teaching the first version of Drawing/Writing. The results suggested that drawing did affect writing in positive ways for this language-troubled group of students. What was the connection between drawing and writing? What was happening in the brains of students whose hand-writing was tortured, yet whose drawing was fluent? There couldn't be two different fine-motor systems, could there, for hand-use, depending on what one was doing? I started research in neurobiology, convinced that answers and help for the troubled student lay there.

Before starting a formal program of research at the doctoral level, I traveled to several universities, and to one university hospital. I asked people in the fields of art education, of special education, of psychology, of neurobiology, in cognitive science about the feasibility of combing drawing with writing. I wrote to educators, to scientists, and to doctors about the usefulness of a combined drawing-writing activity to the mind, including the young, language-troubled mind. I received encouragement from these disparate fields. Furthermore, I discovered that Drawing/Writing, as I taught it, appeared to be unique. There were approaches to writing that asked students to draw a picture first, and to write about it second. But no one was using a studio art-like approach to the teaching of drawing with the kind of writing that reflected on that drawing.

I tried Drawing/Writing with five-year olds in Extended Readiness (pre-kindergarten) programs. I taught two summer sessions of Drawing/Writing to eighty Elderhostlers. I went to a maximum security prison, and taught Drawing/Writing to inmates who were involved in their own writing out-reach program with elementary schools.

I asked these inmates for their advice on the usefulness of Drawing/Writing for children. I observed dramatic changes in the quality of both the drawing and of the writing in this group of eight men in a three-hour period. I saw no evidence of the high percentage of learning disabilities that are said to exist among prisoners. Whether these men were or were not part of a supposed 70% to 80% in a prison population who might have learning disabilities, I could not tell. I suspected that something like Drawing/Writing might have impacted their adult decision-making abilities. We can't take control of our lives if we remain ignorant of the options.

I taught workshops in Drawing/Writing to Special Education teachers at the elementary and junior high school level. I taught Drawing/Writing to what is called the Whole Language Society. I taught Drawing/Writing to anyone who would sit down for three hours. Art teachers who were artists were particularly responsive. They already knew the power of the arts for growth of mind; they could also see the implications of drawing for writing.

I wanted to see what Drawing/Writing could do. What were its limitations? What were its advantages? Would it appeal to teachers as well as to students?

At first, the question that drove the writing was "What have you learned about your object from your drawing?" I wondered how useful this question was. Continually inspired by Douglas Hofstadter (1980), who suggests that the fundamental question of intelligence is how things are and are not alike, the question that drove the Drawing/Writing process became, "How is your drawing like the object, and how is it not like the object?"

Currently, the question is, "What does your drawing tell you that you know about the object?" Research in neurobiology has confirmed what we suspect; we take in a great deal of information in non-verbal ways (Gazzaniga, 1985). Drawing is one way to show us what we know about the world. Training in drawing allows us to know more precisely, more completely, and to show ourselves this knowledge in clearly readable ways.

Three years of teaching Drawing/Writing in classrooms that include the so-called dyslexic student, who has trouble reading, writing, or understanding spoken language, with students who suffer from a damped down, or a souped up attentional system (hypo- or hyper-active children), and with students whose understanding of English is minimal, suggests that training in drawing positively affects thinking expressed in writing. Drawing/Writing is engaging for "regular" students as well. The data is there, in drawing and in writing.

The three years of teaching Drawing/Writing comprise phase one of the current research. This phase, based on personal experience as an artist and a writer, and on professional experience as a teacher of art and as a teacher of English has resulted in the operationalization of Drawing/Writing, and in a fairly well-developed philosophy of education called "The Thinking Child."

1.3.2 Phase 2, Research

Phase Two of the research into the activity called Drawing/Writing has been a search of the literature in education, in neurobiology, and in artificial intelligence. Tangential research into math and physics has also proved useful. In the fields of education, neurobiology, and artificial intelligence, sufficient evidence has been discovered to support the usefulness of Drawing/Writing to development of mind on a theoretical basis. The three fields suggest that, to be effective, early learning must be independent yet mediated, interactive, multi-sensory, relate to problem-solving, and involve attention, memory, and positive emotion. Drawing/Writing is on the mark neurobiologically and educationally. Drawing/Writing also appears to be in

agreement with what researchers into artificial intelligence and into the larger, combined field of cognitive science are discovering about how the brain learns to learn.

Drawing/Writing operationalizes the general understanding shared by the fields under consideration that the brain processes information in two broadly distinct ways, spatially and linguistically (Changeux, 1985; Llinas, 1986; Kosslyn, 1983, 1984; Wolf, 1988). The fact that the spatial processing precedes and underlies the linguistic processing (Llinas & Pellionz in Churchland, 1986) provides solid theoretical support for the order, and the intimate connection between drawing and writing in the dual, or interhemispheric, or "whole mind" activity called Drawing/Writing.

1.3.3 Phase 3. The Study

Phase Three of the research has been the multi-subject, quasi-experimental study conducted in two elementary schools, using grades K, 3, 4, 5 and 6, involving both student- and teaching-training. Roughly 2,000 pieces of data, in the form of drawings and of writings, have been collected and have been evaluated by a ten-person committee using what is called the holistic method.

1.3.4 Phase 4. On-Going Teaching and Research

Phase Four is my continuing teaching of Drawing/Writing, as well as the teaching of Drawing/Writing by a handful of others. Phase Four includes a deep interest in the generalizeability and larger usefulness of the ideas and methods presented in the study.

A change in educational approach may be necessary. Budget cut-backs are eliminating positions held by those who are called Special Education teachers whose responsibility is the students with special needs. It may be true that all students, at some time, have special needs. What if it were true that every student is "at risk" at some time? What if it were true that teachers may never be able to put their fingers on the exact time when any one student will be at risk for any one thing? What if, in particular, the road to writing is a potentially rocky one?

There is a self-directing, self-defining quality to the arts that allows students to express and to fulfill many of their own invisible needs. If, in addition, the arts provide accessible symbol systems that can be used to move children into less accessible symbol systems, like writing, or mathematics, then there is good reason to incorporate the arts with academics.

The regular classroom teacher has enormous challenges ahead. We can equip that teacher in a very simple, very effective way by making that teacher an applied or performing artist as well as an academic teacher. The approach such a teacher takes will work because combined art/academic activities appear to operate the way research suggests the brain works, spatially and linguistically. One model for this kind of activity, called Drawing/Writing, works. The ripples appear to be widening.

The following questions confront the research: Are drawing and writing connected skills? Does an activity that combines drawing with writing result in enhanced thinking and learning? If a combination of drawing and writing does develop mind, can it be used in the regular classroom? Specifically, does an activity called Drawing/Writing encourage the development of thinking skills expressed in writing? Does it do so across abilities? Is the effect statistically significant? Can the effect be better measured using descriptive case studies? May a combination of statistics and anecdotal observations provide the best evaluation of the data generated by this study?

A connected question concerns early education. How important is it? Is the combination of drawing and writing of particular importance at the elementary level? Might such a combination prove preventative or remedial in connection with potential attention and language-related learning problems?

The more general question is whether Drawing/Writing is a model for other kinds of combined, whole mind educational activities? Only the research of other teachers (by someone who dances and is a mathematician, for instance) will answer this larger question, just as longitudinal research must answer the questions of the preventative and remedial possibilities of art/academic teaching and learning.

1.4 Purposes of the Study

The study has five purposes: the first is to summarize and to report research pertaining to how the brain grows, including thirteen generalizations; the second is to describe educational tactics based on this research that are likely to facilitate the brain's neural development, suggesting four basic tactics; the third is to design a teaching and learning activity that is consistent with these tactics, suggesting an approach to writing that incorporates drawing; the fourth is to devise a study to test the effectiveness of the model activity called Drawing/Writing; the fifth is to evaluate the effectiveness of Drawing/Writing, to search out the implications of its effects, and to attempt to sketch out the bare bones of a curriculum appropriate to developing symbolic thinking skills in a broad range of elementary school children, including those with a variety of special needs, including difficulties with attention and with language.

The study suggests that the relationship between drawing and writing may be used in ways analogous to the relationship between the brain's two hemispheres, where information appears to be processed both spatially and linguistically in nearly indivisible ways. In addition, if drawing is introduced before writing in the classroom, and is recognized as an integral part of the linguistic continuum that includes speech and symbolic play, the relationship between drawing and writing will reflect not only the modus operandi of the brain, but the development of human brain activity, both phylogenetically and ontogenetically, in connection with information processing in general, and in connection with language in particular. It appears that spatial processing did and does precede and undergird linguistic processing.

The study rests on two general hypotheses: one hypothesis is that cross-modal activities will be appropriate to developing mind because they are like mind; the second hypothesis is that what works well for the dysfunctional or developmentally delayed mind will work as well or even better for the "normal" one.

The neurobiological research in Chapter 2 describes the cross-modal aspects of thought (Allport et al., 1985; Kosslyn, 1985; Minsky, 1985; Gazzaniga, 1985; Winograd and Flores, 1986), while the educational research suggests that what works well for children with learning problems will work even better for children who do not have them (Montessori, 1912; Vygotsky, 1978; Luria, 1979).

The study suggests that participating in the program, Drawing/Writing, may help children use the abstract symbol system called writing. Instead of thinking about writing as a transcription of oral language (which research suggests may not be how children first think about writing: Montessori, 1912; Vygotsky, 1978; Ferreiro, 1979; Scinto, 1986), it may be possible, in the context of an activity like Drawing/Writing, to think of writing as an abstract form of drawing. If children construct their own intermediate symbol system, as they do in Drawing/Writing, they may more easily make the jump to the deeper understanding that writing is a mark-making system that will come to stand for the thing itself as a first-order symbol, just the way drawing does. If children who are at risk for writing and reading problems think of writing as drawing, it may be able to build remediation into the educational process even before it is necessary.

In general, if children approach writing confident of their ability to think using drawing, they may have an easier, more significant, long-term relationship with writing.

1.5 Definition of Terms

Artificial Intelligence: the scientific study of the structure, and the process of intelligent behavior, using the computer as a model. Ideas central to this study are that intelligent behavior is experience-dependent, and experience-responsive; that it involves an information-processing, internal feedback system that relies on a complex system of independent, but interconnected subsystems; that intelligent behavior involves the kind of problem solving that uses multiple levels of modeling, including symbolic representations, in computational ways, in stored programs (McCorduck, 1979).

Computations are understood, by artificial intelligence, to be both digital and serial; and analog, or parallel, capable of interacting in a nonlinear way. This combination of processes means that intelligent thought is "both discreet and continuously variable" (McCulloch, in McCorduck, 1979, p. 75). Systems of intelligent behavior are understood to be, at first, undifferentiated, and then self-organizing. One characteristic of this kind of system is built-in redundancy (McCulloch, 1979). This kind of redundancy allows for small changes, for fine-tuning - for altered programs that do not necessitate the scrapping of an older, still functional program (Minsky, 1985). This same kind of structure and process appears to underlie redundancy, modularity, modification, and remediation in the brain (Changeux, 1985; Gazzaniga, 1985; Kosslyn, 1983, 1984, 1988 ; Geschwind, 1982).

Cross-modal:

"Cross-modal" or "cross-domain" will mean, in the context of these papers, the various ways in which the spatial and linguistic capabilities of the brain complement and cross-cue each other in intelligent problem

solving (Allport, 1985). Just as the nerve-rich strip of tissue called the corpus callosum connects the two hemispheres in the brain, so the various cognitive functions of the mind work in intimate connection. Attempts to pinpoint language, or creativity, or memory, are recognized as being less possible, less valid (Rosenfield, 1988). Brain research suggests that any kind of thinking is a global operation.

Constructivism: is an epistemology which, when applied to education, places its emphasis on the kind of learning that allows the child to construct knowledge. Its roots are in Piagetian theory. Constructivism assumes that the mind of the child is qualitatively different from that of older children and adults. Constructivism holds that the source of knowledge, intelligence, and morality lie in the action of the child. This child-action has the quality of being "spontaneous." The essential characteristics of this kind of spontaneous action are play, and experimentation (Devries & Kohlberg, 1987). Drawing/Writing appears to fall into the constructivist tradition. The child learns to learn through drawing and through writing that reflects on drawing. The child judges himself or herself, as a learner, and as a thinker, using drawing and writing.

Drawing/Writing: Drawing/Writing is one example of a cross-modal learning activity. It combines a (spatial) drawing process with a (linguistic) writing process, and it is designed to complement a regular classroom approach to the teaching of writing. Its goal is the effective communication of observational and reflective thought. While drawing does not serve as the handmaiden of writing in Drawing/Writing, but is regarded as a co-equal medium for self-expression, for reasons of practicality and expediency, it is so regarded in this study. In the final analysis, writing may drive thinking skills farther in more generally accessible, precisely communicable ways than drawing. Effective writing may be regarded as a truly legitimate goal in development of mind (Luria, 1979; Zinsser, 1988). Training in drawing appears to drive this development. The complete methodology of Drawing/Writing is found in Chapter 3.

In connection with the larger philosophy called "The Thinking Child" (described in the appendix), Drawing/Writing provides a model for a cross-modal activity.

Frames: "frames" is a term coined by researchers in artificial intelligence, notable among them Marvin Minsky. A frame, or a schema is a representation of knowledge (Minsky, 1985). It can be something like an image or a word. The activity called Drawing/Writing uses two kinds of frames, spatial ones or images, and linguistic ones, or words.

Infant Stimulation Programs: early sensory/motor enrichment programs for at-risk infants.

Holistic Method of Evaluation: a way of evaluating writing using a consensus based on quick, but trained conclusions about samples of writing. Criteria are established that are appropriate to the evaluation. Scores from highest to lowest are established by the sample itself.

Intelligence: for the purposes of these papers, intelligence will be defined as the kind of human problem solving skills that demand focussed, sustained attention, deliberate recall, and logical thought. These abilities are the basis for higher psychological processes, including language (Luria, 1979). This kind of intelligence uses accurate, comprehensive observations to make valid inferences, and to hypothesize and to predict effectively (Perkins, 1981).

Drawing/Writing appears to provide a way to develop, and to appreciate this kind of intelligence in a range of children with differing abilities and skills, including those with language and attentional problems. Drawing/Writing may provide a way not only to develop, but to formally assess these problem solving skills.

Intertheoretic Integration: the combining of two or more theories for the sake of focussing upon useful information or understandings held in common. An intertheoretic integration uses one or more theories to explain, to enrich, and to modify, to change, or to replace another theory (Churchland, 1986). In this paper, information from neurobiology, and from artificial intelligence impact education. Research in neuroscience and in artificial intelligence may allow us to build upon educational theories and practice of exploratory learning, focussing and defining the character of the optimum exploratory, learning experience as cross-modal.

Mind/Brain: neurobiology suggests that the mind and the brain are at least intimately connected, if not indivisible (Churchland, 1986). Although we may not be able to, nor want to reduce mind to brain, it is still practical to approach the mind as brain, particularly in this study. Learning how the brain appears to learn to learn is of great practical importance to education. As Churchland writes, "We want a unified theory of how the mind-brain works...how the brain represents, learns, and produces behavior" (1986, p.5-6). By joining the words "mind" and "brain" by a slash, mind/brain, a relationship of intimate if not indivisible connection is made. The same relationship holds true for the cross-modal activities like Drawing/Writing described and supported in this paper. The conviction is that, for all practical intents and purposes, just as the mind and the brain are in some ways "one," so the activities of drawing and of writing are part of an integrated development having to do with language. In the first case, the two words describe the organ and the constellation of cooperative agencies that do the thinking. In the second, the two words describe two closely related systems for one of the activities that distinguish human thought, mark-making of significance.

Neural Drift: remediation occasioned in the brain when one functional area extends its influence to another, less functional, or entirely dysfunctional area.

Non-pharmacological approach: an approach to the remediation of learning problems that does not involve drugs. The arts may provide a natural way to "normalize" certain aspects of neurochemistry having to do with attention, motivation, and cognition. This process of normalization may have a self-regulatory aspect. In

other words, using the arts in connection with academics, a child may learn how to focus, attend, examine, conclude, and express. The child may learn how to initiate and to sustain, and to regulate attention.

Referred Child: is a general appellation used in this study for any child who is sent out of the classroom for special services for any reason. In this study, the phrase "children who have been referred to the resource room" will serve to identify all children whom the teachers have selected to leave the room for special attention, of any kind, in both schools. Thus, the operational definition of "attention deficit," or of "learning disabled" will be subsumed under the description "referred children."

One of the intents of this study is to discover whether an activity like Drawing/Writing can serve, in the regular classroom, as a "special needs" activity that is appropriate to a wide variety of children, from those who are called talented and gifted, to those who are described as "special needs" children.

Scripts: an all-purpose procedure; a term from artificial intelligence. Minsky describes a script as "a sequence of actions produced so automatically that it can be performed without disturbing the activities of many other agencies....A script-based skill tends to be inflexible" (Minsky, 1985, p. 331). Drawing/Writing provides an all-purpose procedure for gaining knowledge. Its discrete steps are meant to be internalized, no longer necessary in the mature thinker who works with images and words. By suggesting that a thorough knowledge of the givens should proceed and will determine the validity and quality of the conclusions, Drawing/Writing provides a syntax or order, for intelligent thought. Drawing/Writing is meant to provide flexible "script-based skills."

Sensitive Periods: a window of time when the developing brain is especially susceptible to certain kinds of growth; after this time, the growth that was potential will not occur. It appears that for many activities, excepting learning, the plasticity of the brain for growth has time-determined parameters. Changeux writes, "They (synapses) proliferate in successive ways from birth to puberty in man. With each wave, there is transient redundancy and selective stabilization. This causes a series of critical periods when activity exercises a regulatory effect... To learn is to stabilize preestablished synaptic combinations, and to ELIMINATE surplus" (Changeux, 1985, p. 248-249). The word "sensitive" extends the time-frame suggested by the phrase "critical period," and may be more appropriate to describe the way in which the central nervous system develops (Greenough, 1986).

The Thinking Child: is a philosophy and theory of education presented in Chapter 5 of the study. The Thinking Child supports the idea that cross-modal learning activities are appropriate to the development of mind because they are "like" mind. Chapter 2 provides combined neurobiological/educational research supporting the feasibility of what could be called a "neuro-constructivist" approach to education. The Thinking Child rests on this new theory called neuro-constructivism.

Whole Mind; is a term used to describe a complex, combined spatial/linguistic, interhemispheric teaching and learning activity. Because the place of the "the arts" in education is controversial, and because the word "interhemispheric" may appear too technical, the word "whole mind" is used to suggest the kind of learning activities appropriate to an increasingly popular concern, the whole child.

1.6 Significance

The study is significant because it addresses the problem of dissociated learning, especially in connection with writing. The study addresses this problem by constructing a theory, by designing a practical program, and by testing the program. The research suggests that cross-modal teaching and learning activities, involving exercises in the deliberate transfer of meaning will be effective at connecting children with thinking because they model ways in which mind appears to process information. Not only in theory, but in practice, a complex or combined thinking activity, like Drawing/Writing, appears to allow a broad range of students to explore fundamental aspects of learning, while encouraging and constraining teachers to explore fundamental aspects of teaching. It is possible, on the strength of the theoretical and empirical research in this study, to propose a model teaching and learning activity, as well as guidelines for an integrated approach to education that will be both more appropriate and therefore more effective for the growing mind.

There are six conclusions that can be distilled from the combined neurobiological and educational research. These six understandings are incorporated in the activity Drawing/Writing, and they provide guidelines for curriculum design. These conclusions are:

The first is that intelligence is dynamic. It changes over time. Intelligence is developable and retardable (Bloom et al., 1985; Changeux, 1985; Goelieb, 1978; Harwerth et al., 1986; Haskins et al., 1978; Ottenbacher et al., 1987; Levine et al., 1977; Read, 1956; Freeman & Cox, 1985; Pauls, 1988). Beyond the contribution of genetics, experience affects intelligent behavior. Experience, particularly early experience, can affect intelligence in irreversible ways. Children undergo a series of sensitive periods for neurobiological development. The way experience affects the visual system, for instance, becomes permanent (Hubel & Weisel, 1962; Weisel, 1982), and may have far-ranging effects for thought in general.

It appears that the richer, that is, the more appropriately natural the learning environment is, the better the brain will be (Rosenzweig & Bennett, 1978). "Better" relates to quality and quantity in neural connectivity (Changeux, 1985). "Better" is the result of interactive, non-invasive, positively affective, appropriate problem-solving activities (Rosenzweig & Bennett, 1978; Diamond, 1988; Huttenlocher, 1988; Piaget, 1960, 1962; Papert, 1980; Perkins, 1981, 1984; Weir, 1976, 1980, 1981, 1982; Brigham, 1974; Holt, 1967; Howard, 1971; Kegan, 1982; Kemp, 1987; Zinsler, 1988). Brain development and experience are connected. Each impacts the other.

The brain is plastic for a lifetime of learning (Rosenzweig & Bennett, 1978). But the plasticity of the brain for most other neural patterns is confined to various windows of time (Changeux, 1985; Harwerth et al., 1986; Mistretta & Bradley, 1984;). Since how we think depends upon how our brain is organized, early

patterns of thought are important to later capabilities (Ottenbacher et al., 1987; Shonkoff & Hauser-Cram, 1987; Snider & Tarver, 1987). For students and for teachers this means that the quality of elementary education is critical. This also means that throughout the educational experience each student's ability to think will change, often in indefinable ways. There may be no invariant stages in cognitive development.

A second understanding, related to the first, is that the ways in which we try to test for intelligence are largely inappropriate (Feuerstein, 1981; Chance, 1981; Maloney & Ward, 1976; Perkins, 1981). What may be useful is a test that can measure the ability to learn, over time, in ways that are both verbal, and non-verbal. A method that uses a test-teach-test approach (Feuerstein, 1981), and which allows for a demonstration of spatial, as well as linguistic intelligence, may reveal thinking abilities in ways that students themselves, as well as teachers will find useful. Drawing/Writing provides a spatial/linguistic, test-teach-test approach to intelligence. One of the most useful aspects of this approach is that growth is evident to the child. The child is easily able to judge his or her ability to learn to draw. The ability to learn to think in writing can be judged, with time, by the child, once the child knows what to look for, in connection with the quantity, variety, and depth of factual information, and in connection with the quantity, variety, and depth of inferential thought expressed in simlies, metaphors, analogies, hypotheses. The teacher, on the other hand, is given two different ways to evaluate intelligent behavior. Being able to see how well a student draws may help a teacher to work better with a student who is a poor writer.

A third concept embedded in the study is an understanding of the approximate nature of any symbol system (Hofstadter, 1980). Children who engage in Drawing/Writing learn that there is more than one way to think about things, and that several ways of thinking may be combined to produce a more complete and satisfactory understanding. Children understand that marks make knowledge permanent. Marks are visible memory. Children can look at their drawings, using drawing as a multi-sensory notation system for a variety of pieces of non-verbal information, and then tag all of this information with language. Once the information is tagged, it can be elaborated. Children learn to move from one symbol system to another, in increasing orders of abstraction. Drawing and writing can be used in interconnected ways to learn and to teach across the curriculum.

The fourth understanding is that learning and teaching should be interdisciplinary (Hofstadter, 1980). Learning should combine several approaches. Relationships create meaning. Neurobiology suggests that, in addition, information that is stored in more than one way, is remembered more strongly, and is more broadly accessible (Allport, 1985; Changeux, 1985; Hellerstein, 1988; Johnson, 1988). Teachers should be interdisciplinary in outlook, and students should learn to think across domains (Garvin, 1987).

The fifth concept important to the study is that the basis for abstract thinking about ideas is a thorough concrete understanding of things (Piaget, 1960, 1962). Drawing/Writing is training in concrete understandings that are pushed, at every juncture and level, into increasingly abstract metaphorical, or hypothetical thought. Children progress as they are able to, through these levels. Teachers must sit back, and let them. Children's mark-making drives their thinking processes. Their own connections make possible further connections, on a neural level, as well as on an intellectual level.

The sixth concept important to the study is that students need to learn to be involved observers. Theories from math and physics about relativity and quantum mechanics (Zukav, 1979; Hawking, 1988) suggest that the observer has something to do with the event. The observer may even determine the event. Theories from math and physics about chaos and turbulence and dynamic systems (Gleick, 1987; Mandelbrot; 1977) suggests that there are patterns of order common to many, or even all systems. As an active, involved observer, the student must not only learn to make, but to discover meaning. Teachers must also learn to become active observers. They must encourage learning to take place, without imposing it.

1.7 Methodology

The design of the study is a pre-test, post-test, follow-up test quasi-experimental/control group design, with multiple treatments and multiple subjects in self-contained classrooms in two elementary schools. The study took place in western Massachusetts in the spring of the year, 1989.

The study attempts four levels of comparative analysis: experimental with control school; males with females; regular students with special needs students; the individual child's pre-test performance with that same child's post- and follow-up test performances.

The treatment is an activity called Drawing/Writing. Each of the grades K, 3, 4, 5 & 6 in the experimental school participated in a week of Drawing/Writing, one hour and one-half per day. Two teachers were trained by the researcher to teach Drawing/Writing in classrooms other than their own in an attempt to factor out researcher effect; the 4th and the 5th grade teachers returned to their homerooms to teach Drawing/Writing. Corresponding grades in the control school received pre-, post- and follow-up tests in drawing and in writing. The subjects for drawing and writing were an assortment of objects, two of the four Seasons, and two prints by the woodcut artist, MC Escher.

The pre- and post- and follow-up tests in both the experimental and control schools produced approximately 2,000 pieces of data in the form of drawings and writing. These data were evaluated by a method called an holistic evaluation carried out by a group of 10 adults, and by a method designed by the researcher called Rescore, carried out by the researcher. Twelve descriptive case studies were also undertaken. The intent of the statistical analyses and of the case studies was to try to determine to what extent the activity Drawing/Writing affected descriptive, analytical and inferential thinking skills expressed in writing in a broad range of children in the regular elementary school classroom.

1.8 Limitations

There was no control situation providing an alternate method of teaching writing. This is the critically limiting aspect of the study. By using Drawing/Writing as the treatment in the experimental school, and by using writing and drawing as forms of testing in the control school, drawing had a possible treatment-like effect on writing in the control school.

As the study was designed and conducted, both the use of drawing in both schools, and the decision (see below) to coach the follow-up test in both schools may have limited the study.

Non-Random Designation of Control and Experimental:The decision concerning which of the two schools was to be control and which was to be experimental was not a random decision, but was dictated by circumstance. The researcher had done a pilot study in an elementary school system system, and one of the three schools was very receptive to being the experimental school.

A coached pre-test that was not supposed to be coached: The teacher who was trained in the sixth grade, and who returned to the fifth to teach Drawing/Writing in his own homeroom, coached the pre-test heavily. The pre-test in all other classes was given without embellishment. The children were asked to draw their object and to write about it in any way they chose. The teacher gave no suggestions. The intent of this non-coached pre-test was to try to determine the initial level of drawing, writing, and thinking skills of the children. The researcher/master teacher/observer did not remonstrate with this "illegal" coaching. Part of the intent in my teaching Drawing/Writing to any teacher is that the teacher make the process his own. He was doing just that and made good suggestions on how to use Drawing/Writing in specific ways to increase language use. Because of this teacher's influence, the final follow-up test in this study made use of a heavily coached approach, in line with a theory and practice of evaluating intelligence called the test/teach/test approach (Feuerstein, 1981).

Possible confusion of variables in follow-up study: Because the follow-up test involved two variables, a new object, and coaching, the effect on drawing or writing cannot be attributed solely to the new object, nor to the coaching. The solution to the anomaly is that the two variables be understood as one; that is, novelty is an important component of attention (as will be made clear in the section on neurobiological research in Chapter II), and what is called a mediated learning experience is also important to learning. A new object provides novelty, and coaching provides mediation. It simply seems neither prudent, nor reasonable to expect young students to know how to look carefully, and how to move into reflective thought, if they are not given the skills and strategies to do both. In this case, the experimental group was given a week of participation in the skills and strategies of observation and reflection, plus a final coaching session, and the control students recieved, at least, one high-energy, directed coaching session in connection with the final, follow-up test. This approach may make statistics hard to interpret, but it was important to this researcher.

Possible researcher influence: the researcher taught Drawing/Writing in the third, and in the sixth grades at the experimental school, combining teacher-training with student learning. The researcher conducted all of the pre- and post-testing at the control school. The fourth and fifth grade teachers taught Drawing/Writing in their own classrooms, personalizing the treatment to their individual situation, minimizing the effect of the researcher's modeling. In the final post-testing with the follow-up study, all of the respective homeroom teachers tested, and coached their students, except in sixth grade in the control school, where the teacher was sick, and the researcher did it. The students had a substitute that day, and, as is usual, were not as focussed or attentive without their regular homeroom teacher. Hopefully, the inevitable use of the researcher to teach

teachers in classrooms other than their own will allow a comparison between researcher and homeroom teacher effect, with homeroom teacher effect being greater.

Possible problems with differing abilities at different times of day during testing: In the control school, the testing was done in the morning, and in the experimental school the testing and teaching were in the afternoon. It is hoped that the study favored the fresher control students, if it favored any students.

Possible problems with slight maturational differences: Students in the same classrooms in the two schools were generally tested on the same days, minimizing the effect of maturation on the final results. In some cases, as when the 5th grade in the experimental school was post-tested two days later than the control group, exact correspondance of testing dates could not be maintained. For the follow-up study, control students were tested 2 to 3 days later, again, hopefully, being older, if anything. This difference allowed the researcher to make sure the control school teacher could be advised on a coaching method that matched that of the observed coaching in the experimental school.

Possible problems with differing lengths of treatment periods: Because of weather, some of the teaching sessions were a day shorter in the experimental school than the planned six days.

Possible problems with inter-rater validity: Three people in the holistic evaluation group dropped out after the first session, and three new people joined. The researcher in no way entered into the evaluation process except to set criteria. In connection with the Rescore method of evaluation, the researcher conducted this evaluation alone, but she was spot-checked for accuracy in counting words, and in identifying parts of speech, and in determining grammatical constructions.

Possible problems with inter-rater invalidity in connection with evaluating drawings: Only one member of the evaluation committee was an artist. The judges tended to over-rate the drawings in the estimation of this researcher, inflating pre-test drawings. Because the presentation of all drawings was random, the evaluators could not see the often appreciable differences between pre- and post- test drawings in the experimental group.

1.9 Delimitations

This study will not attempt to compare, or to define specific special needs groups in connection with the possible effect of Drawing/Writing on attention, emotion, or language skills. The study will simply attempt to evaluate changes in thinking skills expressed in writing in a population of elementary students of varying abilities, including those students who are sent out of the regular classroom for special services.

Anecdotes and case descriptions may suggest, however, that the loosely defined special needs, or "referred children" benefit in special ways in connection with the regular classroom use of an activity like Drawing/Writing.

1.10 Summary of the Chapters

Chapter 2 reviews the literature in neurobiology and in education, and includes pertinent asides from artificial intelligence that support a multi-sensory, cross-modal, interactive, exploratory, developmental, open-ended, problem-solving, spatial and linguistic approach to learning. As these aspects are discovered to be incorporated in Drawing/Writing, they underscore its theoretical validity, in and of itself, and they make it possible to propose Drawing/Writing as a model for other learning activities that are appropriate to mind because they work in ways that mirror the mind.

Chapter 3 describes the process of Drawing/Writing and discusses the methodology and the process of the study that was designed to evaluate the effect of Drawing/Writing on thinking skills expressed in writing. The holistic method of evaluation is described, along with an alternative, finer-grained approach to evaluating written language designed by this researcher called Rescore.

Chapter 4 contains the results of the study, in multi-and univariate statistical analyses of both the holistic and the Rescore methods of evaluation, along with a set of descriptive case studies.

Chapter 5 discusses the results of the study in relation to the major hypothesis - that training in drawing in connection with writing affects analytical and inferential thinking skills - and in connection with several subsidiary hypotheses. Chapter 5 recommends further research into the educational usefulness of cross-modal activities in general, and of Drawing/Writing in particular and suggests the guidelines for a new theory and practice of education called The Thinking Child. The term coined within the study for this new integrated approach is neuro-constructivism.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction: Attention, Memory, Language

The higher human psychological operations involve attention, memory, and logical operations (Luria, 1979). The acquisition of language plays a decisive role in the development of these processes (Vygotsky in Luria, 1979). A search of the literature in neurobiology and in education allows a comparison between descriptions of these processes. An integration of these descriptions provides the sketch of an educational program and of a model activity appropriate to developing attention, memory, and logical operations. After describing a writing activity consistent with the program, it should be possible to devise a study to see whether the activity is effective. There may be a more "natural" way for children to learn to write. The research suggests that a developmentally appropriate approach to teaching writing would intentionally reflect brain processes and would include drawing.

The world understands the brain by using a variety of systems of comparison (Hofstadter, 1979), using cross-modal processes (Allport, 1984) that are either spatial or linguistic in the most general sense (Kosslyn, 1984; Gazzaniga, 1985). It appears that spatial understanding precedes and underlies linguistic understanding (Llinas in Churchland, 1986; Churchland, 1986).

Parallel research in neurobiology and in education reveals common understandings about the importance of cross-modal or multi-sensory experience to development of mind, particularly in the young. Both fields share a common interest in the development of symbol systems, including language, and both suggest that attention and action play decisive roles in the construction of these symbol systems. Both fields of research suggest that a distinction between non-linguistic modes and linguistic modes of symbolic expression may not be meaningful (Llinas in Churchland, 1986; Kosslyn, 1984; Wolf, 1988). This common understanding is important to a study that focusses on the interrelationship of drawing and writing. An appreciation for the interdependence and possible equivalency of the languages of the mind might be the hallmark of an educational approach consistent with neurobiology.

An epistemology called constructivism (Piaget, 1948/1973; Devries, 1987) has much in common with neurobiological understandings about learning. Both neurobiological research and constructivism agree that the child constructs knowledge through experience, within certain genetic parameters (Changeux, 1985; Piaget, 1955/1959, 1960). Both neurobiologists and educators conclude that the construction of knowledge involves attention, memory, and logical operations, as these processes develop within the context of language (Vygotsky, 1978; Ferreiro & Teberosky, 1979). Both neurobiologists and educators agree that writing drives these higher cortical operations (Luria, 1979; Zinsser, 1988). Finally, both researchers in both fields accept the

fact that drawing and writing are part of a linguistic continuum (Luria, 1979; Vygotsky, 1978; Montessori, 1912/1964; Piaget, 1960; Ferreiro, 1979; Scinto, 1986).

2.2 Research in Neurobiology

Research in neurobiology provides guidelines for effective learning activities. These guidelines suggest that vision and attention are intimately related processes; that the quality of early exploratory, interactive experience is critical to later capabilities; that multi-sensory or cross-modal storage of information results in stronger, more broadly retrievable "memories" or learning; that language is a higher-order organizational system in a hierarchy of brain operations. The kind of problem-solving that is challenging but not invasive affects attention, motivation and logical operations and registers at a neural level in the visual cortex, whether the problem-solving has been strictly visual or not (Rosenzweig & Bennett, 1984). Outer and inner searches of interest that are "visual" in the most general sense affect both attention and motivation. The impact of motivation on the central nervous system is both neural and biochemical, affecting higher-level hierarchies of organization, particularly within the limbic system (which has to do with emotions), and within the reticular activating system (which has to do with attention) (Rosenzweig & Bennett, 1984; Changeux, 1985; Gazzaniga, 1985, 1987). Vision, attention, problem-solving, learning, memory, and logical operations are processes and phenomena that describe a neurobiological processing loop. They are highly integrated. Each process impacts the others.

Because memory depends on an effective associative system, it is important to understand the existence of critical or sensitive periods for the development of the brain's neural connection system. Enriching experience affects connectivity. Brain tissue of an enriched animal differs from that of an impoverished animal (Rosenzweig & Bennett, 1984; Marg, 1982). Early experience that qualifies as "enrichment" is a useful concept. Enrichment in a laboratory setting is understood to barely approximate the richness of the natural learning environment (Rosenzweig & Bennett, 1984). The question for educators is what a "natural" learning environment for children might be that could be duplicated in the unnatural world of the classroom, providing opportunities for authentic learning.

The research suggests that enrichment should not be peripheral to education, but that it should be built into education, particularly early education.

Neurobiology contributes to an understanding of what a natural learning environment for children might be by addressing the issues of attention, memory, logical operations and the acquisition of language. In connection with this understanding, the following topics will be explored: cross-modality, sensitive periods, vision and attention, mental representations, hemisphericity. The neurobiological research closes with thirteen recommendations for educators, highlighting four major tactics. Speculations on the active nature of the corpus callosum, which are pertinent to education, are offered.

2.2.1. The Brain as a Cross-Modal Connection System

The central nervous system (the brain and the spinal cord), is characterized by dense interconnection and multi-level cooperation in its gross structure (Gazzaniga, 1985). It is characterized by individuality in its fine structure (Changeux, 1985). It is, in general, cross-modal in its information processing and in its design (Allport et al, 1985; Llinas in Churchland, 1986; Kosslyn, 1983, 1984, 1988). Whether or not the mind and the brain are one, how the brain functions determines what is going on in our minds.

Neurobiology describes the brain as a connection system that compares, translates, and transforms information. It is a transformation system. It works from a spatial understanding of things in the world to what is, ultimately, in man, a symbolic understanding of what the world is, and of what the world means. The move is from a coordinate to a categorical system, from the "where is it?" to the "what is it?" mode of processing information (Llinas, 1982, 1985, 1987; Kosslyn, 1983, 1984, 1988).

The brain takes one kind of stimulus (for instance, in the case of vision, the stimulus is electro-magnetic energy) and turns this stimulus into the electro-chemical energy that the rest of the brain can use. The fundamental character of thought is that it is cross-modal at the instant information from the world enters the brain. Any kind of brain activity, any level of thought depends upon the kind of translation that neurobiologists call transduction (Bloom et al., 1985), when one form of energy is converted into another. This act of transduction is achieved by specific receptor cells located in our sensory organs (Carpenter et al., 1983; Changeux, 1985; Bloom et al., 1985). In the case of vision, the transduction cells are located in the retina, the light-sensitive sheet of cells at the back of the eye.

As the brain grows, it becomes increasingly interconnected. The functional unit of the brain is the neuron. We are born with a certain number of these neurons - about ten to the eleventh power. Each neuron grows an axon. The axon grows dendrites or branches. Sites for receiving and for sending information grow on these branches, and are called synapses. The synapse is where the translation, and the connection occurs. It is where one dendrite communicates with another, through chemical interaction. Chemicals released by the pre-synaptic vesicles fall into the post-synaptic space, hitting or missing receptor sites. The message that was electrical and which has become chemical is passed along, or not. A synapse can be excitatory or inhibitory.

Strong memories and effective learning have to do with something called "long-term potentiation." This quality characterizes a powerful synapse. If several senses are used to store information, if spatial and linguistic considerations come into play in the storage of information, if the thing stored has ideas attached to it, or if the idea stored is accompanied by so much information that the idea is as real as a thing to that mind, then the activity at the synapse is heightened, neurochemically, and there is what is called long-term potentiation (Johnson, 1988; Carpenter & Suttin, 1976). This kind of sustained electro-chemical phenomenon is thought to be responsible for effective learning, and for memory (Johnson, 1988; Changeux, 1985) . Effective learning, and memory mean that the information stored is readily accessible, in a variety of ways.

The way that dendrites connect, and the level, kind, and strength of electro-chemical activity at the synapse determines the kind of thinking that goes on in a brain. After a certain point, more is not better. Just

before a new skill is achieved, an "exuberant" growth of synapses is followed by a functional pruning (Huttenlocher & Courten, 1987). Pathways pruned by complex problem solving (Bennett & Rosenzweig, 1978), which exhibit strong synaptic connections, result from multi-modal information processing (Johnson, 1988). These kinds of pathways result in learning, or memory, that is flexible, readily retrievable, and long-term (Johnson, 1988; Changeux, 1985).

Because the brain is both columnar and laminar, that is, because the brain is set up in columns, and in sheets of columns, the communication between neurons, and between groups of neurons is not just hierarchical, is not just serial, but is parallel (Bloom et al., 1985; Changeux, 1985; Diamond, 1985; Gazzaniga, 1985; Van Essen et al., 1983). Neural events happen between and across systems of thought, because of "precision wiring, and association nets" (Crick, 1984).

The parallel nature of human thought means not only that two things are going on at once, but that the two things going on at once affect other operations. The degree to which the concurrence of neural events results in effective problem solving behavior affects intelligence (Rosenzweig & Bennett, 1984).

Animal research suggests that the kind of activity that makes a difference in the density of dendrites and of synapses has to do with exploratory problem solving. Increasing the complexity of the problems appears to make animals more efficient at problem solving (Rosenzweig & Bennett, 1975).

Ideas of control are important in these animal studies that focus on problem solving (Rosenzweig & Bennett, 1978; Gottlieb, 1978; Harwerth et al., 1986; Huttenlocher & Courten, 1987; Van Essen et al., 1983). The novelty of a shock, say, to the feet of rats, is not the kind of novelty that occasions neural growth. The shock may present a novel problem to the rats, but it is not one the rats can solve. The rat needs a sense of control to exhibit brain growth. Psychology and education have found that the element of control is critical to effective human problem solving, too (Piaget, 1960, 62; Papert, 1980; Kegan, 1982; Denkla, 1987; Coleman, 1988).

Beyond the intrinsic nature of multi-sensory cross-modality in animal thinking, the human adds the additional domain of language. It is possible to conclude from the animal research studies that the child who engages in spatial problem solving of an exploratory non-invasive nature will become an increasingly powerful thinker by influencing the density, weight, and thus the effectiveness of his thinking skills on a neural level.

For the purposes of this study, the terms "cross-modal," or "cross-domain" will mean the ways in which different kinds of thinking are combined in intelligent problem solving (Allport, 1985). The words "right-hemisphere" or "left-hemisphere" will not be used to describe any particular problem solving approach. The more general words "spatial" and "linguistic" will be used instead. The attempt to localize cognitive functions is understood to be less and less possible, or useful (Rosenfield, 1988). However, it does appear that the mind processes information developmentally, and continuingly in two more or less distinct ways (Changeux, 1985; Llinas, 1986; Kosslyn et al., 1984).

The words "cross-modal," or "cross-domain" will mean three things in the context of this study:

1) The words "cross-modal" will mean "multi-sensory," and will suggest that intelligent problem solving combines the ways in which the senses interact to process information. This kind of cross-modal thought is intrinsic to all organisms with sensory systems (Bloom et al., 1985; Changeux, 1985). Cross-modal thought, as multi-sensory processing, happens in the course of adaptive experience, in an intact sensori-motor system.

2) Second, the terms "cross-modal," or "cross-domain" will mean that intelligent problem solving in humans is inter- hemispheric. In the intact human central nervous system, or brain, thinking involves both hemispheres. In the most general terms, two somewhat distinct processes appear to cooperate in intelligent human thought. These processes are spatial, and they are linguistic in character (Kosslyn, 1985, 1987; Gazzaniga, 1985, 1987 ; Changeux, 1985 ; Llinas, 1987; Fox, 1988; Levy, 1985; Gooch, 1980). It appears in the most general sense that these processes or capabilities become lateralized, or specialized, in one hemisphere, or the other for the sake of maximum information processing efficiency, including fine-tuning in action, and in thought (Geschwind, 1982; Galaburda, 1987; Kosslyn, 1983, 1984, 1988; Gazzaniga, 1985, 1987; Levy, 1985; Gooch, 1980; Fox, 1988).

Current research (Fox, 1988) suggests that the hemispheres (just like the neuronal system, which exists initially in an undifferentiated state), are equipotential. Either hemisphere may assume any capability. The spheres compete (Fox, 1988) to synapse on neurons in the neural-rich tissue that connects them. The left hemisphere most commonly becomes the hemisphere associated with language, and the right hemisphere becomes most commonly associated with spatial tasks.

Each hemisphere suppresses the other for the general ability it assumes, for the sake of delegation of tasks, and to maximize the capability of the brain for specialized, fine-tuned operations.

Multiple brain scans of the same individual can now be averaged, and combined with large numbers of other averaged individual scans, by using a tracer chemical called oxygen 15 (Fox, 1988). These average scans show that a language task reveals metabolic activity in BOTH hemispheres, and that an exceedingly fine motor task done with the right hand will light up that area on the left known as Broca's area (Fox, 1988). This area has been accepted since the 1860's as the area exclusively used for the motoric aspects of language. Because of current computer- imaged findings, it is prudent to avoid localizing functions, and to speak in general terms about capabilities of thought, keeping firmly in mind that these capabilities are interrelated, and that each involves what are probably globally distributed areas of influence and contribution.

Cross-modal, spatial/linguistic thought is intrinsic to the human mind. Research suggest that this intrinsic spatial/linguistic cross-modal character of thought may be used in extrinsic, deliberate ways to consciously develop intelligence, as problem solving skills, through an increasingly deep and broad use of language, driven by rigorous spatial exploration.

3) Third, the word "cross-modal" means that intelligent human thought is both concrete and abstract in nature. As problem solving skills develop, the intelligent human mind thinks about things and

ideas in the same ways (Minsky, 1988). Doing something to a thing, having an idea about a thing, and having an idea about an idea become so integrated in effective abstract problem solving, that making a distinction between these ways of thinking in the effective problem solver becomes meaningless, or irrelevant (Minsky, 1985; Howard, 1971; Wolf et al., 1988; Kosslyn, 1985, 1987 ; Gazzaniga, 1985, 1987; LLinas, 1987).

In connection with cross-modality, the "cross-domain cue" is responsible for "linking or integrating codes across different domains of representation....(these cues may) be critical...in the construction of an integrated perceptual description, on which selection for action (and perhaps phenomenal awareness) is based...(there may be) cross-domain selective cueing between 'physical' and 'categorical' (or semantic) attribute domains" (Allport et al., 1985, p. 110).

It appears that the brain needs cues to create an image, or to come up with an idea. The cues trigger the combination of several modes of representation. Language appears to be one of these high-level combinations that provides both the means to store information, and the means to cue the retrieval, and re-combination of complex stimuli (Kosslyn, 1985). Vision and attention cue cross-modal operations, including language.

One kind of cross-domain thinking that artificial intelligence discusses in connection with language is called "consensual" (Winograd & Flores, 1986) Language is the behavioral outcome of "recursively interacting structurally plastic systems" (Winograd & Flores, 1987, p. 48). Winograd and Flores describe the interaction between two human organisms. The two humans are "plastic," capable of adaptation and change. The interaction that goes back and forth between them occasions language. It is possible to make the jump that the cross-modal systems of thought that exist between the two humans are like the ones that exist between the two hemispheres of the brain, creating "cooperative domains of interaction" (Winograd & Flores, 1987, p. 50). The character of individual human thought is deeply interactive and recursive, self-referential, and self-reflective. This cooperative action, this society of mind (Minsky, 1985; Gazzaniga, 1985) makes intelligent problem solving possible. Cross-modal thought, including language, creates, or more properly is a consensual domain

2.2.2. Sensitive Periods and the Uses of Immaturity

The advantages and implications of the immature brain as a connection system include lifelong plasticity for one thing-learning (Rosenzweig & Bennett, 1984). Otherwise there are what are called "critical" or "sensitive" periods for neural growth (Hubel & Weisel, 1962; Marg, 1982; Weisel, 1982; Bloom et al., 1985; Changeux, 1985; Galaburda et al., 1987; Greenough, 1986; Harwerth et al., 1986) when connection systems stabilize for a lifetime. The way in which the brain matures has educational implications.

Morphological change, going from a less dense to a more dense state appears similar enough between the brains of animals and humans to provide a useful conceptual model (Marg, 1982). Animal studies suggest

that there are critical periods for stabilizing sensory systems. Just as with young animals' brains, early experience plays an important part in shaping human minds.

There are early critical periods for stabilizing sensory systems. In the case of human vision, wiring is completed by the end of the elementary school years (Changeux, 1985; Harwerth et al., 1986; Hickey, 1977; Rosenzweig & Bennett, 1978; Huttenlocher & Courten, 1987). There are implications for these time-tables; sensory experience in infancy and in early childhood matters. Some of the effects are reversible, and some are not (Changeux, 1985; Weisel, 1982) . Timing appears to be important (Changeux, 1985; Huttenlocher & Courten, 1987). All experience impacts the child's brain. Some experiences, if they occur at certain sensitive times, may have more impact than others (Changeux, 1985; Marg, 1982; Van Essen & Maunsell, 1983). Early childhood and the elementary school years appear to be times when the ways in which children learn how to learn, especially visually, determines later structures and processes of mind.

When the eyes of cats and monkeys are sutured shut, the retinal tissue fails to compete for, and to stake out, neural territory. These changes are irreversible after the critical period of growth has stabilized (Thor & Weisel, 1977; Goldman Rakic, 1981; Changeux, 1985). Children born with congenital cataracts become functionally blind in the same way (Changeux, 1985). Depending upon timing, deprivation can have lifelong effects.

When kittens are raised, immobile, in a visually stimulating environment, they never learn to ambulate normally. Not only visual stimulation, but active exploration of the environment is critical to normal sensory-motor development. We can extrapolate that exploratory learning for humans, too, leads to development of mind.

When a monkey's finger is amputated, that part of the representation of the monkey's body in the sensory motor cortex does not become a dead zone, but extends its influence, by a process called neural drift, to the other intact fingers (Merzeniach & Kaas, in Changeux, 1985) . Neural drift has implications not only for adaptation, but for preservation of function. When faced with dysfunction, the brain can patch in other functional areas.

Observation of animal brain tissue shows that early enrichment, in the form of interactive, non-invasive problem solving, results in increased dendritic and synaptic connectivity. This kind of change is the result of better learning, and it results in better learning (Rosenzweig & Bennett). Using the animal model, it is possible to extrapolate the same conditions for the human mind. The child needs sensory stimulation and opportunities to problem-solve in increasingly complex, exploratory ways to take advantage of the cross-modal mental processes available to her.

2.2.3. Vision, Attention, Memory and Learning

2.2.3.1. Vision

Working with cats, Thor and Weisel isolated retinal cells that fire for lines, edges, contrasts (1982). At the neural level, contrast gets attention.

William Calvin, the anthropological neurobiologist and story-teller, writes, " Individual nerve cells in the visual pathways (are) specialists in contrasting light and dark. They're most involved when something changes, either a light patch becoming dark or vice versa. For a cell to show sustained interest in what's going on, there may have to be a dark area adjacent to a light area... Contrast in time, or contrast in space: without one or the other, a cell may pay little attention to the visual world" (Calvin, 1986, p. 159).

Calvin provides a complex understanding of "specialist nerve cells" (1986, p.159) that fire for contrast on a variety of cognitive levels . He also provides a broad understanding of the human attentional mechanism. Humans are attuned to contrasts in time, and contrasts in space.

As primates, men are visual learners. As much as a third of human information processing capability deals with visual information (Bloom et al., 1985) For human beings, there is an intimate connection between vision and learning. There is a visual-attentional-learning loop.

This study suggests that at a basic neural level, and at higher levels of linguistic organization, the mark-making human beings engage in to make meaning for themselves and others in a permanent way is a visual-attentional stimulus. The marks human beings make on paper stimulate the brain's lowest level visual systems by achieving contrast between the dark marks and the light paper. As these marks carry meaning, they stimulate the mind in higher level, self-relective ways. Mark-making drives the visual-attentional process in connection with logical operations and language.

2.2.3.2. Vision and Attention

Neurobiology suggests that vision and attention are closely related activities (Parasurman & Davies, 1984; Posner & Marin, 1985; Gottlieb, 1978). Because sustained attention is part of intelligent problem solving (Luria, 1979; Perkins, 1981, 1984), one of the effective modes to use in exploratory problem solving is the visual.

In Varieties of Attention, editor Raja Parasuraman writes," William James linked attention to interest and emphasized its active role in shaping conscious experience...According to James, the immediate effects of attention 'are to make us: a) perceive, (b) conceive, (c) distinguish, (d) remember better than otherwise we could.'...(Others) shared James' belief that the problem of attention was of prime psychological importance" (Parasurman, 1984, xi).

Neurobiological research into the mechanisms of attention support the importance of attention to cognition, bearing out James' convictions. Attention is a product of the arousal system in the brain. An attentive state is induced by, and, if sustained, allows us to learn about, what is novel or strange or changed in the environment (1984). Sustained attention allows the brain to form some enduring mental representation of that event.

Research reveals not only how correct James was in his convictions about attention, interest, and thought, but about how intimately vision is involved in the thinking process.

Calvin writes, " The most puzzling role of consciousness remains that of the selective attention mechanism... Selective attention...(may be many processes going on simultaneously, each competing for access to the language mechanism (1986, p.385-386).

Ultimately, the attentional mechanism in humans involves language.

"In the broadest sense, ALERTNESS involves a change in the receptivity of the nervous system to external or internal information" (Parasuraman, 1984, p. 244).

A less neurobiological, more behavioral description of attention is, " Visual search is, rather, an active interrogation of the visual world during which people systematically detect and use meaningful patterns of relationships to decide where to look first and in what sequence to seek for further information. ...control of what to look for next...may be learned and optimised" (Rabbitt, 1984, p. 273). Attention can be used to train the mind in the kinds of decision-making involved in organized searches for meaning.

There is some kind of attentional spotlight, some scanning mechanism, that determines the object of the brain's selective attention (Treisman in Churchland, 1986, p. 475). There must be some process that allows the mind to decide to think about one thing rather another thing.

Crick looks to neurobiological data to inform the spotlight hypothesis. Selective attention is the sequential activity of thalamic cells (Churchland, 1986, p. 477).

Calvin uses an orchestral metaphor to explain attention. He writes " Conductor/coordinators don't have to be single spotlit entities. Just as the frog heart creates a sharply rhythmic beat from the interactions of lots of jittery cells, in the same way the brain's coordinator may be the emergent property of a widespread committee" (Calvin, 1986, p.385).

Marvin Minsky, researcher in artificial intelligence at MIT, writes about the "society of mind." The brain appears to work by committee; one agency can set off a domino-like reaction among other agencies, based on limited capacities, and associative relationships between higher and lower agencies (Minsky, 1985, p. 221). Minsky, too, suggests that a kind of attentional decision- by- committee is going on in the mind.

Attention and consciousness and visual perception appear to be closely related. Whether we are dealing with external vision, and the orienting reflex and voluntary attention, or with internal mental representations and some attentional process that allows the mind to fix its inner gaze on one idea, there is a focusing mechanism in the mind.

For external vision, the novel, the changed, or the strange is the stimulus for the spotlight. The novel is the focus for the orienting reflex, known as the "what is it?" reaction. The orienting reflex kicks on the rest of the attentional system.

The reticular activating system, in connection with a highly influential neuronal body called the locus ceruleus, or "dark-blue spot," appears to bring the brain to outer and inner attention. Of this small but powerful body of cells, Carpenter and Sutin write, "The remarkable feature of the locus ceruleus projection is its wide distribution throughout the neuraxis...no other cell group of the reticular formation has been shown to have such an extensive projection. The projection of the locus ceruleus directly to the neocortex is unique... it plays a role in ...sleep (Changeux, 1985, p.69), and in the facilitation and inhibition of sensory neurons, and in the control of cortical activation" (Carpenter & Sutin, 1983, p.404-406). The attentional system has general power in the brain. The biochemical attentional regulatory system (Bloom et al., 1985, p.111) has influence far beyond waking and sleeping.

The attentional system could be very like a reflex (Calvin, 1986; Minsky, 1988). What ultimately focusses attention, and brings the mind to conclusions may have something to do with physics, and neural events involving settling into a minimum energy states (Llinas, in Churchland, 1986). Attention and thought may have a kind of automaticity that is deeply below and beyond consciousness (Churchland, 1986, p. 467). On a conscious level, the mind believes it has control over its attentional processes.

2.2.3.3. Vision, Attention and Learning

What is the OR? What is the VOR? What is the orienting reflex, and what is the vestibulo-ocular orienting reflex? How do they relate to vision? How do they relate to attention? How do they relate to learning?

The major human attentional mechanism is the VOR, the vestibulo-ocular reflex. It is an automatic reaction triggered by vision, and by hearing. The vestibule referred to exists in the inner ear, where sound waves impact enclosed liquid, and exposed hair follicles that, in turn, stimulate nerves which send messages to the brain.

This vestibulo-ocular reflex "enables an organism to track an object smoothly even while the head is moving in any of its possible parameters. The crucial part of the circuit for this reflex originates in the vestibular apparatus of the inner ear, where receptor neurons detect acceleration of fluid in their semicircular canal and project to the vestibular nuclei in the brain stem and then to the oculomotor nerves that direct the extraocular muscles to move the eyeball" (Churchland, 1986, p.108).

The mind detects something novel that is moving or making noise. The brain comes to attention, tracking it with its eyes.

It appears that the OR and the VOR are inseparable. They may be indistinguishable, except, or even in, the blind. The vestibulo-ocular system, mixing information from the eyes and ears, is an interconnected

system in the brain (Diamond et al, 1985, p. 6-19, 6-20). Humans orient themselves to light and to sound. They look at what they hear. They turn their ears toward what they see to hear it better. Both novel sounds and novel sights get the mind's combined attention.

The power of the visual to arouse attention, and to orient the body are central to this study, which has to do with the power of meaningful mark-making in humans to arouse, and to sustain attention.

A number of conditions are responsible for eliciting the OR. The quality of novelty, as suggested above, is an eliciter. The novel item is detected by a matching process. The new item is compared with a library of internal representations of previous stimulations. Rohrbaugh suggests, "A failure to find a neuronal model as a match for current stimulus gives rise to an OR" (Rohrbaugh, 1984, p.324). If the new item finds nothing like it in memory, it becomes especially interesting.

The OR alerts the mind to the novel. The OR is sustained by confirming the fact that the possible novelty is really novel. Daniel Kahneman and Anne Treisman describe the nature of the comparative searching to confirm novelty in this way, using the language of information processing: "It is natural to think of the object file as defined by salient physical properties of the object, including in particular the time and location of its initial appearance. The semantic knowledge associated with the object may become available in the file much later, and may not be the feature by which the content of the file is most easily accessed" (Kahneman & Treisman, 1984, p.55).

As suggested in Churchland (1986, p.388), Gazzaniga (1985, p.77), and Minsky (1985, p.270), language develops later than other information-processing systems in general. Kahneman and Treisman suggest that language may not be the primary way in which much of the information we use is stored and accessed. From experience and from research it becomes clear that much of the information humans consciously use is that information that has been tagged by language, and which is retrievable through language. Therefore, attentional search mechanisms must be able to access language files, as well as those having to do with "salient properties," and with "time and location."

The article by Treisman and Kahneman goes on to suggest that "The actual detection of significant stimuli within the field triggers an increase information scanning coupled with a lowering of OR criterion levels... Bernstein notes that some evaluation of 'importance,' 'pertinence,' or significance is a feature common to virtually all theories of attention." (1984, p. 331).

The suggestion is that if a person sees something that means something to that person, she'll keep looking at it. If that person keeps looking, she may need need less attentional priming to do so.

The key in connection with the design of intelligent education activities may be to determine what has meaning, or pertinence, or importance for the child. It might be even better in the long run to equip the child with strategies for enhancing the significance of what she sees, so that it will be increasingly easier for her to pay attention. The second task, that of teaching a child to pay self-sustained, self-directed attention, is probably easier, and more valuable to the child, than trying to figure out what would interest a child at any one point in her development. Of course, it may be possible to do both.

Deliberate attention has been described as an interhemispheric task. Parasuraman writes " ...the OR is asymmetrically determined, and... the nature of the OR follows from the hemisphere of origination (Demina & Khomskaya, 1976; Luria, 1973). Maltzman (1979b) explicitly proposed...that involuntary ORs (researcher note: i.e. those elicited in response to a novel or unexpected stimulus) originate in the right hemisphere. In contrast, voluntary ORs (i.e. those mediated by factors of significance or 'noteworthiness') are predominantly left hemisphere in function. The rationale for this dichotomy lies principally in observations that verbal and reasoning processes presumed to underlie a significance factor are largely functions of the left hemisphere. Unfortunately, little empirical evidence is available to support this sort of bilateral dichotomy in OR generation" (Parasuraman, 1984, p. 333).

A novel task that has significance factors built in would be an interhemispheric task. An activity that involves deliberate attention, having to do with significance or noteworthiness, expressed, say, in drawing and writing, might most particularly engage both the right and left hemispheres.

The novel stimulus itself, plus determination of spatial qualities, would involve the right hemisphere. The noteworthiness, along with the linguistic aspects of the task would engage the left hemisphere. Research on hemisphericity suggests that in people with intact brains it is probably not only difficult but unnecessary to determine exactly which hemisphere does what in an attentional operation. With what is known about vision and attention, it should be possible to design activities that will engage the whole mind.

Parasuraman suggests, "So long as significance or signal value is maintained, or so long as the required stimulus processing resists automatization (1984, p. 335).

The question is whether a deliberately designed educational task can set up a dishabituation situation. Can the automatization of processing be avoided? Can a visual activity, emphasizing the new - if it is followed by another visual activity, concerned with novelty - provide this kind of dishabitatory stimuli? Could, for instance, drawing, set up an attentional situation where writing sustains and recovers attention, not only for itself, but also for subsequent drawing, and so forth, for writing?

Is it possible to design a kind of self-referential loop in learning tasks, where one kind of novelty stimulus, if followed by another, sustains the attention for both? In the case of children with what are called attention disorders, or with language learning disorders, could this kind of switch hitting between tasks be useful attentionally and cognitively? Empirically, it appears true to this researcher that the combined task of Drawing/Writing sustains interest and results in both better drawing and writing in attention- disordered and in language- disordered children.

Attention affects information processing ability. Parasuraman suggests, "The OR also is held to have a role in the establishment of a conditioned bond between the signal stimulus and subsequent stimuli and lead to a temporary decrease in sensory threshold" (1984). This could be one of the most important observations about attention for education. If a conditioned bond could be made between two activities, like drawing and writing, for children whose wiring in connection with attention and with language might be somehow dysfunctional or inadequate, a first signal stimulus might lower the threshold for the second. If one activity

by its very nature made it easier to pay attention to a second, more difficult activity, that kind of task would be useful. The research provides a theoretical basis for designing educational tasks that take advantage of activities that children find it easy to pay attention to.

A conditioned attentional bond has implications for information processing capacity. Robert Hockey discusses capacity theories: "Capacity theories have emphasized the amount of information processing that the system is capable of...The most influential attempt to incorporate arousal into capacity theory was that put forth by Kahneman (1973) in his book *Attention and Effort*. Kahneman argued that capacity is a highly variable commodity that is related to the current level of arousal" (463) It appears that the more attentive the mind is, the greater its ability to process information.

Marcel Kinsbourne, and Mark Byrd, in their article "Word Load and Visual Hemifield Shape Recognition: Priming and Interference Effects:" write:

"(There is a) continuity between priming and interference...Light prior workloads prime neighboring brain areas. In contrast, interference becomes reliably demonstrable at heavier levels of prior workload...and generalizes across both hemispheres" (Kinsbourne & Byrd, 1980, p. 529).

Because there is a continuity of effect between hemispheres, the research suggests that a light load will prime the brain for a heavy load. It appears that a heavy processing load interferes with other loads, even light loads. The research suggests that an easy task makes harder tasks easier. A hard task, that uses a lot of processing capacity, interferes with other tasks. If drawing were thought of as a light work load by children, might drawing prime a neighboring area for language is located?

Kahneman writes, "A number of investigators have emphasized the role of the OR within a broader context of learning and memory....' when one no longer pays attention to the occurrence of an event, it is difficult to learn anything new about it.' (Kahneman & Treisman, 1984, p. 342).

"Similarly," Kahneman writes, "Ohman (1979) specifies that 'we learn primarily about novel and unexpected events' (Kahneman & Treisman, 1984, p. 450) for which there exist no well-defined internal representations. Consistent with these assertions are data from a number of studies that have found recall performance to be greater for items that elicited large ORs during their initial presentation" (see Cruik and Blankstein, 1975, in Parasurman, 1984, p. 342).

A connection between learning and memory and attention and the novel and the unexpected exists. Memory is enhanced by large ORs. That is, a very novel, or a very unexpected event will be remembered better than one that is not very novel or unexpected.

Davies, Jones, and Taylor write, "It seems clear that not only does a child's understanding of the nature of attentional skills, and in particular, of the conditions that facilitate the effective deployment of those skills become more accurate and more complete with age...but also the ability to attend selectively markedly improves as a child grows older...between the ages of 5 and 14" (Davies, Jones, & Taylor, 1984, p.402). The elementary school age child and the junior high school age child are the prime candidates for activities that take advantage of critical cognitive abilities having to do with attentional skills that are developing naturally.

Davies, Jones, and Taylor continue, "Developmental changes in selective attention become more apparent...central and incidental learning both increase with age" (Davies, Jones, & Taylor, 1984, p.406). The authors describe the distinction between these two kinds of learning: "Merely pointing to a central stimulus, which focuses attention on the relevant task feature without providing an encoding strategy, does not affect central learning, although it does reduce incidental learning" (1984, p. 406).

The research suggests that incidental learning happens without specific cue-ing. It involves what the authors call a "no-cue search" (Davies, Jones, & Taylor, 1984, p. 408). (However), central learning occurs when there are cues, and there is an "encoding strategy." (1984, p. 408).

Central learning involves an encoding strategy. This kind of learning is age-related. As the child gets older, he can pay selective attention longer, allowing him to use strategies to store information, to remember, to learn in a voluntary, deliberate, non-incidental way.

The authors add, "Young children tend to integrate stimulus dimensions that older children are able to separate...shape and color may be viewed as integral by younger children" (Davies, Jones, & Taylor, 1984, p.407).

(It has been this researcher's experience with five year olds that, when they draw, they can separate shape and color, but that they cannot separate values, or degrees of light and dark in normally lit circumstances. To date, the research with Drawing/Writing has not made use of a spot-light. It is probable that young children see distinct patterns of extreme light and of dark as well as adults do. Most adults need training in sorting out values by natural light, and have a hard time distinguishing them at first.)

The authors add, "Visual-search performance also improves with age in children...and in no-cue searches, the selective attention of younger children was as efficient as that of older children...Developmental changes in children's visual-search performance thus appear to be situation dependent" (Davies, Jones, & Taylor, 1984, p.408).

Marvin Minsky, AI researcher, deals with attention in a pervasive and complex way. In Society of Mind, Minsky explores how higher level agencies tell lower level ones what to do (Minsky, 1985, p. 221). He describes how the word "apple" may arouse a series of agencies "that represent an object's color, shape, size" and that these agencies "automatically affect the LOOK-FOR agency" (1985, p. 221). In this sense, there is a kind of automatism to attention. This kind of apple-finding script might involve, Minsky suggests, "no 'general purpose communication at all" (1985, p. 221), and yet might be "one explanation of what we call 'focus of attention'" (1985, p. 221).

Minsky approaches attention from another angle. He suggests that interruptions and questions get our attention. It is not precisely the novel, or the strange that Minsky describes as attentional in connection with an interruption. He writes, "Now a question is really a sort of command: it makes the reader focus attention on a certain subject" (Minsky, 1985, p. 233). Minsky suggests that attention is a response we make to a "felt" command. In this sense, a question is a command. Just as the brain is able to internalize other processes, so

the brain internalizes this question/command, interrupting itself, forcing itself to focus attention in other directions for the sake of an answer.

Minsky devotes nearly forty pages to the subject of attention in his book, *Society of Mind*. He connects attention and expectations by saying that, when a situation does not meet a person's expectations, when it is different ("not like," "novel," "changed from") what that person expected, the mind is shocked (Minsky, 1985, p.258). The brain is forced to attend to specific stimuli, rather than to its expectations, to deal with the situation. This point of view is shared by the authors quoted above. But Minsky, in a characteristic way, gives this understanding a twist. With the twist comes illumination. Minsky writes, "a major proportion of our brain machinery is involved with such calculations and corrections, and it takes a long time to learn to use all of the machinery. The psychologist Piaget found that it takes ten years or more for children to refine their abilities to imagine how the same scene will appear from different viewpoints" (Minsky, 1985, p.258).

The important thing about attention is that not only is it involved with what is different, but that attention is involved with what could be different. This takes attention into the world of hypothetical thought, and shows us how this kind of high-order thinking, having to do with calculations, gets and sustains attention.

2.2.4 Mental Representations

Mental representations relate directly to attention, to memory, to logical operations, and to language. They are the stuff of the last three, and they are the result of the first. Mental representations encode information. According to Gazzaniga, a great deal of information is processed by the brain non-verbally. The brain has, in addition, some kind of verbal mechanism which he calls an interpreter which draws conclusions from what it infers about the host of non-verbal information being processed by sensory-motor systems. Kosslyn adds that language is a cue to store, and to unlock this non-verbal, multi-sensory information. Besides encoding information, the mind can move through levels of representations, transforming sensory information into entirely different kinds of things.

Research into the nature of mental representations suggests that vision in humans is a primary process in the construction of knowledge, and that this process is cross-modal. Language is included as a cross-modal representation. (Llinas, in Churchland, 1986; Kosslyn, 1983, 1984, 1988). Vision is a powerful way to initiate, to sustain, and to drive cross-modal thought in connection with the development of language.

The mind remains aware of an object of attention by "refreshing" the image (Kosslyn, 1983). Just as neurobiology is proving useful to understanding processes of mind, so are computer metaphors. "Refreshing" is a command written into computer graphics programs to sustain an image. Stephen Kosslyn, Harvard psychologist, writes, "Our eyes are continually moving, even when we try to keep them still. Paradoxically, this movement allows us to remain aware of an object: If you can rivet your gaze into a single point on an object, after a while the edges of the object will seem to fade in and out. If the object is fixed on one spot on your retina with a special kind of contact lens, then the entire object will seem to fade out after a while."

" If stabilized patterns on the retina fade because neural mechanism adapt (researcher note: adaptation means that the neurons stop firing), then it might be expected that there are similar effects when a mental image is stabilized... the stabilized image can 'adapt out'"(Kosslyn, 1983, p. 67). Just as computer-generated images need "refreshing," so do mental images. When a human moves his eyes back and forth, he is stimulating the neurons in his retina to fire again and again, refreshing the image that is adapting out. How the brain uses the eyes determines how long and to what degree an image is clear in the brain.

Kosslyn suggests that attention is necessary to sustain mental images, for both short-term, and for long-term use (1983).

Kim Kirsner and John Dunn write, "In the present model, perceptual analysis is assumed to proceed through a hierarchy of levels of increasing abstraction, and activation of a stimulus representation at any level is assumed to leave an enduring record that facilitates its subsequent reactivation. In essence, this record constitutes a 'memory' for any particular perceptual analysis" (Kirsner & Dunn, 1985, p. 552).

Education is concerned with learning and therefore with memory. If a memory for any "particular perceptual analysis" results from moving through a hierarchy of representations, then moving through this hierarchy is important. If each representation in such a hierarchy leaves an enduring record, then this kind of movement relates not only to perception, but to memory. Proceeding through this kind of perceptual hierarchy is therefore important to education as a learning and teaching device.

The research suggests that perceptual analysis that moves through increasing levels of abstraction provides a series of representations that are remembered. Drawing followed by writing provides a way to moves through increasing levels of abstraction.

Graham, Kramer, and Haber suggest in an article entitled " Attending to the spatial frequency and spatial position of near-threshold visual patterns," suggest that patterns have a visual, spatial frequency that relate to the degree of attention a subject achieves (269). There is the suggestion that the clearer the image, the higher the spatial frequency (Graham, Kramer, & Haber, 1985, p.280). Education would want to make a note that strong, clear visual images are attention-getting.

If spatial frequency has to do with focus and attention-then an activity, say, drawing, using magic markers, is going to result in drawings with higher visual frequency than drawings with pencils. Given a choice, the beginning draw-er past the age of 8 or so, chooses a pencil. It is not possible to erase magic markers. Since a person who is drawing might make a mistake, it is important to be able to erase it. Pencils are a safer drawing medium, but they not the most stimulating medium visually.

The above research provides some understanding of how mental images are formed in connection with vision and attention. Recent research has also probed into the material nature of mental images. (Changeux, 1985; Kosslyn, 1983;Llinas, 1986;Arnheim, 1969; Berger, 1972; Calvin & Ojemann, 1980; Calvin, 1986; Churchland, 1986). This research tries to describe how mental images work together to provide various levels of understanding, particularly in connection with the level of language. In what ways is language a mental

representation? Does language rest on other levels of mental representations? Does spatial understanding precede and support linguistic understanding? Do the two become inter-dependent in effective thought?

Llinas' and Pellionz' (1986) describe a mental process called "the space phase sandwich." Pedestrian as the image of a sandwich may be, it graphically describes the layered nature of human thought. Llinas' and Pellionz' explanation goes something like this; if a person looks at a cup-like object, he registers its coordinates on his retina, and then project a map of this coordinate system into the brain, exactly preserving the relationships between points. This (retinotopic) map exists in more than one place in the brain. The map can be used with the muscles in fingers and hands, so that the hand can reach out for the cup. Or the map can be used to think about the cup in other ways. For instance, it is possible to classify the cup as a certain kind of vessel.

The brain constructs something like a sandwich of maps, distorting them so that they fit onto each other. The ways in which they fit produces a new kind of map, which is read by the mind as a level of meaning (Llinas & Pellionz, in Churchland, 1986). The theory is that, from coordinate maps, which give the brain information about "where" something may be in space, brains construct classification systems, having to do with "what" the thing may be. The brain might, for instance, recognize the thing as a special kind of cup that falls into the categories of "religious," "mythical," or "holy." This understanding involves pattern matching, which is another order of mapped-maps activities.

Something like an over-lapping of maps constructs semantic or syntactic thought, ordered in some context. The over-lapping itself occasions a process that could be called the construction of "meaning lines." This kind of process becomes a new map. Eventually, the result is some representation that is linguistic in a sentential or sentence-like sense (Churchland, 1986; Llinas, 1986). One of the symbolic languages humans use is the one we speak. To complete the sandwich map in connection with the cup, a mind might eventually come to the conclusion that the cup it is looking at is The Holy Grail.

The idea of a "space phase sandwich" allows an appreciation for the layered character of attention, memory, logical operations, and language. Llinas calls the space phase sandwich explanation the "tensor transformational theory" (in Churchland, 1986). The idea is that there is a computed relationship between systems. This description encourages an increasingly deep appreciation for the layered, transformational nature of thought, and for the spatial basis of language, as a location, and as a classification system. Instead of making language "other," it allows an understanding of language as the adaptive result of increasingly complex responses to the environment. And it suggests that it is language that ultimately allows the mind to construct and to transform an inner environment of thought. It is in connection with the interaction between maps that the reader will understand logical thought in the context of this section on neurobiological research. Until the research moves on to education and Piaget, logical operations can be described as what happens when the brain "settles" into minimal energy states." In this part of the research, logical operations are what happens when mental representations are compared and are transformed in complementary interactions. Logical operations are representational interactions that follow some (probably genetically proscribed) order in

the brain's meaning and mapping system. It appears that it is possible to effect the quality of the maps the brain works with through the use of selective attention. Thus, it is possible to connect vision, attention, and logical operations.

Of a variety of theories about mental representations, Rodolfo Llinas' descriptions of what he and fellow researcher, Pellionz (in Churchland, 1986) call "space phase mapping" is useful to this study. Llinas and Pellionz suggest that language is a "mapped map." The description explains language itself as a cross-modal, fundamentally spatial phenomenon of intelligent human thought (1986). This understanding is that linguistic and non-linguistic symbolic representations are deeply inter-dependent. As will be seen in the section on education research, this understanding is like that of Project Zero at Harvard, where researchers have come to the conclusion that making a dichotomous distinction between the linguistic and the non-linguistic symbolic expressions, is not useful, nor may it be meaningful (Wolf et al., 1988).

The general understanding reached after an exploration into the nature of mental images from a neurobiological point of view is that symbolic representations, whether they are spatial or linguistic, rest on ordered thought (Luria, 1979; Llinas, 1987; Gazzaniga, 1985; Kosslyn, 1985, 1987, 1988). Ordered thought, or thought in context, results in different kinds of symbolic representations, from art, to literature, to music, to math. It appears that the mind works through these systems of ordered thought by moving from less abstract to more abstract forms of representation.

Besides providing an explanation for the layered, inter-influencing nature of thought, the concept of mapping provides a way to understand how the mind changes ideas, and how it may be possible to remediate dysfunctional areas in the brain. The brain can not grow new neurons. Dead nerve cells in the brain stay dead. Adjacent areas, adjacent maps may take on the lost or damaged function. This is what is meant by the plasticity of the brain. There are different times when the brain is most plastic, most amenable to certain kinds of connection. These are called "critical periods" (Mistretta & Bradley, 1984; Hubel & Weisel, 1962; Greenough, 1978). However, it appears that the neural reorganizations that learning effects may go on over a lifetime.

The problem in remediation is suppression of function. For instance, if the left hemisphere is damaged, and if it is entirely removed in what is called a hemispherectomy, the right hemisphere takes over the function of language (Gooch, 1980). If part of the left hemisphere remains, it suppresses the ability of that intrinsically equipotential mass of cells that make up the right hemisphere to take on the function of language (Gooch, 1980).

Neurobiology suggests that, despite suppression of function, one way of thinking may impact, enhance, remediate, or restructure another kind of thinking. The result of the impact may be heightened attention, enhanced information processing ability, and the priming of another area for a heavy work load (Parasurman & Davies, eds., 1984).

This cross-modal effect has implications for not only for remediation, but for learning. Unlike other structures in the brain which are stage-specific (Marg, 1982; Changeux, 1985; Mistretta & Bradley, 1984), the

kind of structural changes that accompany learning can go on over a lifetime (Rosenzweig & Bennett, 1978). The educational usefulness of visual-attentional-cross-modal operations appears not only to be extensive, but enduring.

As a final piece of research in connection with brain function, computerized images of brain function increase our understanding of thought as cross-modal. Neurobiological research on a micro, and macro level, using electron microscopes, and computerized metabolic tomography, or brain scans, underscores the integrated, global nature of thought (Andrews, 1986; Fox, 1988, Cleveland Clinic lecture). When a person speaks or reads, there is whole-brain metabolic activity. The activity is not confined to the left hemisphere (Fox, 1988).

2.2.5. Hemisphericity

The brain has two hemispheres, oval, deeply convoluted bodies that are joined by a nerve-rich strip of tissue called the corpus callosum (Changeux, 1985). The corpus callosum makes a constant interchange of information between the two hemispheres possible. The word "hemi" suggests that the two information-processing bodies are part of one whole operation. This appears to be the case in the brain. Two somewhat different ways of looking at things, two spheres of influence, are combined in the meaning-making process. Changeux writes about the "comparator" (1985), and Gazzaniga writes about the "interpreter." The interpreter makes linguistic sense out of a host of non-verbal information. The language system, according to Gazzaniga, is inferential.

Because it was possible, after the 1950's, to isolate spatial and linguistic functions in split-brain patients, it became a popular misconception that the brain could be either spatially astute or linguistically astute (Gazzaniga, 1985). One could be so-called "right-brained," and good at art, or "left-brained" and good at language or math. Current averaged brain scans (Fox, 1988) reveal the fallacy in this thinking. Any task is a global operation (Levy, 1979). Educators adopted this fallacious thinking about thirty years later, which only served to exacerbate the dichotomy between art and academics. Art was for the "right-brained" child. Math and science were for the "left-brained" child. Because art had been so long neglected in schools, its effect on the child who was having trouble with academics was dramatic. However, this meant that art was relegated to the special needs classrooms where special needs teachers noticed that one thing these children could do was draw.

2.2.6. The Social Brain

Like neurobiologist Michael Gazzaniga, Marvin Minsky of MIT describes mind as a society. Cross-modal communication occurs between cooperating structures. The folds of the cortex, Minsky suggests, may be a way to get subsystems closer to each other, so that they can communicate in something

like a society of mind (1985). Minsky suggests that lower level subsystems do not know what higher level systems are doing, and vice versa. No system as complex as the human mind could have complete cross-modality. The cross-modal character is discreet, and modular, with some larger, over-arching systems that allow for higher psychological functioning (Minsky, 1985).

Marvin Minsky sheds light on the connection between concrete and abstract thought when he writes about the tendency of the mind to "thingify" ideas (1985). What Minsky calls "trans-frames," or "trans-scripts" provide general- purpose scenarios for dealing with things, or with ideas. These scenarios takes us from some origin, to some destination. These "trans"-scenarios are cross-modal in structure, process, and purpose. They treat concrete things and abstract ideas as if they were the same thing. Minsky suggests that human beings think about ideas as if they were things. The brain itself does not make a distinction. The mind, may. Just because an idea is abstract, however, does not mean that it is in any way less precise, less clearly defined, than the mind's physical understanding of some thing.

2.2.7. Research Speculations and Recommendations

2.2.7.1. The Magical Mirror of Thought

An apt metaphor for the brain is a magical mirror. Like the print of MC Escher where griffins file in an endless Mobius curve through the very stuff of a mirror that both reflects them two dimensionally and transforms them three dimensionally, the brain's tri-part structure with its two spheres of influence transduce or translate a variety of kinds of information into electrical-chemical signals that are generally usable. It is possible that the corpus callosum is like the mirror in the print, and that the two hemispheres which it connect are like the two lobes of the ever-changing figure eight with its stream of griffins. The corpus callosum, like the magical mirror in the Escher print, may act as a transformer, which, like other electrical transformers, changes the nature of the energy states in a flow of signals in such ways that a series of sets of interpretations, which in this case may be loosely defined as spatial, are open to another series of sets of interpretations which may be loosely defined as linguistic. The very act of transformation, this kind of shunting that is also, apparently, a kind of redefinition, may be at the heart of the active agency of thought. The corpus callosum may not only be a conduit, but it may act in concert with other executive agencies as (Changeux's) comparator and as (Gazzaniga's) interpreter.

The mind works in ways that are so densely interconnected that attempting to locate physically, or to distinguish procedurally, one mode from the other is at least unnecessary, and is most possibly, from the point of view of educational theory and practice, counterproductive to the development of intelligent thought.

The general structure and process of the brain that is responsible for the cross-modal character of thought is the increasingly parallel, and interconnected nature of the information processing that goes on in the maturing mind. This cross-modal structure contrains and defines the process. The constraint is intimate

connection. This means that the way the mind uses the senses is intimately connected; the way the mind relates spatial thinking to linguistic thinking is intimately connected; and the way the mind relates concrete to abstract thinking is intimately connected.

The most important implications of brain research for this study is the continuity of the brain's language system with other processes. Language appears to be a ramification of the sensory motor system; it is a "mapped map;" it is the "what" of a "where" system (Kosslyn, 1983, 1984; Llinas, 1988).

This continuity is at the heart of what is called cross-modality. The mind works in a variety of interconnected, interdependent ways, simultaneously.

What this researcher described as a "neurobiological processing link" four years ago may in fact exist between the ability to draw and the ability to write and to read. The link seemed feasible to neurobiologist Galaburda in correspondance. The link implies that functional drawing skills could be used to impact dysfunctional writing skills. Drawing, writing and reading appear to be spatially-based ways of locating and classifying things or ideas. If one mental map can affect another, if one functional area of the brain is able to impact another, increasing its attentional, and informational capacities; if thought is fundamentally cross-modal in character, then it may indeed be sound educational practice to combine drawing with writing and reading to remediate language-related learning difficulties. Spatial modes of understanding may remediate dysfunctional linguistic modes of understanding.

The neurobiological research suggests that if the mind is cross-modal by nature, education should be cross-modal by design.

2.2.7.2 Thirteen Research-Based Recommendations

Detailed treatments of the brain's growth have been published by Piaget (1960), Calvin and Ojemann (1980), Llinas (1974, 1982), Carpenter and Sutin (1983), Ornstein and Thompson (1984), Changeux (1985), and Levy (1985).

A set of generalizations about how the brain grows has been drawn from publications like these and from the contributions of Hofstadter (1980), Kegan (1982), Minsky (1985), Winograd and Flores (1986), Kosslyn (1983, 1984, 1988), and Gazzaniga (1988). The latter set of authors relate brain growth to artificial intelligence and to cybernetics.

Thirteen generalizations along with brief explanations follow. The explanations use computer metaphors at times to make the complex operations of the brain clearer.

Generalizations and Explanations

1-The brain builds itself.

The brain builds neural assemblies.

To use a computer metaphor, the brain builds its own hardware and software from the same raw materials. Incoming information is sequenced in serial and parallel ways, often simultaneously. Wholes are built from bits and pieces of input into modular structures. Mental images and language comprehension emerge from much-processed and ordered input. The brain is "booted" by genetics and by experience.

2-The brain grows in stages.

One system within the brain matures and stabilizes before another system is able to follow. Since systems seem to develop simultaneously, the exact timing of these multiple maturations is indeterminable. No two brains grow in exactly the same way at the same time.

3-Each brain is different.

Since a brain grows its own hardware and software based upon genetics and experience, the wiring "pattern" of the mature brain is unique. Because of an element of randomness associated with the growth-cones of neurons, a principle called "indeterminability" insures the uniqueness of each individual's brain. A random function coupled with a mirroring or self-reflecting, self-referential function appears to drive brain growth, just as these two functions are at the heart of other dynamical processes.

4-There are critical periods for brain growth.

The early stages of brain growth appear to be particularly susceptible to influence. For example, the human visual system stabilizes at about the age of 11 and is mutable until then. It follows that the quality of elementary education in connection with visual stimulation is important.

5-Experience impacts brain growth.

The brain grows according to what it thinks it is experiencing. It thrives on activities that involve meaningful interaction; it can atrophy as a consequence of disuse. Experience enriches or deprives the brain.

6- Bodily experience affects brain constructs.

The geometry of physically-experienced space becomes a frame of reference for the brain's sensorimotor and retinotopic maps. Spatial understanding helps direct actions of the eyes, hands, and feet. This spatial understanding preceeds and undergirds multiple levels of linguistic understanding and expression. This information should make it impossible to dichotomize non-linguistic and linguistic systems of representation. Language systems are continuous with non-verbal, spatial systems and depend on them for structure and for information. Brain research describes and underscores the dense interconnection of all systems of representation.

7-Experiences and learning bring about changes in the brain over a lifetime.

Experiences and learning impact both the hardware and the software of the brain. Neural changes in response to experiences and learning register in terms of dendritic and synaptic mass. Although many systems in the brain become set, changes in response to learning occur over a lifetime.

8-The brain is plastic.

The brain can change; it is redundant. It makes more than it needs. It can repair itself and make spare parts. It can use old areas in new ways, new areas in old ways, and new areas in new ways. Because of a phenomenon called "neural drift," a functional area may impact a dysfunctional area; this information is relevant to remedial education. A strength may help a weakness.

9-Visual searches of interest help the brain to grow.

As the brain's visual system matures, it decodes information (e.g. a person's face) in ways that facilitate recognition and attachments. The ability to make distinctions influences the ways in which information is stored in the brain. This early ability to make distinctions and comparisons contributes to what will be more general abilities. Visual searches are a primary source of information that profoundly impacts the brain's growth.

10 -Interactive, exploratory problem-solving helps the brain to grow.

The more problems a brain solves, the better it gets at problem-solving. Complex problem-solving not only affects neural assemblies, but also the production of myelin, the fast-axon insulator.

11-Feelings of control help the brain to grow.

Personal control seems to be related to human well-being, which, in turn, relates to brain growth, influencing thinking and learning. Again, in connection with remedial education and with education in the largest sense, brain research suggests that it is critical to "play to strengths."

12- Cross-domain information storage results in stronger memories and therefore in better learning.

The computer metaphor applies especially well in this instance. Computers are able to access various kinds of information simultaneously by drawing on sophisticated programs, cross-referenced directories, files and expert systems. Computers are able to access the same information in different ways, or different information in the same ways. The brain has similar capabilities, which are far more complex than present computing resources.

13-Language is central to thought.

Numerous processes occur simultaneously within the brain for any single task, whether the task is picture-like, word-like or number-like. These processes become the grammar of the language of thought. It appears that there is a syntax to intelligent thought. There is a formal ordering system for information that appears to employ a variety of systems of comparison. Some of the templates for comparison appear to be inherent. Language appears to take its form from more fundamental ordering systems, like the one for vision. This ordering system appears to move from the particular to the general. It may be concluded that this move is responsible later for the ability to move from the concrete to the abstract and for the ability to move from the literal to the metaphorical.

The brain uses some formal system along with a variety of languages to order stimuli and to create lists. The symbol system we call language appears to be particularly useful to list-making, which is, in turn, particularly effective at cue-ing memory. A word can generate a complex mental image. A word or two facilitates the orderly presentation of a variety of pieces of information. The research suggests that it is possible to devise educational programs that allow children to take better advantage of both their spatial and linguistic ordering systems to store and to retrieve information and to make meaning. We may be able to teach something like the syntax of intelligent thought.

2.2.7.3 Four Tactics to Facilitate Brain Growth

The thirteen generalizations offer a simple, but reasonably concise scenario of the growth and development of the brain. Sufficient information is included within the scenario to suggest tactics apt to influence brain growth. Parents and educators entrusted with the minds of young children are those most likely to profit from the implications.

Some of the tactics that might promote, rather than retard brain development are these:

Tactics and Probable Consequences

1-Provide training in a variety of forms of symbolic representation. In particular encourage mark-making (e.g. drawing and writing) to stimulate ordered thought.

Ordered thought relates to symbol-use. Symbol-use develops voluntary attention, deliberate recall, and the logical operations (Luria 1979; Gazzaniga, 1988; Zinsser, 1988). Children who become adept with a variety of symbol systems will be more effective thinkers.

2-Make use of children's mark-making skills to help them store, retrieve, process and de-bug information. Images and words are cross-referential and are mutually retrievable in the brain. One system of representation can cue the other. Systems of representation are constructed, stored, and strengthened over time (Minsky, 1988). Simultaneous storage of multiple representations of the same person or place, thing or event or idea result in efficient, comprehensive, flexible retrieval systems. Children who learn to move comfortably between images and words will create these kinds of flexible, comprehensive information processing systems. Other names for such systems are memory or learning.

3-Involve children in complex learning tasks which stimulate vision, focussing attention on both non-verbal and verbal information, and encouraging open-ended exploration.

Complex non-invasive learning tasks including visual searches of interest contribute to complex brain structures. Complex brain structures are streamlined by the act of successful problem-solving, becoming more efficient with training and practice (Rosenzweig & Bennett, 1978). Children who solve a variety of complex problems on their own will be attentive, confident learners.

4-Introduce children to varied problem-solving experiences that are likely to be rewarding.

Problem-solving experiences that are intrinsically rewarding affect complex neural development. Emotion affects cognition. Successful complex problem-solving helps build cross-referenced, or cross-cued information storage and retrieval systems. These systems are mutually enhancing. They appear to impact the brain's processing capacities allowing for a heavier work load; they facilitate de-bugging; they are the bases of reflective thought (Gazzaniga, 1985; Minsky, 1985; Parasuraman & Davies, 1984). Children who feel successful will be more effective, efficient thinkers.

2.2.7.4. A Model Learning Activity

Can we train the mind to process information quickly and efficiently?

Walter Schneider asks, "What is the microstructure of skill development? ...It is generally agreed that the acquisition of almost any cognitive motor skill involves profound changes with practice" (Schneider, 1984, p.475). Schneider goes on to make a distinction between "controlled" processing and "automatic" processing. "CONTROLLED PROCESSING is characterized as a slow, generally serial, effortful, capacity-limited, subject-controlled processing mode that must be used to deal with novel or inconsistent information...AUTOMATIC PROCESSING is a fast, parallel, fairly effortless process that is not limited by short-term memory capacity...(and results in) well-developed skilled behaviors" (Schneider, 1984, p.476).

The research suggests that training in a skill that results in a learned skill results in parallel processing - which is the way the fast mind works. Schneider concludes, "The present model (of controlled and automatic processing) illustrates how continuous improvements in associative strength and message gain...can shift the processing from a serial to a parallel mode. The present model also predicts the importance of consistent practice in developing fast, efficient processing" (Schneider, 1984, p.476).

What distinguishes the human mind from the computer, at this point in the history of the development of the computer, is complex parallel processing. Many people maintain that they can think of only one thing at a time. Research suggests that this is not so. Everyone's mind is processing a multiplicity of things in parallel all of the time. It is simply that no one is, nor can be, aware of it all on a conscious level. But people can learn to be aware of more of what is going on. Tagging non-verbal knowledge that has been encoded in drawing with language provides one way for the mind to take conscious advantage of the processes available to it.

Parallel processing is inherently cross-modal. The process is also recursive, or self-referential. The new message goes home again, to the sender. Processed information circulates through neural levels in what Douglas Hofstadter calls "strange loops" (1979). This kind of densely recursive inter-influential information processing is what the human mind increasingly does best as it grows (McCulloch, 1979 ; Minsky, 1975; Drexler, 1986). This kind of information processing is not fast, but it is exceedingly deep.

Cross-modality not only impacts attention, memory, logical operations, and language, but the levels of thought at which we engage in these operations.

It is not a new idea to education that learning takes practice. What is interesting is that the mind can practice so that it develops fast parallel processing. We all know that the mind can practice and practice and not learn anything - or not learn anything in a memorable way. One of the keys to effective practice is cross-modality. Another is attention. If we are paying attention to what we are practicing, we will learn it. To pay attention, we must be interested. It follows that what the mind likes to practice will be engaging to it, resulting in effective learning. The sleight of hand that enables the teacher to convince the student that practice and interest and mastery and discovery are part of the same process is part of the magic of education. The magic tricks appear to involve cross-modal activities that are intrinsically attentional.

Children can learn to increase their abilities to sustain selective attention. By sustaining their attention, children will put into motion the considerable emotional and cognitive processes that are part of the "neurobiology of an attentional mechanism."

The neurobiological research suggests that a learning activity appropriate to encouraging automatic (parallel) processing, and to developing attention, memory, and logical operations is highly visual, exploratory, and involves several ways to process information. The activity should provide alternative ways to encode information, and it would include more than one system for symbolic representation. The activity would join a spatial system with a linguistic system. In addition, because its intent is to mirror brain development, the activity would precede linguistic processing with spatial processing.

There is precedence for the usefulness of neurobiological research to education. Rudolph Arnheim, Stephen Kosslyn and Howard Gardner have found neurobiology useful in understanding and explaining the complex or multiple nature of human intelligence (Arnheim, 1969; Kosslyn, 1983, 1984 ; Gardner ,1974, 1983, 1985). If the findings in neurobiological research are compared with educational theories on childhood and learning, will there be areas of common understanding that have mutual implications for education? Might an integration suggest the outlines of an integrated theory of learning? If such a theory should emerge, could it be put into practice? What would its activities look that? Would they be powerful enough to develop thinking skills in a broad range of students?

The research suggests that a combined drawing/writing process might match the ideal neurobiological-educational profile for a teaching and learning activity that is appropriate for developing thinking skills expressed in writing. The neurobiological literature search warrants the study of such a combined drawing and writing activity.

2.3 Introduction to Research in Education

Neurobiology provides information that is important to education. As will be apparent, educational research often mirrors or complements this information.

One of the important contributions from neurobiology is an understanding of the process by which neural connections are made, and of the implications of the quality of that process for thought. It appears that the extent to which the neural processes are cross-modal determines the strength of the connections. Early experience impacts the structure and therefore the process of the cross-modal connection system which we call the brain. In particular, vision and attention affect the way the brain constructs its "association nets" (Crick, 1984). These neural nets are responsible for learning and memory, as well as being the material basis of mental images (Crick, 1984; Changeux, 1985). Brain processes are densely interconnected and transformational in character.

Analogous areas in education relate to the kinds of learning that children feel connected to. These kinds of learning are called associated learning and involve exploratory interaction (Piaget, 1960,1962; Papert, 1980). Multi-sensory approaches to early and to remedial education fall into this category, as does art education in general. Connectedness in education is also achieved by interdisciplinary programs. Whether programs are described as multi-sensory, sensory-integrative, sensori-motor, art-related or interdisciplinary, if they involve more than one of the senses and a symbol system or two, they take advantage of the cross-modal processing that neurobiology describes as being characteristic of intelligent thought.

This part of Chapter 2 will explore the areas in education that do or could provide "cross-modal-like" thinking and learning activities. Educational attitudes and theories about drawing and about writing are included in the educational research, as well, as ways in which the mind acts on outer and inner worlds. An epistemology called constructivism provides a possible conceptual homebase for a study that attempts to determine the extent to which a deliberate connection between drawing and writing may affect connectedness in relation to early learning and language.

Like neurobiology, educational research puts a premium on vision and attention in connection with logical operations and the acquisition of language. Logical operations, according to Piaget, depend upon the scaffolding of thinking skills (1960). Neurobiology suggests that scaffolding occurs in neural brain growth (Changeux, 1985). The structure and process of the neural connection-system is driven both by genetic blueprints and by experience as it becomes more densely connected. Through the mental processes of comparing (Changeux 1985) and of interpreting (Gazzaniga 1985), the brain increases its capacity for and efficiency in information processing. Logical operations are another name for what the brain does with information. Whatever way the brain processes information is logical to it. How the process affects behavior in the world reveals how effective, or how "logical" the process is.

Piaget links mental action in the external world with action on the inner world of ideas. Minsky suggests that the distinction between outer and inner actions is spurious to the brain. The brain "thingifies" ideas

(Minsky, 1988). It appears that the brain uses the world of things as a training ground for thinking about ideas (Piaget, 1960). The ways in which the brain works with actions and ideas can, it appears, be optimized by deliberately using cross-modal approaches.

2.4 Research in Education

2.4.1 Connection through Action and Language

Jean Piaget approached the basic questions of epistemology through the scrupulous observation of a few children. He wrote in this way about the process of knowing; "When we speak of experience, we must distinguish two different types, which will help us see that a child learns very little indeed when experiments are performed for him, and that he must do them himself rather than sit and watch them done" (Piaget in Almy 1966, p.v).

Piaget writes, "Children have real understanding only of that which they invent themselves, and each time that we try to teach them something too quickly, we keep them from reinventing it themselves. Thus, there is no good reason to try to accelerate this development too much" (Piaget in Almy 1966, vi).

Piaget suggests that the character of authentic knowing involves open-ended exploration on the part of the child.

Seymour Papert of MIT studied with Piaget. Papert champions the importance of children's personal connection to learning (1980). He writes about the perils of "dissociated" educational approaches which result, ultimately, in "constraining assumptions ... about ourselves," which result not only in phenomena like "mathphobia," but in other kinds of academic fears (1982, p. 47).

Papert describes "body-syntonic" learning as a way to connect children to powerful ideas. The child acquires knowledge in ways familiar to bodily experience. Papert designed a computer language called LOGO. LOGO encourages the child to identify with the cursor on the computer screen by calling it a "turtle." (An actual cybernetic "turtle" existed in the early stages of this program.) The child programs the turtle to move as if it were his own body moving in space. Using LOGO to build and to "de-bug" programs, the child participates in exploratory, interactive, play-like learning. The powerful ideas the child learns in this kind of play is that his mistakes are not failures; they are simply procedures that do not, for the moment, work. The child also learns that a program can call back a part of itself in a process called recursion. Simple programs, which embed other simple programs, result in complex structures through this kind of self-referential or recursive process. LOGO was designed to connect children to math through geometry, and, in a more general sense, to ideas about the power of procedural knowledge (Papert, 1980).

Like neurobiology, education suggests that growth of mind depends upon active experience. This kind of experience connects children with learning.

Human beings first connect with the world through direct action, and, soon after, through the use of language. Language is one of our most useful connection systems. The system may or may not be inherent

(Chomsky, 1968, 1973; Bever et al., 1984). The consensus is that language is socially driven (Itard & Sequin in Lane, 1976; Montessori, 1912; Luria, 1979; Vygotsky, 1978; Ferreiro & Teberosky, 1979; Scinto, 1986; Lightfoot, 1986; Changeux, 1985; Llinas, 1986).

Naom Chomsky posits a "LAD," a "language acquisition device" (1968/1972). For Chomsky, a predisposition to language must be inherent. He writes, "When we study human language, we are approaching what some might call the 'human essence,' the distinctive qualities of mind that are, so far as we know, unique to man and that are inseparable from any critical phase of human existence, personal or social" (Chomsky, 1968/1972, p. 100).

Chomsky suggests that the "core problem" of studying human language is how it is acquired; how does a child come to understand "an indefinite number of expressions that are new to (that child's) experience.....able to produce such expressions...independently of detectable stimulus configurations?" (100). Given the insufficiency of the stimuli (Lightfoot, 1986), how are children able, by about the age of five, to generate what will potentially be an infinite number of well-formed sentences? (Chomsky, 1968/1972; Lightfoot, 1986). Chomsky concludes that the process of language is built into the human brain. He describes the process as "generative grammar." Leonard Scinto suggests that something called "langue," a "virtual system of form" is the ordering system beneath phenomena like generative grammar. Spoken language and written language are "manifestations of language (as "langue") in phonic or graphic substance respectively (Scinto, 1986, p. 26).

The neurobiologist Jean-Pierre Changeux suggests that there is a neural template for the way we go about making connections whether we act or we speak. We have a system for matching sensory information with some pre-existing criteria for ordered meaning. He calls this template-like process the "comparator" (1985). The comparator sounds very much like Scinto's "langue," a "virtual system of form." The triggering experience of being spoken to (Chomsky, 1968/1972) activates a patterning or an ordering mechanism for meaningful strings of sounds or symbols, whatever natural language the child has inherited in the "language lottery" (Lightfoot, 1986). Changeux writes about Chomsky's "humanly accessible grammar" (1985, p. 180). Both neurobiology and education agree that our brains organize and programs themselves for meaningful action, including language use, using some system of form (Gazzaniga, 1985, 1988; Llinas, 1988; Piaget, 1960; Kegan, 1982; Haldoway, 1989).

Research suggests that, just as spoken language is a manifestation of some inherent principle, so are symbolic play, drawing, and writing. All of the forms of symbolic representation describe a continuum (Vygotsky, 1978; Montessori, 1912; Piaget, 1955, 1959; Ferreiro & Teberosky, 1979; Wolf et al., 1988). It follows, then, that the predisposition in the child to draw and to write is as natural as the predisposition to speech. These skills scaffolded themselves upon each another. Society appears to determine to a large extent which skills emerge.

The predisposition to connect by making contextural order precedes sensori-motor coordination (Changeux, 1985; Lightfoot, 1986). Babies make sense out of the patterns of human faces before they can do much moving around (Bloom et al., 1985). Contextural order can be spatial, or it can be linguistic. It can, for

instance, express itself as art, or as language. Language qua language seems to be coded for, genetically, in different ways in connection with specific kinds of self-expression. Dysfunctional aspects of linguistic behavior are apparently hereditary (Pauls, 1988). In some cases, one form of symbolic expression appears to be coded for more strongly than another (Gardner, 1983).

A "DAD," or drawing acquisition device, if such a phenomenon should exist, appears to be universally programmed. Some children who can draw with ease have trouble with writing. Letter formation for some children is arduous. The meaning-making process itself, using the symbols we call letters, appears to be painful. These children are somehow dysfunctional in connection with writing. This condition, called dysgraphia, appears to relate to neural disconnection (Geschwind, 1982; Galaburda, 1987). Trouble with writing usually extends to reading (Orton, 1937). This condition is called dyslexia and includes a constellation of language-related learning difficulties (Keogh, 1988).

This study suggests that what the brain thinks is going on determines the ease or dis-ease that the brain experiences in connection with mark-making. An act called "drawing" may be easy, while an act called "writing" may be hard. If the two mark-making systems are so similar that the brain really thinks of them as extensions or ramifications of one system, where levels of abstraction built in over time, then are some of the ways "writing" is currently taught somehow disconnected? Are educators creating learning disabilities in connection with abstract symbol systems, like writing and math (Lieberman, 1984), by omitting early exploratory mark-making experience on less abstract levels? If writing were deliberately taught as an extension of drawing, would it make any difference, eventually, in literacy levels or with the numbers of students who are identified as learning disabled in connection with language?

Unlike the brains of laboratory animals, children's brains are not routinely sectioned and examined under the microscope for anomalies and for change. It is currently difficult to know for sure which students are disconnected from language-learning through poor teaching, and which students are disconnected because of neural wiring. Eventually, individual and averaged brain scans will help sort out levels and kinds of learning disabilities, allowing actual visualization of what works and what does not work, where, if not why, in the brain (Fox, 1988; Andrews, 1986).

If speaking and the making of meaningful marks are part of most children's genetic make-up, and if, like spoken language, given some stimulus by the environment, inadequate as it may be, these skills are programmed to unfold naturally, why are there any language disabled students and why do the numbers appear to be growing? Educators may simply be more sensitive to alternative learning styles and to a variety of anomalies and dysfunctions. There may always have been an appreciable number of children for whom writing and reading were difficult. However, the problem remains. Many children have trouble with writing and reading in elementary schools. Is it possible that teachers are trying to introduce skills in unnatural ways instead of allowing them, somehow, to unfold? Do some kinds of teaching stifle, or even cripple their unfolding? (Haldoway, 1989). Is it feasible to suggest that drawing might provide a more natural approach to writing?

There has already been a change of approach to teaching writing. The change is one of attitude as well as practice. The practice is called process writing; the assumption behind it is that children will write of their own accord and that engaging in the very process of writing will help to develop effective writing skills (Graves, 1979, 1983; Calkins, 1979, 1986; Holt, 1967; Zinsser, 1988; Haldoway, 1989). Still, some children continue to have difficulty with writing.

The predisposition to make marks of meaning, as well as meaningful strings of sounds appears to be built into our central nervous systems. It is possible that some children's brains are genetically programmed in ways that make spatial understanding easy but language-related understanding hard (Orton, 1937; Geschwind, 1982; Galaburda, 1987; Bloom et al, 1985)? Drawing may provide an approach to symbolic expression that allows a broad range of children to connect to their own processes of thought in personal ways that are transferrable.

Somehow, in the maelstrom of concern for the language-troubled child, the regular classroom has been neglected (Lieberman, 1984, 1986). Research suggests that strategies that are effective in special education will benefit the regular classroom (Lieberman, 1984). The idea of the general usefulness of remedial strategies has a long history (Itard & Sequin in Lane, 1976; Montessori, 1912; Vygotsky in Luria, 1979; Lieberman, 1984). If drawing helps writing in language-troubled children (Sheridan, 1989), it follows that a combination of drawing and writing will work as well for the apparently untroubled students.

2.4.2. An Overview of Theories of Early Childhood, Early Education, and Intelligence

Jerome Bruner wrote, " We are only beginning to appreciate how subtle the processes of growth are - how natural endowment and environment interact to bring into being what exists potentially in the human genetic code....There is some deep biological principle that abhors the imposition of one person's will on another - even when one is mother and the other is infant, and vice versa. The deepest principle is mutuality, and it begins early. But a baby is no clock and there is no timetable that can tell exactly when to expect a baby to reach a new landmark in his life" (Bruner in Brazelton, 1969, xiv). The suggestion is that the child needs to grow on his own, in child-timed ways.

Brazelton writes, " Since our culture's emphasis on the development of each individual's potential is now pressing us into more and earlier stimulation of this potential, I should like to stress again the balance between personality and cognitive development which may be crucial to the ultimate formation of healthy adults" (Brazelton 1969, p. 281). Brazelton suggests that children will take a new step, when they are ready. Forcing children intellectually may drain them emotionally (Brazelton 1969, p.281).

Bruner suggests (1969), "Pediatric care is going through a revolution, with much greater emphasis placed on the 'fitness of the environment' for growth - the environment not simply in the physical sense, but in the social and institutional sense as well. How to make a better environment in which to grow?" (Bruner in Brazelton, 1969, xv). Bruner suggests that it is not only early, independent exploration that occasions growth

of mind, but the kind of mutuality that does not dominate nor suppress. There is an element of nurturing mediation that the child needs in early education, as well (Feuerstein, 1981).

The consensus among educators, psychologists and pediatricians is that a nurturing environment is important to early development; it must be appropriate to the developmental age of the child. Pre-school programs will not affect changes unless "internal maturation has occurred" (Bechtle, 1973, 1975). Neurobiology, too, suggests that the expression of a new skill depends upon the unfolding of the appropriate neural network (Changeux, 1985).

About thirty years ago, educators recognized the existence of dysfunctional children as a problem and declared them an educational emergency (Weber, 1970). Elementary schools brought problem children to the attention of parents, communities, states, and the nation. Some children were hard, or impossible to teach. Since children, by law, must go to school, the question was asked, "How can these children become functional?"

Schools were made responsible. A host of special education programs were designed to meet the needs of children who, apparently, could not be taught in the regular classroom. Teachers and parents were led to believe that the intelligence of children could be measured, and that it was static. Arnold Gesell's theory of measurable "ages and stages" contributed to the idea of fixed intelligence (Weber 1970, p. 14). The inference was that parents and teachers could do nothing about intelligence one way or the other (Weber, 1970). This was both comforting and dispiriting. Some parents assumed a "hands off" attitude (Weber, 1970).

Paralleling Gesell's understanding of developmental intelligence was a psychoanalytic approach to personality. The personality was something that unfolded. If the child were met with sympathy, patience, and support in a highly permissive atmosphere, he might more easily adjust to the classroom and to society as he passed through stages of development (Weber 1970). Artistic expression was encouraged, in an undirected way. This led the way for schools where the choice of the learner would be honored, and the environment would be "autotelic," allowing activity for its own sake (Weber, 1970, p. 106). Adults became mediators of experience, but they did not initiate conversation or activity (Weber, 1970).

Expressions of child-centered programs were the Montessori Schools and the Steiner Schools, which emphasized the place of the arts and of the natural world, to children's learning.

The physician and educator Maria Montessori championed children's needs and abilities. She focussed on "sensitive periods" and "explosions into exploration" (Elkind, 1974). Current research in neurobiology suggests that Montessori's psychological observations of the early 1900's are still valid.

A change in thinking about development occurred (Weber, 1970). Abilities might not be fixed at birth. Perhaps stages of development were not absolutely invariant. Experience was important.

Two educators, J. McVicker Hunt and Benjamin Bloom, suggested that experience influenced the timing of development and the way in which it happened. They suggested that neither development nor intelligence were fixed (Weber 1970). The idea that changes in thinking could be brought about by the very act of thought gained vogue in the 1960's. These transformations in thinking skills involved an inward integration and an outward adaptation (Piaget, in Weber 1970). The child was recognized as playing an active role in these

processes.(Weber 1970). According to Piaget, self-regulation and self-correction are critical aspects of the developing mind (1960).

A 1987 evaluation of early intervention programs suggests that both the home and the school must continue early enrichment (Denhoff 1981; Haskins 1978). The school gets children too late to impact early development and cannot counteract on-going negative experiences at home. Currently, there is an attempt to involve parents in the early and continuing care of their children (Brazelton, 1969; Chamberlin, 1987). Schools understand that a lion's share of general education goes on in the home. There are programs that support, in particular, the parents of handicapped children (REACH). In addition, laws mandate that local elementary schools take children from the age of three who have special needs, tailoring programs to them.

Pediatrics has moved from concentrating on the sick baby, to the well baby, addressing the relationship between mother and child (Brazelton, 1969). Pediatrics attempts to educate parents about proper baby and early child care, educating parents on the critical role they play in the physical and mental health of the child. There is a psychological twist involved in the focus on the mother as the environment of the child. There is evidence that the mother's response depends upon the baby's development (Shonkoif & Hauser-Cram 1987). A baby who is slow to develop may initiate a lack of responsiveness in the mother. Pediatricians and community intervention programs have to help mothers to understand their reactions to their disabled or developmentally delayed children so that the mothers can deal effectively with these children . Parents of children with motor difficulties also adopt patterns of behavior that can "impede a child's learning" (Shonkoff & Hauser-Cram). Parental expectation, or lack of expectation bears on development.

The attitude of the 1950's and 1960's was that dysfunction in the classroom impacted the family and community. The attitude has become that dysfunction in the family impacts the classroom and the community. There has been a shift from trying to fix the child, to trying to fix the environment (Weber, 1970).

There is an expanded understanding of what it is to be "at risk." At age two weeks, there may be considerable physical and demographic findings; over a six-month period, there may be instability in these findings; the conclusions are that " early education services should not be instructed to admit only 'high-risk' newborns, since this would exclude many children whose needs would become manifest later and would take in a number of children falsely identified (Levine et al., 1977). Concomitantly, there are hazards to early identification. It is "inappropriate to offer services only to economically deprived children, since we can see the significant indicators of need also exist in children with high demographic ratings" (Levine et al. 1977).

The idea of being at risk is expanded by the writings of Gardner and Walters (1983). There may be as many as seven different kinds of intelligence, including musical, mathematical, social, and bodily intelligence, as well as linguistic intelligence. Some children could even be said to be "'at promise ' for one kind of intelligence, while others are 'at risk' for that same "frame of mind" (1983). Gardner writes, " In the absense of special aids, those at risk for one kind of intelligence will be most likely to fail in tasks involving that intelligence" (1983). This point of view moves risk beyond early education into the elementary classroom. Gardner's conclusion is that there must be ways for children to develop musical, artistic,

mathematical, social, and bodily intelligences, or they will not be developed. Children need to "discover something of their own peculiar interests and abilities" (Walters & Gardner). The responsibility is placed on the teacher to divine, and to provide the "kindling" experience for each child in connection with the perceived particular intelligence (Gardner, 1983). The onus is back on the classroom to provide enrichment.

In line with educational research about the multiple nature of intelligence, Shonkoff & Hauser-Cram discuss the inappropriateness of IQ tests. According to these researchers, current intervention programs report the most success with programs for the "developmentally delayed," and less for the retarded (Shonkoff & Hauser-Cram 1987). One of the major problems is measurement. Conventional tests do not work for infants with motor deficits, or for children with "atypical developmental patterns" (Shonkoff & Hauser-Cram 1987). "The popularity of IQ tests often overshadows other important measurable functions, including social competence, behavior, and motivation" (1987). Martha Denckla, too, describes the often ignored social gifts of the learning disabled child (1988). In the case of the older attention deficit and learning disabled child there appears to be a need for ways other than the verbal and the mathematical to measure intelligence.

Maloney and Ward in their book *Psychological Assessments* write, "Intelligence is considered to be a function of the interaction of multiple variables...including the cerebral, sensory, motor, emotional, and cultural...this model suggests that no one variable in and of itself (with the possible exception of severe cerebral insult), necessarily leads to mental retardation...It is the interaction among these variables that is important, and it is this very interaction that should be the main focus of developmental research" (Maloney and Ward 1976 p.235).

Maloney & Ward write, "The striking feature is that people differ in terms of intelligence, often markedly" (Maloney and Ward 1976, p. 202-204).

"The thrust of the developmental model would be that the mentally retarded think or know differently" (1976, p. 213). Maloney and Ward make this comment; "It is now believed that the determination of adequate developmental programs and their effective application at the 'critical periods' of development will result in phenotypes not encumbered with the maladaptive behaviors, referred to as mental retardation...Finally, in terms of retardation, there is a broader concept of remediation" (Maloney & Ward, 1976, p. 236).

This rather astonishing statement suggests that what is called mental retardation is "maladaptive behavior." The implication is that the environment is at fault. The right kinds of programs at the right times may preclude mental retardation. Intelligent behavior clearly relates to the environment.

Haskins et al. suggest much the same thing: "For a large group in our society, the natural environment will not adequately support the development of intelligence. Therefore, these children fall towards the lower end of the possible phenotypes for intelligence specified by their genotype" (Haskins et al., 1978, p.99).

How children interact with their environment determines, to some extent, how they will think. Levels and kinds of action and levels and kinds of thinking are related. The child and the environment share in the responsibility for mutual care.

2.4.3 Early Experience and Language Acquisition

Infant stimulation programs were developed for babies born "at risk" because of low birth weight, or pre-, peri-, or post-natal trauma that might or did result in physical or mental handicaps. Sensory integration is at the heart of infant stimulation programs. The goal of such programs was to prevent mental retardation and school failure by stimulating the babies' in multi-modal ways. There was a presumption that cross-modal effects were salubrious (Ayres, 1977). "There are studies to show that early preschool stimulation programs for the baby from low socioeconomic environments have both short-term and long-term benefits, providing that the support systems are maintained during the school years (Denhoff 1981). Enrichment must be maintained past infancy.

An article evaluating infant stimulation programs suggests that the mother as a conversationalist is one of the single most important factors in the normal developmental growth of children. Haskins et al. write, "You have to enrich the mother, especially in the ability to initiate 'verbal interaction...in the context of a challenging task'" (Haskins et al., 1978, p. 110).

If the mother and the elementary school do not help to sustain enrichment programs, by the third grade in elementary school, there is "wash out" of the 20 or so point gain in IQ (Haskins et al., 1978, p. 105). Haskins concludes that early stimulation programs "have difficulty producing gains in IQ that last after children enter the public schools" (Haskins et al. 1978, p. 111).

The mother or the caretaking adults must talk with children about things of substance; schools must sustain this kind of meaningful linguistic interaction. It is, apparently, no good to stimulate the bodies and minds of babies and young children if the neurophysiological gains are lost at home and at school.

An approach called Paideia took the challenge of language development through verbal exchanges of consequence to heart. Paideia is a Greek word for "the rearing or bringing up of a child." Children needed coaching in skill development. According to the Paideia approach, effective coaching involves a "lively conversation about one's skills." The aim is to make the student a "habitual, probing questioner" (Sizer). The focus of the "The Paideia Proposal" is the development of critical judgement.

The greatest impact of intervention programs for disabled infants and their families appears to be in connection with language ability. According to the research, this is the least assessed component in intervention programs. It is, however associated with the highest mean effect (Shonkoff & Hauser-Cram, 1987). Children with motor impairments may not receive as comprehensive language programs as those with other types of developmental delays. Children with motor impairments may look less capable than they are, intellectually. The mildly impaired do better the younger they get into programs. The severely handicapped have a constant rate of improvement no matter when they come into the programs. Well-defined curricula have better effects than less structured approaches (Shonkoff & Hauser-Cram, 1987).

Jean Ayres' work suggests that sensory-motor development bears on this kind of success. For Ayres, there must be sensory integration. If there is not, learning deficits are the result (1977;1974;1972;1968).

If retardation is maladaptive behavior (Maloney & Ward, 1976), then it follows that the environment that produces retardation must be compatible with being retarded. If the behavior is adaptive in an effective sense, then the environment that produces intelligent behavior must be conducive in that sense. To adapt effectively, an organism must be challenged by situations it can deal with. The idea of successful interaction appears to be central to a sound developmental theory of intelligence.

Experience clearly impacts intellectual development. Successful early experience involves sensory stimulation and integration. In connection with language, it must involve conversations of consequence. The dynamics of intelligence relate both to genetic unfolding and to the quality of early experience. Trying to measure where any child may be in terms of intellectual development at any one time appears to be extremely difficult, and it may be counterproductive. The best approach for parents and for teachers to take is an alert, nurturing attitude when raising or educating children. This kind of attitude will allow the people who influence children's minds and lives to provide children with places that approximate the optimal "natural" learning environment for the child.

2.4.4 Multi-Sensory Remedial Language Programs

In 1853 a Dublin doctor, William Wilde, published his observations on children who were mute but not deaf. Children had specific, isolatable language dysfunctions. In 1865, W. Morgan published a paper on what would later be called developmental dyslexia. Morgan's paper detonated an explosion of papers about dyslexia in the English and German medical literature. There were a number of children who had defects in visual, auditory, or associational processes having to do with language (Benton, 1979). Because the dysfunction had to do with words, these students were called alexic ("without reading") or dyslexic ("pain with reading"). Because they could not "see" words, touch was thought to be the way to teach these children to read. This theory of the 1900's gave way to a number of psychological theories and then to a number of neurological theories.

In the 1930's, Leta and Samuel Orton brought the phenomenon of specific reading disabilities to the attention of the medical profession. Some children could not read. They were not retarded. Their brains, it appeared, were different. Psychology and education took note of the information.

Orton wrote, "One side of the brain is all important for the language process and the other side is either useless or unused" (Orton, 1964, p.27). Orton concluded that damage to the language area or a failure of the brain to localize language functions in the language-dominant hemisphere or some genetic predisposition to dysfunction could result in striking language losses. These losses were known as language aphasias. Children could be word-blind; they could be word-deaf; they could have trouble with handwriting; they could have trouble with speech; they generally had trouble with reading (Orton, 1930). Maybe handedness had something to do with it, maybe eyedness. There was probably trouble with motor integration (Orton, 1930).

Orton concentrated on the stages of the physical production of speech and in the motoric aspects of handwriting, and of reading. He emphasized the developmental nature of these defects and delays.

Orton concluded that "such disorders should respond to specific training if we become sufficiently keen in our diagnosis and if we prove ourselves clever enough to devise the proper training methods to meet the needs of each particular case" (Orton 1937, p.200).

Orton was the first researcher to point out that there might be compensatory, inherent advantages for the dyslexic child in connection with enhanced spatial skills. Furthermore, Orton observed that the sisters of dyslexic boys were often highly talented (Geschwind, 1982, p. 17).

Orton pioneered a three-way, multisensory approach to remediating dyslexia, using touch, hearing, and body movement (Geschwind, 1982). This became the Orton-Gillingham method which is used today.

This multi-sensory approach was known as the VAK method, or visual, aural, kinaesthetic approach. A variation on this developed called VAKT, adding the tactile to this form of physical stimulation for the sake of literacy. Children drew letters in sand, and they ran their hands over letters cut out of sandpaper or grooved in clay (The Fernald approach, Hynd & Cohen, 1983). Touch appeared to provide an important remedial strategy for reading.

Was remediation possible through the ear? An aural remedial strategy called the I.T.A., or Initial Teaching Alphabet was developed (Downing, 1969). Words were spelled the way they sounded. Then they were translated to T.O., or traditional orthography.

Another aural approach was teaching sounds before letters (Lebrun & Caen, 1975). Eventually, children learned to associate the sound with a letter, and, later, they learned to write the letter to go with the sound. In other words, "an alphabet script consists of rendering of phonemes (sounds) through graphemes (drawings)." The idea of drawing as an initial way to represent sound might be useful to writing.

Another idea in connection with sound and training the ear was that clearly spoken language was the basis for writing (Lebrun & Caen, 1975, p. 205).

One problem arose with the aural approach. It appeared that there was a "dysphonetic subgroup" (Hynd & Cohen, 1983). This children could not listen to sounds and associate them even with the phoneme, or the word picture for the sound.

Kephart in 1971 concluded that the dyslexic student needed visuo-motor training. He designed a kind of calisthenics for the eyes. The problem, he thought, was ocular control.

Subjects who came to intervention programs for remediation of other language-related problems like dysgraphia, or unintelligible handwriting, showed, in general, "poor body tone and postural control" (Cowden, 1980). This poor physical presentation suggested that "we function as a sensori-integrative-motor-sensory-feedback system, and with the omission of any component we stop functioning as humans" (Cowden, 1980). Cowden's program used balls and frisbees to train dysgraphic students in visual tracking and in bilateral tasks. The program involved a great deal of individualized physical training and exercise, with emphasis on hand-eye coordination. Individualized training in visual tracking appeared to help the dysgraphic student.

The emphasis in the perceptual diagnosis of what was troubling the student who had writing and reading problems switched from a kinetic to a more static understanding. Dyslexic students had trouble with

"figure-ground perceptual ability" (Sovik, 1984). They could not discriminate what was important in a text; were letters or the spaces around them important? However, the solution appeared to be training; once children were talked to about letter formation and shown how to form letters, they improved their writing significantly (Sovik, 1984).

Beyond practice with figure-ground discrimination, there was directionality training (Bechtle, 1976; Steen & Jansen, 1977). Children needed to learn about right and left and up and down in order to tell letters apart and to read and write them facing the right ways.

The idea became, in connection with directionality, that children who reversed letters did not have perceptual defects; they just needed training. However, training in left and right and up and down did not appear to facilitate writing or reading.

Current viewpoints are that young children are simply not interested in directionality. They are not confused. They are simply not concerned with the ways that letters face (Conversation, Jackie Haines, Gesell Institute, 1988). This researcher has observed, in addition, that a child can draw an object in a reversed position with complete surety and then demonstrate clearly where the front of the object is and where the front of the object in the drawing is. This observed tendency (Sheridan, 1985-89) toward natural reversal in drawing objects might provide fertile ground for directionality research in writing.

Research into directionality training suggested that, over the age of 7, such training had no effects on children who reverse letters and words (Steen & Jansson, 1977). Additionally, it was concluded that, up until 5 or so, reversals were considered normal (Steen & Janssen, 1977).

Another remedial approach to difficulties with written language was called the Delman-Delacato method. It was what is called a psycholinguistic approach, and it assumed that the way children thought about language was at the heart of the problems. There were two aspects to literacy, process and organization. The Delman-Delacato method tackled the process of receiving stimuli and of making meaningful connections between them. There had to be integrity in the sensory and motor processes (Myers, 1969). The child who could not write was having trouble with sensory-motor patterns (Myers, 1969, p. 173). The child who could not write might not be able to read.

Later studies focussed on psychomotor approaches to intervention. Sensori-motor stimulation of the eyes, ears, sense of touch, and the whole body is used to impact hand-writing (Cowden, 1980). The vestibular pathways (in the ears) are considered to be critical for experience feedback (Cowden, 1980; Ottenbacher, 1984, 1987).

Besides the multi-sensory approaches, there was a psycholinguistic approach, which tried to analyze the receiving and transforming of stimuli. This approach to dyslexia used perceptual training. It assumes that the child can interpret and organize concretely, but not abstractly (Hynd & Cohn, 1983).

The neuropsychological approach is in favor now. It is a mind/body approach that plays to children's strengths (Hynd & Cohn, 1983, p. 223). It says, given the neurophysiological profile of a certain child, what can we do? It does not rely on trying to retrain some possibly unremediable part of the brain (223). It assumes that what might be broken might not be fixable. If, for instance, the right hemisphere or some

particular ability appears to be stronger, the conclusion is to "play to it." Children with language-related learning disabilities appear to have particular spatial strengths, as athletes, and as artists (Denckla, 1988). The literature has not singled out the drawing strengths of dyslexic children.

Research into dyslexia resulted in two emotion-based approaches. One was called Frostig-Horne. The intent was to restore confidence (Hynd & Cohn, 1983, p. 221) by training the dyslexic student to distinguish figure from ground, and to determine form constancy, and position in space (221). (As will be discussed below, figure/ground distinction is no trivial matter, and is a central concern in art education, as is position in space) Another emotion-based approach was that of Hartlage and Reynolds (1981). They stressed the danger of remedial programs for self-concept. Separating the child from the regular classroom injured self-image. What to do in place of remediation was the problem. The idea was to play to the students' strengths, whatever they might be (Hartlage, 1981; Hartlage & Reynolds, 1981; Reynolds, 1981). As has been suggested, spatial understanding appears to be one considerable strength the child has who has trouble with writing and reading.

Currently, educators underscore the fact that feelings of success and control are important to self-image (Kegan, 1982). Educators have reached this understanding, as they have about so many things, by studying the child who is unhappy and who feels unsuccessful. The child who feels this way does not learn well (Cohen, 1986). The child feels "chronic, low-level depression and relatively high, free floating anxiety...learning disabilities ...seem to contribute to a sense of being traumatized and to character rigidity" (Cohen, 1988). Children with attentional problems and learning problems have "profound feelings of inadequacy" (Levine & Jordan, 1987). Children who have trouble with reading and writing respond with "negative compensatory mechanisms, including rebellion and misbehavior... the nerve of endeavor is severed...(children with learning disabilities need) empathy and rapport." Once esteem has been rebuilt, and the student has genuine success, there is a chance for overcoming perceptual confusions (Bechtle, 1975).

Not being able to learn in traditional ways sets a child up for bad feelings. The conclusion that educators have come to is that we need to devise alternate ways for these children to learn to learn.

Part of the cluster of problems (McCracken, 1986) that plague language-troubled students may not have so much to do with sensory-motor problems as with attention. A child may not only be LD, or learning disabled, but AD, or suffering from attention deficit, or ADD, suffering from an attention deficit disorder. The problem may be neurochemical, in part or wholly out of the student's control (Bloom et al., 1985; Snyder, 1987). The question is whether physical training can impact what may be over- or under activity of a neurochemical attentional system. Normal children appear to respond to stimulant medication in the same ways as children with attention deficit hyperactivity disorder, or ADHD (Anastopoulos & Barkley, 1988). It is possible that non-pharmacological approaches, involving emotion and action, can impact neurochemistry in ways that are not yet fully appreciated (Snyder, 1987). Strategies that help children learn to regulate themselves attentionally may prove most effective in the long run in bringing children "up to," or "down to" speed, making it possible for them to concentrate on the task at hand.

Many factors relate to attentional disorders. Some are hereditary and some are environmental. The suspicion is that genetics plays a considerable part in these disorders (Anastopoulos & Barkley, 1988).

One of the motoric tests devised in the last ten years for dyslexics involves drawing. In 1980, ten dyslexic boys in Melbourne were asked to draw and write about their favorite T.V. program. There was no difference between them and the other boys on the drawing task (Stanley & Watson, 1980).

Mattis (1981), too, advocates a visual perceptual approach to dyslexia that involves drawing (Hynd & Cohn 1983, p. 227). The child selects a letter from his name and is asked to describe it. The letter is removed, and he draws it. "Once the child can reliably draw a letter, its name and sound referent are introduced. Eventually the verbal description is faded out by having the child gradually decrease the amplitude of his vocalization when drawing " (Hynd & Cohn, 1983, p. 228). The act of drawing parts of the word that names the self has positive affective and cognitive effect.

Kasner suggests that drawing pictures of what words mean can help the dyslexic student acquire a vocabulary which has personal meaning. This personal vocabulary is learned by the child and can then be read (Kasner, 1985)

The question of major concern in connection with language disabled students has to do with knowledge and with problem solving. The question is whether, because of language disabilities, dyslexic children are doomed to knowing less and therefore to thinking less well? In trying to help dyslexic students learn to read, the motivating force should be the conviction that the ability to read is critical to form a knowledge base (Snider & Tarver, 1987). The idea behind the conviction is that a broad knowledge base is indispensable to effective problem solving.

Snider and Tarver write, "Problem solving difficulty of novices can be attributed to the inadequacies of their knowledge bases and to limitations in their processing capabilities...LD (learning disabled) students are not necessarily deficient in metacognitive skills, just less skilled in reading...they seem to plateau at the fourth- or fifth- grade reading level early in high school and show no further progress...they are unable to demonstrate their thinking ability...their knowledge base is small...their concepts are imprecise" (Snider & Tarver, 1987).

According to Snider and Tarver, the solution is to help these students with automatic decoding. LD students stay bogged down in "stage 1" of reading, which involves decoding. They have trouble with fluency, reading for meaning, and therefore with acquiring knowledge. They have no bases for hypothesizing.

In conclusion, language is important to intelligence because the ability to read written language is a way to know. Levels of knowing are based on levels of information. Levels of information impact problem solving abilities.

At the present, the computer is providing new ways of knowing for a wide range of children who have physical or mental handicaps, or whose brains appear to function differently (Weir, 1980, 1981; Watt, 1980). For all children, multi-sensory ways of acquiring knowledge are useful and compelling. Both the computer and the arts have appreciable visual holding power.

The educational research has provided a handful of cases in which drawing was used diagnostically and remedially as a "benign stimulus" (the term Dr. Shaywitz at Yale used, in conversation, about the possible effect of drawing on writing). The research of Shaywitz (1988), Kasner (1985), Hynd & Cohn (1983), Mattis (1981), and Stanley & Wason (1980) have observed that drawing has a positive influence on students who are having trouble with written language.

Currently, remedial approaches try to locate the intact parts of the system in the dyslexic student and to use them. The current attitude is to try to understand the dyslexic child - making sure that the child understands himself in this way, too - as someone who has "certain neurophysiological strengths that can be reorganized and developed to assume the learning processes necessary for reading at some level" (Hynd & Cohn 1983, pp.224-225).

The understanding arising out of research into language disabilities that may illuminate future educational strategies is that feelings of success have neurophysiological ramifications. Good feelings affect neural networks. Feelings of powerlessness and of worthlessness go hand-in-hand with disabilities in writing and reading. The neurobiological research made clear that successful problem solving distinguishes and develops intelligence. Successful problem solving continues to be a very important consideration in educational research because it impacts emotion as well as cognition. The combined research suggests that drawing would be one ideal way that the child who has trouble with writing and reading can feel good about the process of building a knowledge base.

The research suggests that activities that capitalize on children's strengths will have remedial effects on attention and on language dysfunctions. The literature has not yet made the suggestion that drawing can be used as a non-pharmacological approach to attentional linguistic disorders. If all of the suggestions about sensory motor stimulation, about spatial strengths, about drawing skills are added up, however, it is possible to conclude that drawing might provide some of the positive effects that good affect brings about neurobiologically.

In conclusion, developmental stimulation programs, early enrichment programs, and remedial language programs share an understanding that sensory-motor stimulation and perceptual integration are important to writing and reading, as well as feelings of success and control. It remains to make the jump from theory to practice. Training in drawing might operationalize useful general conclusions from the theoretical and practical research.

2.4.5. Vision, Attention, Memory, Learning and Language Acquisition from the Point of View of Art Education

A logical places to look for the deliberate connection between vision, attention, and the development of affect and intellect is in connection with art education. Here, there is clear support and understanding for the working relationship between intelligence and problem-solving abilities in connection with the use of

symbolic languages. In addition, art education places a premium on feelings of self-esteem, and of control (Eisner, 1982).

The field of art education addresses the issues of stimulation, integration, perception, abstraction, emotion, vision, and attention.

According to Rudolph Arnheim, vision is central to thought. "A review of what is known about perception, and especially about sight, made me realize that the remarkable mechanisms by which the senses understand the environment are all but identical with the operations described by the psychology of thinking" (Arnheim, 1969, v).

Arnheim writes, "Active selectivity is a basic trait of vision, as it is a trait of any intelligent concern: and the most elementary preference to be noted is that for changes in the environment. The organism, to whose needs vision is geared, is naturally more interested in changes than in immobility. When something appears or disappears, moves from one place to another, changes its shape or size or color or brightness, the observing person or animal may find his own condition altered: an enemy approaching, an opportunity escaping, a demand to be met, a signal to be obeyed" (1969, p.20).

Human beings orient to every change in the environment, because they need to examine, at least briefly, all changes. From among all of these changing things, humans select one or two for full attention.

This ability to orient to the novel is, according to Arnheim, a high-order skill. He writes, "The organized response of fixation can be assumed to correspond to an equally orderly organization of the perceived field of vision, a simple distinction between a neutral ground and prominent 'figure.' It is a highly abstract primary experience. The field (or ground) is reduced to 'noise,' i.e., the undifferentiated foil from which the positive message is set off" (Arnheim, 1969, p.168).

When Arnheim uses the word "simple," he is not denigrating the fundamental ability of the human mind to distinguish the subject from its context, to distinguish figure from ground. It is a high level ordering ability. It is a strategic approach to a wealth of undifferentiated information in the field of vision. As suggested in the section on neurobiological research, the ability to order thought appears to be inherent to mind; it is a distinguishing characteristic of the mind, particularly in connection with language.

The question asked by members of Project Zero at Harvard is whether art education is a specialized field. Can its emotional and intellectual advantages be made more generally available (Goodman, 1964)? One of the sacred provinces of art is creativity. David Perkins suggests that creativity can be demythologized if its strategies are described in applicable ways (1984). Perkins suggests that creativity has to do with how some minds approach problem solving. A person can be creative "by design" (Perkins 1984). The design for "creative" behavior has to do with attention to purpose, mobility "more than fluency," "working at the edge more than at the center of one's competence," being "objective as well as subjective," and being "intrinsically motivated." Perkins suggests, "Creative people feel that they, rather than other people, are in charge, and that they choose what to do and how to do it" (Perkins, 1984). Art education shares insights from neurobiology about the connection between control, attention, flexibility, and challenge to the development of effective thought.

According to Perkins, attention and effort and the possibility of open-ended solutions are preconditions for creative problem solving. Perkins feels that education is too "right answer oriented." This kind of education works against creativity. Perkins writes, "Pieces of knowledge are designs shaped by human invention. "Children can learn that acquiring knowledge is action in design" (Perkins, 1984). "The mind's best work" can be the result of a deliberate approach to problem solving (Perkins, 1981). Perkins appears to feel about education as Montessori (1912) did; current practices may be injurious to the development of thinking skills.

Elliot Eisner has written extensively about the usefulness of art education to the development of mind. He suggests that a thorough psychological understanding of children should instruct educators. In his book, *Cognition and Curriculum, A Basis for Deciding What to Teach* (1982), Eisner emphasizes the role that the senses play in the development of children's minds. Eisner wonders what kind of stimuli educators are failing to provide. He suggests that cultivation of the senses is "the primary means for expanding our consciousness" (Eisner, 1982, p. 35). Eisner suggests that the distinction between feeling and knowing has become dichotomized, or "reified," and that this distinction results in differing attitudes toward art and academics. Eisner writes, "Affect is supposed to deal with feeling and not knowing, while cognition supposedly deals with knowing and not with feeling" (Eisner, 1982). Eisner states firmly that feeling is not antithetic to logical operations.

It is fallacious, according to Eisner, to separate feeling and knowing. It is also wrong to say that children learn only one thing at a time. In addition, Eisner maintains that it is not true that only discursive reduction (or language) that carries meaning. Other non-linguistic, sensory-based expressions carry meaning as well (Eisner, 1982).

Eisner suggests that syntax (which, Eisner reminds the reader, is word that "means 'to arrange,'" a word which is commonly used in connection with language, more truly relates to the arrangement of any parts with the whole. "In the arts, for example, a variety of the terms used relate to the problem of putting and arranging elements into a coherent structure" (Eisner, 1982, p. 63). Clearly, for Eisner, the arts provide a non-discursive, syntactical, sensory, affective way to problem solve that expands consciousness. Educational research suggested that one of the most important affective kinds of training for the dyslexic had to do with spatial relations in connection with how parts related to wholes (Hynd & Cohn, 1983). Educational research also suggested that stimulation and integration of the senses is critical to early infant stimulation programs, and to remedial approaches to language-troubled students. The research implied that one of the problems troubling the dyslexic student might have to do with abstraction. Art education routinely deals with problems and exercises in abstraction.

The arts provide powerful ways to get at issues of vision, attention, motivation, and integration, and at levels of organization, including abstraction. Drawing is a traditional part of art education programs. It follows that drawing has considerable developmental and remedial educational potential.

2.4.6 Symbolic Representation

2.4.6.1 Piaget: Symbols and Operations

For Piaget, symbolic representation in the mind happens when action in the physical world is interiorised. Mind, including language-use, does not exist above nor apart from biological processes. Language is an extension and a ramification of language (Piaget, 1960).

Piaget resolves logic and mathematics to "genuine actions, produced by the subject and a possible experiment on reality. The problem is therefore to understand how operations arise out of material action, and what laws of equilibrium govern their evolution; operations are thus...groupings...into complex systems...that are mobile and reversible" (Piaget 1960, pp.16-17).

Piaget maintains that a mental image is "not a primary fact... it is a sensori-motor schemata...an active copy...an internal imitation" (126). For Piaget, these imitations of actions eventually become symbols. The symbols become language. Language is a "new aspect of sensori-motor behavior and consists in representing one thing by another" (126).

Piaget writes, "Representation ...goes beyond the present...it evokes what lies outside the immediate perceptual ..field. Representation is thus the union of a 'signifier,' that allows or recalls, with a 'signified,' some entity supplied by thought. For Piaget, language is the main factor in both the formation and socialisation of representations .. the beginnings of representation require the support of a system of usable 'signifiers' ...for this reason the child's thought is much more symbolic than that of the adult" (Piaget, 1962, p. 273).

Because the child is a beginner at mental representations, the child, even more than the adult, deals with "signifiers," or "interiorised imitation" (Piaget, 1962, p. 273). According to Piaget, children make interior imitations in abundance (1962). Piaget's observation echoes Kosslyn's comment about children as particularly gifted visualizers (Kosslyn, 1983).

Piaget asks why the body, using the mind, moves away from the physical world, into the inner mental world of operations? He suggests the the move involves a progressive understanding of spatial operations. At some point, understanding of outer spaces which permit physical action over short distances, results in building of the kind of inner structures which permit mental actions " beyond the limits of near space and time" (1960, p.121). Once the child moves from the idea of near, to far (which recalls Arnheim's observations about the importance of vision as "thinking-at-a-distance," 1969), the child moves away from the object, to thought about the object. This analysis of Piaget's jibes with LLinas and Pellionz' description of space phase maps, and with Kosslyn's coordinate and categorical systems, as well, where spatial understanding comes first in mental operations, with categorical understanding (including language) second.

As Maloney & Ward write, the move is away from actual objects in the real world to "internally organized conceptual systems which represent reality" (1976, p. 198).

Piaget's theory of developmental intelligence is dynamic. "Along with all other species, man's biological inheritance provides him with intrinsic tendencies to organize his actions and thoughts in the adaptive process of maintaining an equilibrium between himself and his environment...man creatively interacts with his environment, changing himself in the process" (Maloney & Ward 1976, p. 201). Piaget understands language as an adaptive and transformational part of the biological unfolding of intelligent thought. There is a continuum for Piaget between biological unfolding, logical action, and levels of symbolic representation. The distance between the educator, Piaget, and the neurobiologist, Jean-Pierre Changeux, is not great.

It is possible to ground an understanding of language in the largest sense both in biological unfolding and in experience and, in addition, in something like truth-or what is called, in linguistics, the Platonist alternative (Bever et al., 1984). Whether Chomsky's generative grammar (1968/1972), or Scinto's "langue" (1988), or Changeux's template for ordered patterns of meaning (1985), or Piagetian sensori-motor operations, or space phase maps and tensorial transformations and settling into minimal energy states (LLinas in Churchland 1986) underlie image-making, including language, or whether language is a branch of mathematics, where, like numbers and systems of numbers, sentences and systems of sentences are part of what is real (Bever et al., 1984) depends upon one's point of view. In the final analysis, the fundamental nature of language is of secondary concern to this study. Of primary concern are practical ways to encourage its successful unfolding.

2.4.6.2 Symbols and the Arts

Project Zero at Harvard was founded by Nelson Goodman in 1966. Research has been concerned with "human symbolic functioning, with special emphasis on the creation and comprehension of the arts" (Project Zero publication, "Project Zero: the development group," 1985). In its initial phase (1967-1971), research focussed on problem solving in the arts. In the early 70's, the emphasis was the psychology of art. Presently, both symbolic development and the development of other kinds of thinking skills are related concerns (Gardner, 1983).

The supposition of Project Zero was that we must start at ground zero in our approach to art education. General knowledge about art education was almost nonexistent in our country, Goodman felt, in the 1960's. The idea was that artistic behavior had cognitive importance, and that it could be "rationally, usefully, constructively studied" (Howard, 1971). The questions Project Zero asked in the 1970's were whether the arts drew "upon the ordinary range of cognitive and motor abilities possessed by most people?" and whether "the solutions to artistic problems (were) anything like the solutions to scientific problems (Howard, 1971).

Vernon Howard of Project Zero suggested that both the arts and sciences call upon the same human capacities "to recognize auditory and visual patterns, percieve rhythm and symmetry, use language, and

develop motor skills." Both the arts and the sciences aimed at understanding through the use of symbol systems.

The research explored how and why children engaged in symbolic representation, "non-linguistically, and linguistically" (Howard 1971).

By the 1980's, the focus for Project Zero had become the nature and the teaching of thinking skills. It researched depth cues in line drawings (Perkins, 1968), style detection (Gardner, 1969), the recognition of melody (White, 1960), musical, mathematical, and scientific talents in normal and gifted children (Walters et al., 1985), the development of metaphoric understanding (Winner et al., 1975; 1980), visual memory (Rosenblatt & Winner 1988), spatial perspective and rotation problems (Ives & Rakow 1980), alexia without agraphia (an inability to read without an inability to write; Judd & Gardner, 1980), story-telling (Ives et al., 1981), rhythm and symmetry (Garner, 1968), feed-back loops in sensory-motor systems (Held, 1963), arts in alternative schools (Leondar, 1971). Perkins teased apart the discrete steps involved in creativity and said that it was teachable; a student could be creative by design (1981;1984).

One of the conclusions was that early informal ways of learning can teach us to "invert the usual priorities" that insist that we start with notational systems (Howard, 1971). Children respond to visual images, they have what is called "physiognomic perception," a mode of experience common to children which links several senses in a "sharply prominent" way (Wolf, 1987). As Arnheim makes so clear, the use of the senses in non-notational ways is an early and enduring part of intelligent behavior (Arnheim, 1979).

Project Zero currently describes "the human mind (as) capable of diverse forms of thinking. ...some competence or 'literacy' in each form of thinking seems a reasonable educational goal" (Gardner & Grunbaum, 1986). Project Zero concludes that there is no single form of artistic thinking (Gardner & Grunbaum, 1986). "Literacy" as a goal means competence in a variety of kinds of symbol systems, including the one we traditionally call written language.

One of the more recent questions Project Zero has attempted to answer is "whether the linguistic-nonlinguistic distinction (has) psychological significance" (Howard, 1971). In 1971, Project Zero upheld the distinction. By 1988, the Project had changed its point of view, suggesting that the spatial-verbal distinction might be dichotomous, or even spurious (Wolf et al, 1988).

The question Project Zero has been asking itself for the past twenty years is this: "(Are) different information processing skills ...necessary to deal with such different symbol systems? ...(is there) a distinction between the systems (and if there was, this)... raised interesting questions about the transfer of learning between and within the two realms" (Howard, 1971).

Project Zero suggests that research must "move beyond the traditional spatial-verbal dichotomy, and determine the actual processes used to solve problems children encounter and develop training strategies utilizing the appropriate medium" (Ives & Rokow, 1980).

Project Zero's research has done just this. Since 1971, the Project has come to the conclusion that the linguistic-nonlinguistic distinction is invalid. The research group suggests that the arts should be included in education because they provide approaches to symbolic expression appropriate to pre-linguistic or

para-linguistic problem solving. Other relevant conclusions are: literacy learning is an active process, not an imitative one (Wolf et al., 1988); children "exhibit many individual approaches to solving the same problem;" children who explore different ways to record information, and who ask "searching questions about how to capture information, consistently outperform children whose early learning ..contains the more rote aspects of letters and numbers" (Wolf et al., 1988).

The consensus is that children need training in literacy skills. The researchers conclude that there is " a need for a more complex model of literacy learning" in which languages are understood to be various. There is a "range of symbolic forms (they) can use (that) far exceeds letters and numbers" (Wolf et al., 1988).

These conclusions from Project Zero are important for this study.

2.4.7 Theories of Drawing

At the outset, it is important to define one kind of drawing; the "tadpole" drawing is the one children do that looks like a tadpole, but which is a representation of the human body. It is an oblong with legs, arms, and eyes. It looks like a tadpole. It is tempting to ascribe profound developmental significance to this kind of imminently appropriate representation by an immature member of the community of mark-makers who himself was, in embryonic form, tadpole-like not so long ago.

A comparison of the work of Jaqueline Goodnow, Howard Gardner, Ellen Winner, and Norman Freeman provides a range of theories about children's drawing, including those which compare tadpoles with frogs to the discredit of the tadpoles, and those which explicate and champion the tadpole, seeing mental markers and milestones in children's changing approaches to representing the human form over time.

Goodnow (1977) suggests that drawing presents a set of problems to children. How children draw shows how they are approaching problems. The problems in connection with drawing people, for instance, have to do with the placement and inclusion of body parts. Goodnow suggests that young children omit connections between body parts because of a principle called "to each its own space" (1977, p. 11). Boundaries between things are apparently inviolable for the young mark-maker. Therefore, children simply do not attach body parts. To avoid overlapping, children will give up other requirements, like those having to do with how things fit together, or go over or under. On the other hand, "threading" or drawing of the body in one continuous contour line, while it comes and goes as a drawing convention with children (36), suggests that children are beginning to understand that shapes form units (78).

Children's drawings reveal not only their spatial but their temporal thinking. "An orderly sequence can be a hazard" because it "increases the likelihood of error" (14). The suggestion is that children avoid orderly sequences for this reason, so that they won't be wrong. This avoidance suggests that they know when they are wrong.

Armless humans reflect "no strange perception." Once the child has put on legs, they have got to the bottom of the drawing, and are done. This is the phenomenon of "no-return" (56). Children have starting

rules: topmost point, leftmost point, vertical line (78), and so on to the bottom. Children are not aware of rules, but consistency exists (79).

Children's plans may change, as they draw. They do not indicate head and trunk as adults do, and it is unwise for adults to ask why either has been left out in a drawing. Drawings should be thought of as decorative units (61, 36).

Children's drawings are equivalents. Children intend their drawings only to contain the essentials to produce an "acceptable person." (17). They are content with schemata.

Children are actively engaged in "abstracting and extending rules and principle" when they draw (19). They are searching for structure and "graphic vocabulary" (23).

Preschoolers show a right-left preference (53). The left-right preference later "is probably the effect of learning to write English" (53).

"X-ray" drawings include what children know is there, even if it cannot be seen (56).

Drawing shows that children are actively involved "in their own early learning" (97), and that it is unwise and invalid to think about the way young children draw in the same way one thinks about older descriptive drawing. Goodnow suggests that children know more than they choose to show. The Piagetian stage of egocentricity appears to apply to the graphic representations of the young; the idea and the child form a unit; there is no impulse to draw so that someone else will understand what the child is thinking. The child is artist and audience at once (Feinberg, 1989).

Goodnow concludes, "Graphic work is truly 'visible thinking'" (145).

Goodnow makes three points about the relationship of drawing to writing. One is that early sequences appear in mark making before children learn to write (86). Another is that there are "few data on relationships between letters and graphic work" (86). A third point is that the practical consequences of drawing are printing (73).

Goodnow concludes, "We need to know far more about differences among children" (93). The suggestion is that drawing is as yet a largely unresearched way to try to get at differences in children's thinking before they learn to write, and even as they begin to write.

Howard Gardner asks in Artful Scribbles (1980) whether children's drawings should be considered works of art or "youthful exercises?" (7). He would like to establish the aesthetic status of children's drawings. His agenda seems to be very different from Goodnow's. Gardner wants to determine to what extent children's early drawing is "art."

Gardner writes, "Though a child is often artistic, he is not an artist...The charm of the child's productions comes of their being foreign to his will; once his will intervenes, it ruins them. We may expect anything of a child, except awareness and mastery" (8). Gardner seems to bring the eye of the adult critic to children's drawings, in direct contrast to Goodnow's approach.

Even though Gardner observes, "One has the strong feeling that drawings constitute an important and perhaps a primary vehicle of expression for the young child" (11), and a way to explore and problem-solve (269), he suggests that for most children, interest in drawing wanes, and only a few continue. The children

who continue may have special talent, or no other means of expression. These children may have "unusual motivation, or obstinacy" (11).

Gardner agrees that the child is trying to make sense of the world when the child engages in art. Gardner suggests that the development of stages is unclear; it is too simple to say that children scribble, then make geometric forms, and then draw the "tadpole" human.

In sharp contrast with Goodnow, Gardner feels that early scribbles are "devoid of any purpose" (20). Doodles are a way to use up energy, or express a fantasy, and serve as some kind of release (231). However, Gardner admits that the child comes to care deeply about the marks he makes. His awareness that his marks have significance to those around him is of "critical developmental importance" (24). Then Gardner observes that, from being an act that was of psychological importance to the child, drawing becomes supplemental to a story (112).

Gardner concludes, "Given adequate genetic potential, it is obviously possible for individuals to develop to the point where they can readily draw as convincingly as the cavemen or Nadia did" (189). Both the cavemen and Nadia achieved highly sophisticated levels in drawing skills. Gardner's interest is in skill mastery; he is interested in drawing as a way to describe thought with accuracy and power as an artist.

Gardner would like to categorize children's drawings in connection with art history. He does not appear to value them as a developmental step in the symbolic mark-making process.

Gardner's approach to children's drawings is judgemental; Goodnow's is exploratory.

Ellen Winner has written a book about the psychology of the arts, called *Invented Worlds* (1982). She states clearly that the ability to produce art "delineates the development of perceptual skills" (11), and "requires the ability to process and manipulate symbols and to make extremely subtle discriminations...the arts are viewed as a fundamental way of knowing the world" (12). Goodnow and Winner agree that art, as drawing, is one way that children learn about the world.

Winner explores art in connection with creativity. She suggests that there may well be a connection between creativity and autonomy (25). Children who become artists had parents who respected them at a very early age. Winner catalogues the attributes of the creative person, including the ability to "juxtapose and integrate elements ordinarily considered diametrically opposed" (31). She adds, however, that creativity does not correlate with high I.Q. (31). Winner suggests that for creative people mental activity is an end in itself. Creative people discover or invent problems. The artist is "the stimulus-seeking person par excellence" (32). The formal use of space is only a means to the end, which is problem solving (43). Art is rational, directed thought (48). Ordinary thinking skills can produce extraordinary art (49). In connection with drawing, Winner suggests that children are "typically prolific draftsmen" (144).

After this exegesis on art as thinking, Winner appears unsure; she comments, "Why preschool children draw such odd pictures is puzzling" (145). Preschool children have artistic flair, which, according to Winner, echoing her husband, Howard Gardner's observations, they lose. The tadpole drawing "reflects the child's deficient concept of the organization of the human body" (146). Children have difficulties representing a

three-dimensional object in two-dimensional space (147). Children draw parents as big as trees because children have "simply not yet differentiated size" (165).

Winner suggests that all children draw, and have flair at the preschool age, but later lose this natural, or naive flair for form, line, and color. Both Gardner and Winner are looking at children's drawings to see how they stack up with a very sophisticated genre of art called "primitive."

Where Winner's evaluation of children's drawings is negative, Goodnow's evaluation of their drawings is positive; the latter posits fledgling ordering rules and strategies; the former, deficits. There is a great difference between the research that starts with the child, and the research that starts with the expert adult.

Norman Freeman has written two compendia of children's drawings (1976; Freeman & Cox, 1985). Both books concentrate on drawing as evolving strategies in symbolic representations and in systems of order. Using scrupulous observations, Freeman, like Goodnow, draws fundamental conclusions about the significance of children's drawings.

Freeman suggests that children know more than they can show (1976, p.7) Their undeveloped drawing skills, their budding representational strategies result in drawings without arms, or legs, with arms stuck on heads, or with heads that serve for both head and torso because they do not have the strategies to include them. Drawing is a problem-solving exercise for the child (8), involving recall and "ordered internal search" (8). The child is concerned with the relation of parts to the whole (15). "Clearly there is more to the tadpole drawer than meets the eye" (293). Children are showing linear order when they draw; they anchor on the "top structural feature" (the head; on the face, the eyes) and then they tend to end-anchor on "terminal structural item (the legs; on the face, the mouth) . They have two serial strategies; start at the top and work down; end-anchor. The problem of drawing the human body is a problem in serial order.

Children have rules of organization. The drawings have a "multi-purpose core" (22). This is a basic formula that can be used for many topics. Drawing is a hierarchy of design puzzles (26). A drawing "gives a print-out of a child's conceptual store" (28). Children's drawings provide clear mental imaging of structure (41).

"The child draws what he knows only because he does not know enough to do otherwise" (28).

Children know that the human body has a head, two arms and two legs, and a trunk. Their developing strategies lead them to put things in the "wrong" place. When they draw an arm too big, or a person too big, they are not "disinterested in size," as Winner suggested (1982). They are using drawing as a system of meaning. Size has to do with emphasis (281).

Children need cues and accessing strategies that have not yet developed to put body parts in right places (7). Children devise "canonical forms" (28). Children devise shorthand, all-purpose ways to draw things. It is a little like cartooning (340). The child is concentrating on meaning. It is the kind of drawing that includes only what is essential to get the message across. "Children are deadly serious about their drawings," and the drawings are "tangible evidence of careful planning and well-defined intentions" (36). "Even scribblers have immense graphic knowledge and ability" (61).

Freeman takes issue with the idea of "synthetic incapability" that is used to describe children's incomplete drawings (277); "arms may be a particularly weak link in the chain of drawing" (289);

Freeman concludes, "Drawing is more like speech than language. It is the system for ordering the parts, rather than a representation of ordered parts (353). It is a system for making order more than it is an orderly picture.

Freeman suggests that developmental psychologists are gradually moving away "from the question of what abilities the young child might lack to the different uses he makes of his abilities compared with the older child" (68).

Norman Freeman takes Piaget to task on two counts; the first is that Piaget underestimates what a child knows...Arnheim overestimates it (11). The second is that Piaget's tasks for children were too complex (71). According to Freeman, Piaget's water-level test was "worthless" (348). Children experience a "break down in relational coding ..in response to a particular kind of alignment: the perpendicular relationship" (348). Because this factor of perpendicularity is so compelling to a child, it competes for the child's attention and confuses him about the significance of the horizontal lines, as, for instance, in differing water levels in differently shaped containers.

Freeman's research is thorough, painstaking, and deeply respectful of young children's drawings as ordered systems of thought.

2.4.7.1 Children's Drawings as Measures of Developmental Ability or Intelligence.

What happens when research tries to draw conclusions from how children draw when they are copying adult designs? Koppitz writes about the use of drawing in the Bender Gestalt Test (Koppitz, 1975). "Prior to that age (8 to 9) even normal youngsters tend to have difficulty copying the Bender Test designs without some imperfection" (5). "The Bender test record reflects the child's level of maturity in visual-motor perception and can reveal possible malfunction or impairment in visual-motor integration. In addition, the protocol can also be used as a personality test" (9). The total Developmental Bender Test score is a negative score, since it records imperfections...a perfect score is zero" (17). "I have noticed that some very young or very concretist boys and girls have difficulty copying the abstract Bender designs" (23). "The Bender test can only detect normal and below-normal perceptual-motor integration in older children" (127).

The Gesell Institute uses drawing for grade placement. They state, "Perhaps fifty percent of school failure could be prevented or cured by having every child in the grade for his behavior age" (Ames et al., 1964, p.xiii). The Gesell Institute suggests, "The beauty of the Gesell development tests lies in their simplicity...we have gradually come to realize that the significance of such a test as Copy Forms is not simply in the success of copying. It is also in the way a child copies" (Ames et al., 1964, p.4).

The Institute recognizes that it is not how the child sees the forms he copies, but what is involved in the process of seeing (p.171). The Institute came to the understanding that vision was not automatic. Vision was

not something that happened to a person. On the contrary, "visual abilities must be considered a total part of human functioning..vision is an involved process" (Ames et al.,1976, p. 171).

Because visual skills were apparently developmental, like other sensori-motor skills, a child's visual skills in connection with drawing geometric shapes became one of the Institute's criteria for evaluating the child's grade placement. The Gesell Institute has definite ideas about when a child is able to draw a circle, a cross, a square, a triangle, a British flag-like design, a diamond (41).

In 1976, the authors of the book , Behavior Tests at the Gesell Institute, wrote, " It is time for close scrutiny of the neurological and biochemical processes for the disturbed child and the learning disabled child" (188).

Many researchers have dealt with the connection between how children draw and how they are thinking (Rand, 1973; Grossman, 1971; Campbell, 1976; Davis, 1983; Fujimoto, 1981; Rennert, 1969).

The Chilean neurobiologist Humberto R. Maturana gives us perspective on the relationship of children's drawing to their thinking. The consequence of our biological structure is the "phenomena of interpretation" (Winograd & Flores, 1986, p.10). These phenomena in turn give rise to language. "We create our world through language" (Winograd & Flores, 1986, p. 11).

The attempt of the child to draw should be understood in this context. As a biological being, the child is compelled to interpret. His speech, his drawing, his writing are his ways to create his world. Trying to understand how someone else, particularly a young someone else, is trying to create his own interpretation of the world is a different kind of interest than that of trying to categorize that child for a certain kind of intelligence, a certain kind of personality, a certain stage or amount of intelligence. This kind of attitude, of ATTENDING ON THE CHILD while he or she tries to interpret the world, is akin to Kegan's (1982) natural therapy. This is the way to look at children's drawings, and it is the way to look at children's writings.

Freeman suggests that children's "contextural responsiveness...may be built in" (348). Concepts of "relational coding and contextural responsiveness form a package which defines a powerful general purpose strategy in young children" (348).

The research suggests that these built-in, innate strategies for relational coding and contextural responsiveness are the ones by which we order all thought, including our mental images, and all of our languages. Freeman describes something akin to Changeux's template, Chomsky's generative grammar, Gazzaniga's interpreter, Kegan's meaning-making. Relational coding and contextural responsiveness are the truths suggested by the Platonic alternative. They are pre-existent, or, one might say, inherent. If educational activities are designed so that they have to do with relational coding (or cross-modal, or interdisciplinary learning), if they are contexturally responsive (the context can be the child, the class, the subject matter, the school, the culture), they should be effective.

2.4.7.2 Speculations about Children's Drawing

Piaget was not as dubious about young children's thinking skills as he appeared; posthumous publications (Malaguzzi, 1988) showed that he recognized possibilities for early logic in very young children, beyond what he had called sensory-motor operations. In fact, Piaget suggested that a "pre-causality" could be observed in oral language, and in drawing (Piaget, 1955/1959, p. 51).

Piaget describes the "drawings and free compositions" of children 3 to 8 in Montessori's *Maisons des Petits* as early explanations of "why" and "because" (51). Piaget suggests that language is a logic system first, and a communication system second, and that drawings serve the early logic system before the introduction of the causal, logical cues "why?" and "because" in speech, or in writing.

Piaget's understanding of the relationship of logic to drawing to language to action to thought is important to this study. Piaget writes, "...and this is of the very first importance...Intelligenceis enabled through the bond established by language between thoughts and words to make an increasing use of concepts" (Piaget, 1955/1959, p. 64).

Piaget makes a distinction between the logic of autism, or early, undirected thought (65), and the logic of intelligence, found in directed thought, which is first characterized by the "egocentric monologue" (38), and then expressed by the kind of language use that constitutes communicated intelligence (65).

Piaget describes ego-centric logic in this way: " (It) is more intuitive, more 'syncretistic than deduction, i.e., its reasoning is not made explicit... Visual schemas also play an important part, and can even take the place of proof in supporting the deduction that is made" (66). Drawings are visual schemas.

Piaget observes that children use language first not to communicate with others, but to motivate themselves into action. "Language serves to accompany and reinforce individual activity... (This use of language) is from the child to the child" (Piaget, 1955/1959, p.59). "Logic and language are obviously interdependent" (28).

The "egocentric monologue" (38), which moves the child into action, is of considerable importance to Piaget. Not only does "language accompany motion" (36), but it allows the child to "create reality with words" (37). Language allows the child to represent the world in terms of some level of logical or causal relations. For this kind of understanding, Piaget suggests, mere mental images will not suffice (44). The word "why?" and "because," which drive the child to search for causal, or logical relations, eventually enter the world of children's conversations (45-47). Drawing is a manifestation of the egocentric monologue.

Drawing taps the early, intuitive, syncretistic logic of the child. Children's drawings are not only explorations in explanation, but in communication. The child intends his drawings to be readable by himself at first, and later, by others. Long before writing develops, the child tries to show what he knows, to himself, and to others. Drawing is part of the child's early symbolic monologue - it antedates, or accompanies, in a nearly simultaneous way, the oral ego-centric monologue. It appears that self-explanatory, quasi-causal drawings can drive levels of thought in connection with language. In conclusion, research suggests that children use drawing to think.

Adults use children's drawings in a professional way to measure children's levels of intelligence, or levels of development. The intent to measure a child's intelligence, through the child's ability to copy adult drawings may not be useful. Copying geometric forms may be in the range of the "too complex tasks" Freeman suggests (1980) that Piaget posed for children, and on which he based his understanding of their developmental levels.

Tests like the Kinetic Family Drawing (Burns, 1982), Koppitz' Human Figure Drawing (1968), and the Goodenough Draw-a-House, Draw-a-Person, Draw-a-Tree tests may not provide truly useful ways to determine a child's intelligence or developmental level until children's natural inclination to draw has been trained. Training children to draw, from kindergarten on, as a natural expressive skill, may invalidate many of these tests. What these tests may show is the extent to which children cannot show what they know for developmental reasons, including lack of skill mastery (Freeman, 1980). After training in drawing, a shaded-in trunk of a tree may not mean depression, but simply that the child has learned to "render."

We should not expect young children to show ability on tests that test them for skills inappropriate to their development. Drawing should be used for children, not against them through misunderstandings of what the drawings say.

2.4.8 Theories of Writing

In the article "The Kindergarten Game: Is your child ready to play?" Madeline Drexler reports that there is a 47 percent drop-out rate and a 21 percent retention in the first grade in the Boston public schools (Drexler, 1988). She writes, "kindergarten and first grade need a complete overhaul - they've become too dauntingly academic, a permanent turnoff to learning. Better to have a flexible environment where children of varying ages and abilities are mixed, each receiving individual attention" (Drexler, 1988). Drexler says that there is a "dangerously wide" gap between the quality of urban and suburban schooling. 85% of the 3 to 5-year old population is in school. There is a correlation between learning disabilities and being "in the youngest third of the class...the youngest are vulnerable, both emotionally and academically."

Drexler supports David Elkind's developmental curriculum that is play-oriented and hands-on for preschoolers. She suggests that developmental programs would be "cost-effective...you save money on special needs teachers..Eventually, we'll see so many damaged children, we'll have to change" (Drexler, 1988).

In 1982, Donald Murray wrote an article that was important for achieving a radical change in attitude about how to teach children to write. It was called "Teaching the other self: The writer's first reader." In this article, Murray wrote, "The self speaks, the other self listens and considers. The two selves collaborate" (Murray, in Calkins, 1986). Murray describes the child writer as speaker, and, as the child reads his own work, as listener, and as critic. The idea of becoming a critic extends to what is called "peer editing." Each child becomes the listener and the critic for the other.

Two people - Lucy Calkins, director of the Writing Project, at Teachers College at Columbia, and Donald Graves, at the University of New Hampshire- have promoted the process approach to children's writing. (Others who have written about process writing are : Burris, 1985; Giacobbe, ; Schneider, 1988; Bunce, 1986. Others who have written about the relationship of writing and reading to thinking are: Boiarsky & Johnson, 1983; Suhor, 1983; Dilworth, 1985; Wroblewski, 1985; Anderson, 1985; Elbow, 1983; Dyson, 1982; Moffat, 1968; Britten, 1971; Getty & Jensen, 1980; Lee & Rubin, 1979).

Calkins writes, " Children need time to be children, to grow through natural childhood activities. It is not children, but adults, who have separated writing from art, song, play..." (35). She writes, " The young child's writing is an outgrowth of the infant's gestures...Babies learn the power of their gestures from our response...children view writing quite differently. For them it is exploration...long before children come to school, they leave their marks on foggy car windows, and wet beaches" (Calkins, 1986, p. 35).

Calkins suggests, " Our job is to respond to children in such a way that youngsters learn that marks on paper have the power to convey meaning" (38).

For Calkins, the mark making called drawing is a step on the way to writing. She writes, " Children may, for a time, by-pass the print altogether and convey their meaning through pictures...it is easy to dismiss these picture stories...Usually more is happening in their drawings than meets the eye" (Calkins, 1986, 40-41).

Calkins writes about the basic skills of spelling, grammar, and punctuation. She says that they must be built into the context of the child's writing. If they are imposed, out of context, they have no meaning. Children forget them. They make no sense (Calkins' article, The Writing Process Lab).

Calkins reports that children's writing workshops establish " a new sense of personal connectedness" (Calkins, 1986, p. 8). She says that revision is just that, "re-seeing" (17). Essential to teaching writing is that the child is deeply involved in the process of writing (9). Calkins elaborates: The point of contact comes when we allow students to teach us how they learn. This transforms our teaching into a course of study" (Calkins, 1986, p.32). Calkins urges the teacher to become a researcher in the classroom.

Donald Graves writes, "Children want to write... from the first day they attend school...The child's marks say, 'I am'" (Graves, 1983, p.1). Graves feels that good teachers of writing should write themselves. " We don't find many teachers of oil painting, piano, ceramics, or drama who are not practioners in the field" (Graves, 1983, p. 6).

According to Graves, the teacher sets the tone for writing by writing. The teacher "receives" the children's work (17). Writing is treated respectfully.

Graves suggests, " A craft is a process of shaping material toward an end" (6). In this sense, the child is involved in the craft of writing. In process writing, "children become independent learners" (11).

Graves makes an important comment in connection with the writing of very young children: "Writing, of course, must be liberally interpreted...Let them know their scribbles come through...Tell me about this. Can you tell me more about this part?" (Graves, 1983, p.18).

The biggest challenge for the writing teacher are the "nonknowers" (23). These are children who have no place to stand. These are the children who need writing the most (23).

The teacher whose work deeply moved this researcher four years ago, bringing process to her attention, is Nancie Atwell. Atwell teaches in Boothbay, Maine.

Atwell writes, "Teacher-initiated writing is a parody of writing. If you want kids to really write, to really find themselves as people, you have to say, 'You're in charge. I'll help you. I'll even push you. But, finally, you're in charge of your writing, because it's got to be about you and how you see your life and the things around you" (1984).

Since Nancie Atwell began her version of the writing project in the elementary school in Boothbay, Maine, the reading scores have gone from the fiftieth percentile to the seventy second (Atwell, 1984).

William Zinsser describes writing as a way to learn. "Writing, learning, and thinking are the same process" (Zinsser, 1988). Zinsser comments, "Much of the writing assigned (traditionally) is based on literature - on what somebody else has already written - and therefore has no meaning" (Zinsser, 1986).

Learning through writing depends on one's own experience of writing. Sometimes, Zinsser observes, writing is the only way to understand something (1986).

A holistic approach called Whole Language is gaining favor. This approach surrounds children with language in natural, everyday ways. The theoretical and philosophical antecedents of process writing and of the Whole Language movement (Haldoway) go back to Montessori (1912), Piaget (1960), Dewey (1916). The conviction is that the child will take charge of the learning process, if he is allowed to do so. Although the child-centered writing and language programs use drawings as a natural precursor to and as a stimulus for writing, formal training in drawing is not a part of these programs.

A book somewhat on the lines of Betty Edwards' book, *Drawing on the Right Side of the Brain*, is the book by Gabriele Lusser Rico called Writing the Natural Way: using Right-Brain Techniques to Release Your Expressive Powers (1983). Rico's book (which is as dichotomous as Edwards about right-brain processes) makes use of "story webs." Story webs are drawings of ideas. A child draws a schemata for a story. Boxed or circled ideas, and connective, radiating lines between them help images to surface. "The inner eye of the child directs the hand" (Rico, 1983). Using the web as an organizer, the child begins to write. Rico suggests, "Creative acts most readily arise from the things closest and most profoundly meaningful to us (Rico, 1983, p. 261). With Atwell, Rico agrees that children should write from what they know. Drawing is an organizational tool that allows children to get at powerful personal images. The method of using story webs is taught by the teacher, and the web itself is not pictorial. It is a way to create logical relationships between words that stand for images.

2.4.9 Speculation on the Relationships between Drawing and Writing

For Calkins and Graves, Atwell and Zinsser, drawing in connection with writing is a way to know, to learn, to think about one's life. For Rico, drawing is a way to organize the words that stand for images.

Norman Freeman and Lucy Calkins agree. There is more going on in children's drawings than meets the eye.

This combined research suggests that children's drawings are visible thought. For children, drawings are powerful conveyers of meaning before writing takes over that function.

The research suggests not only that children draw, but that they should draw, and that they should enjoy a "process" approach to drawing. Just as in a process approach to writing, where a child learns to use writing to express meaning, so, in a process approach to drawing, the child would learn to use drawing to express meaning.

Using drawing hand in hand with writing, a child will grow in language skills. In this way, no child is left behind. In this way, many children may grow through the combined use of mutually enriching forms of expression.

2.4.10 Constructivism

As a theory of knowledge, constructivism belongs to a cognitive developmental tradition that owes a large debt to Piaget (Devries, 1987, p. 397). Constructivists appreciate thinking skills as complex, variable, dynamic activities which involve the child socially, intellectually, affectively, and morally in the classroom (371). Constructivism describes cognitive development as "invariant, sequential, and hierarchical" (3). Biological determinism proscribes the order of the stages of thought a child moves through. The nature of the unfolding of each stage depends, however, upon experience. Given a nurturing environment, the child will be a powerful learner; he will be a "philosopher, or scientist poet who progressively reorganizes knowledge" (7), (whose) knowledge "is a product of the process of acting...(This acting is a) 'reading' of experience and (it involves) eventually confronting inadequacies and contradictions in this 'reading' " (8). The aim of the constructivist educator is to encourage the child to move "toward greater epistemological or ethical adequacy" (9). The Piagetian understanding is that the child is responsible for constructing useful knowledge and acceptable behavior.

Constructivist educators Forman and Fosnot refine the Piagetian process of "reading," or knowing. They write, "Unlike a naive realism that assumes that knowledge is a direct product of making better mental copies of an external world, constructivism assumes that we have no direct accessibility to an external world and therefore have to construct representations that have more to do with the act of knowing than they do with the external object per se" (Forman & Fosnot, 1982, p. 186). This definition of the removedness of knowing is very like the biologist Maturana who questions the nature of a commonsense understanding of perception. Rather than believing that there is an objective reality, external to the human mind, and independent of it, Maturana describes the nervous system "as a closed network of interacting neurons such that any change in the state of relative activity of a collection of neurons leads to a change in the state of relative activity of other or the same collections of neurons...the nervous system does not have 'inputs' and 'outputs.' It can be PERTURBED by structural changes in the network itself, and this will affect its activity but the sequence of states of the system is generated by relations of neuronal activity, as determined by its structure."

"Perception...must be studied from the inside rather than the outside" (Winograd & Flores, 1986, p. 42). Maturana pushes past naive realism, and past action, to a determining structure that can be perturbed.

Rather than this understanding of perception, it of practical usefulness to rely on more accessible neurobiological explanations where direct knowledge through what is generally understood as sensory perception is possible. This understanding makes experience a determinant of the structure of mind. It also validates educational programs that train or allow the child to make "better and better mental copies" of things and places and people in the world as the necessary underpinnings for effective thinking at all levels, including the ones carried out eventually on mental images. The Piagetian and constructivist way for the child to "read" the world is by acting directly on it, thereby constructing accurate mental representations. Neurobiology provides descriptions of sensory-motor map making. How children act on what they perceive determines the representation in their heads. Forman & Fosnot and Devries champion the overriding importance of action to perception. For constructivists, action and perception are mutual determinants. The more accurate the perception, the more successful the action. The obverse is also true. Even if an intelligent system should be closed, if it is equipped with sense receptors, they are there for a reason. Even if that reason is labelled "perturbation," the purpose of the sense receptors is adaptive behavior. To adapt, the intelligent system needs accurate representations of the environment. The frog who catches the fly on its tongue needs an accurate mental map of where the fly will be to catch it (Churchland, 1986).

According to Forman & Fosnot, Piaget took as a "given that the human intellect is a question-seeking organ and not an answer-reacting organ" (Forman & Fosnot, 1982, p. 187). It appears that the reaction to any answer drives further questioning and seeking. Both questions and answers are means and ends in the Piagetian "built-in need to eliminate contradiction" (187). Piaget suggests that the human intellect both poses the questions and supplies the answers, through "self-regulated learning" (188). The fact that the answers resolve contradictions, achieving some "equilibration" (187), means that the answers have validity. What Forman & Fosnot suggest is that children are not meant to react mechanically to somebody else's answers. Children are meant to be "answer-reacting organisms" vis a vis themselves. Whether children pose their questions and test their answers against the world or against their inner representations of the world, their physical and mental actions create meaning. If the mind and the world were one, interaction would be irrelevant because it would be impossible.

It appears that the world and the mind are distinct. A Piagetian or constructivist educator concludes that intellectual growth comes about through closer and closer understanding of how the world works in relation to how the child acts on it. Piagetian conflict, or contradiction, or error, is endogenous; it grows within the mind of the child himself (Forman & Fosnot, 1982, p. 195). The endogenous aspect of the questioning and answering determines both the degree of consciousness the child achieves in thinking and acting and the meaningfulness of the child's thought and action (198).

Equipped with an appreciation of the degree to which, in Piagetian and in constructivist thought, the child's thought and action must be self-determined, it is clear that within the constructivist framework the attitude and role of the teacher needs definition. How does the teacher relate to the child's growth of mind

(Devries, 1987, p.371)? Somewhat in the Paideia tradition (Adler,1984), the constructivist teacher is a Socratic enabler rather than a cultural-transmitter. The teacher asks or elicits questions; he or she does not impose answers. The constructivist teacher believes that young children are capable of thought as well as emotion, while understanding at the same time that children must be encouraged to build their thinking skills. These skills will not spontaneously unfold (373-4). Keys to getting children to construct their minds are interest and undivided attention (376). What is of particular note for this study beyond a constructivist interest in attention and participation that is shared by neurobiology is that constructivist aspirations include the teacher, too. Both teacher and student are to become capable of independent thought, including self-reflection (xii).

What contributions from Maria Montessori might have influenced a version of constructivism that would tally with the combined research in this study?

In 1912, Montessori wrote about applying "new principles of science" to "revolutionise the work of education" (Montessori, 1912/1964, p. 1). Montessori was talking about psychology, and physiology, and a new approach to anthropology. She wanted teachers to observe the child in a scientific way. She hoped to establish a "pedagogical anthropology" (5). The kind of integrated curriculum that might spring from the research and the study would look to the new science of its time, just as Maria looked to the new sciences in hers, for educational direction. A new theory would look to cognitive science, a field which includes neuroscience, anthropology, linguistics, psychology, and artificial intelligence.

Montessori describes the public schools of her time as places where "children are repressed in the spontaneous expression of their personality till they are almost like dead beings....The school must permit the FREE, NATURAL MANIFESTATIONS of the CHILD ...the concept of liberty is practically unknown to educators" (14-15). Montessori sees school furniture as crippling and demeaning to students (16-17). Loris Malaguzzi, founder and director of the Reggio Emilia preschools, echoes her (Lecture, U. Mass., 1988). Montessori writes about "the fundamental error of the desk" (17). Montessori anticipates Malaguzzi's conviction that we are belittling children with tiny expectations. She writes, "The real punishment of normal man is the loss of the consciousness of...individual power and greatness" (26). She envisions "auto-education" through "auto-correction, brought about by the use of didactic materials that take advantage of the spontaneous interest of children (169-170). Montessori writes about "isolating the inner attention of the child," (224). She feels that "well-refined senses" allow the child to observe the world ever more closely, "attracting and continuing the psychosensory education" (229). She feels that drawings "reveal the capacity of the child for observing, and also show his individual tendencies," (240), and that "these designs are important as they constitute 'preparation for writing'" (241). (Parenthetically, Montessori's comments (236-240) about children and geometry support the "naturalness" of the second step in the drawing process called "Basic Shape").

Montessori's dilemma was to "establish the method peculiar to experimental pedagogy" based on the idea of complete freedom of the child (30). Maria takes her lead from her considerable experience with teaching "abnormal children," meaning "idiot" children who were then routinely housed in insane asylums (31). She

felt that applying similar methods to normal children " would develop or set free their personality in a marvelous and surprising way" (33). That is, Maria felt that education could structure experience in such ways that it led to children's freedom.

Montessori makes a parallel between the mentally deficient child, "whose development has been arrested, and the underdeveloped normal child" (Lane, 1976, p. 280). Montessori comments, "I...differed from my colleagues in that I felt that mental deficiency presented chiefly a pedagogical, rather than mainly a medical problem" (Montessori, 31). Maria inherits this attitude through careful study of two nineteenth century Frenchmen, Itard, and Sequin, who worked with the mute and the deaf, teaching them to sign, and then to speak. Itard began his work with what was then called an "enfant sauvage," a feral boy, whom many described as an idiot. After five years of individualized education, which allowed Victor "the free use of all his senses," the so-called feral boy was able "to demonstrate attention, reflection, memory," discernment and judgement. He was "an almost normal child who does not speak" (Lane, 1976, p. 124.) Itard believed that teaching would be successful if it began "with any action that the child already imitates, and (if it were) gradually complicated and extended" (Lane, 239). Itard's premise was that thought depended utterly on language (243). It has been suggested that Itard failed to teach Victor to speak normally because he did not reinforce Victor's own (possibly southern French) vocalizations (169), and that he omitted touch, an approach that has proved effective with the deaf and the mute (169).

Montessori's educational beliefs echo Itard and Sequin. Montessori is, in turn, echoed by contemporary psychologists like Ward and Maloney, who aver that most forms of retardation are preventable or remediable (1982). It appears that Maria's understanding of the importance of the education of the senses, most particularly that of touch, is important to the development of language, spoken, and written, under difficult and under normal, situations. A Montessorian constructivism would hold with the understanding that if an activity works for the language disabled child or for the attention deficit child, it will work even better for the normal child.

The combined research suggests that a good constructivist activity could well combine drawing with writing. It is possible that the contemporary child is crippled in his sensory-motor abilities to know as a result of an extensive system of second-hand knowing. From infancy on, second-hand knowing involves television, videos, computer games. Furthermore, the child spends six hours a day in educational systems where the emphasis is more often on teacher instruction rather than on student construction. The contemporary child may be crippled most particularly for knowing through touch. A Montessorian constructivism would design activities to put children back in touch with their thinking, just as Montessori designed activities in the early 1900's to get children quite literally in touch with writing and reading.

The constructivist Emilia Ferreiro differs from Maria Montessori in her understanding of the nature of writing, and of reading. For Ferreiro, tracing or copying is not writing, nor is associating spoken language, in a kind of sound-to-letter, or letter-to-sound deciphering, reading (Ferreiro, 1979, p.272). Ferreiro feels that children come to school knowing a good deal about language (7). Traditional education is "based on two assumptions, both false: that six-year old children do not know how to distinguish phonemes...and that

alphabetic writing is a phonetic transcription of oral language" (10). "These thinking children play an active role in learning written language" (12). Ferreiro maintains that contemporary psycholinguistics "coincides (although unintentionally) with the conception of learning sustained...by Piaget" (9). By this Ferreiro means that, despite the fact that Piaget did not write about reading and writing, within his theoretical framework it is possible to "introduce written language as an object of knowledge and the learner as a thinking individual...introduc (ing) the notion of assimilation" (15).

Ferreiro sets about discovering how children construct the writing process. Writing is not copying, but a "conceptual task...Although far removed from conventional calligraphy and orthography,...children begin to write (by producing) visible marks on paper, putting into play their hypotheses about the very meaning of graphic representations" (21). Children produce not only early drawings, but early text, using curvy lines, or discontinuous lines (178) which are the precursors of writing. Because their names are so important, children "include signs representing their own names in their drawings" (178). Drawing/Writing also observes a nearly simultaneous development of child-differentiated drawing and writing marks.

Ferreiro suggests that, at first, children "move back and forth between picture and text with ease" (Ferreiro, 1979, p.186). Ferreiro sees only "momentary" difficulties with differentiating writing from drawing in the psychogenesis of child writing (185). Children believe that "drawing supports writing," and that it is "a complement to it" (186). Drawing "guarantees the meaning" of the writing as if writing alone could not say any specific thing. (186). Whether "drawing is an escape from the difficult task of writing or whether drawing serves a certain function in relation to writing, the data leads us to favor the second interpretation" (186).

Contributions from Piaget to the kind of constructivism that would tally with the combined research are these: Piaget suggested that, "No matter what the content domain, young children think in qualitatively different ways from older children and adults" (Devries, 1987, p.18). The neo-, or, more properly, neuro-constructivist would ascribe the differences between children's and adults' to fundamental developmental differences in thinking styles, and would agree that teaching children in ways that adults have learned to think may create learning disabilities (Devries, 1987). This point of view coincides with the thinking of Montessori (1912/1964), and of Emilia Ferreiro. Ferreiro writes, in connection with the traditional teaching of writing, " Attempting to unveil the mysteries of the alphabetic code, teachers proceed ...from simple to complex...defined in terms of adult notions...The underlying assumption is that all children are prepared to learn the code...school is directed toward those who know...The others fail, accused by the school of having 'incapacity to learn, or 'learning disabilities'....What is only a difference in the timing of the child's conceptual development is viewed as a deficit" (Ferreiro,1979/1982, p. 280).

The pedagogical consequences of Ferreiro's understanding, she says, are that reading and writing must not be taught mechanistically, " as something foreign to children" (282), but as something they actively construct, by being allowed "to reinvent the written language to make it their own" (285). Key to Ferreiro's understanding of writing is " the writing system itself permits new processes of reflection which cannot easily take place without it" (284).

A neuro-constructivist program would insist upon developmentally appropriate, interactive, child-centered approaches to thinking and learning. Drawing would be combined with writing to encourage reflective thinking and knowing.

2.4.11. Research Speculations

2.4.11.1 Dyslexia Revisited

Some children who are not dyslexic have combined writing and arithmetic learning disabilities. This has been described as "developmental output failure" (Siegel & Feldman, 1982). Children with this problem perform poorly in school, have difficulties with organization, and typically come to the attention of pediatricians in the 4th and 5th grades. These children have trouble with fine motor coordination, and visual/spatial abilities (Siegel & Feldman 1982). These children have a high degree of attention-span disorders. They have low intelligence scores on the WISC-R (Wechsler Intelligence Scale for Children- Revised), and the WRAT (Wide Range Achievement Test; Siegel & Feldman, 1982).

Margaret Mead pointed out that as recently as three hundred years ago, the three skills necessary to survive involved the ability to find shelter, make clothing, and procure and prepare food (Clarke, 1973). Now an ability to read is necessary to survival. Secretary of Health, Education, and Welfare, Wilbur J. Cohen stated, "The ability to read is becoming increasingly necessary for every person growing up in America today" (Clarke, 1973, p. 224).

Hundreds of thousands of children are absent from school every day. Part of the truancy problem is that children who did not learn to read in the primary grades find the upper grades "bewildering and hateful" (Clarke, 1973, quoting an 1972 New York Times Article, January 30).

Truancy relates to delinquency. Delinquency and dyslexia are related. A chairman of the California committee for the Neurologically Handicapped conducted a study of a total case load of 60 juvenile delinquents. Birth traumas were discovered, severe early childhood illnesses were unearthed, and a long list of reading problems were documented. The conclusions was, "If some of these children had been discovered and properly treated in the early grades, they would have achieved successes which may have prevented their delinquent involvement" (Clarke, 1973, p. 229).

An interest in the adolescent and adult dyslexic has encouraged businesses to take on the task of providing training to overcome reading inadequacies (Clark, 1973, p. 229).

Failure to help these unsuccessful children may mean that brilliant youngsters have no alternative but to lead riots and burnings and killings...with intelligence and courage" (Clark 1973, p. 238).

Mary McCracken, author of Turnabout Children writes, " There is not just one single, simple learning disability, but many. The term 'learning disabilities' cover disorders in written language (also known as dysgraphia), disorders in arithmetic (known as dyscalculia), and disorders in receptive and expressive

language and reading (dyslexia), as well as difficulties in perception of spatial relations and organization" (McCracken, 1976, p. 8).

In light of the research, the last disability may be the lynch-pin. The research suggests that language in the broadest sense has to do with spatial understanding. It is an understanding of spatial order, which is analagous to temporal sequence, in the brain. One appears to be converted into the other, or both are aspects of the same mapping function.

The question educators need to ask is not whether the dyslexic student has structural defects, or minimal dysfunction in the central nervous system, but whether all children learn to read and write in the same way, and whether all individuals can be effectively taught by the same method, and whether activities that get at ways of ordering spatial information may not be a key to at least some of the troubles (Kandel & Tsao 1981). The problem may be "dyspedagogia," or difficulty with teaching (Kandel & Tsao 1981, p. 169). If teachers were better at teaching, they might not have to rely on the effect of behavioral interventions to try to alter the nervous system.

The definition of the dyslexic is someone whose reading level is significantly below what would be expected, given his "native intellectual endowment" (Kandel & Tsao, 1981, p. 170).

Dyslexia in the form we know it in the Western world is unknown among those learning to read Chinese, and "1/5 to 1/10 " of what it is in the U.S.A. among the Japanese (Kandel & Tsao, 1981, p. 176-7; Morinaga 1985).

Both Chinese and Japanese have forms of writing that are logographic. The word looks like what it means. It is picture-writing. Sound has nothing to do with it. It is not phonological. It is not even meant to look like how the word sounds. One might call it drawing/writing.

There are two kinds of reading processes. One is phonological, and relies "heavily upon the production of mediated analytical phonic processes" (177). The other relies on the "direct association of meaning with the written symbol" (178). An alphabetic language like ours can be taught either phonologically, or logographically. The way to read English logographically is by the "whole-word" method (178). This is part of the Fernald method (183). Combining drawing with writing might make the move from a logographic system to a phonetic one easier for some children.

While problems with input and with output may be responsible for learning disabilities, the connection between attention and learning problems appears to be intimate (Levine, 1987). Attention deficit children focus on the wrong stimuli at the wrong times. They have trouble interpreting language. They have trouble with handwriting and with reading. The consensus is that they have trouble with discrimination in the most general sense-in connection with both sights and sounds. They may have memory deficits because of deficient or scattered attention. They can not pick out the salient. They have trouble with cause and effect. Their "inability to organize cuts across everything they do" (Levine 1987).

If the research coming out of Project Zero at Harvard were integrated and applied to the definition of language provided by neurobiology, Project Zero might provide an alternate approach to language acquisition in children through the organizational strategies and the training in discrimination that are inherent in the arts.

One of the questions Project Zero seeks to answer is "whether the linguistic-nonlinguistic distinction has psychological significance." " (Are) different information processing skills ...necessary to deal with such different symbol systems? ...(is there) a distinction between the systems (and if there is, this)... raises interesting questions about the transfer of learning between and within the two realms (Howard 1971).

These questions are at the heart of this study's attempt to integrate the findings in the combined research. If an integration proves possible, it will involve transformational relationships between levels or kinds of symbolic representation. It is the position of this research that all levels of symbolic representation are related, and that spatial processing precedes and underlies all forms of linguistic processing, and that spatial and linguistic processing continue to relate to each other in a transformational way over a lifetime.

To recapitulate; if it is true that the motor-learning of Llinas and of Papert create body-geometry maps, which, in turn, results in spatial/linguistic maps, there is a progression in spatial understanding that starts with the body and ends in activities like the performing and applied arts as well as in natural languages. The post-Sperry work on hemisphericity suggests that the "linguistic-nonlinguistic distinction" does not have psychological significance. At least, the brain does not recognize it. If the mind learns what the brain knows about how it operates, the mind won't either.

2.4.11.2 Parallel Understandings

Early stimulation programs, remedial language programs and art education programs share concerns and strategies. Speculation about these common concerns and strategies brings the combined neurobiological and educational research to parallel understandings:

1) The child is born into a complex visual environment. As his visual system grows, he grows more discriminatory. What the child chooses to attend to fully becomes fully processed information (Churchland, 1986, p. 217). It appears that, had a child never attended, that child would never have learned. A child would never attend, it appears, were it not for change, for the novel in the environment. The attentional/learning mechanism appears to form a neurobiological processing loop.

2) Research on vision suggests that many systems are growing at once in the human brain. In addition, the visual system impacts how some of these systems grow. The growth of the visual system is influenceable by experience. Therefore, visual experience can impact other developing systems directly and indirectly. The ability to distinguish the salient from the inconsequential involves some kind of evaluative ordering. This kind of evaluative discrimination is a complex task (Arnheim, 1969; Changeux, 1985; Bloom et al., 1985).

Perhaps what the language troubled student needs most is training in two things: first, in the ability to attend and to sustain sensations of novelty; second, to move between increasingly abstract symbol systems in

an integrated, personal way. Many dyslexic students do not have trouble with attention nor with perception nor with sensorimotor control nor with abstraction when they draw (Sheridan, 1985 to the present). It is possible that the marks that are used to write with and to read with simply do not make sense to these students.

It seems feasible to suggest like hieroglyphics might provide a useful transitional symbol systems for dyslexic students. The following study incorporates a self-generated symbol system which bridges the gap between representational drawing and the abstraction of writing. "The new hieroglyphics" appears to be both possible and meaningful for a broad range of students including the language- and attention-troubled student. This self-invented, transitional system appears to ease the move into written language. Students introduced to writing in this way might stay connected with writing as a way to think over a lifetime.

If training children to make orderly discriminations in complex visual situations is useful to the development of a discriminatory mind, then educators would want to make note of the fact. If drawing provided this kind of training and impacted writing skills as well, then drawing might be doubly attractive to educators.

Only longitudinal studies will show the effect of drawing on writing and reading if drawing is used in a personal, integrated, developmental way. By building a grace period into language training programs for children whose development with symbol-use is delayed or dysfunctional, the effects of something like a combined drawing/writing process (Sheridan, 1989) might not only be remedial but preventative.

2.4.11.3 Profile of a Theory of Education Designed to Develop Attention, Memory, and Logical Operations within the Context of Language Acquisition

A curriculum that might spring from the foregoing research would share the constructivist focus on the development of thinking skills through self-determined, self-regulated action. It would appreciate that intelligence is both dynamic and variable, while recognizing the importance of the affective, and socio-moral aspects of development within the context of a rich learning environment. It would encourage the development of thinking skills, as well as socio-moral understanding, through art-related activities. This "neuro-constructivist" curriculum would recognize the arts as appropriate domains of action for developing thinking skills in the child, including "reflection on transformations" (Forman & Fosnot, 1982). Drawing and writing would provide ways to transform meaning, and to reflect on transformation.

Because variation within representation is necessary (200-201), drawing would be built into the structure of play (200) Drawing permits, in addition, the exercise of Piagetian conflict and error (189, 195) in the form of distortions and omissions. Even when distortions and omissions are satisfactorily rectified by the child, each drawing, or piece of writing is understood to be an approximation of meaning.

Constructivists underscore the importance of "erroneous ideas." Errors honestly arrived at by the child are part of the process of coming to the "final correct solution" that makes sense to the child (Devries, 1987, p. 29). In connection with children's language, Piaget writes about the "clash of affirmations," where

"primitive arguments" between children create conflict, and drive thinking (Piaget, 1955/1959, p. 45). As suggested, error is built into the Drawing/Writing process in the form of distortion, omission, and approximation. In the case of the first two "errors," the child learns to correct them to whatever degree he feels necessary, in drawing, or in writing (where he takes into account his audience and what they may not understand, or may need to know more about). The child learns to appreciate that any symbolic representation, from art, to written language, to mathematical notation is approximate in its ability to tell the whole story of any thing. Some degree of error is inherent. The child learns to know, to know that he knows, and to know the degree to which he knows using several symbol systems in interrelated ways. He learns that two, or more symbol systems are better than one for getting close to meaning, and for distancing himself from it. This understanding is the basis for the success of Drawing/Writing, and for the interdisciplinary course, "Styles of Thinking." Students get closer to knowing things, and to expressing them by looking at them in several different ways.

Approximations attest to the enduring separation between the knower and the known. The sensation of separation is one of the conditions that drives thought. To suggest to children that the gulf between knower and known is so great that no authentic firsthand knowing is possible, would be deeply confusing. For all intents and purposes (the ability to reach for something, and to grasp it is proof enough) we can know, and we can know that we know. The ability to know in a variety of ways would be the springboard of this curriculum.

The way the ideal curriculum would approach morality and socialization, as well as cognitive growth in children, would be through art-related activities. In what are called "group crits," or group critiques, in connection with drawing, and in what is called the "author's circle " in connection with writing (Graves, 1983), children would learn to discriminate, and to praise. They praise the pleasing things in their own work, and in each others'. Rubrics like those outlined in Chapter 1 would provide socio-moral, art-based guidelines: "The Rule of a Good Design" (neither too much, nor too little); "The Attitude of Acceptable Differences," and the understanding that "The Thing Has More than One View: the Artist has more than One View Point" could be used to develop an Aesthetic of Ethics. These ethics would be based on an appreciation of "right relationships." An understanding of right relationships might provide not only a basis for decision-making in drawing and in writing, but in human relationships. Experience with Drawing/Writing, including this approach to aesthetics, suggests that tolerance, acceptance, self-esteem, courage, even compassion can be built into a art-related curriculum that centers on the child.

The intent of the curriculum would be to move the child, and the teacher, toward "greater epistemological or ethical adequacy" (Devries, 1987, p. 9). Both student and teacher would learn to know, in more complete, more personal ways because both participate in activities. Both would learn to make judicious decisions, involving a tolerance for, even an understanding of, differences.

In connection with writing, the curriculum would specifically connect a drawing process with a writing process, to try to achieve a "natural" transition between writing and reading for a broad range of children, including the potentially language-learning disabled. Because of the gulf between teachers' teaching and

children's understanding, the curriculum would assume that all children are at risk for some level of misunderstanding.

In her chapter, "The Evolution of Writing," (179-207), Ferreiro describes the development of writing and reading in ways that may possibly be paralleled in the Drawing/Writing five-step. The blind contour is like the first wavy or staccato marks of pre-writing; it is the non-differentiation, the global relationship of picture and text. The contour drawing is like the writing that can be interpreted as a substitute object (170); it is the separation of iconic and noniconic representation (282). The Basic Shape drawing is like the abbreviated letter-like shapes children make - "schematizations are frequent...letters are reduced to their basic shapes" (187). It marks the beginning of attempts at a figurative correspondance between writing and the object referred to (180). It is seeing that pictorial elements are represented in the text. It is a global appreciation of written strings as undifferentiated wholes. The Light-Medium-Dark drawing is like combinatorial operations, where the child knows that order of letters, or words, has to do with meaning. It is Ferreiro's Name hypothesis, her Syllabic hypothesis, her Minimum Letter hypothesis. The Perfect Whole is the understanding that words work with syllables, that sentences work on subject/predicate constructions - or, in connection with reading that writing represents sound segments, and that there is a grapheme to phoneme correspondance. The Composite Abstraction is the coordination of multiple hypotheses. It is the move from the syllabic to the alphabetic hypothesis, to the sound value of letters in the face of stable strings. In reading, it is being capable of a one to one search for correspondance between symbol and sound. It means that prediction will figure in the construction of meaning in the kind of reading that does not depend upon deciphering (272).

The idea behind Drawing/Writing is that " the capacity for integrating information increases with the organization of the stimulus" (273). The act of drawing and writing are both organizing actions. As they organize the stimulus, the stimulus reveals more layers and levels of organization, driving the process of categorization, of generalization, of knowing onward. Drawing/Writing agrees with Ferreiro that "we must let children write, not so they invent their own system, but so they discover that their system is not the conventional one, and in this way find valid reasons to substitute their own hypothesis for our conventional ones" (277). And yet a forward-looking curriculum would be able to entertain the possible value of a transitional, personal symbol system, or even accept as useful idiosyncratic, iconic, mnemonic systems, like the one called "the new hieroglyphics" that develops within the psychogenesis of writing in the activity called Drawing/Writing described in Chapter 1.

Ferreiro maintains that, although drawing and writing are both "manifestations of the semiotic function" (51) - or drive to make signs - "drawing maintains a relationship of similarity to the objects or occurrences it refers to: writing does not. Writing, as language, constitutes a system with its own rules; drawing does not" (53). Drawing/Writing parts company with Ferreiro on these two points. In Drawing/Writing, just as in any drawing class, or just as in the approach of any artist, drawing has a system of rules. Furthermore, drawing in the five-step process refuses to remain "stuck on" realism - it moves on to abstract semiotic function. In

the composite abstraction, drawing turns abstract deliberately, in order to become a transitional object, or a "substitute object" (53) in the passage from drawing to writing.

When Ferreiro writes, "In psychogenetic development, written language maintains close links to both drawing and oral language, but it is neither the transcription of oral language nor a derivative of drawing" (54), Drawing/Writing comes back to the fold. "Written language constitutes a specific type of substitute object" (54).

The constructivist understanding that interest is critical to intellectual functioning (Devries, 1987, p.25) would continue to hold true. The new curriculum suggests that teaching a child to learn how to be interested and how to give undivided attention is of greater usefulness than trying to design individually appropriate, engaging activities that will elicit, or take advantage of, spontaneous interest.

Where would the new curriculum differ from the Piagetian model? It differs in its broader expectations of what makes enduringly useful thinking skills. Literal thinking, intuitive thinking, inductive thinking, metaphorical thinking, associative thinking are all prized. A premium is not placed on deductive, logical-mathematical thought alone. The exclusive intent of the curriculum would not be to get children to think like the proof-intent mathematician, or like an experimental scientist. The artist and the writer would find a place. For it is true that both the physicist and the artist share intense curiosity and thus both provide fine models for thinking.

An activity like the one called Drawing/Writing in this study begins with inductive thinking, and, using simple questions, builds toward the kind of deductive thinking that might result in strict syllogistic operations. The "could" questions that accompany the drawing process stimulate many kinds of logical operations. It is useful to remember that abstract mathematicians rely on intuition first, using logical operations second, to demonstrate their answers to others in the field. Logical-mathematical operations are far from the spontaneous thought of children that Piaget prizes.

In this curriculum a distinction would exist between knowledge and reason. Knowledge, in a sense, precedes reason. Reason, as intentional mental action, is an operation on a knowledge base. A deep, accurate knowledge base allows for deep reasoning. The goal in early education would be to allow broad, accurate information storage, and for the development of a host of operations on these knowledge bases. Those who espoused the curriculum would neither expect, nor preclude the development of certain operations as they worked with children.

It seems wise to agree with Devries that early knowledge can be achieved through observing the "similarities and differences" between things (72). However, it is possible that attempting, through games (as Devries does), to achieve multiple classifications could cause cognitive "burn-out." Perhaps it is better at the kindergarten level, and at the highschool level, to ask the same simple questions: how are things alike and how are they different? What can something be used for and what can't it be used for? What could the thing be used for, and what could it not be used for?

These questions result in a variety of classification systems. The Escher pre- and post- tests used in the Drawing/Writing research explore how young children respond to "illogical" pictures. It is possible that, in real life situations, where the illogic has to do with what could be called bodily-knowing, or with knowing informed by touch, children are much more adept at logical operations than they are when posed with dissociated, formal reasoning tasks, like conservation (Kuhn, 1979; Donaldson, 1979). That is, children would be if they still were encouraged to know by touch.

Devries suggests that she, too, does not want to over-emphasize logical operations for the very young (78-79). Teachers who accept the new curriculum expect them to develop within the context of searching for sameness and difference. As Douglas Hofstadter suggests, the basic question of intelligence is how things are alike, and how things are different (1979).

From a neuro-constructivist point of view, the usefulness of preoperational thought is the ability to focus on the thing itself, on quidditas. This ability to focus intently on the task at hand is a skill to be maintained over a lifetime. Being able to focus, to evaluate, and to describe the givens of a situation accurately before drawing conclusions from them is a thinking skill of importance. If preoperational thought exists, it is valuable in and of itself because it constrains focus on the thing alone. It is the mental set of "good physical knowledge activities." It is the early attitude of undivided attention.

In connection with writing, neuro-constructivism suggests that assimilation - or accomodation, depending upon how you look at the relationship between drawing and writing - might be facilitated if drawing and writing were thought of as two kinds of meaning-making systems with equal importance. Past the scribbling stage, and perhaps within it, children's drawings mean something to them, just as the marks they make in pre-writing mean something to them, at least as mnemonic devices (Luria, 1979). A constructivist approach to writing and reading would logically begin with drawing, and use drawing actively as a structurable, spontaneous activity of interest to allow the child to organize his own understanding of what an abstract, non-literal, condensed, hieroglyphic-like symbol system would be. This connection of writing to drawing might ease the transition, over time, from drawing, to writing and reading. Reading appears to be inherent in the Drawing/Writing process, existing as part of the very act of intelligible drawing and of writing.

Luria describes the development of writing in this way. He dictated a series of sentences to preliterate children, and asked them to write them down. "Drawing," Luria suggests, "is not just topographic marking" (Luria, 1979, p. 264). He adds, "A mark is a cue to the presence of meaning" (250), and the mark "organizes the child's behavior" (250).

In the first phase, pre-writing is "pre-instrumental, pre-cultural, imitative....(in the second phase writing is) undifferentiated marks" which can be used as a jog to memory (248-50); in the third stage, the "sign stimulus" becomes a "sign symbol," a pictogram... a complex intellectual act. In the fourth stage, there is picture writing, and then, with the 5 or 6 year old, symbolic alphabetic writing (263). Luria suggests that "drawing has a dual relationship to drawing as pictogram writing, and to spontaneous drawing" (265). Luria concludes, "It is not understanding that generates the act, but far more, the act that gives birth to understanding" (276). This suggests that, in the very process of working through the kinds of drawing that

eventually become writing, the child comes to understand that writing carries meaning. Luria's observations of how children learn to write suggests that drawing is an integral part of the writing process.

Vygotsky observes that "the teaching of writing is based on artificial training" (Vygotsky, 1978, p. 105). Writing is not just a "complicated motor skill" (106). It is "a critical turning-point in the entire cultural development of the child" (106). Vygotsky adds, "A feature of this system (of symbols and signs) is that it is second-order symbolism, which gradually becomes direct symbolism" (106). By this Vygotsky means that the "intermediate link, spoken language, disappears" (106), and writing exists autonomously. "As in play, so too in drawing, representation of meaning initially arises as first-order symbolism" (110). The marks stand directly for the thing. These kinds of drawings should be regarded "as a particular kind of child speech" (112). Then the child discovers that he can draw not only things, but speech (114). "It is difficult to specify how this shift takes place....One thing only is certain - that the written language of children develops in this fashion, shifting from drawings of things, to drawing of words" (115). "Make-believe play, drawing, and writing can be viewed as different moments in a ...process... of development...(that includes many discontinuities" (116).

Opinions differ on the order in which children learn to write and read (Ferreiro, 1979). In neuro-constructivism there would be no sudden jump into having to make sense of totally abstract marks. The gradual understanding of the possibility that non-pictorial marks carry meaning would be self-constructed, over time, according to interests, and personal style, just as Luria, Vygotsky, Ferreiro, and Devries might wish.

2.5 Integration of the Combined Research

The research suggests that drawing and writing are two ways to know, and that their combination works like the brain works, cross-modally, or spatially and linguistically through the interaction of map-like neural assemblies (Kosslyn, 1984; Changeux, 1985; Llinas, 1988; Rosenfield, 1988). Visual-tactile sensory information provides the kind of initial maps that determine contours, or continuity; "these tracings are abstracted" in other maps, or panels. "It is the very coupling of maps....(that is the) basis of the brain's ability to generalize" (Rosenfield, 1988, p. 188-89). Rosenfield continues, "Categories are created by COUPLING, or correlating different samplings of the stimuli. This is best achieved through mappings that create a variety of possible groupings of stimuli...through reentry or cross-correlations" (189). The suggestion is that the more samplings of a stimuli there are, the more cross-correlations are possible. Intellectual maturation has to do with increasingly complex systems of neural sheets, or maps, that speak to each other in cross-correlational ways (180). Drawing and writing are both ways to use touch directly, or "as if tracing," to map a variety of samplings of stimuli. Each activity is useful to the construction of thought. Together, drawing and writing appear to drive the process of map-based cross-correlation - of categorization, and of generalization - by starting with, and by returning to sensory information. Our cross-correlations are as accurate as our initial maps.

CHAPTER 3

METHODOLOGY

3.1. Introduction

The following study was an attempt to try to evaluate and measure in a formal study the empirically observed effects of an activity called Drawing/Writing. Experience and research suggest that a combined activity like Drawing/Writing does have, or should have an appreciable impact on drawing, writing and thinking skills.

The study was a quasi-experimental/control design, with multiple treatments and multiple subjects in self-contained classrooms in two more or less matched, or homophilous elementary schools in western Massachusetts.

The study attempted four levels of comparative analysis: experimental with control school; males with females; regular students with special needs students; the individual child's pre-test performance with the child's post- and follow-up test performances. The first three levels of analysis are normative; the last level is what could be called ipsative, having to do with the self in relation to, or against, the self. The last two levels of analysis are the most important to this study, pedagogically. The usefulness of special needs approaches for all students has been discussed in Chapter II. In addition, the research in Chapter II suggests that, to grow as a thinker, and, in particular, as a thinker who is a writer, a child himself or herself must be able to appreciate personal growth over time. The particular advantage to drawing is that skills improve quickly and observably for a broad range of children. Furthermore, the child who draws appears to have more to write about than the child who does not.

3.2. Drawing/Writing, the Experimental Treatment

Drawing/Writing is a drawing process combined with a writing process. A set of drawing instructions move the student into an increasingly complete understanding of an object, and then allow the student to move away from that object in a variety of ways, using recombinant strategies and systems of comparison. Each drawing step is followed by writing. The writing reflects on the accuracy of the information expressed in the drawing. Using this integrative process, the student becomes competent as a realist, and as an abstractionist in connection with drawing. In connection with writing, the student becomes more descriptive and more reflective in connection with writing, increasingly comfortable with analytical and with inferential strategies of thought.

A description of the five-step Drawing/Writing process follows. At the outset, it should be emphasized that all of the following editorial comments should be made by the teacher to the students. Students need to know the reasons for what they are doing. It should be noted, however, that it is the expectation that any teacher who decides to use Drawing/Writing will use it in his or her own way. There is no right way to do it. I simply present my way, as the designer and first teacher of what is called Drawing/Writing. Every time I do a workshop, I learn from the teachers attending more possibilities in and for Drawing/Writing. Every time I teach Drawing/Writing in the classroom, I learn more about Drawing/Writing from the students.

3.2.1. Steps One through Seven

Step One:

The teacher and the students each choose one object from a wide variety of objects, including animal bones, ice hockey skates, lacrosse gloves, gardening tools, old shoes. When asked what makes a "good" object for Drawing/Writing, the answer is that there are no "good" and no "bad" objects. Every object has advantages and drawbacks. In general, the simplest objects become boring. The students need to be told that the object itself is not important. Any object will serve the purpose. The object simply stands for something they want to know about. The object provides practice in getting close to, and in gaining distance from some knowledge base.

The chosen object remains constant during the week-long session of Drawing/Writing. This is the first lesson learned in Drawing/Writing, and it deals with choice, decision-making, and commitment.

Step Two:

The pre-test provides the student with bench marks for drawing and for writing. The student draws the chosen object with as many of the provided materials as the student wishes to use; then the student writes about it. Students generally ask how to do both of these things. Suggest that they draw and write in any way they choose to.

There is a folder for the student's drawings and writings. Drawing and writing for each step in the process are generally combined on the same page. Although each discipline is given equal dignity, the suggestion is that the two activities exist in an interrelated rhythm to advance the meaning-making process. The drawing and the writing pre-tests are each about 10 minutes long, or, in the classroom situation, outside a formal study, as long as the majority of students wish to work. This pre-test is used informally by the student him or herself to measure gains in drawing and in writing.

Each drawing exercise is followed by writing. The writing focuses on what the student has learned about the object from his or her own drawing. " I learned from the contour drawing that my object is..." Or, "My drawing tells me that I knowabout my object." Or, "My drawing is like my object in these ways.....; my

drawing is unlike my object in these ways." Lists of apt adjectives, a five-senses simile exercise ("my object looks like a, tastes like a..... smells like a"), and a handful of concrete and abstract metaphors are part of the first homework assignment. The teacher demonstrates each drawing step. Talk should be larded with specific instructions, and with philosophical asides. This kind of talk results from the dialogue between students and teacher that is an integral part of Drawing/Writing. The process is Socratic and constructivist.

The first 3 drawing steps use magic marker. This is the second lesson in Drawing/Writing and it, too, has to do with courage, risk-taking and commitment. Insistence on markers protects the child from fussing over erasures, slavishly or anxiously.

Step Three:

The third step is demonstration of a contour drawing. A contour drawing is a continuous line that defines what appears to be outside of the object. It is an outline drawing. The contour drawing is fundamentally an expression of the distinction between figure and ground. Where does the object start and where does the space around it end? (Note: this is not the kind of contour drawing that describes a kind of topographic surface map of the object) With pre-K children, a teacher might call the contour drawing a "go-around drawing." Some young children trace the object at first. Tracing appears to be straightforward bodily-kinaesthetic knowing (Papert, 1980). Eventually, the child needs to move away from tracing, just as the child must gain distance on any other set of ideas.

First, the children are shown how to do a blind contour drawing (when they look at the object as they draw, and not at the paper), and then a regular contour drawing. The children are asked to write as they can about the drawing. With kindergartners, a teacher could take down the children's dictation. However, it is better for young children to make their own "writing marks." In this way they make a direct connection between the two mark-making systems as pictures of meaning.

The contour drawing is the most demanding and generally least satisfying for students, and so it is very good to start with this and get it over with. Because it establishes figure and ground it is, however, a critical first step in the knowledge process. The contour drawing is important, cognitively, for it measures the child's ability to judge spatial relationships and to make distinctions in a demanding way. The student draws with one continuous, strong line. It is as if a spotlight were being shone on the object, throwing its silhouette on the wall. No internal lines are drawn.

Step Four:

After several attempts at the contour drawing, and after writing about what they have learned about the object from this kind of drawing, the first day of Drawing/Writing is over. On the second day, the class moves on to what is called the Basic Shape drawing. This drawing must also be done using marker (for the same reasons as those presented above). Basic Shapes involves drawing the object using simple geometric

forms that seem appropriate to the object. First Euclidean geometry, and regular polygons (squares, triangles, rectangles, circles...) are used to describe the object. Then the teacher talks about fractal geometry. The age of the student determines the technicality of the discussion. Since there are, at this point in the history of mathematical ideas, two quite different kinds of geometry that describe reality, with fractal geometry coming out ahead for general relevance (dynamical processes have a different kind of ordering principle that holds across scales), students should know about both kinds. Students learn that there is another kind of geometry, that describes irregular shapes. Using a fractal approach (though this approach is a gross oversimplification; drawing the object using self-similar units across scales has not yet seemed useful to this researcher), the child draws the object in terms of irregular shapes. The child moves away from straight lines, into curved lines. Parenthetically, the "fractal" drawing is also a way to sneak up on value. Often the way lights and darks play over an object results in irregular, "fractal" shapes.

The students write, as usual, after every drawing, discussing what they have learned about the object.

Step Five:

The third drawing in the process is called Light, Medium and Dark. Simple shapes are used in a hard-edged way to define the shapes of the light, the middle value, and the dark areas on the object. The student is introduced to ideas about light-source and the illusion of three-dimension that is achieved when any object is drawn or modeled according to its values, that is, in connection with degrees of lightness or darkness. This is a good time to talk about visual tricks and powerful illusions.

Step Six:

The Perfect Whole is the fourth drawing. Quotation marks around the words "perfect whole" suggest that perfection is only an approximation. As soon as the students touch pen to paper, they are abstracting. It can be suggested that the so-called real drawing of the object may, with time and experience, no longer seem like the most real description of the object to them. The quality of "ice-skateness," for instance, or "dog backboneness" may be better expressed in less literal ways. In other words, the suggestion is that nothing is perfect, and the illusion of reality that a figurative drawing provides may be no closer to a perfect representation of the thing than some more abstract approach.

Being able to do a realistic drawing is very empowering to students. It is therefore important for students to learn to draw well. In this way, students can readily see how good they are. In this way, successful, effective drawing is a hook attentionally, motivationally, and affectively. Drawing is deliberately used in this way to impact writing. Drawing/Writing is a kind of intrinsic reward system, where the reward is drawing.

The students put aside their markers, and take up pencils. The teacher shows what pencils are useful for, which is making a smudge, allowing soft transitions between values. The result is subtler, more "real." Lift-off, or how to use an eraser to take away some of the graphite, creating a highlight is demonstrated. If a

school can afford it, students may use not only pencil, but charcoal, conte crayons, water colors, pastels for the Perfect Whole.

By this time, the students can work in a more sustained way, without much concern for failure. The object they are working with has become, to some extent, familiar. The student is feeling competent to deal with it. The students are shown how to use the media, and are encouraged to experiment with them, before they return to writing about the chosen object. The students continue to concentrate their writing on what they have learned from their own drawings about the object. This is another good time to work on generating similes and metaphors and analogies. Using the five senses, the students are asked to write about what their object looks, tastes, smells, feels and sounds like. This is a way to get five similes "for free." Asked to write about what their object is for, the students move from thinking about form to function. Asked to write about what the object could be for, the students move into prediction, and into hypothetical thinking. This is also a good time to move into the power of negative thinking. The students are asked to write about not only what their object is for, but not for; not only like, but not like; not only could be for, but could not be for. In this way, the students are moved into speculative, predictive, hypothetical thought on a variety of levels.

By this point in the process, the student has drawn a variety of "perfect wholes" that are satisfactory. The amount of precise, accurate information about the object is accumulating. The student is learning how he or she sees, that is, how he or she learns to learn. A kind of self-monitoring process goes on, particularly in connection with drawing. The ability to see more and to reflect powerfully is well underway, and the student is aware of it. The individual is emerging as what could be called a Mark-maker of Significance.

The perfect whole is confirming. It has powerful affective ramifications. Students who can draw things the way they look to them feel very good about the drawings and about themselves. If those students happen to be learning disabled, the effect is enhanced.

Step Seven:

The last step of the five drawing lessons may be the most important from the point of view of cognition. Creative or original thinking has a good chance to flourish in step five. Step 5 is called the Composite Abstraction. Rather than letting students roll their eyes and groan over this polysyllabic term, the teacher should launch into the etymology of the words. Using Latin, the explanation goes this way; "co" means "together", "pono" means "to put," "ab" means "away from," and "traho" means "to drag." The suggestion is that the abstract artist drags away from the object under consideration whatever he or she finds of interest, putting these items together in a way that is personally satisfying and which may have a general power to communicate. This is the kind of approach the students take in Step Five, becoming abstract artists themselves, in the process.

The Composite Abstraction is approached in this way; the student identifies in all of his or her accumulated drawings those parts that are particularly powerful. "Powerful" may have to do with design, or with meaning, with being accurate, or with being like the object being drawn. The chosen part may look good to the student

because of formal considerations, or it may be a part of the drawing that most faithfully describes the object. The student then combines drawing fragments into a new whole that expresses the object in a particularly telling way TO THE STUDENT. This composite abstraction may be done several times. The teacher or another student rotates each composite abstraction for the one who drew it. The question each student is asked to answer for himself or herself is where the drawing has too much, or too little. This question relates to Bates' (1960) definition of what makes a good design discussed in Chapter 1. Rotation allows the student to see the work upside down and sideways. Looking at work upside down allows clearer understanding of where the drawing needs work in connection with "too much" and "too little." Betty Edwards discovered that drawing things upside down allowed students to produce a far more faithful representation than drawing rightside up (1979). The success was based on the conviction that most people thought they could not draw something if they knew what it was. The Drawing/Writing process uses rotation, including the upside down position, as a way for the student to evaluate work, particularly abstract work, in new ways. Novelty and therefore attention are maintained.

Looking at work upside down involves risk-taking. Every step of the drawing process involves risk-taking, but the composite abstraction demands the most. The composite abstraction becomes more powerful as it becomes more coherent. The organizing and integrating of form, line and color take some time. It is left entirely up to the student how he or she does this. The only stricture is that the student be thinking carefully about "too much" and "too little." The teacher does not impose expectations about how the perfect whole is to look, nor about how the composite abstraction is to look. The phrase, "you are the boss of your drawing and your writing" becomes a litany in this process. Children will start to quote it to each other after while, whenever a student asks for the answer to a drawing or writing question. Children need to learn how to take control of the learning process. Control is salubrious.

3.2.2. Socio-Moral Ramifications of "Neither Too Much, nor Too Little"

One of the useful ideas that I discovered while teaching drawing to college undergraduates is what I now call "The Rule of the Good Design." It works for drawing and for writing. The rule is that a good drawing, or a good piece of writing should have neither too little in it, nor too much. I have found that most groups of students come more or less to the same general conclusions about what is "too much," and what is "too little" in their own, and in others' composite abstraction. There seems to be a common general understanding of balance, or of what is needed, or of what is appropriate. Interestingly enough, there appears to be less consensus at the age of the Elderhostel student, between the ages of 60 and 80, of what is needed or appropriate. This may argue for greater individuation of mind with age.

It is not necessary, and it is usually confusing, to use traditional art terms when discussing composite abstractions. "Too much," "too little," and "just right" are all of the descriptors the self-judging or other-judging student needs. The teacher will find that when he or she holds each piece of seemingly finished work up, rotating it around, so that the student sees it at all angles, including upside down that the students

will look, and look, and then start nodding. As soon as the teacher hands the work back, the student usually goes quickly, absorbedly back to work. This phenomenon of complete non-verbal understanding happens with children, and with adults. There is a recognition, an apparently deep, sudden appreciation for what the work needs. Rotation of work keeps decision-making going.

The writing in connection with Step 5 and the composite abstraction has to do with making meaning in new ways. The abstract drawing may serve as a new way to look at the object per se, or it may serve as a kind of projective, Gestalt-like, Rorschach-like stimulus to writing. Extraordinary writing has been produced by young children in connection with this fifth step.

There is, in addition, a socio-moral spin-off of the Rule of a Good Design in the Drawing/Writing process. This neither-too-much, neither-too-little approach to basic design lays the basis for what I call the morality of aesthetics, or aesthetic morality. Knowing what is too much, what is too little, knowing what is just right, is a good basis for morality in human relationships. It does not imply a careful blandness. It implies strong decisions. The student has gained an understanding of what I call "acceptable differences." The student sees that there are many possible ways to do a composite abstraction of the same object. At a young age, the child learns that a variety of correct answers are possible. This understanding should encourage tolerance, compassion, and flexibility. The arts may be used as a natural training-ground for morality.

3.2.3 The Cognitive Ramifications of Drawing/Writing, Including Remedial Spin-Offs

When the student has finished a series of composite abstractions, he or she understands, covertly or overtly, what it is to create an abstract symbol for an object. The student may be encouraged, in this way, to believe that the abstract marks we call writing will be freighted with meaning, too. The student also understands the creative strategy involved in putting things together in new ways. Students of Drawing/Writing learn to "read" visual reality in a variety of ways. Increasingly observant, open, and flexible minds are useful within the educational environment, and beyond it.

The teacher may discuss creativity as a constellation of strategies, a good many of which are being taught in Drawing/Writing. Finally, the student may gain a personal understanding of abstract art that will make possible an appreciation for a variety of non-literal forms of expression. Perhaps most importantly for an approach to remedial education in the regular classroom, a group of information processing strategies may have been internalized that will be useful to students who have problems with sequencing. Problems with sequencing impact the use of language.

3.2.4. Step Eight

The post-test consists of a comparison of the final perfect whole drawing, along with the final writing of the student, with the pre-test drawing and writing. The quantity and the quality of the drawings and the writings is assessed on the basis of the amount and kind of information expressed. An increasing number of

accurate adjectives, verbs, adverbs, nouns, apt similes, metaphors, and analogies suggest the development of metaphorical and inferential thinking skills. This post-test provides a way for a student to appreciate his or her own progress. The formal battery of five post-tests that were used in the study were devised for the sake of the research. A regular classroom teacher might, or might not find them useful.

The materials in all teaching and testing situations were identical or analogous: a box of objects, pencils, fat and thin magic markers, and legal-size blank paper. Each child chose an object to draw and write about. Each child received a manila folder with 3 sets of random numbers to identify the work done on the 4 pre-tests, the four post-tests, and on the follow-up-study. These random numbers identified the students for the purposes of the study, preserved the privacy of the students, and allowed the study to be blind in terms of its evaluation process.

3.3 Research Population and Setting

The study involved 209 children in 5 grades (K, 3, 4, 5, and 6) in intact classrooms in 2 comparable elementary schools in western Massachusetts. The holistic pre-test mean scores for drawing and for writing suggest that the schools were pretty evenly matched (See Table 1, Chapter 1V). The Rescore mean scores suggest that the experimental school had a definite edge in writing skills. The setting for the treatment and for all testing was the regular classroom.

3.4 Procedure of the Study

3.4.1 History

The data gathering covered a 3-month period of actual testing (January, February and March, 1989), and a 4-month period of evaluation (April, May, June and July, 1989). The study started with teacher-training in the experimental school. All testing in both schools occurred on the same day. Each grade was tested in general at the same time of day, on the same day of the same week to avoid problems with maturation. Both groups received the same tests, and these tests were measured in the same ways. The treatment was 1 and 1/2 hours per day of Drawing/Writing.

In the months of January, February and March of 1989 a six-day rhythm was established for the study. On Monday, or Day #1, in both the experimental and control schools (control in the a.m., and experimental in the p.m.), all of the students "took" the four pre-tests. On the next Monday or Day #6, all students took the four post-tests. In January, grades 3 and 6 were tested in this way. In February, grades 4 and 5 were tested in this way. In early March, the two kindergartens took only the drawing and writing tests, and discussed the Escher prints verbally.

In mid-March, all of the students except the kindergartners took the follow-up test, drawing and writing about a new object. The reason for the follow-up test was that the experimental students appeared "jaded"

with their object, which they had been drawing and writing about for a week. Their drawing and writing scores went down. It was also possible that the experimental students could not generate energy or interest to write and draw in the few minutes allotted (10 minutes) on the two post-tests after a week of 1 and 1/2 hour drawing and writing periods. It seemed important to run a second set of post-tests with a new object. The researcher went back into both schools and re-tested all of the students on new objects. Chapter 1V shows that the follow-up test results did, indeed, show significant gains. The effect, however, extended to both schools. In addition to the follow-up tests themselves, the researcher had decided that both sets of follow-up tests should be coached. Theories (Feuerstein, 1981) about the usefulness of a test/teach/test approach influenced this decision. The researcher coached the experimental teachers on how to coach both the follow-up drawing and writing; the instructions for drawing were to fill the page, to use strong lines, to include all details, to think about shading. The instructions for writing were to include all details, and to use similes and metaphors. Both of these word constructions were explained in the coaching session. The control teachers were given a write-up of what their corresponding teacher had done in the experimental school, and were also given a brief coaching session by the researcher.

In March and April, the holistic evaluation was conducted. In June and July, the Rescore evaluation was conducted, with statistical analyses of all sets of scorings.

3.4.2 Mode of Inquiry

The mode of inquiry was a series of pre- and post- and follow-up tests. To generate data for evaluation other than the individual folios of drawings and writings, four pre- and post-tests, and one follow-up test were administered to all of the students. These tests involved drawing the object and writing about it, as well as writing about two of the seasons of the year (Winter and Spring), and about two prints by the woodcut artist, M.C. Escher. Approximately 2,000 pieces of drawing and writing were generated.

3.4.3 Teacher-Training

To factor out researcher/teacher effect, teachers in the experimental school were trained in Drawing/Writing along with a classroom of students in a grade other than their own. They then returned to their own classroom to teach Drawing/Writing for a week. The 4th grade teacher and the 5 grade teacher were trained in this way, the 4th in 3rd grade, and the 5th in 6th grade. The teachers were responsive to their training and did a thorough job as teachers of Drawing/Writing. The experimental school was supportive and enthusiastic about the study; the control school was also very supportive.

3.4.4 Schedule

Week 1- 4th grade teacher trained in 3rd grade experimental school. Control school is pre- and post-tested on same days as the experimental school.

Week 2- 5th grade teacher trained in the 6th grade, experimental school. Control 6th grade, pre- and post-tested as above.

Week 3 - 5th grade teacher taught Drawing/Writing in own room. Control 5th grade is pre- and post-tested.

Week 4- 4th grade teacher teaches Drawing/Writing in own room. Control 4th is pre- and post- tested.

Week 5- Kindergarten, experimental school, p.m. session, Drawing/Writing. Control K is pre- and post-tested.

Week 6- Follow-up tests, all grades, both schools.

Week 7- Kindergarten, a.m. session, experimental school, Drawing/Writing.

3.4.5 The Tests

On day 1 of each session, and on day 5 or 6 (whichever was the last of each session), in both of the schools, with the control school being tested in the morning, and the experimental school being tested in the afternoon, all students were given four, timed, ten-minute pre- tests and four post- tests. The pre- tests were a first drawing of the child-chosen object, a first writing about it, a piece of writing about the season Winter, a piece of writing about the Escher print that is called in this study as "Relativity" (Appendix A, print #1). The post- test was a second drawing of the object, a second piece of writing about the object, a piece of writing about the season Spring, a piece of writing about a second Escher print which the youngest children called "Mummy Birds" in this study (Appendix A, print #2, "Other Worlds"). These pre- and post-tests were given matter-of-factly, with no coaching.

The rationale for these four, timed tests is that the research must not only show a change in descriptive and reflective skills in connection with an object and Drawing/Writing, but in connection with a sample of writing distinct from Drawing/Writing- thus the choice of the seasons as forms A and form B of tests whose subjects should be equally accessible to the combined population of students.

The Escher prints were used to try to determine changes in thinking skills in connection with levels of awareness of discrepancy, or paradox - that is, in connection with how things are like, and unlike, our understanding of the world. The prints were chosen for accessibility to general bodily understanding, across ages, of the world, in terms of up and down.

In kindergarten, audio tapes, as well as drawing and writing samples, provide additional pre- and post- test data.

A final follow-up test was conducted, involving all students except kindergartners in drawing and writing about a new object. The researcher felt that the experimental students were "jaded" with their original object, and that they did not draw nor write as powerfully as they might have on the brief, 10-minute post test. It appears that this follow-up test with a new object has produced the kind of drawing and thinking in writing that this researcher has found does develop within the experience of teaching, and learning, through Drawing/Writing. This follow-up test was accompanied by a "coaching guide" (described in section 3.3.1)

which was, in essence, a mini course in descriptive writing, in simile use, and in powerful drawing. Notes were taken by the researcher on how the experimental teachers coached, using the guide, and the same kinds of coaching were suggested to the corresponding control teachers. The rationale for the coaching was that the previous timed post-testing was mechanical and dull. It seemed reasonable to let the students know what thinking skills the study was interested in. The expectation of the researcher was that the students trained in Drawing/Writing would be better equipped to respond to the specific instructions. The researcher also felt that testing should provide a learning experience for the control school. A naive largesse may be antithetic to sound statistical research.

All research procedures were approved by the appropriate school committees, principals, and teachers.

Letters informing parents of the study were sent home in the experimental school, before the study took place (Appendix B, #1). Letters of release went out to all parents in the grades involved in the study in both schools, asking permission of parents, guardians, and students to use the drawings and writings in the evaluation process (Appendix B, #1 & #2). In both schools, the parents were asked whether their child received special services outside the regular classroom. For the most part, parents gave permission, and provided this information. The special services information was critical to the strategy of the study, in which the identification of the population designated simply as "referred" provided an important target for possible appreciable gains due to the treatment. The release letter followed the guidelines of the University of Massachusetts Human Resources Committee, Department of Education.

3.5 Sample

The sample involved 209 students in two schools. The choice of which school was experimental and which one was control was not random, but was dictated by the circumstances that were part of the preparation for the study.

The holistic evaluation (see below) of the study involved all 209 students and 12 teachers. There were 106 boys and 103 girls in the study. Of these, 163 were regular students, and 46 were referred students. As defined by this study, "referred" simply designates those children who receive special services of any kind outside the regular classroom.

The students were from grades K, 3, 4, 5 and 6 in two elementary schools. Grades 1 and 2 were not included in the study simply because of constraints on time and energy.

The Rescore evaluation (see below) of the study included a total number of 105 students. There were 41 referred students, and 64 regular students. The total number of students in the experimental school in this sample was 57; 33 of these were regular students and 24 were referred students. The total number of students in the control school in this evaluation was 48; 31 were regular students and 17 were referred students. The Rescore evaluation did not focus on the difference between the sexes.

All special needs children were retrieved from Resource rooms, or from any kind of special help, for the testing and teaching sessions in both schools.

3.6 Study Design

The form of the study was a 2 (control, experimental) X 5 (kindergarten, grades 3, 4, 5, 6) X 2 (male, female) X 3 (times of measurement) analysis of variance design. Subsidiary analyses involved the selection of children with special needs to compare with regular classroom children. The form of this design was 2 (control, experimental) X 4 (grades 3, 4, 5, 6) X 2 (male, female) X 2 (referred and non-referred) X 3 (time of measurement).

3.7. The Hypotheses, General and Specific

3.7.1 The Spatial/Linguistic Hypothesis

The theoretical research hypothesis is that a complex spatial/linguistic information processing activity results in more effective thinking and learning than a linguistic activity that does not integrate spatial processing. The hypothesis rests on research relating to cross-modal storage, including its impact on processing capabilities and on memory, and on the suggestion that training in thinking skills in connection with what could be called the syntax, or orderly form of intelligent thought results in automatic processing that will allow the mind to range farther and wider than it might otherwise be able to.

The modus operandi of mind appears to involve a move from specific descriptive knowledge to more general metaphorical or inferential knowledge. Developmentally, the human mind appears to move from the concrete to the abstract, and from the literal to the figurative. These earlier levels of thought appear to be pre-conditions for later ones.

3.7.2 Drawing/Writing as a Spatial/Linguistic Activity

The practical research hypothesis is that a drawing process combined with a writing process will develop descriptive and inferential thinking skills better than a writing program that does not include this kind of training in drawing. The more complex training is more effective because it models or reflects the integrated spatial/linguistic workings of the mind.

Thus, what could be called the cross-modal hypothesis suggests that training in an activity called Drawing/Writing will change the quantity and quality of the writing that is produced. More words will be written, and the writing will reflect an increase in the number of facts described, and in the number of inferences made.

Note: Drawing/Writing underscores the necessity of mediated learning. The gradual approach to observation and to reflection provided by the Drawing/Writing teacher is critical to the effect of this activity. It is not assumed that increasingly accurate, comprehensive thinking skills develop without training, and it is not assumed that the transfer of such skills from drawing to writing will happen without the child's personal

experience with a variety of comparative strategies, including simile, metaphor, analogy, prediction and hypothesis. It is not assumed that information processing strategies become automatic without practice, over time. Just as the five-step drawing process becomes automatic with practice, so grammar, punctuation and spelling become automatic in writing over time. In a general way, powerful descriptive and inferential thinking skills may become automatic over time.

3.7.3 The Six Specific Hypotheses

The six hypotheses generated by the study are as follows:

Hypothesis #1; Drawing/Writing will increase descriptive and inferential writing about objects, reflected in numbers of words produced, numbers of facts, similes, metaphors, analogies, predictions and hypotheses.

Hypothesis #2; Drawing/Writing will increase drawing skills, strengthening line quality, decreasing distortion, increasing scale, increasing the amount of specific detail, developing the ability to use value to give the illusion of three dimension, including the ability to create abstractions.

Hypothesis #3; Drawing/Writing will increase descriptive and inferential writing about the seasons.

Hypothesis #4; Drawing/Writing will increase descriptive and inferential writing about Escher prints.

Hypothesis #5; Drawing/Writing will increase descriptive and inferential writing and drawing skills in referred children to a greater extent than in non-referred children.

Hypothesis #6; Drawing/Writing will be taught better by the regular classroom teacher than by the researcher teacher. The reason for this hypothesis is that Drawing/Writing is not meant to be an occasional form of enrichment, taught by an outside expert. It is meant to be a regular classroom activity, taught by the person who is in a position to know the students' needs and strengths the best.

3.8. The Variables

The independent variables in the study are school, sex, grade, child-type and teacher, and the treatment, Drawing/Writing.

The dependent variable is the ability to make increasingly accurate, comprehensive observations, along with a variety of levels of logical inferences based on these observations. In observable form, the dependent variables are drawing and writing skills.

3.8.1 Holistic Dependent Variables

#1; pre-, post- and follow-up writing, object one and two.

#2; pre-, post- and follow-up drawing, object one and two.

#3; pre- and post-writing about the seasons Winter and Spring.

#4; pre- and post- writing about two Escher prints,

"Relativity" and "Other World."

#5; teacher effect on follow-up writing and drawing about a new object.

These variables (14) were expressed as samples of drawing and writing. The samples were collected in the regular classroom in both the experimental and control schools during the pre-, post-, and follow-up testing sessions.

These samples were scored by the holistic method (see Evaluation section below).

3.8.2 Rescore Dependent Variables

- #1; pre-, post- and follow Nb1, Nb2, Nb3 or number of words per sample.
- #2; F1, F2, F3 or number of facts per test sample.
- #3; N1, N2, N3 or number of nouns per test sample.
- #4; A1, A2, A3, number of adjectives.
- #5,6,7,8,9,10, 11 and 12 are numbers of verbs (V1, V2, V3), adverbs (Adv1, Adv2, Adv2), similes (Sim1, Sim2, Sim3), metaphors (M1, M2, M3), predictions (P1, P2, P3), hypotheses (Hy1, Hy2, Hy3), scores (S1, S2, S3), and holistic scores (Ho1, Ho2, Ho3).

The Rescore included the holistic scores (the Ho variables) as a variable to allow comparison with its more finely grained system for evaluating changes in language. Rescore provided a numerical value arrived at by counting words and identifying word-use and construction in the form of scores described as S1, S2, and S3.

These (45) variables focussed on the writing samples solely about objects collected in the pre-, post- and follow-up tests. Because the researcher felt that the gross measures of the "ballpark"-like holistic evaluation were not providing a true picture of the changes going on in the study, and because one of the strategies of the study was to use referred students as agents of change, Rescore worked with the object-related writing of all of the referred population in both schools, and with every other student in grades 3 through 6 in both schools, giving extremely close attention to these writing samples.

3.9 Methods of Evaluation

The 2,000 samples of drawing and writing were evaluated by a group of ten, using the holistic method (CTB/Mcgraw-Hill, 1986); roughly half of the object-related writing samples were re-evaluated by the researcher, using a system devised by the researcher called Rescore. Both of these methods have been analyzed statistically, using univariate and multivariate approaches. In addition, individual descriptive case studies are provided in Chapter IV, providing a third way to evaluate these data. The question that all of these methods of evaluation attempted to answer was whether training in the activity Drawing/Writing had measurable effects on thinking expressed in writing.

The number and quality of the facts and inferences (and the level of awareness of discrepancy or paradox in connection with writing about the Escher prints), are the criteria for the holistic evaluation of the 1,000 pieces of writing in this study, using a scale of 0 to 4, which is then translated into a scale of 0 to 8. The 1,000 drawings are also evaluated for increasing factual information, including accuracy in shape, shading, and detail, as well as increasing strength in line quality, and increasing scale. The larger the drawing, the closer

the observer appears to be, and the more room there is to include information. Small, tight drawings do not allow the observer to include much specific information. Furthermore, the stronger the line quality, the greater the degree of light/dark contrast. The "stronger" the drawing, the more engaged the eye is as a neural assembly that fires for edges, attitudes of lines, and contrast. Beyond light/dark contrast, the eye as part of the mind (Chapter II described the eye as part of the brain, that traveled) is engaged by the amount of meaning conveyed by the drawing.

3.9.1 Evaluation, Holistic

A ten-person team, excluding the researcher, using the method for evaluating writing called the holistic method (see terminology, Chapter 1) has given each of the 2,000 pieces of drawing and writing a numerical value, from 2 to 8. The two training/evaluation sessions were run by an experienced holistic evaluator, who is also a consultant for writing at the elementary and secondary school levels. The dates of the workshops were March 5, and April 9, and April 23. The April 23rd session was devoted to the evaluation of drawings. Only six members of the team were involved in this final session. The trainer did not attend, for the group was fully trained by then. The team included a principal, teachers, parents, an architect, a lawyer, a weaver.

The criteria for the holistic evaluations of drawing and of writing are as follows:

Kindergarten, Drawing/Writing: (Note, Invented Spelling: The holistic workshop trainer taught the group about early invented spelling, and the early use of initial and final consonants, with the eventual inclusion of some vowels so that they would be sensitive to early forms of writing.)

CRITERIA A:

Score of 1: Minimal drawing, no writing.

Score of 2: Drawing with some information about the object, minimal writing, including name, some numbers, letters. Writing may be invented spelling, but does not generally appear to be.

Score of 3: Drawing that is accurate in terms of information, including proportion, with writing that appears to have meaning, including invented spelling - also any parts of the string known as the alphabet, or any strings of numbers. (This criterion was modified by the group; it originally read, " writing, but meaningless." Rightly so, members of the group who teach the very young objected to this.)

Score of 4: Fairly good drawing - that is, drawing with good observed detail, and lots of meaningful writing, with a clear attempt to encode words having to do with the object.

It was also the observation of the group that this made scoring hard. What if a student drew well, but wrote nothing? Did that student get a 1? This scoring needs to be modified to include this particular category for later reference. See Chapter IV, discussion of data.

CRITERIA B, Kindergarten:

After discussion with the evaluation committee, and some thought, the entire set of kindergarten drawing/writings were re-evaluated, receiving two new scores. One score was for the drawing, alone; the second was for the writing, alone. These two scores can be combined, if it appears useful to the study, to yield a single "drawing/writing" score.

The criteria for drawing is exactly like that for the older grades, described below, except that a drawing could gain a 4 without having to include shading. A detailed, big, fairly faithful rendering of a thing could get a 4.

CRITERIA writing:

0-no writing marks at all.

1-child's name, and/or marks clearly meant to be writing instead of drawing.

2-name, letters, numbers but seemingly random, used as a different mark-making system, but not to encode meaning.

3-Any level of invented spelling, involving single word(s), or short phrases.

4-Any phrases, sentences, strings using invented spelling, where the intent is clearly to write with meaning about the object.

CRITERIA C, Writing about Object, grades 3, 4, 5 and 6:

Score 0 through 4, for amount of precise, factual information, taking note if the information relates to the use of all five senses. This score also reflects the inferential level of the writing; is simile, metaphor, analogy (functional similarity rather than a physical similarity), or hypothesis used?

CRITERIA Writing about a Season, grades 3, 4, 5 and 6:

Score 0 through 4 for precise, factual information, including those about weather, activities, natural growth or non-growth, associated objects. Include in scoring, inference level: feelings about, memories, similes, metaphors, analogies, hypotheses.

CRITERIA writing about an Escher print, grades 3, 4, 5 and 6:

Score for the amount of factual information, level of factual observation - obvious? unusual? Score for level of awareness of paradox, or discrepancy. Is the awareness low-level? That is, does the word "weird" carry all of the understanding? Score high for phrases that imply there are lots of ways to look at these prints. Score for level of simile, metaphor, analogy.

CRITERIA, drawing about the object, grades 3, 4, 5 and 6:

Score 0 through 4 for "realism," that is, for the amount of accurate information in terms of shape, details, size. Large scale drawing scores higher. Score for line quality, with stronger scoring higher than faint. Score higher for attempts to shade.

Score of 1: Minimal drawing - small, or vague, diffuse, fast, brief, unrefined, amorphous.

Score of 2: Pretty good information, sense of careful recording of information, but considerable distortion.

Score of 3: Good shape, and proportions; strong lines; good information, lots of details; attempt to shade and/or show multiple views.

Score of 4: Large scale; sensitive and accurate line quality; sense of sure seeing and recording of accurate information; attempt to shade; to show how things fit together, and/or work. Unusual point of view, or multiple views.

COACHING guide, follow-up test, with new object:

For drawing: Fill the page; use strong, accurate outlines; good sense of shape; attention to all important details; think about lights and darks - cross-hatch, stipple, smudge?

For writing: Fill the page; use strong description of the facts, thinking about a sense chart, about how the thing looks, feels, smells, sounds, tastes. Think about the function of the object.

Use strong comparisons - use similes, metaphors (with coaching on what these are).

Give a strong description of the meaning of the thing.

Note: The experimental school teachers coached first. The researcher took notes on how each teacher coached, and coached the control school teacher on these additional points. For instance, the experimental third grade teacher really pushed similes.

3.9.2 Evaluation, Rescore

The holistic scoring of the 2,000 pieces of drawing and writing did not provide statistical significance. The null hypothesis appeared to have been proved, contrary to several years' dramatic successes with Drawing/Writing. The researcher decided that her earlier decision to do a more fine-grained analysis of the data was important. Therefore, each of the three pieces of writing produced in connection with objects in the pre-, post-, and follow-up tests of the referred children were evaluated in the "Rescore" way, and every other regular child in grades 3, 4, 5 and 6 in both schools was evaluated in this way.

The intent behind Rescore, beyond trying to get at statistical significance, was to attempt to pinpoint the positive effects of Drawing/Writing on thinking skills in connection with language. A condescriptive evaluation of variables including pre-, post-, and follow-up scores for numbers of words per writing sample, along with the Rescore cumulative score for word use and construction was conducted. Rescore focussed on the interaction between school, child type, and time of test, examining the relation between child type and sex, as well.

For each sample, Rescore came up with a score equal to the number of words in the writing sample; for number of facts; for number of "facts" as opinions, or events in a narrative, or events in memory that occurred in connection with the object; for number of adjectives, nouns, adverbs and verbs. All forms of the verbs "to be," and "to have" were excluded from the "strong" verb category. Only "strong" verbs counted. Part of the Rescore evaluation involved the number of similes and metaphors produced, along with the numbers of predictions and hypotheses. To be a prediction, the following words (the following words are chosen because they occurred in the students' writing) had to be used: "could be for," "might be for," "might," "reminds me of," "from my guess," "it appears to be," "I think," "probably," "maybe we should." To be a hypothesis, these words, also generated by the students' writing had to be used: "because....then," "if," "seems" with "because," "so if," "unless it is," "it must have been." Numerical values were given to each kind of word, and to word-use (see below, point system).

In this way, each piece of referred student writing and a large sample of regular student writing had, by the end of the study, 3 possible scores: a holistic score, a "Rescore" score, and a "# of words in the writing sample" score. It was hoped that the Rescore Method, and the simple counting method would show statistical significance at least for the referred child, if not for the group.

A three-level system of scoring called "Nb" or "Numbers" dealt with numbers of words; a system called "S" or "Scores for Word Use and Construction" attributed numeric values to parts of speech and to word-constructions. These two sets of scores, as well as the 3-levels of the original holistic scores, designed as "HO1, HO2, and HO3" were additional variables in this study. The point system for the "Nb" and "S" system are as follows:

POINT SYSTEMS for scoring, Rescore method. (One point for each word, yields the Nb score. If a student writes 20 words on the pre-test, the Nb1 score is 20.)

- Two points per facts
- One point per opinion, narrative point, reminiscence)
- One point each, nouns, adjectives, verbs, adverbs
- Three points per similes
- Four points per metaphor
- Five points per prediction
- Six points per hypothesis

3.10 Summary, Evaluation Methods

The data collected by the study was evaluated in three ways: by what is called the holistic method (CTB/McGraw-Hill, 1986); by the Rescore method (Sheridan, 1989); by descriptive and anecdotal case studies. The first method provides precise criteria but results in gross measurements; the second approach provides both precise criteria and precise quantitative measurements for change in language use; the third provides visual and verbal, qualitative measurements.

CHAPTER 4

DESCRIPTION AND ANALYSIS OF THE DATA

4.1 Description of the Data

4.1.1 Overview

The study involved 209 students in two schools. It generated approximately 2,000 pieces of data in the form of drawing and writing samples. Table 1 describes the distribution of these students between schools, and the numbers of students whose work was evaluated by the two scoring systems, as well as by the numbers of students discussed in the descriptive case studies.

Tables 2-7 present means and standard deviations for the writing scores and drawing scores. Table 6 focusses on the drawing scores alone. Table 7 provides means and standard deviations for the Escher print writing scores. Tables 8-13 provide a variety of comparisons and analyses of the combined data.

The six hypotheses in the study are evaluated statistically in two separate ways. First, each hypothesis is tested using the holistic method. Then, each hypothesis is tested using the Rescore method. Each hypothesis has been analyzed for significant effects in connection with the variables of school, sex, grade, child type and trial.

Twelve illustrated case studies complete the chapter.

A marginally significant effect will mean that the results produced an effect between .08 and .05. Significance will be reported at the .05 level or less level. Highly significant results will be reported below the .01 level.

Table 1 follows. It shows the numbers of students in the experimental and control groups in general, and it shows the numbers of students in the Holistic, Rescore and Ipsative Evaluations.

Table 1 The Study Populations

Abbreviations:
 Exp.=Experimental School
 Con.=Control School
 Ho.=Holistic
 R.= Rescore
 Child type 1 = non-referred child
 Child type 2 = referred child
 Child type 1 m, or f = non-referred male, or female
 Child type 2 m, or f = referred male, or female

General numbers:
 Exp., n=117
 Con., n=92
 Holistic evaluation, total, n=209
 Rescore evaluation, total, n=105
 Ipsative Case Studies, n=12

	Ho.Exp.	R.Exp.	Ho.Con.	R.Con.
n of students	115	57	94	48
n of girls	60	28	41	2
n, grade K	27		20	
n, grade 3	22	14	19	19
n, grade 4	22	13	14	8
n, grade 5	24	16	15	10
n, grade 6	22	14	24	11
n, Child, 1	94	33	79	30
n, Child, 2	23	22	13	17
n, Child,1, m	17	17	16	16
n, Child,1, f	16	16	14	14
n, Child, 2, m	11	11	7	12
n, Child,2, f	11	11	6	5

4.1.2 Review Study Design

The analysis of pre-, post- and follow-up scores involved 10 dependent variables in connection with the holistic scoring method, and 41 variables in connection with the Rescore method.

The holistic dependent variables were pre-, post- and follow-up writing samples about an object; pre-, post- and follow-up drawing samples of an object; pre- and post-test writing about the seasons Winter and Spring; and pre- and post-test writing about two Escher prints "Relativity" and "Other Worlds."

The Rescore dependent variables included numbers of words, facts, imaginary and/or narrative ideas, nouns, adjectives, adverbs, verbs, similes, metaphors, predictions, hypotheses, pre-, post- and follow-up

holistic scores, pre-, post- and follow-up "S" scores (S scores tallied up word numbers, word-use, and word-construction into an overall numerical score).

Variation in these scores was examined as a function of the following independent variables: a) Treatment (two levels: experimental and control), b) Standard or Grade (five levels: K, 3, 4, 5, & 6), c) Ability Track (two levels: non-referred and referred), d) Gender (two: male and female), e) Content of test (four: object-related writing, object-related drawing, Seasonal writing, Escher writing). The content of the tests and the scores of the tests are within subjects factors, while all of the remaining factors are between subjects. The impact of each of the independent variables was examined using IDAP, CSS, and SPSS analyses packages.

Because transfer of skills is an important element in education, the study tried to test for transfer of the kinds of skills that Drawing/Writing specifically tries to develop. These are increasingly comprehensive descriptive skills, and increasingly abstract levels of inferential skills. The move into abstraction was encouraged by asking students to write similes about the objects they were drawing, using the five senses as starting points, and then moving the students farther out in thought by asking them to write about the function of the object, followed by predictions about the object in connection with function. These predictions were both positive and negative. For instance, the student was asked to write, " My object could be used for.....My object could not be used for...." The consensus among the students is that negative thinking is harder. Students are not usually asked to decide what some thing may incontrovertibly not be used for.

Hypothesis-writing followed, based on the same kinds of positive and negative thinking, but using "if...then...." or "if not....then not....." constructions. The attempt to test for changes in writing skills that transferred from the object-related writing took the form of what are called the Seasonal Tests. These tests looked for increasingly descriptive and inferential thought based on observation of the (then current) season, Winter), or of Spring (which meant tapping into memory).

In addition, there was an attempt to evaluate transfer of skills in connection with an ability to describe and to make inferences about anomaly or paradox, using what are called the Escher Tests. In these tests, the students wrote about the prints of the woodcut virtuoso and intellectual gamesman, M.C. Escher. It has been the observation of the researcher that older children begin to ignore, to suppress and in general not to notice novelty as they progress through grade school. Noticing and evaluating the novel is a critical survival skill. The question in the case of the Escher tests was whether, after a week of Drawing/Writing, students would be more aware of and better equipped to deal with novelty or anomaly or paradox.

Initial descriptives statistics for the holistic scoring were determined using a program called IDAP. Multivariate analyses were carried out using CSS. Because the results of the holistic scoring procedure showed only marginal significance for effect on writing of the treatment on the experimental school, a sample of the data was reevaluated using SPSS. This sample included all of the referred children and half of the cases in grades 3, 4, 5 and 6. The number of cases in the re-evaluated sample was 105. An alternate method for a more fine-grained approach to scoring changes in language use was devised. The presumption was that changes in language use reflect changes in levels and kinds of thought. This fine-grained method of

evaluation was called Rescore. Only the writing having to do with the object was used in the Rescore evaluation. The holistic evaluation was done by committee. The Rescore evaluation was done by the researcher, with validating spot checks. The criteria for Rescore allowed the evaluator to be objective and the work was largely clerical.

The Rescore method involved numbers of words, the numbers of times a variety of parts of speech were used including nouns, verbs, adjectives, and adverbs, and numbers of higher-order word-constructions like similes, metaphors, predictions, and hypotheses. The intent was to try to determine whether the holistic evaluation had missed some main effect between school and treatment, or school, child type and treatment. This evaluation resulted in several levels of statistical significance, allowing a better understanding of what effect the study had on both sets of subjects, as well as confirming the central hypothesis of the study, that Drawing/Writing affects thinking skills expressed in writing.

In the Rescore evaluation, the number of pieces of data was 315, as opposed to the approximately 1,000 pieces of writing evaluated in the first study. Of those 1,000 pieces, 600 pieces in the holistic analysis had to do exclusively with the objects. Therefore, Rescore dealt with about half of the possible object-related writing data generated by the study.

Multi-variate and univariate analyses were conducted with both the Holistic and Rescore sets of scores for writing, and, in the case of the holistic evaluation, for drawing. The two sets of scores were not in agreement. According to the holistic evaluation, the study appears somewhat inconclusive about the specific effect of Drawing/Writing on writing, and/or on thinking skills in the experimental school, although the holistic method does show a significant effect for the treatment on drawing skills for the referred girls in the experimental school. Rescore, on the other hand, shows a significant effect on writing in connection with generation of words, and of similes in the experimental school.

The holistic design was a 2 (schools) X 2 (sex) X 5 (grades) X 2 (child type) X 3 (repeated measures) analysis of variance.

The Rescore design was a 2 (schools) X 2 (sex) X 2 (child type) X 3 (repeated measures) analysis of variance.

An attempt to match school in the absence of random assignment is not only theoretically unsound but proved to be so in this study. Although the holistic means suggested that there were no great initial group differences between the two schools for drawing and writing (refer to Table 2), the Rescore analysis showed that the experimental school was significantly ahead of control school in the number of words generated, $f(1,78) = 7.23$, $p < .01$ on the pre-test, and that it was the non-referred student who had this edge, $f(1, 75) = 5.54$, $p < .05$. Statistical analyses along with percent-of-change comparisons reveal the appreciable effect of Drawing/Writing despite the initial differences between the schools on the targetted skills: increasing use of observable facts and the increasing use of simile. Bu the post-test, the experimental school showed a significant effect for simile use, $f(1, 77) = 6.16$, $p < .05$, and for facts, $f(1,77) = 4.68$, $p < .05$. It may be important that the experimental school showed a marginally significant effect $f(1,77) = 8.65$, p of .07 for generating facts, despite the fact that the follow-up session was coached.

4.1.3 Significant Interactions

Taking into account the Rescore method, the holistic method, and the ipsative studies, it is clear that the treatment contributed to a number of significant interactions in connection with gender, ability, and time of test. The holistic method reveals that referred girls in the experimental school had significant drawing gains $f(2, 54) = 5.52, p < .01$. The Rescore method reveals that referred males made substantial percent gains in writing, even if these gains did not show up as statistically significant.

The study suggests that some relation between drawing and writing - either in the form of the treatment, Drawing/Writing, or embedded in the treatment-like test for the control group which included drawing - occasions writing and drawing gains across the groups. The effect for drawing pre- to post-test was $f(1, 162) = 14.70, p < .01$. The effect for writing over all three trials was $f(2, 206) = 21.60, p < .01$. There was thus a significant effect for both populations for an increase in drawing skills.

Drawing appears to be a treatment, whether it is used informally (as it was in the "testing") or formally, as it was in the Drawing/Writing procedure.

4.1.4 Overall Results

Overall, the holistic scoring showed significance for the effect of school in connection with drawing as described above in connection with referred experimental girls. In addition, the evaluation showed marginal significance for the effect of school in connection with writing, $f(1, 164) = 2.91, p$ of .08. The effect was for the experimental school.

The holistic scoring showed a significant effect for the effect of sex for writing, $f(1, 164) = 25.00, p < .01$. The girls scored higher over all three writing tests. The analysis indicated marginal significance for Gender in connection with trial, both schools, $f(2, 206) = 2.64, p$ of .07. This might have been expected, since girls are reported generally to have stronger verbal skills than boys at the elementary level. What was interesting to note was that in connection with thinking skills and the Escher prints, Gender remained a significant source of variance, $f(1, 119) = 12.45, p < .01$. Here, the nature of the effect was that girls in the experimental school did significantly better than the boys in that school on the Escher tests.

The evaluation showed significance for grade, $f(3, 110) = 2.26, p$ of .08. It was the sixth grade experimental girls whose scores went up while their counterparts in the control school went down.

In connection with child type, the holistic scoring showed a marginal effect for drawing, $f(1, 37) = 3.29, p$ of .07. It is the experimental referred girl students who made greater gains than their counterparts in control, with their means moving from 4.64 to 5.55, while the others' moved from 4.70 to 4.73.

The holistic analysis indicated, as suggested above, that child type was a significant source of variance, $f(1, 34) = 12.06, p < .01$. The nature of the effect was that referred girl students in the experimental school did better on drawing than the control referred girls.

The Rescore analysis suggests that there was a significant effect for trial and child type in connection with the 41 variables. For instance, the non-referred girls, as will be seen in following analyses, in general scored significantly higher on pre-test numbers of facts, narrative or imaginary "facts," adjectives, nouns, verbs, adverbs, numbers of words, and numbers of similes. As suggested above, Rescore found statistically significant effects for school and for child type in connection with pre-test numbers of words, where the advantage lay with the experimental school. What will be interesting to note is how the statistics change as the referred students in general, and as referred males and females in both schools, erode this initial lead of the non-referred females in both schools. The changes argue for the effect of the treatment, or of the tests/treatments to improve descriptive and reflective writing skills and drawing skills in a broad range of children.

4.1.5 Results by Scoring Methods

Holistic

Multivariate analyses were run for post- and follow-up writing to test for the effect of the treatment by trial on school in connection with object-related writing, and with Season- and Escher-related writing. The analyses dealt with the effect of sex and child type and grade as well. Effect on child type was especially important to the study. One of the major hypotheses of the study which is critical to the overall argument of the usefulness of Drawing/Writing is that the referred child will make more writing gains than the non-referred child. Although statistical analyses did not show this kind of gain, analyses of percents of gain and loss did, as will be seen below.

In connection with child type and trial, the experimental girl student made marginally significant gains in drawing pre- to post-test, $f(1, 37) = 3.87$, p of .05, and statistically significant gains on the follow-up drawing, $f(2, 54) = 5.52$, $p < .01$. As suggested, it is not surprising that the non-referred student who is also a girl scored highest in writing at this age level. However, it turned out to be the control non-referred girls who had marginal significance for the highest scores, $f(1, 164) = 3.33$, p of .06. This kind of gain by the control girls might suggest that Drawing/Writing was not as useful to the experimental group as the repeated tests were for the control group, who are closing the initial gap in scores that Rescore picked up in connection with word numbers on the pre-test where the experimental group clearly had significantly higher scores in connection with many word-use categories.

There was a significant effect for trial in relation to all writing, $f(2, 206) = 21.60$, $p < .01$, as there was for drawing, $f(1, 162) = 14.70$, $p < .01$. All students made significant gains over time.

Rescore

Rescore shows an effect for the non-referred student in both schools, the effect was significant for numbers of words, $f(1, 75) = 2519.12$, $p < .01$, and for pre-test use of similes, $f(1, 75) = 3.80$, p of $.05$. For non-referred students, there was a significant trial effect on post- and follow-up word-number-use-and-construction score, with S2, $f(1, 77) = 32.61$, $p < .01$, and S3, $f(1, 77) = 10.77$, $p < .01$.

For school in connection with child type, there was an effect for pre-test number of facts, $f(1, 80) = 3.58$, p or $.06$, and for follow-up facts, $f(1, 77) = 8.65$, p of $.07$. The lead or the gains belonged to the non-referred students in the experimental school.

For school by trial effect, the study showed significant results for post-test facts, F_2 , $f(1, 77) = 4.68$, $p < .05$, for the experimental school. In connection with post-test and follow-up test simile-use, the gains were also with the experimental school, with $f(1, 77) = 6.16$, $p < .05$ in both cases.

For the effect of child type and trial, Rescore showed a significant effect for follow-up simile use. The advantage lay with the non-referred child in the experimental school, $f(1, 77) = 5.34$, $p < .05$.

For the effect of sex, Rescore, reinforcing the holistic findings, showed a significant effect, $f(1, 75) = 4.88$, $p < .05$. The effect was for girls by trial. Here the effect was in connection with simile use on the post-test, $f(1, 75) = 31.28$, $p < .01$, for simile-use on the follow-up test, or Sim3 by the non-referred girls in general, $f(1, 75) = 10.44$, $p < .01$, and for number of words on the post-test, $f(1, 75) = 12.86$, $p < .01$.

Rescore showed an effect for sex by child type for post-test adjective use (A2), $f(1, 77) = 3.43$, p of $.06$, for follow-up adverb use (Adv3), $f(1, 77) = 7.04$, $p < .01$. In both cases, the non-referred girls showed significant levels of word use.

Rescore sharpens the picture for the nature of the girls' advantages in connection with language, and for the experimental school's advantages, and for levels and kinds of language use in connection with child type. It also moves marginal significance to significance at the $.05$ or less level for the experimental school's use of facts and similes on the post-test.

The following table of means and standard deviations provides group levels in writing and in drawing for the two groups at the outset of the study.

Table 2 Comparison of Groups, Means and Standard Deviations, Outset
 Pre- WRITING and DRAWING
 Pre-test performance of Experimental and Control Groups
 using Holistic pre-write and Rescore S1 (or pre-test word-number, -use and -construction score).

	Experimental			Control		
	n	means	st.dev.	n	means	st. dev.
pre-writing Holistic						
all	108	5.08	1.74	85	4.84	2.10
K	21	5.28	1.25	17	4.94	3.03
3	22	4.95	1.25	18	4.88	2.19
4	22	4.22	2.13	12	4.83	1.89
5	23	5.52	1.20	14	5.28	1.54
6	20	5.45	1.60	24	4.50	1.71
Rescore,	55	38.09	17.57	47	32.46	15.94
	word-number and use score					

pre-drawing- Holistic						
all	107	4.54	1.44	86	4.23	1.45
K	23	4.65	1.64	18	4.72	1.31
3	21	5.04	1.49	18	3.72	1.56
4	22	4.45	1.14	12	4.33	1.07
5	21	4.57	1.28	14	4.28	1.20
6	20	3.95	1.53	24	4.16	1.71

Rescore, not applicable pre-Season Holistic						
all	84	5.39	1.62	68	5.55	1.65
3	21	5.38	1.56	18	5.27	1.74
4	21	5.80	2.01	12	5.83	1.85
5	22	5.27	1.57	14	5.14	1.65
6	20	5.10	1.25	24	5.87	1.48

Rescore, not applicable pre-Escher Holistic						
all	79	4.37	2.01	68	4.20	1.70
3	21	4.09	1.60	18	3.22	1.47
4	20	4.40	2.52	12	4.25	1.48
5	20	4.65	2.25	14	4.00	1.70
6	18	4.38	1.61	24	5.04	1.62

The holistic means suggest that the schools are fairly evenly matched. The experimental school had a slight edge (.24) in writing, drawing, and Escher-related writing. Rescore underscores the experimental edge in pre-test writing, with a lead of 6 points in a group mean score that reflect the sum total of words used in the group writing sample (including the number of facts, the number of nouns, verbs, adjectives and adverbs used, the number of similes, metaphors, predictions and hypotheses used). The 6 point lead suggests that the experimental school started the study writing more and better. Rescore sharpened this lead by showing that it lay simply with the number of pre-test words written by the experimental group.

Post-scores follow in Table 3. In each section of the table, both the post-test, and post2 or follow-up scores for the Holistic evaluation are included, as well as S2 for post-test word-number-and-use scores, and S2 for follow-up word-number-and-use scores from the Rescore evaluation.

Table 3 Comparison of Groups, Post- and Follow-up Tests
 Post- WRITING and DRAWING
 Comparison of post-test scores, Experimental and Control,
 using means and standard deviations

	Experimental			Control		
	n	means	st. dev.	n	means	st. dev.
post-writing Holistic						
all	108	5.09	1.87	86	4.66	1.95
K	25	5.52	2.21	18	5.00	2.22
3	22	4.77	1.37	19	4.42	2.21
4	19	4.78	2.46	12	3.91	1.44
5	21	5.00	1.37	15	4.80	1.32
6	21	5.28	1.73	22	4.90	2.11
Rescore,	55	39.05	22.34	44	33.40	16.86
post-test word-number-and-use-score						
post-writing2 Holistic						
all	81	4.97	1.55	60	5.28	1.78
3	19	4.78	1.47	16	6.12	1.31
4	44	5.50	1.71	12	5.91	1.08
5	20	4.50	1.53	14	5.85	1.23
6	20	5.05	1.39	18	3.66	1.90
Rescore	55	39.05	22.34	44	33.40	16.86
follow-up test word-number-and-use-score						

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Table 3, continued
 post-drawing
 holistic

all	109	5.11	1.59	84	4.67	1.43
K	25	5.64	1.35	18	4.77	1.47
3	22	5.27	1.75	17	5.00	1.45
4	21	5.14	1.49	12	4.91	1.08
5	21	5.04	1.59	15	4.13	1.30
6	20	4.35	1.66	22	4.59	1.62

post-drawing2
 holistic

all	80	5.46	1.69	59	5.45	1.53
3	22	5.40	2.15	15	5.73	1.33
4	20	5.80	1.60	12	5.25	1.28
5	19	5.36	1.49	14	5.07	1.63
6	19	5.26	1.44	18	5.66	1.78

post-season
 holistic

all	84	5.01	1.66	67	5.14	1.65
3	21	4.90	1.70	19	4.57	2.11
4	22	5.59	1.79	13	5.53	1.50
5	21	4.90	1.60	14	5.21	1.25
6	20	4.60	1.46	21	5.38	1.45

post-Escher
 holistic

all	81	4.27	1.67	66	3.96	1.87
3	22	3.81	1.57	17	4.05	1.78
4	20	4.70	1.94	13	3.15	1.86
5	20	4.15	1.30	14	3.92	1.73
6	19	4.47	1.77	22	4.40	1.99

An analysis of variance among these sets of means was conducted to try to determine the effect of the treatment on the experimental school in a variety of contexts. Would children in the experimental school write better about objects than control, and would they then write better about seasons and about Escher prints because of transfer of skills? Would they draw better than the control school? If drawing and writing skills are related, as the hypothesis suggests, would improvement in one set of skills impact a second? In this case, would improved drawing skills, which seemed a guaranteed benefit of the treatment from the researcher/teacher's past experience, benefit writing skills, another previously observed benefit?

What the study design had not anticipated was the ease and speed with which drawing skills improve. However, in connection with writing skills, the means, although not differing to a statistically significant degree, suggest that the treatment was having some effect.

The means suggest that the experimental school increased its lead in writing scores over control from .24 to .43; Rescore shows the lead moving from 6 in the pre-test to 7 on the post for the experimental school. However, by the time the students performed on the heavily coached follow-up test, in connection with object-related writing, the control school gained a lead of .31 over experimental. This proved to be marginally significant, $f(1, 110) = 2.98$, p of .08.

The small lead (.17) that experimental had over control on the Escher pre-test moves to a lead of .31. While not statistically significant, the gain may show some cognitive gains in connection with focus and attention. What is interesting to note in connection with the Escher tests is that there is a significant effect for child type in connection with grade, $f(3, 28) = 2.68$, p of .05. It is the referred sixth grader who does better on the Escher tests. This effect is startling on a test for the higher-order cognitive abilities in connection with a group that receives special help outside the classroom.

Overall, means for writing in the experimental school hold about the same from pre- to post- test and drop on the follow-up; in control, means drop on the post- and rise on the follow-up test. It is important to recall that the follow-up test was heavily coached in both schools. Drawing scores go up in both schools. The scores of both schools drop on the seasonal writing. The control group drops more on the second Escher writing than does experimental. Because the holistic method provided such gross measures, it is difficult to determine results and therefore effects with precision.

4.1.6 Kindergarten Results

If Drawing/Writing were used at the elementary level, it should show an effect even at the kindergarten level. There should be some indication that it eases or is at least compatible with the transition from a (somewhat) more concrete, representational mark-making system to a more abstract one. For this reason, it is important to examine the kindergarten means carefully.

Kindergarten means and point gains suggest the following:

Kindergarten	Experimental	Control
prew	5.28 1>2 .34	4.94
posw	5.52 1>2 .5	5.00
	gain, .24	gain, .06
pred	4.65 1<2 .07	4.72
posd	5.64 1>2 .87	4.77
	gain, .99	gain, .05

The kindergarten in the experimental school consistently made gains, even when it started slightly behind on the pre-test drawing. As discussed in Chapter III, these drawings were scored two times by a committee of

ten, once with a composite "drawing/writing" score, and a second time separating the two mark-making systems, and giving drawing and writing each a separate grade. Only repeated, longitudinal studies using Drawing/Writing at the kindergarten level will validate this apparent early pattern of gains for the treatment, as opposed to the more general effect of drawing on writing.

It is useful to approach means and standard deviations in a second way. This approach focusses not on school or grade, but on child type, and on sex. Because the holistic evaluation failed to showed statistical significance for the effect of treatment on school, the statistical analyses focussed on other populations within the study. Table 4 provides means and standard deviations for these groups in general, and for the experimental and control groups by these populations. The groups include sex, child type, and child type by sex.

Table 4 Means and Standard Deviations, Both Scoring Systems
WRITING
 Comparison of Sexes and Child Types in general
 and by Experimental and Control Groups

Abbreviations						
m=male						
f=female						
Exp.= experimental						
Con.=control						
cht1=child type 1						
cht2=child type 1						
cht1m=non-referred males						
cht1f=non-referred females						
cht2m=referred males						
cht2f=referred females						
hwr=holistic writing score						
Rwr=Rescore writing score						
GENERAL WRITING						
	HOLISTIC - prew			RESCORE - S1		
	All males, females, referred and non-referred					
	n	mean	st. dev	n	means	st. dev.
M	92	4.41	1.94	56	31.33	15.71
F	91	5.56	1.66	46	40.56	17.29
CHT1	158	5.20	1.90	63	38.30	16.22
CHT2	35	3.97	1.59	393	30.97	17.44
CH1M	80	4.61	1.96	33	34.23	16.35
CH1F	78	5.80	1.65	30	42.76	15.11
CH2M	18	3.33	1.64	23	27.17	14.04
CH2F	17	4.64	1.27	16	36.43	20.67

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Table 4, continued
 HOLISTIC -posw, posw2 RESCORE -S2 S3
 All males, females, referred and non-referred.

	n	HOLISTIC				RESCORE					
		posw	St. Dev.	posw2	St. Dev.	S2	St. Dev.	S3	St. Dev.		
M	91	4.51	1.91	4.69	1.78	51	30.37	17.19	50	47.56	22.49
F	90	5.54	1.70	5.35	1.57	48	43.10	21.21	40	52.05	27.74
CH1	16	15.13	1.88	5.22	1.63	60	40.21	19.48	55	55.92	26.45
CH2	33	3.75	1.67	4.73	1.69	39	30.89	20.20	35	39.54	18.56
CH1M	82	4.62	1.97	4.92	1.70	293	35.82	17.27	29	54.41	22.20
CH1F	79	5.67	1.62	5.52	1.52	31	44.32	20.78	26	57.61	30.88
CH2M	17	3.11	1.31	4.11	1.83	22	23.18	14.52	21	38.09	19.66
CH2F	164	4.43	1.78	5.35	1.32	17	40.88	22.46	14	41.71	7.26

WRITING

PREWRITING, Holistic and Rescore, Experimental and Control
 All girls and boys, referred and non-referred

	Experimental				Con			
	Hwr.	st.dev	Rwr.	st.dev	Hwr.	s.dev	Rwr.	s.dev.
All	5.08	1.74	38.0	17.57	4.84	2.10	32.46	15.94
girls	5.40	1.60	42.2	17.25	5.9	1.67	38.15	17.51
boys	4.69	1.83	34.0	17.22	4.06	2.05	28.60	13.80
ct1	5.26	1.79	41.0	18.29	5.12	2.04	35.33	13.27
ct2	4.36	1.36	33.7	15.84	3.30	1.79	27.41	19.21
ct1m	4.92	1.89	36.9	20.35	4.33	2.00	31.37	10.56
ct1f	5.54	1.67	45.3	15.27	6.23	1.54	39.85	14.93
ct2m	3.90	1.44	29.6	10.14	2.42	1.61	24.91	17.01
ct2f	4.81	1.16	37.8	19.68	4.33	1.50	33.40	24.85

POSTWRITING

All	5.08	1.74	39.0	22.34	4.66	1.95	33.40	16.86
girls	5.44	1.54	46.3	23.44	5.48	1.93	38.60	17.20
boys	4.71	2.11	31.5	18.70	3.97	1.71	29.08	15.62
ct1	5.36	1.83	42.7	20.73	4.86	1.91	37.55	18.02
ct2	3.95	1.59	34.3	23.87	3.41	1.83	25.40	10.90
ct1m	5.07	2.12	37.6	17.43	4.17	1.73	33.85	17.53
ct1f	5.63	1.51	47.4	22.95	5.72	1.79	41.00	18.38
ct2m	3.36	1.50	23.8	17.99	2.66	0.81	22.40	9.74
ct2f	4.60	1.50	44.8	25.03	4.16	2.31	31.40	11.63

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Table 4, continued
FOLLOW-UP WRITING

	means	st.dev.	means	st.dev.	means	st.dev.	means	t.dev.
All	4.97	1.55	50.25	28.30	5.28	1.78	48.79	20.90
girls	5.11	1.40	49.62	32.09	6.11	1.39	55.68	19.96
boys	4.81	1.72	50.91	24.43	4.64	1.80	44.70	20.72
ct1	5.05	1.49	55.71	32.86	5.43	1.79	56.14	18.22
ct2	4.77	1.74	42.21	17.67	4.66	1.66	36.37	19.65
ct1m	4.96	1.63	54.28	28.42	4.89	1.79	54.53	15.35
ct1f	5.12	1.38	57.14	37.82	6.20	1.54	58.16	21.83
ct2m	4.45	1.96	45.66	16.67	3.50	1.51	32.41	20.46
ct2f	5.09	1.51	39.10	18.84	5.83	1.7	48.25	12.09

4.1.7 Analysis of Table 4

The group scores that ignore experimental and control populations suggest that the holistic pre-test scores that are higher belong to females, non-referred students, non-referred females, and referred females. The post-test scores suggest that these same groups maintain the advantage. The follow-up holistic scores and Rescore, on all three tests, suggest the same pattern. The holistic scores suggest, in addition, that the referred child makes particular gains over the three tests, including both males and females in the referred group. Rescore describes the lead of non-referred students in detail, and shows that all groups make significant writing gains over the three tests, as does the holistic. Holistic describes the significance as $f(2, 220) = 5.91, p < .01$. Rescore defines the significance as $f(1, 77) = 37.94, p < .01$ for S2 or the post-test cumulative score, and as $f(1, 77) = 10.77, p < .01$ for S3, the follow-up cumulative score.

Taking the experimental and control groups into account, the Rescore method shows that the non-referred child in the experimental school gains 14 points overall; the non-referred child in control gains 21. The referred child in experimental gains 9 points, and so does the referred child in control. If anything, control is making greater gains in this study, according to Rescore. The statistics bear out that the control non-referred female has marginal significance for writing, $f(1, 164) = 3.33, p$ of .06. However, the holistic evaluation shows that the experimental group makes a change in direction of gain that is statistically higher than control's in the sixth grade, for the referred child, $f(3, 30) = 3.32, p < .01$. This effect is repeated when the experimental fourth grade students do better than their counterparts in the control group.

Rescore shows a loss over the three tests for the referred child in the experimental school over the referred child in control, moving from a 5-point lead to a score that is 2 less than control, to a score that is much less in the end, lower by 19 points. The overall drop for the referred experimental child is 16 points. Holistic multivariate analyses show that, as suggested above, it is the referred fourth grade child whose writing drops below control, and it is the referred sixth grader in experimental that make gains. These results are diametric to the results that the researcher felt had occurred in these two instances. Upon reflecting, the researcher

concludes that it was the drawing skills of the referred fourth graders in the experimental group that become extraordinary, and that this colored her impression of the overall effect of the treatment on this group.

If we focus on males, the Rescore means show the referred experimental male starts 5 points ahead of control referred male, maintaining a 1 point lead, and then moving to 13 points ahead. The gains made by the experimental referred male against his own pre-test mean is 16 points over all; the control referred male makes gains against the control referred male pre-test mean of 8 points. Referred girls in the experimental school start ahead and drop to 11 points below the control referred female by the follow-up test; the experimental referred female drops 19 points below her own pre-test mean; the control referred female makes a 15 point gain from her own pre-test mean. This is one point less than the experimental referred male's gain against his own pre-test mean. The holistic statistics show significance for males in a negative way, fifth grade males in general and fifth grade males in the experimental school in particular scored lower on the post-seasonal writing, $f(1, 128) = 8.59, p < .01$. Otherwise, both systems of scoring show significant effects for females alone for highest scores, and thus, by inference, lowest scores for the males.

Where the experimental referred male shows large point gains, so does the control referred female. However, the fact that the male makes 1 more point overall than the female, particularly in the referred category, may be important in a study where the girls are, in general, leading the scores, and where the expectation would be that referred males in particular could not score higher than the girls, even the referred girls.

A look at another table comparing the sexes may be useful to determine what is happening between boys and girls in the child type groups simply as patterns of gains and losses.

Table 5 Gains and Losses, Sex and Child Type
Comparison of Patterns of gain and loss,
Sexes by Child Type by Group

	all males				all females			
prew	4.37				5.6			
posw	4.36				5.4			
posw2	4.73				5.48			
pred	4.38				4.42			
posd	4.81				5.01			
posd2	5.11				5.78			

	Experimental				Control			
	m,1	f,1	m,2	f,2	m,1	f,1	m,2	f,2
prew	4.69	5.40	3.90	4.8	4.0	5.9	2.42	4.33
posw	4.71	5.44	3.36	4.6	3.9	5.4	2.66	4.16
posw2	4.81	5.11	4.45	5.09	4.64	6.11	3.50	5.83
pred	4.35	4.7	3.72	4.44	4.42	3.97	3.85	3.66
posd	4.90	5.31	4.27	4.7	4.71	4.64	3.50	4.00
posd2	5.05	5.77	4.70	5.54	5.18	5.80	5.16	5.0

The pattern suggests that girls scored highest as writers and as draw-ers, across schools, starting and ending higher, including those who are referred. The non-referred males in the Control school scored higher than referred males in both schools, and than referred females in that school, but not higher than the referred females in the experimental school.

If all three tests are included in the evaluation:

	Experimental				Control			
	m,1	f,1	m,2	f,2	m,1	f,1	m,2	f,2
% change writing	.12 or 2%	-.29 -5%	.55 14%	.29 6%	.64 16%	.21 3%	1.08 44%	1.50 34%
% change drawing	.70 or 16%	1.07 22%	.98 26%	1.10 27%	.76 17%	1.83 46%	1.31 34%	1.34 36%

If all three tests are included, the control school has the greatest percentage gains across the board. The girls made large gains in drawing, and the referred male, Control school, made gains in writing greater than any others in both schools, as did the control females in percentage writing gains. If the scores of the heavily coached follow-up tests are eliminated, how does the pattern of percentages of gains and losses change?

	Experimental				Control			
	m	f	m,2	f,2	m	f	m,2	f,2
% change writing	.02 .4%	-.29 -5%	.55 14%	.29 6%	-.03 -.7%	-.5 -8%	.24 9%	-.17 -3%
% change drawing	.55 12%	.61 12%	.55 14%	.26 5%	-.22 -4%	.67 16%	-.35 -9%	.54 14%

In the Control School, there are losses in writing for males, females, and referred females; in drawing, there are losses for males and for referred males. Males show gains only as referred males, in connection with writing. There appears to be an appreciable amount of loss in the Control school in particular, pre- to post-test. On the other hand, in the experimental school, males and referred males and referred females make gains in writing, the referred males' percentage gains being greatest. In drawing, there are gains overall for the experimental group. The gains of the referred males in general are important to note.

The statistics for Rescore are as follows:

Table 6 Rescore, Means and Standard Deviations
 Comparison of the Experimental and Control groups, using the Rescore method for word numbers, word-use and construction in connection with child type and sex. Adverbs, metaphors, predictions and hypotheses were so small in number that they are not included in this table.

	all		m		f		ch1		ch2	
	mean	sd.	mean	sd.	mean	sd.	m	sd	m	sd
S1	38.09	17.57	34.07	17.22	42.25	17.25	41.00	18.29	33.72	15.84
S2	39.05	22.34	31.51	18.70	46.32	23.44	42.70	20.73	4.33	23.87
S3	50.25	28.30	50.91	24.43	49.62	32.09	55.71	32.86	42.21	17.67
NB1	68.23	38.25	57.78	37.07	79.07	37.05	66.00	34.99	50.53	32.90
NB2	64.50	38.39	49.18	26.97	79.28	42.26	65.26	29.90	47.79	35.77
NB3	84.26	48.46	79.21	42.07	89.30	54.60	85.24	43.92	67.97	37.78
F1	6.18	4.53	4.60	3.85	7.81	4.67	6.18	4.59	6.184	4.55
F2	6.32	4.69	4.70	4.03	7.89	4.81	6.90	4.46	5.58	4.96
F3	7.91	6.35	7.95	4.95	7.87	7.56	7.71	7.29	8.21	4.81
N1			7.46	5.00	9.00	4.53	9.45	5.13	6.36	3.61
N2			6.74	5.40	11.07	6.10	10.09	6.01	7.45	6.05
N3			10.86	6.41	10.70	7.24	12.10	7.85	8.84	4.25
A1			4.39	2.54	10.40	22.54	5.54	3.05	10.04	25.18
A2			4.18	3.61	6.00	3.72	5.67	3.39	4.37	4.12
A3			6.04	3.94	5.66	4.98	5.84	4.40	5.78	4.66
V1			4.75	3.97	5.18	2.94	5.57	3.47	4.04	3.37
V2			3.29	2.88	4.57	3.74	4.29	3.53	3.50	3.19
V3			4.34	3.76	3.50	3.84	4.53	4.29	3.00	2.7
SIM1			.32	1.05	.32	1.15	.33	96.0	.45	.13 .35
SIM2			.69	1.35	.74	1.34	.64	1.39	.51	1.20 .91 1.53
SIM3			2.53	2.66	2.78	3.10	2.29	2.19	3.14	2.74 1.63 2.31

CONTROL

	ALL		m		f		ch1		ch2	
	mean	st.dev	mean	st.dev	mean	sd	mean	sd	mean	st.d.
S1	32.46	15.94	28.60	13.80	38.15	17.51	35.33	13.27	27.41	19.21
S2	33.40	16.86	29.08	15.62	38.60	17.20	37.55	18.02	25.40	10.90
S3	48.79	20.90	44.70	20.72	55.68	19.96	56.14	18.22	36.37	19.65
F1	4.70	3.79	4.35	3.24	5.21	4.54	5.56	4.11	3.17	2.62
F2	5.50	4.26	4.08	3.75	7.20	4.31	6.72	4.41	3.13	2.80
F3	8.74	5.07	8.48	4.73	9.18	5.73	10.18	4.65	6.31	4.93
NB1	50.55	27.93	42.07	22.01	63.05	31.46	56.60	26.29	39.88	28.28
NB2	50.72	23.81	39.83	18.41	63.80	23.30	57.34	22.84	37.93	20.79
NB3	72.33	33.77	63.42	32.69	86.81	31.22	81.53	26.07	57.37	39.98
N1	6.28	2.91	8.47	4.20	9.33	4.39	7.75	4.23		
N2	6.41	2.96	8.00	3.69	10.16	5.58	9.11	5.18		
N3	9.55	4.82	11.93	4.05	12.3	6.67	9.00	4.38		

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Table 6, continued

A1	4.53	3.00	5.73	3.46	5.60	3.18	4.00	3.10		
A2	4.70	3.50	5.80	4.84	6.31	4.54	3.06	2.05		
A3	6.59	4.61	7.43	4.67	7.96	4.73	5.12	3.86		
V1	2.46	2.04	3.42	3.64	3.03	2.83	2.52	2.80		
V2	2.08	2.22	3.60	3.40	2.75	3.12	2.80	2.48		
V3	3.77	2.66	5.31	4.61	4.37	2.87	4.31	4.57		
SIIM1	.51	.83	.46	.74	.57	.96	.40	.62	.70	1.10
SIM2	.43	.84	.41	.71	.45	.99	.35	.87	.94	1.67
SIM3	1.27	1.98	.96	1.22	1.81	2.81	2.26	2.37	1.78	2.60

4.1.8 Analysis of Table 6 using Rescore Means by School, Child Type, Sex

Rescore showed a marginal effect for child type and school in connection with pre-test facts, $f(1,80) = 3.58$, p of .06. The effect is for the experimental school, the non-referred child. The same holds true for the experimental, non-referred students' leads in connection with post-test facts, $f(1, 77) = 4.68$, $p < .05$, and with follow-up facts, $f(1, 77) = 8.65$, p of .07.

For the effect of sex, Rescore shows a significant effect for experimental girls for pre-test facts, $f(1, 77) = 216.33$, $p < .01$; for imaginary "facts," $f(1, 77) = 15.68$, $p < .01$; for adjectives, $f(1, 77) = 84.65$, $p < .01$; for nouns, $f(1, 77) = 7.66$, $p < .01$; for verbs, $f(1, 77) = 163.96$, $p < .01$; for adverbs, $f(1, 77) = 139.37$, $p < .01$; for similes, $f(1, 75) = 3.88$, $p < .01$, and for numbers of words on the pre-test, $f(1, 75) = 11.54$, $p < .01$.

For the effect of trial, Rescore shows a significant effect for the experimental group for post-test similes, $f(1, 77) = 6.16$, $p < .05$, and for the experimental group in connection with post-test facts, $f(1, 77) = 4.68$, $p < .05$.

Rescore shows an effect for school by child type, with the experimental non-referred students showing marginal leads on pre-test facts, $f(1, 80) = 3.58$, p of .06; significant lead on post-test facts, $f(1, 77) = 4.68$, $p < .05$; and on follow-up facts, $f(1, 77) = 8.65$, $p < .01$.

Rescore showed a significant effect for child type by trial on follow-up simile use, $f(1, 77) = 5.34$, $p < .05$. Non-referred students have the lead.

Rescore showed a significant effect for sex and trial; it was the non-referred girls who had the lead on follow-up simile use, $f(1, 75) = 10.44$, $p < .01$, and on post-test word numbers, $f(1, 75) = 12.86$, $p < .01$. Also in connection with the effect for sex, trial and child type, there was a marginally significant effect for non-referred females in connection with post-test adjective use, $f(1, 77) = 3.43$, p of .06; and a significant effect for follow-up adverb use, $f(1, 77) = 7.04$, $p < .01$.

It is important to note that, while the experimental school started statistically ahead on word numbers alone, it concludes the study statistically ahead on post-test simile, $f(1, 77) = 6.16$, $p < .05$; on post-test facts, $f(1, 77) = 4.68$, $p < .05$; and, in connection with the non-referred child only, marginally significantly ahead in connection with follow-up facts, $f(1, 77) = 8.65$, p of .07.

The same kind of tables of means and standard as those prepared for holistic and for rescore writing can be prepared for means and standard deviations in connection with holistic drawing scores. The study hypothesized that training in Drawing/Writing would affect the drawing skills of the experimental group to a significant degree. The study also hypothesized that the kind of writing that reflected on improved drawing would show a transfer of descriptive skills. The approximately 1,000 drawing samples were scored by the holistic method only. By the time the Rescore re-evaluation took place, the specific focus of the study had become changes in writing, particularly in connection with child type.

Table 7 Means and Standard Deviations, Drawing Scores
DRAWING
Comparison of Control and Experimental Groups using the holistic method.

	PRE-DRAWING			
	Experimental		Control	
	means	st. dev.	means	st. dev.
all	4.54	1.44	4.23	1.45
girls	4.71	1.42	3.97	1.20
boys	4.35	1.46	4.42	1.59
ct1	4.65	1.47	4.31	1.42
ct2	4.05	1.23	3.76	1.58
ct1m	4.52	1.55	4.51	1.50
ct1f	4.76	1.41	4.03	1.27
ct2m	3.72	0.90	3.85	2.11
ct2f	4.44	1.50	3.66	0.81

Continued, next page

Table 7, continued
POST-DRAWING

all	5.11	1.59	4.67	1.43
girls	5.31	1.60	4.64	1.26
boys	4.90	1.57	4.71	1.57
ct1	5.27	1.58	4.83	1.38
ct2	4.47	1.50	3.75	1.42
ct1m	5.07	1.59	4.89	1.51
ct1f	5.43	1.58	4.75	1.22
ct2m	4.27	1.42	3.50	1.51
ct2f	4.70	1.63	4.00	1.41

FOLLOW-UP DRAWING

All	5.46	1.69	5.45	1.53
girls	5.77	1.78	5.80	1.41
boys	5.05	1.51	5.18	1.59
ct1	5.57	1.79	5.55	1.61
ct2	5.14	1.38	5.08	1.16
ct1m	5.20	1.58	5.18	1.64
ct1f	5.85	1.90	6.05	1.46
ct2m	4.70	1.33	5.16	1.47
ct2f	5.54	1.36	5.0	0.89

4.1.9 Analyses, Drawing

In general, the holistic evaluation showed an effect for trial for all students' post-test gains, $f(1, 162) = 14.70$, $p < .01$. There was significant effect on the follow-up test, $f(2, 54) = 5.52$, $p < .01$, for referred experimental girls. There was a marginal effect for child type, $f(1, 37) = 3.29$, p of .07, with the referred child in the experimental school showing gains above their counterpart in the control school.

The same kind of analysis can be done for the Escher prints. As was the case with the seasonal tests, the Escher tests were used to try to determine whether there was a transfer of analytical and inferential thinking skills from the Drawing/Writing process to another problem-solving domain.

Table 8 Means and Standard Deviations, Escher Scores
 ESCHER
 Comparison of Experimental and Control Groups,
 Escher prints, by child type and sex.

PREWRITING				
	Experimental		Control	
	mean	st.dev.	mean	st.dev.
all	4.37	2.01		
girls	4.86	1.94	4.89	1.95
boys	3.73	1.94	3.72	.33
ct1	4.80	1.92	4.36	1.62
ct2	2.94	1.66	3.53	1.94
ct1m	4.2	1.88	4.00	1.29
ct1f	5.2	1.87	4.90	1.92
ct2m	2.00	0.75	2.42	0.53
ct2f	3.70	1.82	4.83	2.22

POST-WRITING				
	Experimental		Control	
	mean	st.dev.	mean	st.dev.
girls	4.34	1.60	4.35	1.83
boys	4.17	1.77	3.62	1.86
ct1	4.44	1.60	4.20	1.87
ct2	3.75	1.80	2.81	1.40
ct1m	4.44	1.80	3.89	1.89
ct1f	4.47	1.48	4.53	1.83
ct2m	3.60	1.64	2.33	1.03
ct2f	3.90	2.02	3.40	1.67

4.1.10 Analysis, Escher Prints

If drawing for referred males is the focus, the control referred males make twice the gain that the experimental males do. Experimental referred males gain .78, and control gains 1.31.

If we focus on Escher, and just look at boys, experimental boys gain .44, and control boys lose .10. The girls in both schools start at nearly the same mean score and drop to almost the same mean score, losing about .50. Because Escher prints are designed to measure gains in descriptive and inferential thinking skills, this

change in direction of gain for boys in the experimental school may be useful to consider. The gain may suggest an increased ability to attend, to analyze and to infer. The gain may suggest that practice has something to do with achievement. The change in direction might also mean that the girls found the second print less engaging. As suggested in Chapter III, a kindergarten male said that the first print was harder, the second easier. To an older female, harder might translate to more interesting, easier to more boring. The observation would be that the boys did better on the easier, more obvious print. It is less likely that the girls were becoming less attentive and less analytical over time.

As described previously, it is the referred girls in the experimental school who make statistically significant gains with the Escher writing, with an effect of $f(1, 178) = 11.17, p < .01$.

If we return to writing and simply look at referred males who appear in this study to be in the greatest need of empowerment as writers and thinkers, the experimental referred males gain .55 points overall, and the control referred males gain 1.08 points.

The means do not suggest that the treatment is having a special effect on the experimental referred males.

4.2 Multivariate Analyses by Hypothesis, Holistic and Rescore

Multivariate analyses, supported by T-tests produced the following results in connection with the specific hypotheses being tested by the study.

These analyses consider school, grade, sex and child type in connection with drawing and writing scores in connection with the six following hypotheses.

4.2.1 Hypothesis #1: Drawing/Writing Affects Descriptive and Inferential Writing about Objects

HOLISTIC MULTIVARIATE ANALYSES:

SCHOOL:

There was marginal significance for the effect of school by time of test if the pre- and post-test writings alone were used, $f(1, 164) = 2.91, p$ of .08. The effect showed a change in direction of gains. The experimental writing means went from 5.05 to 5.16, while the control means went from 5.05 down to 4.62.

There was a significant effect for change in direction of scores of school by trial if all of the 3 sets of writing scores were used, $f(2, 220) = 5.91, p < .01$. The experimental scores went up, and the control scores went down.

SEX:

There was an overall significance for sex for writing, $f(1, 164) = 25.00, p < .01$. The effect was for girls. There was marginally significant differences between the gains in experimental and in control by girls; the difference between the sexes was larger in control, closer in experimental to a marginally significant degree, $f(1, 110) = 2.98, p$ of .08.

There was an effect for sex and the referred child type, $f(1, 34) = 12.06, p < .01$. The referred girls did better than the referred boys.

There was a marginal effect for sex and school, $f(1, 164) = 3.33, p$ of $.06$. Control girls lead experimental girls in writing.

There was an effect for sex and seasonal writing, $f(1, 128) = 21.25, p < .01$. The effect was for girls.

There was an effect for sex and Escher writing, $f(1, 178) = 11.17, p < .01$. The effect was for higher scoring by girls.

GRADE:

A statistical analysis by grade showed marginal statistical significance, $f(3, 128) = 2.47, p$ of $.06$. It was the fourth grade that showed a writing edge.

There was marginal significance for the effect of school by grade, $f(3, 110) = 2.26, p$ of $.08$. Means show that the change took place at the sixth grade level; experimental 6th went up; control sixth went down, and at the fourth grade level, with control going down, and experimental going up.

CHILDTYPE:

There was a significant effect for referred students by grade and school for writing, $f(3, 30) = 3.32, p < .05$. As suggested above, the changes occurred in the fourth and sixth grades.

In connection with referred students there is also a significant effect for sixth graders, who did better on the Escher post-test writing, $f(2, 28) = 2.86, p$ of $.05$. As suggested, this is a startling result, not because it occurred in the older sixth graders, but because it is the referred sixth graders who make the highest scores.

TRIAL: According to the holistic scoring, all students scored significantly higher on writing over pre-through post- to follow-up test, $f(2, 206) = 21.60, p < .01$.

RESCORE MULTIVARIATE ANALYSES:

SCHOOL:

In connection with scores with facts on the pre-test, there was a marginally significant effect for school, $f(1, 80) = 3.58, p < .06$. T-tests show that it was the experimental non-referred student who had the lead in writing. In connection with post-facts (F2), and with follow-up facts (F3), the experimental non-referred student maintains marginally significant leads; for F2, $f(1, 77) = 4.68, p < .05$; for F3, $f(1, 77) = 8.65, p$ of $.07$.

School by trial showed an effect, $f(1, 77) = 6.16, p < .05$ in connection with post-test simile use (Sim2). The effect was for the experimental school.

School by child type showed a significant effect for pre-test numbers of words (Nb1), $f(1, 78) = 7.23, p < .01$. The effect was for the experimental school. The effect for child type was $f(1, 78) = 5.54, p < .05$ for the non-referred student.

The effect for school by child type for overall writing was significant, $f(1, 80) = 8.16, p < .01$. The effect was for the non-referred student in both schools.

SEX:

Non-referred females scored exponentially higher on all pre-test categories. For instance, on pre-test facts, the effect for sex was $f(1, 77) = 216.33, p < .01$. This means that males scored significantly lower for all pre-test categories, as, for example, in numbers of words, $f(1, 75) = 11.54, p < .01$. The effect for girls in connection with imaginary "facts" was $f(1, 77) = 15.68, p < .01$. (Refer to earlier overall analyses for Rescore for the rest of these statistics for adjectives, nouns, verbs, adverbs, and similes.) What is interesting to note is that, by the follow-up tests, since the females are not significantly ahead except in connection with post-test similes, $f(1, 75) = 31.28, p < .01$, and with follow-up similes, $f(1, 75) = 10.44, p < .01$, and with post-test word numbers, $f(1, 75) = 12.86, p < .01$, and with post-test adjectives, $f(1, 77) = 3.43, p < .06$, and with adverbs, $f(1, 77) = 7.04, p < .01$, the males must not be significantly behind anymore in connection with nouns, and verbs, and with numbers of words by the follow-up test (Nb3).

CHILD TYPE:

In connection with scores on similes on the pre-test, there was a marginally significant effect for school in connection with child type, $f(1, 75) = 3.80, p < .05$. T-tests show that this was for the experimental non-referred student lead. Also in connection with the experimental school, non-referred students, there was an exponentially significant lead for pre-test word numbers (Nb1), $f(1, 75) = 2519.12, p < .01$, and marginal significance for pre-test facts, $f(1, 80) = 3.58, p < .06$.

There was a significant effect for child type by school in connection with post-test facts (F2), $f(1, 77) = 4.68, p < .05$. The effect was for the non-referred child in the experimental school. The same effect existed, although marginally, for follow-up facts (F3), $f(1, 77) = 8.65, p < .06$. Child type by sex and trial showed significance for follow-up simile use (Sim3), $f(1, 75) = 4.88, p < .01$. The effect was for non-referred girls.

TRIAL:

The effect of trial was statistically significant for all students:

Gain, Post-similes, $f(1, 77) = 37.94, p < .01$

Gain, Follow-up similes, $f(1, 77) = 10.77, p < .01$

Gain, Post-facts, $f(1, 77) = 25.57, p < .01$

Gain, Follow-up facts, $f(1, 77) = 9.42, p < .01$

Gain, post-test narrative, $f(1, 77) = 9.56, p < .01$

Gain, follow-up adjectives, $f(1, 77) = 4.08, p < .05$

Gain, post-test nouns, $f(1, 77) = 19.76, p < .01$

Gain, follow-up nouns, $f(1, 77) = 5.84, p < .01$

Gain, follow-up verbs, $f(1, 77) = 5.22, p < .01$

4.2.1.1 Girls, Rescore Analysis, Word-Numbers and Uses

Nb1	p .001	F1	p .009
Nb2	p .000	F1	p .000
Nb3	p .060 -not signif	F3	p .901-not signif.

(Girls, Rescore Analysis, Word-Numbers and Use, continued)

S1	p .006	Ho1 p .000
S2	p .002	Ho2 p .001
S3	p .410 -not signif.	Ho3 p .075-not signif.

A possible interpretation of this distribution of scores is that, by the follow-up test (Nb3, S3, and Ho3), boys were making gains in words, facts, and in word constructions that netted enough points to eliminate the girls' lead. The holistic evaluation suggested that boys, including referred boys, were making gains in this way.

The Rescore method, too, showed statistical significance for gains over time for all children in connection with writing. All of these categories made significant gains; F2, F3, I2, A3, N2, N3, V3- that is, facts on the post-writing and on the follow-up writing; narrative on the post-writing; adjectives on the follow-up writing; nouns on the post-writing and follow-up writing; verbs on the follow-up writing. Adverbs did not make significant changes. Facts, nouns, adjectives, verbs and imaginative narrative did. The gain was spread across the groups.

GAINS

F2, $f(1, 77) = 25.57$, $p < .01$

F3, $f(1, 77) = 9.42$, $p < .01$

A3, $f(1, 77) = 4.08$, $p < .05$

N2, $f(1, 77) = 19.76$, $p < .01$

N3, $f(1, 77) = 5.84$, $p < .01$

V3, $f(1, 77) = 5.22$, $p < .05$

Because numbers of facts on the follow-up test increase exponentially for all children, it is possible to conjecture that drawing in connection with writing impacts descriptive skills.

4.2.2 Hypothesis #2: Drawing/Writing Affects Drawing Skills

HOLISTIC:

SCHOOL:

There was a marginal effect for school from pre- to post- test in drawing, $f(1, 37) = 3.29$, p of .07. The effect was for the experimental school for the referred females. Experimental referred females means went from 4.64 to 5.55; control went from 4.70 to 4.73).

TRIAL:

All students scored significantly better on the follow-up drawing test, $f(1, 162) = 14.70$, $p < .01$. All students scored significantly better pre- to follow-up test, $f(2, 54) = 5.52$, $p < .01$.

CHILD TYPE:

All referred students scored significantly better pre- to post-test, $f(1, 37) = 3.87, p < .05$ than non-referred students in drawing. What happens if we re-examine the drawing means? If we return to the means, we can suggest the following:

	Exp., all	Contr., all	Exp.type1	Con.type 1	
pred	4.54	1>2 by .31	4.23	4.65 1>2 by .34	4.31
posd	5.11	1>2 by .45	4.66	5.27 1>2 by .83	4.33
posd2	5.46	1>2 by .01	5.45	5.59 1>2 by .04	5.55

In drawing, the experimental school had a 2% gain over Control's gain if all three tests are considered. The experimental school had a 10% gain over control's miniscule loss in drawing if the pre- and post-tests alone are taken into account.

In the experimental school, the regular students had a 13% gain over the control school's regular students in drawing.

To repeat, the referred students in the experimental school had a marginally significant edge for overall drawing, $f(1, 37) = 3.29, p$ of .0748. The experimental school doubles or triples its lead over the control school on the post-test. The gain is, as shown, marginally significant in connection with the referred child.

4.2.3 Hypothesis #3: Drawing/Writing Affects Descriptive and Inferential Writing about Seasons

HOLISTIC:

SCHOOL:

Students in both schools scored lower to a statistically significant degree. The effect for trial was $f(1, 128) = 8.59, p < .01$. T-tests show that it was the female fifth graders whose scores dropped.

SEX:

There was an effect for sex on seasonal writing, $f(1, 128) = 21.25, p < .01$. The effect was for the girls. There was a marginal effect for sex by trial, $f(2, 206) = 2.64, p$ of .07. The effect was for girls.

GRADE:

There was a marginal effect for grade in connection with seasonal writing, $f(3, 128) = 2.47, p$ of .06. Grade 4 in both schools scored higher. Boys in the experimental school dropped significantly below control on the seasonal writing, $f(1, 128) = 8.59, p < .01$. T-tests showed that it was the fifth graders whose scores dropped.

CHILD TYPE: nothing significant.

RESCORE: did not evaluate drawing skills. Therefore, no information can be included in connection with this hypothesis.

4.2.4 Hypothesis #4: Drawing/Writing Affects Descriptive and Inferential Writing about Escher Prints

HOLISTIC:

SCHOOL: no significant effect.

SEX:

There was a significant effect for sex, $f(1, 178) = 11.17, p < .01$. Girls' writing about the Escher prints was significantly better.

GRADE:

The sixth grades overall did significantly better on the Escher prints, $f(3, 119) = 3.06, p < .05$.

CHILD TYPE: inconclusive

RESCORE: did not evaluate Escher prints.

4.2.5 Hypothesis #5: Drawing/Writing Affects Descriptive and Inferential Writing to a Greater Extent in Child Type 2, the Referred Child, rather than in Child Type 1, the Non-Referred Child

HOLISTIC:

SCHOOL: no effect

SEX:

There was an effect for sex $f(1, 39) = 12.06, p < .01$. The effect was for non-referred girls overall.

There was an effect for sex, child type and trial, $f(2, 54) = 5.52, p < .01$. Referred girls did significantly better on the follow-up or third drawing.

GRADE:

There was a marginal effect for child type 2, or the referred child and grade, $f(3, 28) = 2.86, p$ of $.05$. Referred 6th graders did better than non-referred sixth graders on the Escher prints. Effect for grade also occurred in connection with differences in direction of gain in connection with the referred child, $f(3, 30) = 3.32, p < .05$. The 6th referred graders in experimental went up; the referred 4th graders in experimental went down in relation to their counterparts in the control school in connection with object-related writing.

TRIAL:

There was an effect for child type and trial, $f(1, 162) = 14.70, p < .01$. The non-referred child did better on the post-test or second drawing.

4.2.6 Hypothesis #6: Drawing/Writing is Taught Better by the Regular Classroom Teacher than by the Researcher/Teacher

HOLISTIC:

SCHOOL: effect for experimental school, see grade, below.

GRADE:

There was a marginal effect for grade (3,110) = 3.26, p of .08. The effect was for differences in direction of gain for 6th grades in the study. The 6th grade experimental group scores went up, and the 6th control went down. Since the teacher in both cases was the teacher/researcher, not much can be concluded, except that the treatment had more effect than the coaching.

There was another effect for grade, $f(3, 128) = 8.59, p < .01$. In this case the effect was for the 4th grades. The experimental fourth was better. In this case, the teacher was one of the two trained in Drawing/Writing. The means in 4th in the treatment group rose .7; in the experimental 5th, they dropped .8, as they dropped .1 for the researcher/teacher. The 4th grade teacher is also an artist. This may argue for the gains a teacher who is already an artist may make with Drawing/Writing. In the case of experimental 4th, the gains were significant over control 4th.

Because it seemed important to try to analyze gains and losses in other than statistical ways, another approach was taken involving percentage of gains and losses in scores for drawing and for writing in both groups. The attempt is to determine whether the child who receives special services outside the regular classroom is making a different kind of gain than the non-referred students in connection with this classroom activity. One of the hypotheses of the study is that the referred student will do even better than the non-referred student in Drawing/Writing. Since "even better" could not reasonably mean higher scores, it is necessary to search for less obvious kinds of gains.

Table 9 Comparison by Percentages, Gains and Loss, Both Groups, Drawing and Writing Scores
Comparison of Experimental and Control groups, regular and referred students for percentage gains and losses, overall scores

	Exp.,	all	Contr., all	1, i	2, i
writing	-.11	-2%	.44	9%	-.21, -3%
drawing	+.92	20%	1.22	28%	.31, 6%
					1.24, 28%
	Exp.,	chtyp 2	Contr.,	chtyp 2	
	pt.gain	% gain	pt.gain	% gain	
writing	.41	9%	1.36	40%	
drawing	.99	24%	1.32	35%	

The third test gives the referred child in the control school nearly significant gains in drawing, $f(1, 37) = 3.29$, p of .07. Because it occurred to the researcher that the heavily coached follow-up testing might have invalidated the study results, it seemed reasonable to approach the data by excluding that test.

If the follow-up test is removed, the following pattern emerges:

Table 10 Comparisons, Gain and Loss, Pre- and Post-Tests
Comparison of Experimental and Control, Gains and losses, pre- to post-tests only, means and percents gain and loss

		Exp.=experimental Con.= control %=% gain or loss 1,1= Experimental, non-referred 2,1= Control, non-referred 1,2= Experimental, referred 2,2= Control, referred				
	Exp. %	Con. %	1,1 %	2,1 %	1,2 %	2,2 %
wr.	.01 .1%	-.18 -3%	.10 1%	-.26 -5%	-.41 -9%	.11 3%
dr.	.57 12%	.43 10%	.61 13%	.03 .6%	.42 10%	-.01 - ?

The Experimental school had a fractional gain of .001 in writing, while the Control school had a loss in writing of .03. The regular students in the experimental had a slight gain in writing of .01, while the control school showed a loss in writing of -.05. The referred students in the experimental school had a nearly 1% loss in writing, over Control's (.03) gain, but they made larger percent gains in drawing across the board.

After this percentage gain and loss evaluation, it seemed important to describes the pattern of gains and losses in connection not only with group but with child type using points.

Table 11 Percent Gain and Loss by Group and Child Type
Comparison, Exper. and control; child type 1 and 2
Holistic Drawing

	Exp.,1	Con.,1,	Exp.,2	Con.,2
prew	5.26 1>2 by .14	5.12	4.36 1>2 by 1.06	3.30
posw	.36 1>2 by .50	4.86	3.95 1>2 by .54	3.41
posw2	5.05 1<2 by .38	5.43	4.77 1>2 by .11	4.66

	Exp., type 2	Con., type 2
pred	4.05 1>2 by .29	3.76
posd	4.47 1>2 by .72	3.75
posd2	5.14 1>2 by .06	5.08

The pattern of gains of experimental over control is maintained for the referred child. However, gains held initially by the experimental school are eroded by the control school, referred child. By the time we reach the follow-up test, the control school has either moved ahead in actual points of the experimental school for writing, or closed the gap, so that the experimental edge is 1/10 of what it was initially for drawing. However, experimental referred children maintain a marginally significant edge for drawing, $f(1, 37) = 3.29$, p of .07.

4.2.7 Analysis, Three Sets of Scores

Having analyzed child type within the context of the preceding four hypotheses, it may be useful to analyze three sets of scores for the referred student. This analysis is useful because it describes the amount of gain the referred child is making using two different systems and three levels of evaluation.

In general, the referred child scored significantly lower than non-referred students on the writing tests. The degree of gain these students made is the interesting point, rather than the fact that they started lower on all tests than the other students. The fact that referred students scored lower was to be expected, and may serve to validate the school's identification of these children as less fluent, less complex writers than their peers at the outset of the study, as well as at its completion. The fact that these students can become more fluent, complex draw-ers than their peers is one of the fascinating point (recall the marginal edge the experimental referred students had for drawing over control).

More importantly, to increase the number of words by 29%, and to increase word-use and word-constructions by 53% suggests that something in the study is affecting these children's writing skills in ways equal to or greater than their peers. The referred students may be behind their peers in writing skills, but they are making big gains, fast. Writing is difficult for many of these children. To write 13 more words, and to increase complexity of grammar by 1/2 is a feat for these children- particularly in one week-s time, or, in the case of control, in only three writing sessions.

RESCORE:

Rescore showed a marginally significant effect for child type in connection with school, $f(1, 80) = 3.58$, $p = .06$ in connection with pre-test facts for the non-referred child in the experimental school.

Rescore showed marginal significance for child type in connection with school for follow-test facts, $f(1, 77) = 8.65$, $p = .06$.

Rescore showed significance for child type in connection with trial and simile-use, $f(1, 77) = 5.34$, $p < .05$. The non-referred student in general was ahead in simile-use.

Rescore showed significance for child type and school and trial in connection with simile-use, $f(1, 77) = 6.16$, $p < .05$. The effect was for the experimental school in the post-test simile-use. This statistic is particularly important, for it suggests that Drawing/Writing was effective in developing inferential thinking in the form of simile-use in the experimental school in connection with the non-referred students, even in the face of a heavily coached, simile-emphasizing follow-up test.

4.3 Summary, Both Scoring Systems

In conclusion, a table comparing the Rescore and the Holistic methods for points and percentages of gain and loss may be useful. The comparison may point out the ways in which Rescore provides a more distinct picture of the similarities and differences between the groups in the study.

Each column below should be read down for point change, and for the percent of the preceding score that this gain or loss represents. At the end of each column, the total point gain or loss is computed back against the original pre-test score.

Table 12 Percents Gains and Losses
Comparison of gain and Loss Analysis,
Rescore and Holistic, all students across schools,
referred and non-referred

RESCORE n=105	HOLISTIC n=209
Experimental school, n=57	
Control school, n=48	
nf=non-referred	
ref=referred	
%=percent gain or loss	

Continued, next page

Table 12, continued

	% change		Number of words-scores			
	all		nf	%	ref	%
pre	60.08	1.7	66	.074	50.53	2.79
		2%		1%		5%down
pos	58.38	20	65.26	19.98	47.79	20.18
		34%		30%		40%
pos2	78.56	18.48	85.24	19.24	67.97	17.14
		30%		29%		33%

Continued, below

It is clear that the referred child is making greater gains in post-to-follow-up writing than the non-referred student, and that this gain from pre-test score as a base is the highest.

	S-scores for word-number-use-and-construction					
	all	%		%		%
pre	35.50	1.04	38.30	1.91	30.97	.08
		2%		4%		.002 down
pos	36.54	13.01	40.21	15.71	30.89	8.65
		35%		39%		28%
pos2	49.55	14.05	55.92	17.62	39.54	8.57
		39%		46%		27%

Continued, below

The S-score is more complex. It combines word number, word use, and word construction. The referred child still lags behind in percent gain when these higher-order categories are added.

Table 12, continued
Ho-scores, the original holistic scores

	all	% change	nf.	% change	ref.	% change
pre	4.72	.11	5.2	-.1	3.97	-.22
				2% down		-1%
pos	4.61	.44	5.1	.1	3.75	.9
				9%		1%
pos2	5.05	.33	5.2	0	4.73	.76
				6%		0%
						19%

Here clearly the referred child has made the greater percent gains. This kind of gain appears to be worthy of note.

4.3.1 Analysis of Percents Gains and Losses, Both Child Types, Both Scoring Systems, Writing Only.

Using the Rescore numbers, the referred students as a group made the highest gains of 40% on the pre- to post- test number of words written. The regular student went up 30% on number of words, and 39% in connection with the post-test S-scores for word-usage and higher-order constructions, with a 46% gain on the follow-up S-score. The fact that the referred child made gains of 30% to 40% on the word-number scores, and 27% gain on the S-or word-use scores should not be ignored. These children made great gains in the number of words generated, and their higher-order word constructions gained appreciably, too. If the child who receives special services, often in connection with writing and reading, is making such gains, it is important to note it. The gains suggest that something other than a usual classroom effect is taking place. If these students had already been making these kinds of gains, they would presumably not be receiving special services outside the classroom.

As shown in Table 2 Holistic Scores, the control group average dropped from 4.8 to 4.66 on the follow-up writing, while the experimental group went from 5.08 to 5.09. We know that both the males (who, as a group moved from a pretest mean of 4.3 to 4.36 to a follow-up mean of 4.7) and the referred children (who, as a group moved from means of 3.9 to 4.7) are making gains in both schools. Many different kinds of changes are occurring in the study. The numbers used do not appear to get at the effects in conclusive ways, except for girls and for referred children. It is possible only to suggest that drawing in some form is the cause of the positive kinds of changes.

4.4 Summary, Holistic Analysis

The holistic scoring showed statistical significance in five general areas: school, gender, child type, grade and trial. In connection with school, the experimental school had marginal significance for drawing and for writing, as did 6th grade girls for Escher writing.

A second area of significance had to do with gender; the girls showed an overall ability to score higher than boys when they drew, or when they wrote about objects, seasons, and Escher prints. A third area of statistical significance had to do with child type. Non-referred children clearly scored higher across the board. More interesting are gains made by the referred child from pre- to post- to follow-up test. There was a statistically significant difference in the direction of the change of writing scores in connection with the sixth grades; in the experimental school, the referred children made a gain, and in the control school, they made a loss so large that the difference was significant. The referred students in the experimental school showed a significant effect for drawing. The fourth area of significance had to do with grade; the 6th graders scored higher on the Escher tests; the experimental 4th graders and 6th graders made gains while their counterparts

A fifth area of significance had to do with trial; using both schools, the holistic method showed that all students did significantly better on writing and on drawing over time. There was a general trend across schools for writing scores to rise, with means moving from pre- to post- to follow-up from 4.97 to 4.90 to 5.10. There was a general trend for drawing scores to rise, moving from 4.40 to 4.92 to 5.46. Across schools, the overall gain for writing was .13, and the overall gain for drawing was 1.06. Drawing gains were greater.

Because of the experimental school's marginal significance for writing and drawing, the experimental school may have benefitted more from Drawing/Writing than control benefitted from the effect of repeated tests/treatments with writing and with drawing.

4.5 Individual Cases that Demonstrate Errors in the Holistic Method of Evaluation

Cases that show how far off the holistic scoring could be follow:

Case #13;

	Ft1	Ft2	adj	n	v	adv	sim	met	p	hy	nb	s	ho
pre	5	0	1	10	3	0	0	0	1	0	43	29	5
pos	7	0	2	10	0	1	0	0	1	0	52	32	6
pos2	6	0	2	13	3	2	1	0	1	0	65	48	4

Case #17

pre	4	0	2	6	2	1	0	0	0	0	34	19	5
pos	2	0	4	3	0	1	0	0	0	0	19	12	4
pos2	0	0	2	6	3	0	1	3	0	0	18	26	3

Case #40

pre	5	0	2	5	4	1	0	0	0	0	33	22	5
pos													
pos2	8	0	6	13	8	2	2	2	0	0	89	55	5

Case #61

pre	14	0	12	14	8	1	0	0	0	0	83	63	5
pos	19	0	8	26	9	3	0	0	1	1	65	95	8
pos2	35	0	17	30	12	2	1	0	0	0	258	143	5

In case #13, more words, and a higher S score yields a lower holistic score. The use of simile and of prediction in this case is part of a possibly important move in thinking skills. In case #17, a higher S scores

yields a lower holistic score. Because the criteria had to do with facts and inferences, the holistic evaluators seem to have focussed on facts and on numbers words in their scoring. It is possible that the criteria did not make the identification of predictions and hypotheses clear, as well as their importance. The move in the case of #17 into simile and metaphor use is important.

In cased #40, the two 5's do not reflect the differences between the pre- and the follow-up writing in terms of gains in numbers of words and higher-order word constructions.

In the case of #61, the holistic again gives the same score of 5 to two very different performances in terms of word number, and in terms of higher-order word constructions.

The numbers of times that the holistic scoring failed to produce accurate scores did affect the study as a whole, suggesting inconclusiveness. The fact that it could be so far from what the Rescore numbers showed suggests that the holistic method is not useful to evaluate the data generated by this study.

The statistical analysis provided by Rescore shows that the holistic method was off enough to jeopardize the statistical significance of the study.

4.6 Summary of Rescore Analysis

In the same way that the holistic evaluation addressed the areas of school, sex, and child type in connection with object-related writing, the Rescore evaluation did the same, using more finely grained categories in connection with word usage.

Rescore showed that pre-test writing scores were significantly higher for non-referred students in general. In connection with the treatment group in particular there was a significant effect in connection with pre-test word numbers and similes, and post-test facts and similes, and follow-up facts and similes. Since description of facts and comparison by simile were goals of the treatment, the enduringly significant levels for the experimental school in these two categories is meaningful for the study. Rescore makes more specific the nature of the edge that the experimental group had and maintained over the control school.

Rescore also showed significant edge and gains for girls, as did the holistic method. The non-referred girls had high pre- and post- and follow-up simile use; they had the highest word numbers, and overall word-use scores, as well as the highest holistic scores by the follow-up test. However, Rescore suggests that the boys are making gains in facts and in use of verbs and nouns, for, by the follow-up tests, the girls maintain significance for word numbers and for simile and adjective use only.

Rescore showed overall gains, as did the holistic method. Rescore showed that the gains were made in connection with nouns and adjectives and verbs, with facts, and with similes, as well as with sheer numbers of words. In connection with many of these categories, males and referred children closed the gaps in scores between them and the girls and the non-referred students.

In connection with the "P" score, for predictions, the experimental school went from a mean of .2364 to .4182 to .4468 on the follow-up test, with a gain of .1104; the control school went from .5532 to .5000 to .4186, with a loss of .1346, moving consistently down. Although there was no significance for the "P"

score, with a p of .884, the difference in direction of change may be useful, suggesting a positive trend for the experimental school and a negative trend for the control school in connection with the use of predictions, which are one of the higher-order word constructions that Drawing/Writing specifically encourages.

After conducting a fine-grained evaluation of the data, using the method called "Rescore," it became increasingly clear that the holistic scoring was incorrect in many instances. The Rescore method was critical to defining and clarifying the relationships between the groups in the study.

4.7 Ipsative or Descriptive Case Studies. 1-12

The holistic and Rescore analyses attempted to evaluate group changes over time in response to the treatment and to what revealed itself in the course of the study as the treatment-like effect of the test situation.

At heart, teachers of Drawing/Writing are concerned with the growth of the individual child. The intent of Drawing/Writing is to provide each child with bench marks of personal performance and growth over time. As the Latin word "ipsos" suggests, the self learns to measure and to motivate itself.

An ipsative (Anastasi, 1976) or self-referential evaluation, of a selected number of cases may prove useful in appreciating the effect of Drawing/Writing. Every student has not been evaluated in this way. However, enough case studies are provided to show where the holistic scoring appeared to be on target, where it was off, where the Rescore method provided a truer picture of what was going on linguistically and cognitively, and what conclusions are possible about the data when a number of individual evaluations are added to the analysis.

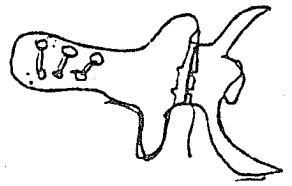
The changes in writing skills were often surprising. For instance, in the Preliminary Illustration, Bones, on page 146, pre- to post-test, the number of words doubled, facts doubled, nouns and adverbs doubled, and, by the follow-up test, the child moved from no use of simile to using four. The drawing skills of this child became appreciably more complex, as did the power and fluency in writing, as meaning and as decipherable marks.

57
0

25
3rd
Sched 1

57
0

Possible a pig bone. Found in pot holes.
bone of pig.



659

0

659
0

My object is bone. it is a back
bone of a pig. it does not look like
a pig bone. it is a inch long
and 1/2 inch wide. it is white. long
and 1/2 inch wide. it has
some jagged ends.

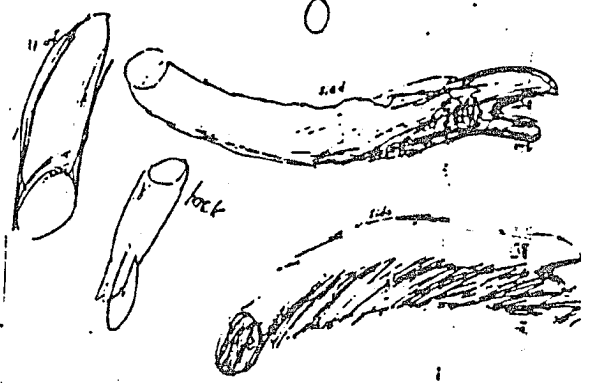


772
0

772/m

772
0

My Bone is right My Bone has jagged ends
in the middle it is small it looks like a claw
it is black inside - it looks like a back of a leg
it looks like a quill I have a quill and a bone
and it looks like a cat has claws in the
time it was found it was not in a hole



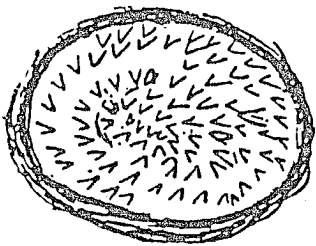
Bones

It will be recalled that one of the strategies of the study, based on the literature search was to use the possibly more visible gains made by the less able child to predict or to infer less visible gains in the more able child. In line with the larger argument of the usefulness of the treatment to referred children, the case descriptions will be limited to one referred case study per grade per school, for a total of 13 thumb-nail sketches, accompanied by 11 illustrations. Drawing appears to have affected the cognitive gains of these children in both schools. To try to stay within the least invalid bounds of the scores, only the pre- and post-test scores will be considered.

Individual studies of particular interest for gains or change, grades 3-6, both schools, referred children include the following ten illustrations accompanied by text.

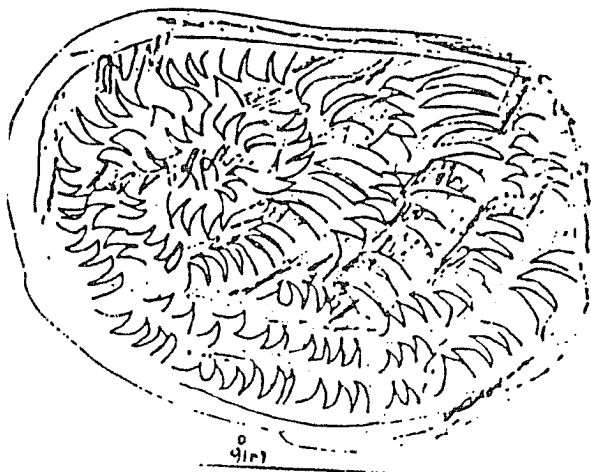
Illustration 2, Geode

The experimental school, grade 3, had 5 referred students. In Illustration 1, Geode, Grade 3, Experimental, referred, the number of facts held at 5, there was no narrative and no reminiscence; the use of language revealed a high degree of affect; the adjectives moved from 6 to 2, the nouns from 3 to 4, the verbs from 0 to 3, the adverbs from 0 to 1, the similes from 0 to 5. Although the number of words moved from 62 to only 66, the combined word-number,-use, and-construction score went from 19 to 35. The child used strong drawing skills throughout. The move from diffuse affect to affect attached to facts and comparative reflective thinking is indicative of what training in Drawing/Writing can do. This case supports the researcher/teacher's experience with the activity Drawing/Writing to improve higher-order content in language use.



213

A Geode is a very nice rock.
 I find it wonderful to look at the cutters are beautiful.
 When the cutters mist to gether It gives you a
 wonderful feeling. It's seems so infoseet than it can
 be so linters. It's the out side and so
 de so ragly. an: the out side and so
 Prity in the insid. I love -



214

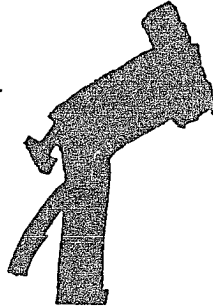
my objet is so finey cut and polished.
 It gliter like the see and shine's like
 the sun. It is so much like the mer. Becas
 the sun ^{glitters} on it. The back is so much like a
 rock becaus the sun bousint shin on it
 and it dousint shin like a merd becaus
 the sun dousint shin on it so it dousint
 shin on it

Geode

Illustration 3. Hose Sprayer

In Control, the number of referred students was 4. In Case #33, grade 3, Control, referred, the gains came in noun use, in verb use, and in prediction, with a jump of 0 to 5. The Rescore s-score went from 13 to 37. The move from tracing to freehand drawing, and the change in handwriting are also interesting aspects of this case.

33
Schritt 2
ref.
Illustr #2



570
0

My object is a Hose sprayer
that can be used for things
like washing the house the car
and the fence and the grass



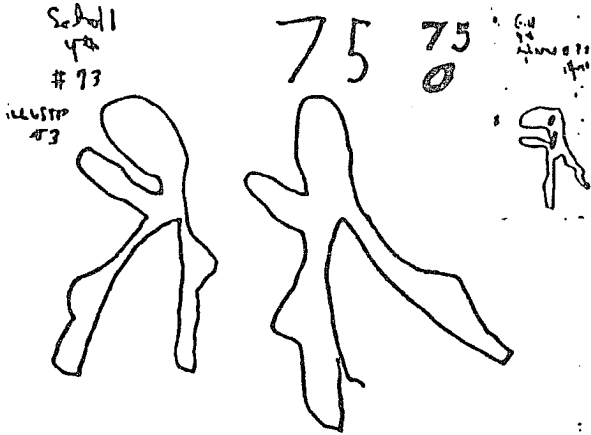
49
0

My Object is a Hose sprayer. It looks like
a Mashin from mars. It isshine

Hose Sprayer

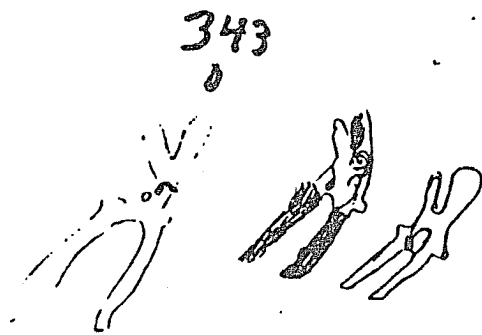
Illustration 4. Garden Clippers

In Experimental, the number of referred students was 5. If pre- to post-test scores alone are counted, all of the experimental students' scores dropped, and the word-numbers dropped a little, or a lot. However, in Case #73, grade 4, Experimental., referred only 1 word was lost, 3 similes were generated on the post-test, the prediction level of 1 was maintained, and the quality of the drawing improved; the writing is more condensed, cramped, and messier, but it says more. In this case, the post-test writing is included for contrast with the pre-test handwriting, as is the post-test drawing for scale and confidence.



75
0

rose clippers clippers roses
you can cut wires
the colored black and
silver. It has a blade
on it a sharp one to



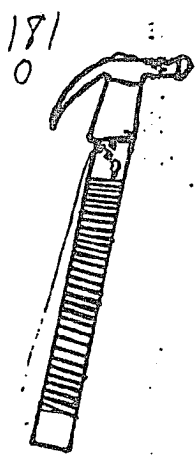
It looks like tool
clippers. It is a pair of
cut an apple you could use
it to slice wire to be sharp
to be pretty

343

Illustration 5. Hammer

There was only one complete referred case study, grade 4, Control, #50. In this instance, both word production and word-use score dropped; from word-numbers dropped from 64 to 33, and S-score dropped from 44 to 24. The two metaphors in the pre-test disappeared in the post-test. Handwriting became less organized, but the fat-tipped marker used may be responsible for the apparent change. Drawing did not change appreciably.

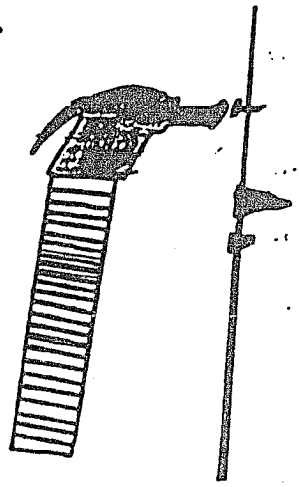
77 70
School 2
4a
Illustr 4



181
0

I have drawn a hammer. It has a long handle. It is used for putting nails in wood. The handle is made of wood. The crown has a curved claw. The iron part is made of iron. The hammer has a point marked on it. The iron part is of right now. But the hammer is not strong. The more it is in a funny shape.

377
0



377
0

11

I AM writing a bout the hammer. It is used for pound ind in nails. It has a tape on th E hands. It is made of two things iron and wood. It has paint on it.

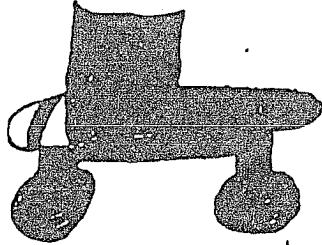
Illustration 6. Roller Skate

Experimental had 8 referred students. Half of the scores went down, half up. In three instances, the number of words dropped. In case #91, tgrade 5, Experimental, referred, the number of words goes from 69 to 88, and the score from 33 to 54. The gain is in number of facts (7-13), adjectives (3-9), nouns (9-15). There is a clear change in drawing skills, involving increasing scale and unusual angle, and there is a move away from distortion; in writing, the mark-making becomes finer, and better organized on the page.

91
5.0 #1
14.6.5

755

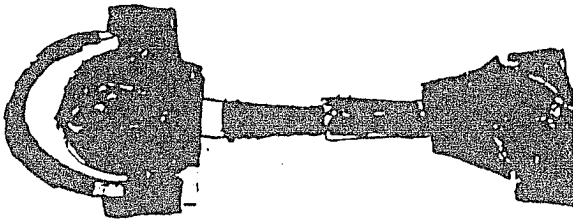
755
0



drawing - IT WAS NOT SO HARD AS I THOUGHT
IT WOULD BE DRAWING A ROLLER SKATE. BUT IT WAS FUN
DRAWING THE SKATE. I WOULD LIKE TO LEARN
HOW TO ROLLER SKATE SOMEDAY. YOU CAN
MAKE IT WIDER OR SMALLER. YOU CAN
HAVE A LOT OF FUN OF THEM. A LOT OF PEOPLE
USE THEM. THEY COME IN ALL KINDS OF COLORS
THEY HAVE FOUR WHEELS. ~~THESE~~ THESE WHEELS ARE RUBBER

755 30
0

755 350
0



my subject is roller skate. it has been
fun drawing and writing about it

I like it I like writing my subject
The picture of my subject the roller skate is
very good even the picture that
I was looking at. My subject
a lot of people like to play with it
it has four wheels. it is made out
of rubber and hard rubber. it
can roll on roller skates. it has
four bearings. all kinds of rollers
wheels that you can see. the rollers
are set. the rollers are just on them.

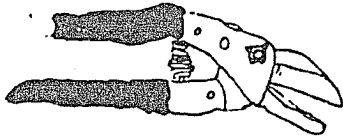
Roller Skate

Illustration 7, Rose Clippers

Control had 5 referred students in the fifth grade. In two cases, the object served as a stimulus to narrative, to memory, or to dialogue. There was self-reflection in connection with drawing skills, there was wondering, a poem, a pun, humor. Case #108, grade 5, Control, referred, shows a move from the literal to the metaphorical in the pre- to post-drawing. The writing in the pre-test is already metaphorical, comparing the rose clippers to a monster with bulging eyes and sharp teeth. The post-writing, instead of reflecting the metaphor in the post-drawing itself, moves into personification and dialogue, and a theatre-like scene-setting provides an explanation for the apparent oldness of the clippers. Although this is the control school, it is possible that drawing provided some stimulus for complex thinking. It is also possible that drawing reflected complex thinking, where a visual move into metaphor reflected a previous verbal one.

108
#2
5
NTR #6

697
0

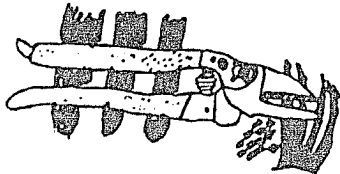


697
0

I think my object looks like a monster. It has a big, bulging eye and its teeth are as sharp as a knife. It looks old and rusty, with part of its yellow handle broken and does not snap back like it should when someone is using it. The metal piece that locks it is stuck and the safety piece on the bottom blade is loose so can't cut anything because rust is on the blades.

615
0

615
0



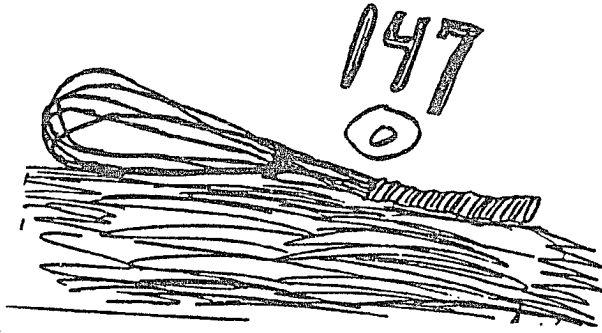
"Smith, Smith?" went the clipper, "Map, snab?" went the branches. The clipper thought, "The man in the green gloves is using me to trim his apple tree again. These branches are so old they're easy to cut." Then the man had to leave. He dropped his clipper in a bush. The next year he was trimming the bush and found them. Then they looked like they do now.

Illustration 8. Mussell, Hammer

The number of referred students in sixth was 6. Here, too, the object served as a stimulus to memory, and to narrative. One of the most interesting cases is #152, grade 6, Experimental, referred, where the number of words went from 35 to 61, the number of adjectives from 6 to 10, nouns from 6 to 11, strong verbs from 1 to 4, and two similes were generated: the mussell shell is compared to a chipped cup, and to half an egg. The score for word-use and construction went from 27 to 41. This student is self-admittedly attention-deficit and is on medication. The drawings show control and attention. In this case, the post-test writing is included, with a number of 188 words, and a score of 70, where 6 times as many words have been generated, the S-score has tripled, and the handwriting is far more organized, fluid, and sustained.

Illustration 9. Whisk, Corkscrew

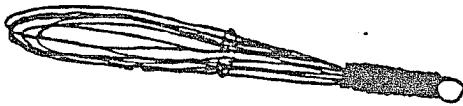
The number of referred 6th graders was 12; only 6 were examined in the Rescore part of the study by some oversight. The pattern of gain or loss remains unclear for number of words, or for score in connection with these cases. In Case #137, grade 6, Control, referred, on pre- to post-test, both the drawing and the writing became less organized; Word number and score rose only slightly, from 16 to 20, and from 10 to 14. However, the follow-up drawing shows what this referred child in the control group can do. However, the quality of this child's writing does not seem to have been affected as mark-making, but meaning is enhanced by simile-use and by precise descriptionb of function, rather than relying on puns and humor.



666
○

This drink is beat up batter. This is used
beat up batter. The latter beat up the batter.

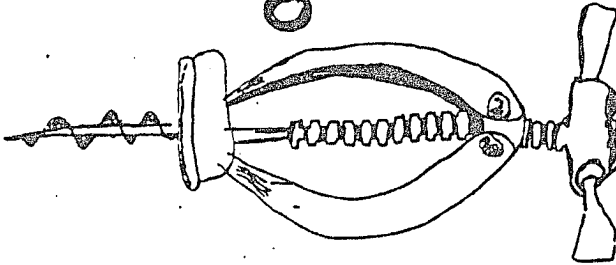
666
○



147
○

This is beat up beater. This didn't
run on battery. I worked on
body power. Now this is ~~for~~
OUT OF ORDER

346
○



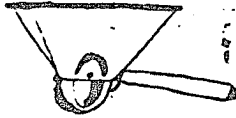
346
○

This object is a useful.
This is used to take us
out to drink the wine.
Looks like a helicopter
a pepeler on top.

Whisk, Corkscrew

Illustration 10. Parsley Grinder, Mallet

A further anecdote may be added. One boy in experimental 5th moved into metaphorical thinking verbally and visually, although he remained unable to write his simile out (Illustration 9). He compared his mallet to a car mounted on a rotating pole in an amusement park ride. Although he could not write anything more than "my mallet is like a merry-go-round," he could draw the simile. The difference in the way this child held his pencil and moved it when writing or drawing was extreme. A back-twisted left hand position, and laboriously slow writing changed to an open, freely moving, surely sustained series of motions in drawing.

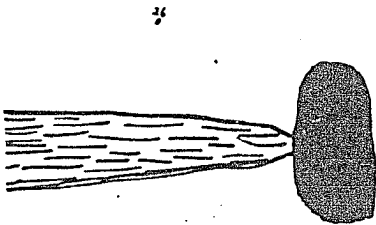


546
0

~~It looks weird and I can't~~
~~read it and I can't~~
~~write it like it~~

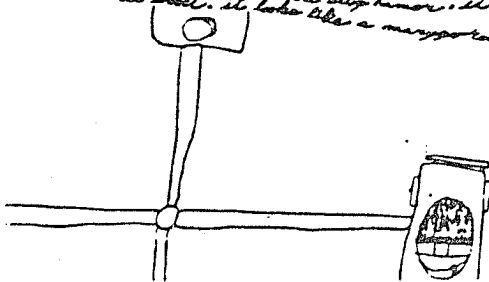


326
0
 you can use it for grinding but and soft
 or cold you can take it apart.



It is made of wood

It is made of bit of wood
 and it had a lot of lines. it
 like a steel net feel. it is small. it look
 like a leg. it is like a deep hammer. it is
 all small. it looks like a mallet.



Parsley Grinder, Mallet

Illustration 11. Verbeta, Shell

A third grader in the experimental school who had done almost no writing generated 16 similes in several minutes.

A fourth grader in the experimental school who has muscular dystrophy clearly enjoyed drawing and was able to register an appreciable amount of information in his drawing.

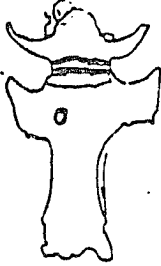
A sixth grader (Illustration 11, Vertebra, Shell) in experimental showed extraordinary writing skills, which moved into increasingly higher-order thinking throughout the trials. The child moved from 90 to 85 to 162 words; he generated 5 similes on the post-test; he moved from 2 to 1 to 2 predictions; he moved from 1 to 2 to 2 hypotheses; his S-score moved from 46 to 82 and held at 82. The holistic score was clearly off in this case, giving him a 6, a 6 and an 8.

662

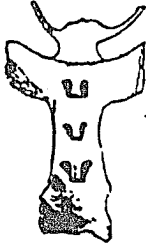
0

Il y a peut-être une de ces choses dans le monde pour ce moment et de nos jours, un animal de ce genre est de plus en plus commun. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs.

662



20



Les choses de ce genre sont de plus en plus communes. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs.

Les choses de ce genre sont de plus en plus communes. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs.

529

0

529

0



Il y a peut-être une de ces choses dans le monde pour ce moment et de nos jours, un animal de ce genre est de plus en plus commun. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs. Les animaux de ce genre sont de plus en plus communs.

Vertebra, Shell

This sixth grader's writing was highly descriptive and reflective. It appears that Drawing/Writing allows the capable, verbal student to be even more fluent:

Pre-writing: "My object seems to be some kind of vertebra from an animal about the size of a woodchuck. It features the upper part of the spine, the place where the shoulder bones would branch off and it has a lower neck which seems to be attached to a hinge (it moves back and forth). It has six little holes (three on each side) in the lower spine. The animal in life had pretty serious bone disease. The bone is pretty decayed and has a series of hole in the shoulder bones."

Post-writing: "The object looks like a piece of bamboo with lines and textures similar. With its holes as though a giant mountain panda had wanted it for lunch. The texture of my object is hard and gritty. The animal had a pretty bad case of bone disease or insects. A very unhealthy animal. Probably from a small farm. Someone has written eyes (on it), so that it looks like a buffalo spirit with two fangs on opposite sides of one mouth and big horns stretching from the head."

Follow-up writing, about a shell:"My object is a conch shell and it's pretty old or it has not been treated with the greatest of respect because there are sections which have broken off. You might think that when I put my ear (to it), it would sound like an ocean or a body of water. Not true it just moves the sounds around me louder and clear, more refined. There are several marker markings. A letter "G" and an arrow pointing inside the shell. There is a spiral going from into the shell. It's hard for me to imagine something being inside. If there was it must have had a very special and pliable body. I have never seen one of these with an animal inside but I have not seen everything there is to see... It's a wonderful object and I'm glad I picked it."

4.8 Conclusion

Evaluation of the data in the study by three methods - the holistic, Rescore, and descriptive case studies - suggests that drawing in connection with writing benefits the language-troubled or language-dysfunctional student, the regular student, and the talented and gifted student in connection with drawing, writing and thinking skills.

CHAPTER 5

DISCUSSION

5.1 Overview of the Chapter: Discussion, Speculations, Recommendations

In this chapter, the results of the study are discussed in general. The results are also examined in connection with the six hypotheses suggested by the research. The limitations of the study are explored. A plan for follow-up studies using Drawing/Writing is proposed, along with suggestions for testing other cross-modal activities like it. The problems and purposes presented in Chapter 1 of the study are reviewed, along with educational strategies suggested by the research that should help to counteract or prevent dissociated learning. In addition, Chapter 5 describes the ways in which Drawing/Writing appears to meet the criteria for effective learning and thinking activities suggested by the research. The profile of a new educational theory and practice is presented for consideration. Practical and theoretical speculations conclude the chapter.

The study showed how easy it is to improve drawing and writing skills. Given sufficient interest and attention and clear instruction, children increase their ability to describe objects and to compare their objects with other objects and ideas quickly, using drawing and writing. It appears that drawing, at least in some form, acts as an attentional, motivational and cognitive "hook" for children in connection with writing.

The study did not demonstrate a significant effect for the treatment in connection with referred students' writing. It was the expectation and strategy of the study that Drawing/Writing would have a significant effect on referred students' drawing, writing and thinking skills, and that Drawing/Writing would show a significant effect for referred boys in particular in connection with drawing and with writing. This expectation and strategy was based on both experience and research. Boys with language problems are able to draw, and drawing appears to have a remedial effect on dysfunctional writing.

Surprisingly, where the holistic method failed to demonstrate a significant effect for the treatment on the experimental group as a whole, Rescore revealed it. Given the apparent failure of the holistic analysis to reveal the significant effect of the treatment on the targetted population in general, the Rescore method focussed on all of the referred students in both groups and half of all the others because it appeared that this approach was the reasonable one to winnow out the clear effect of Drawing/Writing. It is ironic that, by changing from a subjective and qualitative system of measurement to an objective and quantitative system of measurement, the study showed that the treatment had a significant effect on the targetted population in general. The fact that Drawing/Writing did not have a dramatic effect on the referred experimental group in particular was surprising, given the past four years of empirical field studies, and the appreciable body of

research relating to attention, motivation, remediation, and the natural unfolding of symbolic representational skills. The field studies and the research suggested the near inevitability of such an effect.

The goals of the study were several: one goal was to encourage descriptive or factual drawing and writing in a broad range of children in the regular elementary school classroom by using the five senses to inform knowledge; to develop analytical drawing and writing by teaching strategies for dissecting and reconstructing a knowledge base; yet another goal was to move children into reflective drawing and writing by providing instruction in abstraction in connection with drawing, and instruction in inference in connection with writing, using systems of comparison to get at similarities, differences, and logical connections. The inferential, comparative strategies involved learning how to use similes, metaphors, analogies, predictions and hypotheses.

The holistic method of evaluation suggested that the effect of the treatment, Drawing/Writing, was inconclusive. The method called Rescore was designed to try to determine whether the holistic method was inappropriate as a measure of change in thinking skills expressed in writing, or whether the holistic analysis was indeed correct, and that Drawing/Writing had no particular effect on drawing, writing, or thinking skills.

Designed to analyze the effect of the treatment on language in detail, Rescore revealed increased factual and metaphorical language use, reflected by increasing numbers of nouns, adjectives and similes. Where the holistic method showed only a marginal effect of the treatment on the experimental group, Rescore yielded significance.

Descriptive case studies provided illustrations of positive changes in writing and drawing both as "grapho-motor" skills and as cognitive skills. Because of the intimate if not indivisible connection between mind and body, changes in grapho-motor skills most probably reflect cognitive changes. It follows that mark-making that is increasingly organized and intentional in space either relates to or reflects in some way an increasingly organized use of symbols on an interior (mental) linguistic level. The case studies at least allow an appreciation for a clear development in thinking that is spatial as well as linguistic.

It is apparent that the deliberate teaching of strategies in comparison-making allows, encourages and trains children to connect with their own thinking and learning because it models what the mind has evolved to do best, which is to make comparisons between systems of representation. Neural connections make connections between ideas possible, and the very act of connection-making enhances neural connections.

5.2. Discussion of the Results by Hypothesis

5.2.1 Hypothesis #1: Drawing/Writing will Increase Descriptive and Inferential Writing

The study suggests that repeated drawing and writing improve drawing and writing skills. The holistic scoring indicated that the treatment had marginally significant effect (.08) on the drawing and writing skills of the experimental group vis a vis the control group in general, and significant effect on the drawing skills of the experimental referred girls. In some cases, on the post-test, it appeared that a week of Drawing/Writing

made children draw and write slightly worse than when they began. The follow-up study was pursued for this reason. Ironically, according to the holistic evaluation, the control group did better than the experimental group on the follow-up test. Because of the possibly confounding variable of coaching, it may be advisable to downplay, if not to discount, this effect on the follow-up test. The Rescore method showed that in terms of factual and inferential writing skills, the experimental school did make statistically significant gains.

In grades 3, 4, 5, and 6 there was a nearly identical pattern of gains and losses in means scores from pre- to post- to follow-up tests in drawing and writing. All children in both schools except for Control 6th went down on the pre- to post-test writing, and then went up on the follow-up test. All classes, all grades made gains each time they drew. All kindergartners, both schools, made drawing and writing gains on both tests. Experimental kindergartners made greater gains than control kindergartners in both drawing and writing.

The holistic method showed girls scoring significantly higher across schools for writing, drawing, and for thinking in connection with the Escher prints. In general, it was the non-referred girls who were significantly better in all areas of writing. However, the referred girl in the experimental school also made significant drawing gains. This is an interesting result with an age group where the girls are purported to be superior with language-use, while the boys are described as being superior at spatial reasoning.

The holistic evaluation suggests that there was a barely sufficient relationship between Drawing/Writing and writing scores to warrant an analysis of covariance in relation to school, ability and trial.

The Rescore method came up with clearer, more definitive patterns between schools and students. There was a significant three-way interaction between school, child type, and time of test. This effect was for non-referred students, particularly girls in the experimental school who excelled in the use of facts and similes and numbers of words. It is interesting to note that, over the trials, the girls lost significant effect in connection with language use. The girls' mean scores did not drop so much as that the boys' scores rose, including those of the referred boys. The girls end the study significantly ahead with adverb use alone. The fact that the highest scores for facts and for simile-use stay with the experimental school and increase over trials supports the effect of the treatment, Drawing/Writing. The week of training in description and in inference-making appears to have been effective.

The descriptive case studies suggest that both handwriting and drawing are labile forms of self-expression at this age. Drawing appears to impact handwriting, improving it as an orderly, intentional system for meaning. A research-based assumption underlying the study is that the quality of outward sign-making relates to and in some ways reflects the quality of the inner sign-using and can affect it. If true, this is an extremely powerful statement. If it is possible that the usefulness of the computer for the dysgraphic and/or dyslexic student is precisely that it allows for a clean, clearer representation of muddled, imprecise verbal thought, allowing and helping the student to "see" the issues and problems involved in writing.

5.2.2 Hypothesis #2: Drawing/Writing will Increase Drawing Skills

The study suggests the drawing skills improve fast, with minimal coaching. In the experimental school, however, all children's drawing scores rose faster, and they rose consistently, with girls' scores higher across the board. Experimental referred girls' drawing scores showed significant gains over their counterparts in the control school on the third, follow-up drawing. Only in the fourth grade, did boys appear to have a slight edge on girls in drawing. It is interesting to note a significant effect for referred children in general on the post-drawing. As potential change agents (Wolf, 1969), referred students show the kinds of drawing gains that distinguish them for this role in the study. It had been hoped that the referred students would make significant writing gains. It is puzzling that the appreciable percentage gains these students made did not result in significance.

5.2.3 Hypothesis #3: Drawing/Writing will Increase Descriptive and Inferential Writing about the Seasons

The fourth grades in both schools did better at writing about the seasons. Otherwise, the results were inconclusive, except that girls continued to show a significant effect.

5.2.4 Hypothesis #4: Drawing/Writing will Increase Descriptive and Inferential Writing about Escher Prints

Across schools, there was a significant effect for girls on the Escher writing. There was no significant gain for the experimental school. However, examination of means scores shows that the experimental Escher pre- to post- scores were closer between the sexes and went up, and that the control scores were farther apart between the sexes and went down. Again, the fact that means scores in the experimental school are coming closer between the sexes suggests that initial differences in writing skills between the sexes are possibly being equalized by the treatment, and that this equalization is possibly transferring to Escher prints. If drawing alone did this in the control school, the gaps between means scores between the sexes should also be closing.

The descriptive statistics suggest that the Escher tests were somewhat sensitive to age. The pre-test scores reflected age-differences, with the younger students scoring lower than the older ones. However, the post-test means varied between schools and grades. The oldest students did not make the highest scores in a test that was meant to evaluate levels of and changes in higher-order inferential thinking skills. Besides the girls, the experimental 4th graders did the best as a group on the Escher prints. Sixth graders in both schools did well on Escher. The fact that the referred sixth graders did significantly better on Escher tests is important to note. One of the possibilities is that children who are dysfunctional for language skills are often superior in spatial understanding. The Escher prints present anomalies, or paradoxes that are spatial. If the child who has visual strengths and verbal weaknesses can perform significantly better verbally than their verbally stronger peers, then it would be possible to look for a significant transfer of effect from the Drawing/Writing treatment to other problem-solving situations that depend on visual strengths to impact verbal fluency. In this instance,

too, the referred students may act as agents of change (Wolf, 1969). The effect of the treatment on their skills is clear, in this instance, and supports the basic assumption in the study that educational strategies that are useful to less functional students will have general usefulness.

The experimental schools' post-Escher means were higher than control's. Although the gain that the experimental group made was slight, this was in contrast to the control school, whose post-test Escher scores dropped. Training in Drawing/Writing may affect attention and concentration, as well as the ability to deal with the novel or the strange in increasingly sophisticated ways. However, it is also possible that the two prints differed in "holding power" or in degree of difficulty and the differences in scores had to do with other effects than that of the treatment.

By splitting up the two prints on the pre- and post-tests in future studies, it may be possible to use the Escher prints to evaluate changes in analytical and inferential thinking skills more conclusively. The univariate test confirmed the descriptive statistics, showing that for both schools, the sixth grade did statistically better on the Escher tests, while the fifth grades in both schools did significantly better on the seasonal essays. The former is a useful bit of information, suggesting that age may have something to do with intelligence. The ability of the fifth grade to write better about seasons does not appear to have much meaning here.

Note: A kindergartner in the experimental school pointed out that the Escher prints may have been presented in the wrong order in terms of degree of difficulty; this six year-old thought that the first print presented to students, the one with the staircases ("Relativity"), was more difficult, while the second one which the children described as "mummy-birds" ("Other Worlds") was easier. This six year-old said that the first print had many points of view while the second had only three. This experimental group kindergartner was the only child in the entire study to come out and say that thinking about one print helped with thinking about the second, and that both prints showed that there was more than one way to look at things. This move in thinking argues for the possibility of Piagetian formal operations at the kindergarten level.

Whatever the case may be in connection with degree of print difficulty, the significant gain in factual information and in hypothesizing about paradox made by the referred 6th graders bears mentioning.

5.2.5 Hypothesis #5: Drawing/Writing will Increase the Referred Child's Abilities to Draw and to Write to a Greater Extent than those of the Non-Referred Child

Hypothesis #5 is critical to the strategy of the study where one goal is to make a convincing argument for the usefulness of integrating the arts with academics at the elementary level. The steps in the strategy have been: 1) to redefine the arts as the ways in which pre- and peri-literate children think; 2) to make the argument for the usefulness of the arts to mind for all children because of their demonstrated usefulness to the dysfunctional student; and 3) to show how the arts impact writing skills in particular.

The strategy is supported by the search of the literature, by four years of field studies, and, to some extent, by the current formal study. There was statistical significance for the effects of child type in ways useful to the study. This significant effect was observed in connection with drawing and referred girls in the experimental school. They made greater gains than their counterparts with drawing. In addition, there was a

significant effect for child type in connection with referred 6th graders in general in connection with Escher writing. These sixth graders did better than other grades, and they did better than the non-referred 6th graders.

An examination of the direction of changes in means scores for the referred child is also useful. If grade level means are used as a reference point, an interesting picture emerges. The direction of change for the referred child is up in the control school for 4th and down for the experimental school; down for 5th in control and up in experimental; down for control in the 6th and up for experimental. The experimental school's writing scores went down once, and up twice; control school's scores went up once and down twice, in the older grades. The degree to which these changes in direction occurred was enough to be significant in the 4th and 6th grades. Since one gain is for experimental and one is for control, the effect for Drawing/Writing is inconclusive. In general, the referred child made percentage gains in drawing and writing greater than their non-referred classmates. This argues, at least, for the effect of drawing on writing for the referred child, and therefore, for all children.

Because the holistic evaluation retained a marginally significant feel to it, the Rescore method opted for an approach analogous to the Pascalian wager. The researcher decided to re-evaluate all of the referred writing in connection with objects and every other case in grades 3 through 6. The Rescore approach threw most of its evaluative weight behind the results of the referred students. If the Montessori/Vygotsky argument should be true - that is, if what works well for the dysfunctional student works as well or better for the functional student - it made sense to support it. If it should not be true, at least Rescore would gain a more precise picture of what was happening to language use with these students over time and treatment. As it turned out, Rescore won the wager, but in a way that was unexpected; the experimental school as a whole and referred students in particular showed statistically significant effects. Referred students thus presented themselves as potential agents of change (Wolf, 1969) for educational reform in the context of the arguments presented in this study, even though their effect was not critical to the statistical success of the study, after all.

5.2.6 Hypothesis #6: Drawing/Writing will be Taught Better by the Regular Classroom Teacher than by the Researcher/Teacher

There was no significant teacher effect. The post-test scores for writing dropped for the researcher/teacher, and rose for the 4th grade teacher, dropping for the 5th grade experimental teacher. This hypothesis was tested to see if teacher-training might result in teachers as good as or better than the researcher/teacher. It is possible that this effect could not reasonably emerge until the new Drawing/Writing teacher had had time to get comfortable with the approach. The transition from an academic outlook to a combined art/academic outlook will take time and teacher-training. Most teachers lack confidence in their artistic skills.

5.3. Discussion of the Results

The effect of the treatment on thinking and writing skills in this study was consistent with previous results with Drawing/Writing. Young writers became both more fluent and more comprehensive in their observations and reflections when training in drawing is combined with analytical and reflective writing. It is important to underscore the fact that, as Drawing/Writing is taught in the regular classroom, it is the fourth drawing called the "perfect whole" and its accompanying writing that serve as bench marks for gains in the classroom, rather than the artificial construct of the timed post-test. In the natural unfolding of the activity, this fourth drawing and writing usually provide the best work the student has produced to date, and it is these two pieces of work that the student compares with initial attempts to draw and to write about the object. The devices designed to measure gains in thinking and in writing in ways that would be fair to the control group (i.e. the perfunctory, timed test) did not, it appears, always provide a fair appraisal of the gains made by the treatment group.

The fact that referred boys make large gains in writing suggests the remedial usefulness of drawing in general and of Drawing/Writing in particular for the student who may be identified as "dyslexic." Drawing may have affected the referred boys' writing in the control school, but the gain was 9% as opposed to a gain of 14% after a week of Drawing/Writing in the experimental school, where the referred males made a gain that was 5% higher than the gain in the control school. The eventual closeness in writing scores between the sexes in the experimental school may mean that the treatment brought the boys' scores closer to the girls'. This closeness argues against the effect of the simple act of drawing alone for leveling writing differences between the sexes. The study does suggest, furthermore, that some combination of drawing with writing impacts verbal thinking skills in ways that are unusual at the elementary school level.

The trend observed in the study for writing scores to drop as students rose through the grades is of possible importance in connection with follow-up studies with Drawing/Writing, including longer periods of the treatment. If a downward trend were the norm for writing skills as students progress up through the grades in some writing programs, and if an approach like Drawing/Writing were observed to counteract this trend, then an argument for curricular change might be made. A downward trend may signal lack of interest, engagement, affect, or skills. The conclusion might be that in some instances writing is being taught in dissociated ways, or that, even where engaging approaches to writing are used, drawing may still provide a valuable attentional and affective stimulus to verbal thought.

It is clear from the statistical evaluations and from the ipsative descriptions that there is a great deal of individual variation within the study population. In general, an approach to writing that includes drawing appears to benefit a broad range of students.

It is possible that some of the kinds of learning occasioned by the study are not measurable in the ways devised by the study. The gains may not be strictly measurable at all. Drawing/Writing is a teaching and learning activity. It is not a test. It is an activity that has developed organically, over time. Its intent and its apparent effect is to help children to think more precisely and comprehensively because they can appreciate the

visible ways in which their thinking is changing, particularly in connection with drawing. It is still possible that, if Drawing/Writing were used sensitively and informally, and if the Rescore system were applied periodically to writing samples, the process could be used to provide clear, objective evaluations of changes in writing and in thinking skills that might be extremely useful to the most important person involved in the educational process - the child- and to the parents, the teachers and to the school, as well.

5.4. Limitations of the Study

As described in Chapter 3, one of the limitations of the study was that the non-random assignment of experimental and control groups. This non-random assignment was clearly a limitation at the time of the formal design of the study. Previous events determined this assignment. By the time the study was concluded, the limitations of the test as treatment-like because of the inclusion of drawing in both experimental and control schools, and of the coaching as treatment-like were also recognized as limitations.

The study began as a 2 (control, experimental) X 5 (kindergarten, grades 3, 4, 5, 6) X 2 (male, female) X 3 (time of measurement) analysis of variance design, involving two schools and 3 repeated drawing and writing measures, evaluated for sex, grade, and child type. The study became, with the Rescore analysis, 2 (groups; experimental, control) X 2 (sexes; male, female) X 2 (child type; referred, non-referred) X 3 (trial; 3 times of measurement) analysis of variance design. Because the experimental school's scores did not appear to improve significantly, the Rescore method focussed on changes in scores for the referred students. Subsidiary analyses dealt with percentages of gains and losses in writing in connection with these students.

The combined research in Chapter 11 suggested that the referred child might be the one to watch for gains. The referred male child in the experimental school in particular made gains. Even though one can conjecture that it is not only drawing in some form, but Drawing/Writing that is impacting the referred child's writing skills, it is impossible to conclude definitively that Drawing/Writing is solely responsible for this effect in the absence of a control school where writing samples are free of the influence of drawing.

The study attempted to devise a series of reasonable measures for the effects of drawing on writing. The pervasive influence of drawing was inadvertently built into the design of the study. It was impossible to isolate the effect. It would have been possible to reduce the effect of the pre-test on the study had the researcher seen at the outset the problems that drawing as a form of testing would create. Since the researcher did not appreciate the effect of drawing as a test that was also a treatment, a comment can only be made post facto; the pre-test, as it includes drawing, restricts the validity of the study. If the intent was to isolate the effect of drawing on writing, the study would have been better designed with a single writing test for the control group. However, the researcher's curiosity about the development of drawing skills meant that the study needed to provide bench marks for drawing. The researcher's curiosity was satisfied; drawing skills develop fast, without much training. In the final section of the evaluation in Chapter 4, an analysis is made using the control pre-test writing against the experimental post-test writing in an attempt to eliminate, post facto, the pre-test's effect on external validity. This strategy does not, of course, eliminate the effect of

drawing itself on the control group's writing. This analysis did, however, show the nature of the greater gains made by the experimental school on both the post-test writing and on the follow-up writing.

Additional threats to the validity of the study beyond the non-random assignment and the use of drawing in both groups, as well as the use of coaching, are the interaction effects of Drawing/Writing with a host of other variables. One of the possibly confounding variables involves time of test. For instance, the control school was tested in the morning and the experimental school was tested in the afternoon when these children were clearly more tired. In this case, the invalidity works, if anything, against the experimental group. Another possible threat to validity is the difference between the three teachers who taught Drawing/Writing. The univariate analyses suggest that the fourth grade teacher was more effective than the other two teachers because his students made greater drawing and writing gains. Another possible issue in connection with validity is classroom ambience; the experimental school was more permissive, and the control school was more regimented. In this case, regimentation appeared to work in favor of the control school, shortening the time needed to focus on the task. The control children got to work faster on the timed tests.

The study attempted to deal with the issue of the lawfulness of time (Campbell & Stanley, 1963). The study assumed that the closer two events are in time, space, and measured value, the more they tend to follow the same laws. However, it was impossible to get the pre- and post-tests any closer than five days apart because of the process of Drawing/Writing. This period of time between pre- and post-tests allows rival hypotheses to intervene. Furthermore, the fact that forms A and B of the Seasonal Test, and of the Escher test may have been unequal in a variety of ways provides another aspect of the internal invalidity of the study.

In connection with validity concerns, there was, however, no sampling bias in the study; all students in each grade were used. In addition, every other case was chosen at random in the Rescore evaluation which precluded sampling bias in that instance with the within-school and between-school populations.

It is possible to conclude from this study that simple repetition in writing is the cause of the observed gains and changes in handwriting and in word-usage. Only a control situation where drawing were absent might show whether dramatic changes in handwriting from less to more intelligible, from less to more organized in terms of how the marks occupy space on the page, even including the move from printing to script occur simply through repetition. However, if this were so-that is, if the act of writing itself were responsible for such changes, regular writing programs should remediate problems with handwriting ("dysgraphia"), at least, if not problems with encoding and decoding language ("dyslexia"). That is, were simple repetition the key to success, troubles with handwriting should not persist in traditional elementary school writing programs. Furthermore, the gains in word-number, word-use and word-construction for the referred child suggest that drawing does more than impact grapho-motor skills in connection with writing.

5.5 Plan for Future Research

Beyond making sure that the assignment of populations is random, and that the tests are not treatment-like, a more general comment can be made about future research in connection with

Drawing/Writing. A valid experimental design demands that the control group experience the same things as the experimental group except for the treatment. The treatment, Drawing/Writing, is essentially a different kind of writing program. The control school should have received an equally intensive writing program, with all of the same exercises and encouragements as the experimental school, save for the five-step drawing process. The problem is that Drawing/Writing is not just writing about a drawing process; it is a complex, integrative program. As with the intact brain and its myriad functions, it is impossible, or at least undesirable to perform a "commissurotomy," slicing Drawing/Writing down the middle, for the sake of separating out its particular effects. Drawing/Writing is not training in drawing alone. It is not training in writing alone. It is training in thinking, using the two mark-making systems called drawing and writing to encourage descriptive and inferential thinking skills in complementary ways. The fundamental understanding behind Drawing/Writing is that human beings are mark-makers of significance, and that several mark-making systems used in complementary ways enhance thinking skills and, as such, are the hallmarks of powerful thought.

As will become clear in this chapter, future practical research would deal not only with improved studies using Drawing/Writing (exploring not only the usefulness of Drawing/Writing itself but other applications of drawing with writing; for instance, how does drawing as cartooning help students to read with increased attention and comprehension?). Future research would also encourage studies using other complex, interhemispheric, spatial/linguistic teaching and learning activities. In addition, in a theoretical vein, future research should involve studies that combine neurobiology, linguistics, and artificial intelligence. The goal of this combined research would be a more precise understanding of the degree to which language is inherent, and the degree to which it is acquired, as well as an increasing appreciation for the fundamental systems for ordering stimuli in meaningful ways that result, in man, in systems of language. These systems of language include the applied and performing arts, mathematics, and, of course, natural languages.

5.5.1 Design Changes

What kind of design might show the effect of Drawing/Writing conclusively? Or, does this kind of learning activity involve so many variables, and such fine-grained changes over time, including reversals, or slippage, that any kind of analysis is impossible or meaningless?

This study suggests that both statistical analyses and descriptive case studies are possible that will be meaningful, if the design, including sample designation and testing and measuring devices are appropriate and valid.

Before plans can be made for future research, the present design of the study needs modification:

Rather than using one experimental and one control school, it might be better to run parallel studies; in the experimental school, use grades 1, 3, and 5 as experimental; 2, 4, and 6 as control and to reverse this in the other school. Then it might be more possible to get at within-school differences, as well as between-school

differences. As has become clear, to test the effect of Drawing/Writing, the control groups in a well-thought-out design would write only, doing no drawing.

When using the seasons, or the Escher prints, the research design would split each class up, giving one-half one season and one print, the other half, the other season, and the other print. In this way the testing would counteract for differences in difficulty in the prints, or for affect differences, or for differences in the kinds of knowledge children had about the seasons or the prints.

Given these design changes, the study might then be approached incrementally in the following ways:

First, the experimental group would draw an object, and write about it; initially, the researcher would simply count the words. The control group would write about an object; again, the scorer would count only the number of words.

At the next level of analysis, if the results were moving in favor of the experimental school, one could count facts, and inferences. At the next level, should drawing affect writing significantly, the researcher could introduce the five-step drawing process. Would training in drawing affect writing? The procedure would be to train in the five-step drawing process, and have the experimental children write about the object, count the words, then facts, then inferences. The control group would simply write.

If this treatment should prove significant, the third level of experiment would involve training in the process of Drawing/Writing for the experimental group, evaluation of writing as outlined above, with the control group simply writing.

To facilitate future evaluations, it might be useful to write a computer program to do a WORD COUNT, a WORD SEARCH, a COUNT FACTS and at least pick up on similes, doing a COUNT SIMILES, using the words "like" and "as" as cues. If such a program were possible, then the pieces of writing could be typed into the computer, and a program could do a lot of the quantitative analysis. Humans would still have to pick up metaphors, analogies and predictions in connection with qualitative analysis, although the words "could" and "might" could be used as cues for prediction, and "because" could cue hypotheses. At this point, in the apparent absence of such programs, a human being works faster than a computer on both the Holistic and Rescore analyses.

Should the Escher tests be included in the new study design? In defense of the Escher tests the following can be said: most elementary schools do not teach analytical nor reflective thinking skills, nor do they teach them specifically in connection with the novel, the strange, or the paradoxical. One might rejoin, "Why would a school want to teach children about the novel, the strange, and the paradoxical?" A possible response is that novel things are attentional hooks, and that the world is a strange, paradoxical place. Children need to learn how to deal with what Piaget called "assimilation," that process of dealing with the kinds of new information that do not fit into any earlier systems of thought that the child may already have devised.

5.6 Recommendations

The recommendations for applied research are these: the Drawing/Writing study should be duplicated with a "pure" control school where no drawing accompanies writing; there should be further research on other cross-modal activities, like Dance/Math; there should be further integrative research on connections and parallel understandings between neurobiology, education, and the broader field of cognitive science, targeting the special needs students as the agents of change for education in general.

In the area of both pure and applied research, the recommendation is that comparisons between what appears to be essential in non-verbal as well as verbal communication may provide some understanding about the form or pattern or template for order that underlies intelligent thought. One of the questions that this kind of research might answer is how the mind moves from the concrete to the abstract. What are the mechanisms responsible for the move? What is the process of the unfolding of the spatial and linguistic forms higher-level intelligent thought takes?

5.7 Conclusions from the Research and from the Study

Research in neurobiology (Bloom et al, 1985; Changeux, 1985; Gottlieb, 1978; Harwerth et al., 1986; Haskins et al., 1978; Ottenbacher et al., 1987), and in education (Piaget, 1960, 1962; Ayres, 1974, 1977; Levine et al., 1977; Read, 1956; Freeman, 1980; Freeman & Cox, 1985; Pauls, 1988) explores and describes the ways in which intelligence develops through experience, over time.

Research in neurobiology (Rosenzweig & Bennett, 1978; Changeux, 1985; Diamond, 1988; Huttenlocher, 1988), and in education (Piaget, 1960, 1962; Papert, 1980; Perkins, 1981, 1984; Read, 1956; Weir, 1976, 1980, 1981, 1982; Brigham, 1974; Holt, 1967; Howard, 1971; Kegan, 1982; Kemp, 1987; Zinnsser, 1988) suggest that the kind of experience that develops intelligence best is exploratory learning.

Research in neurobiology (Allport, 1985; Johnson, 1988; Fox, 1985, 1988; Telzrow, 1988), and in artificial intelligence, including the use of the computer as a tool to think with, as well as a model for thought (Minsky, 1975; McCormick, 1979; Papert, 1980; Weir, 1980, 1981, 1982; Winograd & Flores, 1986) suggest that the kind of exploratory experience that is most effective for developing intelligence is cross-modal in character.

The combined research suggests that it is the cross-modal character of a highly visual activity like Drawing/Writing, that is particularly successful. Neurobiology and artificial intelligence provide an understanding, and appreciation for the appropriateness, and the power of cross-modal processing.

The idea that experience affects intelligence is not new to education (Denhoff, 1981; Haskins et al. 1978; Levine et al., 1977; Ayres, 1974; Chamberlin, 1987; Ottenbacher & Petersen, 1984; Shonkoff & Hauser-Cram, 1987; Snider & Tarver, 1987).

The idea that exploratory learning affects intelligence is not new to education (Piaget, 1960, 1962; Papert, 1980; Weir & Watt, 1980; Arnheim, 1969; De bono, 1972; Feldman, 1970; Eisner, 1982; Forman, 1985).

Even the idea of using drawing to help with writing and reading difficulties is not entirely unheard of, although this researcher could come up with only one study that dealt specifically with the possible remedial advantage of this cross-modal combination (Kasner, 1985).

It is the idea that the exploratory experience should be deliberately cross-modal in the same way that the mind's processes appear to be cross-modal for the sake of allowing, encouraging and driving the development of intelligent thought that is new.

The study examined the effect of a cross-modal (drawing/writing) activity on elementary school writing skills in connection with a variety of levels of analysis, including factual description and metaphorical reflection, using several systems of comparison, including simile and metaphor, as well as strategies for prediction and hypothesis, including negative and recombinant thinking. This study does not duplicate other research.

The study tried to determine the extent to which a cross-modal activity was more effective at teaching writing as thinking than a less complex approach to writing, in which there was no intentional transfer of meaning between representational systems. The study tried to determine the effect of a cross-modal activity on special needs children, under the assumption that these students might show the largest effect. Would drawing affect the writing performance of children who receive help outside the classroom? Would it be possible to make the argument for the general usefulness of Drawing/Writing, or of some form of drawing in connection with writing, by using the example of the special needs child? Could the "Montessori/Vygotsky argument" be used to try to change elementary education? Four years of field studies and a search of the literature suggested that it could.

The work of Vygotsky (1978) and of Montessori (1912) suggests that what works well for the dysfunctional child will work even better for functional ones. This study's strategy was to make the larger argument (for the usefulness of a combined art/academic learning activity for the regular student) from the smaller one (the art/academic activity is useful to the special needs child). The goal was to be able to demonstrate that writing that reflects on drawing could be used to impact thinking skills in positive ways in a broad range of children because it did so for the language-troubled child. Because drawing was involved in connection with writing in both schools (even though its inclusion may be one of the flaws in the study design), it is possible to conclude that drawing, at least in some form, impacts writing in positive ways for these referred children. It is for the very reason that these children do not make gains as quickly as their peers that they are sent out of the classroom for special help. In this study, the referred children made appreciably greater percentage gains in writing in connection with the simple generation of words than their non-referred classmates.

Analyses of the data suggest that the study did not have to resort to the Montessori/Vygotsky argument, after all. It was the non-referred child in the experimental school who excelled in a statistically significant way in connection with writing in the study, while the referred child made gains. Despite the absence of a pure control group, the study supports the results of previous pilot studies and of the neurobiological and educational research; a combined spatial/linguistic activity is effective in encouraging the higher psychological

functions of attention, memory and logical operations, as all three are expressed within the linguistic continuum that includes drawing and writing.

There is, to date, scant support for this kind of effect (Kasner,1985).

5.8 The Problem and the Purpose Revisited: Review of the Tactics

The problem was a puzzle. Why did an activity that had grown organically over time, called Drawing/Writing, work? The puzzle proved to have two pieces; one was cross-modality, and the other was the effect that success in spatial information processing has on less effective verbal processing skills.

The dissertation addressed three purposes: the first was to learn about how the brain works; the second was to describe educational strategies that paralleled these understandings and to suggest new ones; and the third was to see whether the already existing activity Drawing/Writing might fit into the emerging picture of what constituted effective teaching and learning activities.

Educational strategies exist that have drawn heavily upon the tactics mentioned in Chapter II. These strategies and programs provide training in a variety of forms of symbolic representation; they make use of children's mark-making skills to help them retrieve, process, and de-bug information; they involve children in complex learning tasks which stimulate vision, focussing attention on both non-verbal and verbal information, and encouraging exploration; they introduce children to varied problem-solving experiences that are likely to be rewarding. These strategies or programs include: a developmental arithmetic program promoted by Spitzer (1961) during the 1950s and 1960s; a science inquiry training program developed by Suchman (1962) in the 1960s; whole language programs introduced by Sylvia Ashton Warner (1963, 1964) and developed by others in the 1960s, 1970s and 1980s, and a drawing/writing program conceived and field-tested by the researcher (Sheridan, 1985-89) which is presented in this study. These four programs draw upon two or more of the tactics listed at the end of the neurobiological research in Chapter II. Only one of these four initiatives - the whole language program including process writing - can currently be observed in elementary schools. Drawing/Writing is making initial progress; it is part of a private middle school English program; it is part of a high school Spanish program; it is part of an interdisciplinary course called "Styles of Thinking" designed by the researcher and taught in a senior high school elective program, qualifying for credit in Fine Arts, English, and Philosophy and Religion. It is used in one nursery school (Santoro, 1989).

5.9 How Drawing/Writing Jibes with the Research

The research suggests that the mind works by using multi-sensory systems of comparison, where higher levels of refinement result in symbolic representations that take the form of a variety of languages, including the visual, the verbal, and the mathematical. Drawing/Writing models this innate process and makes it conscious in connection with language systems. Like the visual system of the brain, Drawing/Writing works by a kind of cross-modal pattern-matching between images and words. The theory and practice of

Drawing/Writing sets a premium on training in analytical comparisons between systems of representation because such training is recognized as being like what the brain has evolved to do to navigate effectively in the world.

To make relevant analytical comparisons, there have to be at least two sets of information. The theory and practice of Drawing/Writing presumes that the more comprehensive and precise the sets of information, the more complex and valid the comparisons and the inferences drawn from the comparisons will be. Furthermore, embedded in the theory and practice of Drawing/Writing, is that the child, as a multi-sensory system, needs to be allowed to learn in a bodily, or kinaesthetic way about the world. Being allowed to become familiar in a directly physical way with a knowledge base is one antidote to dissociated learning. The way children learn to use language to acquire knowledge is a measure of intelligent thought.

If language is to be used as a test as well as a measure of intelligence, it is important to equip children in personally satisfying ways with habits and strategies and constructions of thought that will encourage intelligence. Connections make connections. The kind of activities that connect the young mind to learning affect and reflect neural connectivity. (The ability to compare knowledge bases leads to higher level thinking skills.) It appears that Drawing/Writing helps to develop satisfying habits and strategies of thought.

Part of the reason for the success of Drawing/Writing is the ways in which it impacts vision and attention.

In an article titled "Changing Views of Attention and Automaticity," Kahneman and Treisman write, "The classic question of attention theory has always been whether attention controls the buildup of perceptual information, or merely selects among the responses associated with currently active percepts. In the terms of our (computer) analogy, the question is whether focusing of attention on an object file facilitates the accumulation of information IN it, the dissemination of information FROM it, or perhaps both" (Kahneman & Treisman, 1984, p.55).

This study suggests that a combined drawing/writing process impacts attention by facilitating both the accumulation and the dissemination of information. Drawing/Writing creates object files, and after opening them, puts information in, and takes it out again, in cross-cued, workload-sharing ways.

Drawing/Writing incorporates a variety of attentional ploys; one has to do with strongly contrasting marks made by drawing with magic markers. The marks are visually compelling on a basic neural level. The marks have meaning, as well. Meaning engages the brain on levels far above the neural levels that fire for strong light-dark contrast and line-attitudes.

Vision is one of the primary mechanisms of attention in human beings. Once attention has been aroused visually, it may be sustained, by continuing to look at the selected stimulus as novel, different, or strange. Drawing/Writing is visual training in maintaining newness, strangeness, difference through personal production. Drawing/Writing thus prevents habituation by ensuring novelty and unexpectedness. It appears to resist automatization in visual processing. The student may be learning to maintain something called "signal value" by saying to himself something like: "That is not just any old rock, that is a geode. That rock contains garnets in schist!"

Drawing/Writing teaches visual discrimination. The contour drawing sets the child up for a simple figure/ground discrimination task. But the task gets more complicated with each step of the drawing exercise, and at each step of the writing exercises. What starts as an ability to see where the object begins and ends, turns into an increasingly complex visual task. What shapes does the object look like? What areas are light and dark? How can the lights and darks be blended so that the drawing looks "real"? How can all of the tiniest details be added to make up the "perfect whole?" Ultimately, the discrimination tasks involve the ability to choose and to compose the most important features of the object into a new whole, creating a new figure and a new ground. Each drawing and writing step is training in discriminatory ordering, achieved through deliberate selection.

Drawing/Writing is training in calculating qualitative differences and in maintaining flexible expectations. By encouraging the child to look at an object from many different viewpoints, the child, in a Minsky-like attentional way (1985), is encouraged to develop the ability to calculate differences, and to have flexible expectations. The fifth Drawing/Writing step, the composite abstraction, is deeply concerned with calculations, corrections, and hypotheses. Hypotheses have to do with what could be, and thus take the child into the realm of formal operations. Research with Drawing/Writing at the elementary level may reveal the ways in which young children are capable of formal operations by encouraging them to think about possibilities in concrete ways - that is, by drawing composite abstractions. Drawing/Writing moves the perceptual analysis of attributes through a hierarchy of increasingly abstract levels. The move is from the contour drawing, to basic shape, light-medium-dark, the "perfect whole," the composite abstraction.

Drawing/Writing focusses on salience. Drawing/Writing is built on the supposition that we learn to attend to the relevant, and that we store salient information in appropriate files. Drawing/Writing works on the premise that the stored features are not only "pictorial" in the largest sense, but that they are also linguistic, in the largest sense. Children need to learn to tag the salient characteristics of the object, which they have recorded in their drawings, with language, to facilitate general kinds of retrieval.

In Drawing/Writing, the actual representations, the drawings and the writings, have coordinate or spatial significance (having to do with location of the object being drawn on x,y,z axes in space), and categorical significance, having to do with the kinds of "where?" and "what?" descriptions that are coded in words in sentences. This kind of double representation in Drawing/Writing is very much like Kosslyn's coordinate and categorical systems; it is also reminiscent of Luria, and of Churchland, LLinas, Gazzaniga, and Minsky. Drawing/Writing appears to operate like the mind as it constructs its internal representations, mapping language onto space.

Beyond vision and attention, Drawing/Writing impacts logical operations. This in itself is attentional. Douglas Hofstadter suggests in his book *Godel, Escher, Bach: An Eternal Golden Braid*, that the main question of intelligence has to do with how things are alike and how they are not alike (Hofstadter, 1979). Drawing/Writing focusses on analysis by comparison. The student is constantly writing about how his or her drawing is like or not like the object, or the student is writing about what the object itself is like and not like.

This kind of analysis by comparison sustains sensations of novelty. Novelty impacts attention. The question, "How is this object new and different," and "How is this object like other objects?" is a fruitful one for teasing out the novel and the unexpected. Attention can be sustained at increasingly sophisticated levels by using systems of comparison.

Most importantly, Drawing/Writing may create a conditioned bond between drawing and writing, and, in doing so, may increase information processing capacity for the secondary stimulus, writing, which may also be the more difficult task. If a child is able to attend to drawing, research suggests that the stimulus of drawing may condition the child to attend to writing. Research suggests that drawing may lower the sensory threshold for attending to writing, making the more difficult cognitive task easier. Is it possible that Drawing/Writing provides child, including those children who are called dyslexic, a light work load in connection with drawing that primes neighboring hemispheric areas for language? This is a provocative question. It can be tested. Previous research with Drawing/Writing suggests that dyslexic boys find the task of writing easier when it follows drawing (Sheridan, 1985-89).

If Drawing/Writing trains students to discover and to express meaning, then Drawing/Writing should be an appropriate discipline for learning and memory. Previous research in Drawing/Writing (Sheridan, 1985-1989), using what are called Memory Drawing and Memory Writing, shows that students who have done Drawing/Writing have a precise and comprehensive memories of their object. Their interest level was high at the time they drew, and wrote. They had learned strategies for extracting and for synthesizing meaning.

Mature artists go at the meaning-making task using automatic processes, just as mature writers go about their work, using automatic processes. Research tells us that once skills become learned, or automatic, resources for further information processing become available. Drawing/Writing should allow children to speculate more about meaning, and less about how they are going to express it.

Being able to conduct effective searches for meaning in drawing will go beyond influencing children's writing skills. The ability to search for and to find meaning successfully impacts a lifetime of thought. Drawing/Writing is an activity that is important, pertinent, significant to children. Their marks, whether as drawing marks or writing marks, mean a great deal to them. Because they have meaning, children's marks help them to make the world significant.

Drawing/Writing is an integrated visual/attentional thinking and learning activity. Drawing/Writing avoids dichotomizing hemispheric functions in connection with voluntary or involuntary orienting reflexes (Parasuraman et al., 1984). It appeals to both hemispheres in complementary ways. Drawing/Writing presupposes the corpus callosum. Its slashed grammatical construction mirrors the fact that both hemispheres are intimately and densely connected.

The implications of the neurobiological research for the activity called Drawing/Writing can be summed up in these ways:

Drawing/Writing is a spatial/linguistic activity. It is interhemispheric, or whole mind. It works like the brain works, to construct knowledge.

Drawing/Writing is of general epistemological usefulness to students. It provides two powerful ways to know. Drawing/Writing makes sure that thinking skills keep developing, and it puts no ceiling on them. The only expectation in Drawing/Writing is that there can be a more efficient, connected system for thought.

Drawing/Writing approaches knowing from a low-level neural point of view, and from an upper level point of view. The activity makes use of marks of strong contrast to tune up the visual/attentional system, and it uses meaning to stimulate the brain at higher levels of organization.

Drawing/Writing is a multi-storage approach to information as image and as word, and it results in long term memory.

Drawing/Writing is a visual, attentional, complex task that should affect brain morphology and function in positive ways. It should increase the capacity for problem solving by exercising these abilities.

Drawing/Writing is sensitive developmentally. It starts where children are as mark-makers, and as linguists. It uses oral instruction and drawing to make meaning. Drawing/Writing recognizes that children are symbol-makers who are adept at imitating the spoken and written word.

Drawing/Writing recognizes that, beyond the age of 11 or so, after the stabilization of many of the sensory-motor systems, thought is a dynamic continuum, with resting periods. Drawing/Writing builds periods of grace into the growth process. It does not assume that any child will do the same thing, like writing or reading, at the same time as any other child.

Drawing/Writing is training in an orderly search for meaning. If the way in which stimuli are perceived affects brain organization, an orderly, analytical whole- to parts- to whole approach may impact the brain's ability to categorize, to organize and to generalize in positive ways, especially if the emphasis is on relevant comparisons and on logical relationships.

In addition to the neurobiological research in support of the activity, Drawing/Writing, there are good explanations from pediatrics and from education, including early enrichment programs and from developmental stimulation programs, as well as from remedial language programs, to explain why Drawing/Writing, as a multi-sensory, exploratory, open-ended, esteem-building, starting-with-what-the-child-can-do activity, works as well as it does for a broad range of children.

Drawing/Writing may be a remedial device in connection with writing and reading. Drawing is an engaging activity for attention deficit children, providing an area of success for language disabled children (Sheridan, 1985-1989). Training in drawing may cause neural drift from one functional area to another dysfunctional area in an enabling way. There may be the possibility of a neuro-biological processing link between drawing and writing. As Dr. Albert Galaburda wrote in answer to a letter from this researcher on this issue, "Therapy is an empirical issue. It is less theory-bound than practice-bound. One uses a treatment because it works, not because it makes sense to use it. On the other hand, one tries out new forms of treatment because they make sense, hopefully with the clear idea that it will be stopped if not empirical data are found to support their effectiveness (Galaburda, in correspondence, February, 1987). Both the theory and practice of Drawing/Writing make sense.

In a most general sense, allowing a student to do what human beings like to do is a sound attentional ploy. Children like to draw. If there is something valuable about the kind of training in drawing that affects the successful development of written language, then the general attentional ploy of letting students do what humans like to do and seemed programmed to do makes imminent educational sense.

Letting people do what they like to do impacts thought. Research supports the fact that emotion and cognition are closely linked (Rosenzweig & Bennett, 1978; Gazzaniga, 1985, 1988; Kegan, 1982). How a person feels about what he or she is doing has a great deal to do with whether he or she will pay attention to it. Whether the student pays attention or not has a great deal to do with whether that student will be able to process information in the ways that are called learning.

One of the most powerful ways to sustain interest is to center the activity on the self. If the activity allows personal production and involves a highly visual, attentional approach, as well, the educational ploy may be triply effective. This appears to be the case with Drawing/Writing.

5.10 Predictions

Probable consequences of using Drawing/Writing on a regular basis are as follows:

In the resource room, Drawing/Writing will prove useful as a teaching strategy for developing language skills, providing alternative strategies for self-expression and self-definition in the language-disabled child.

In the regular classroom, Drawing/Writing will permit mainstreaming of language-delayed or troubled children, preventing removal, and avoiding some of the subsequent emotional problems of removal. Should resource room teachers be cut-back, Drawing/Writing allows the regular classroom teacher to address many of the same needs, including those of the talented and gifted, in integrated ways.

More learning and less discipline will go on in the classroom where a wide range of children are actively engaged in learning. The students will be trained in skills that are easily transferrable to other areas. Children who practice Drawing/Writing may be more able to write across the curriculum (Zinsser, 1988).

In a room where an activity like Drawing/Writing is going on, the challenge of education is shared by students and teachers. Both teachers and children are empowered in the process. In an effective classroom, both students and teachers should be growing (Devries, 1987).

Drawing/Writing may encourage the development of reading skills as well as writing skills. If, at the outset of educational language arts programs, all children are asked only to read what they themselves have written, fewer children may have trouble with reading. Should a child not yet be able to read, they can "read" their own drawing and word-related mark-making, and be, for all intents and purposes, on an equal footing with the more advanced children in the class who come to school able to write and to read.

Because most children can draw, Drawing/Writing puts the minority child on a par with the more linguistically able children in the class. Whether the child speaks another language, or comes from a home where language is under-used, or abused, the child who is allowed to draw can have some immediate success.

As a model for an activity that appeals to the whole mind of the child, Drawing/Writing is an appropriate learning activity for children with a variety of thinking styles. As such a model, Drawing/Writing may be used in grades K-6 to develop basic skills having to do with description, analysis and inference in connection with writing and reading; in grades 7 through 9 to hone descriptive and reflective skills while focussing on patterns among ideas; in grades 10-12 to ground understanding in an appreciation for the interconnections between ideas.

Drawing/Writing appears to have educational usefulness that is not limited by such variables as age, sex, I.Q. or socio-economic status. The human ability and desire to make meaningful marks transcends such specificity.

5.11. Profile of a New Approach: "Neuro-Constructivism"

Some of the most cogent contributions to a sensory knowledge-based theory of early education are neurobiological. The contributions have to do with enrichment, vision, attention, and cross-modality. If these contributions from neurobiology are combined with parallel understandings in education, it should be possible to design a program that integrates both sets of understandings. A logical name for such a program is "neuro-constructivism." Neuro-constructivism suggests that interactive learning constructs both brain and mind.

Neuro-constructivism would be in agreement with certain aspects of 19th century medical, and educational thinking about the education of the deaf, the mute, and the deficient developed by Itard, and Sequin (Montessori, 1912; Lance, 1976). It agrees with the twentieth century Russian medical and educational thought propounded by Luria (1979) and Vygotsky (1978). It is in accord with Maria Montessori's thought (1912). Neuro-constructivism also appears to be in line with several aspects of Piagetian theory (1955/1959). Taken together, this series of connections suggest that the work of Itard, Sequin, Vygotsky, Luria, Montessori, Piaget, Orton (1937), and Lowenfeld (1964), culminating in the present-day philosophy of the Italian preschool director, Loris Malaguzzi, forms a tradition. This tradition could be called "What's Good for the 'Deficient' is Even Better for the 'Normal,'" or "Special Education in the Regular Classroom," or "Neuro-Constructivism," or "The Thinking Child."

The common denominator of this ad hoc tradition is an acknowledgement of the usefulness of touch to knowledge, most particularly in the young. An appreciation of the general usefulness of the kind of knowing that is informed by touch brings these papers full circle to the definition of art provided in Chapter 1. When taken together, strands of neurobiological and educational theory provide strong arguments for the everyday inclusion of the arts with academics for the sake of encouraging the kind of personal knowledge through literal and figurative approaches to touch that are the basis for effective mature thought. The kind of knowing that is informed by touch should be an integral part of curricula designed to encourage thinking skills in children.

5.11.1 Tenets of Neuro-Constructivism

The research and the study recommend that the following be tenets of a "neuro-constructivist" approach to education; such an approach operationalizes an intertheoretic integration between neurobiology and education:

5.11.1.1 Active Problem-Solving Causes Brain Growth

Let the child take responsibility for brain building. Education should provide visually arousing activities. Teachers should underscore feelings of control and self-esteem. Teachers should work from what the child knows and is good at, to what the child can know and can be good at. Children learn to scaffold learning skills.

5.11.1.2 Attention is Both Automatic and Self-Regulatory

Teachers can design effective attentional activities, including those that are effective with children who are on attention-remediating drugs (Shaywitz, 1984). Good learning activities may provide a nonpharmacological approach to learning, impacting central nervous system imbalances and morphology in positive ways. Greater central nervous system elaboration may help to mitigate attentional deficits in general. The research suggests that an enriched environment can cause cortical, and possibly remedial growth (Telzrow, 1988).

5.11.1.3 Children Move In and Out of Risk

Remediate before it is necessary. Children's brains are dynamical processes. At some point in time, every brain is at some critical stage, at risk for developmental lags, dysfunction, or damage (Brazelton, 1969; Denhoff, 1981; Diamond, 1988; Haskins, 1978). It may be possible to tune up a weak or dysfunctional attentional, emotional, or visual system through carefully designed educational activities.

5.11.1.4 Learning is a Lifetime Possibility from a Neural Point of View

Education should include curricular activities that have inherent appeal and lifetime usefulness. Education should honor the regular child as well as the special needs child and the talented and gifted child. It should honor the adolescent as well as the pre-school and elementary age child. In connection with language use and general thinking skills, the adolescent, too, is growing and changing (Kuhn, 1979).

5.11.1.5 The Immature Human Central Nervous System is Plastic

The human central system is plastic; it is trainable in habits and strategies for thinking that may stabilize as habits of thought. Teachers should not sell short not give up on the slower student. Early training may reap intellectual benefits later.

5.11.1.6 The Young Human Central Nervous System Represents Thought Using Symbols

If the young human central nervous system makes and uses a variety of non-verbal and verbal symbols to represent experience, then experience and practice with a variety of symbol systems should be encouraged. Educators must recognize, allow, and prepare the way for children to grow comfortable and skillful with a variety of symbol systems.

5.12 The Theory of "The Thinking Child"

It is possible to discern in the preceding research an ill-defined but nevertheless powerful series of understandings about language acquisition that may have fed into the epistemology called constructivism as well as into a language program called process writing. Both approaches to knowledge regard writing as a natural development in children who come to school equipped to think in powerful ways (Ashton-Warner, 1963; Graves, 1983; Calkins, 1986; Devries, 1987).

What would a new curriculum look like that focussed on thinking and writing skills? A neuro-constructivist curriculum called "The Thinking Child" would resonate with the philosophy of the Italian constructivist, Loris Malaguzzi, founder and director of the Italian preschool programs in Reggio Emilia. Like Malaguzzi, "Thinking Child" educators would give the child a "special identity," and champion the child as someone capable of "big gestures, and big thoughts."

In a lecture at the University of Massachusetts (December, 1988) Malaguzzi suggested, "Molto piu." "Much more" is what should characterize educational expectations for children. Like Vygotsky's (Luria, 1979, p. 53), the new curriculum would start where children are. The goal, like Vygotsky's, would be maximal use of language. As Vygotsky wrote, language "play(s) a decisive role in the development of higher psychological processes" (55). Educators espousing the new curriculum would expect "molto piu" from children as linguists in the broadest sense.

Educationally, Malaguzzi observed, children are confined to "little dimensions;" there are little expectations for the child. Because teachers are afraid to make mistakes themselves, they are afraid to let children make them. According to Malaguzzi, this fear of risk-taking blocks both teachers and children's mutual growth (U. Mass. lecture, 1988).

Malaguzzi adds, "Children's intelligence is in the tips of their fingers...teachers must learn to use their hands (and let children use their hands) in more complex ways" (U. Mass. lecture, 12/2/88).

This recognition of the importance of touch to knowing is central to an understanding of the applied and performing arts as ways of thinking. This recognition would be central to the new curriculum, too, resulting in the integration of the arts with academics. The kind of knowledge that is informed by touch is important to human thought initially, and continually. Minds need to be connected. The feel of the thing, the knowledge of what it can do, is at the basis of powerful abstract thought. The distinction between concrete and formal operational thought need be neither divisive nor perjorative. Marvin Minsky writes about the tendency of the mind to "thingify," suggesting that formal thought works with ideas as if they were things (1985). Minsky

adds, " Thus reflection is thought raised to the second power. Concrete thinking is the representation of a possible action, and formal thinking is the representation of a representation of a possible action...In terms of their function, formal operations do not differ from concrete operations except that they are applied to hypotheses or propositions (whose logic is) an abstract translation of the system of 'inference' that governs concrete systems" (Minsky, 1985, p. 236). Drawing/Writing is practice in first-power thinking that deals with inferences governing concrete systems. It is preparation for that abstract translation into second power thought, and it may be engaged in at that higher level.

Drawing/writing may be particularly effective in the regular elementary school classroom as a writing program at this point in American educational history. A curriculum like "The Thinking Child" may be effective because many contemporary children have never learned to use their senses critically, especially touch. They have become disconnected from their own thinking. A theory of education like neuro-constructivism and a practical program like "The Thinking Child" may provide remedies for inabilities to learn through the constructive acts of sensory exploration. Children who are raised with television, videos, "tune boxes," and computer games may have mental images that lack depth, texture, meaning and emotion. These children may be bereft of the strategies necessary to construct depth, texture, meaning and emotion.

The modern child has been described as passive, hesitant, non-verbal, adult-dependent. The child is viewed as a receptacle. Just as there are therapeutic programs that take children back to crawling, to fill in some developmental omission, the five-step drawing process may, in somewhat the same way, take the child, step by step, through analytical processes that should be inherent in the young mind when knowing is an integrated act. A film showing 4, 5 and 6 year-old Reggio Emilio children drawing, painting, or sculpting, revealed the focus, concentration, and integration of their acts of knowing. Without touch, children can not construct a multi-dimensional world.

"The Thinking Child" provides instruction in the skills of drawing, and of writing, in incremental ways, a step at a time. Each step is an end itself. Each drawing can be complete and powerful. Each step in the development of the skill of seeing allows for self-expression. Skill and knowing are thus continually combined. Complete, or "perfect" skill mastery is not a precondition for self-expression. Skill mastery, at some level, is, however, understood to be critical to effective self-expression.

"The Thinking Child" provides guidelines for designing activities that are child-timed, child-controlled, child-judged. The process lends itself to individualization. As an example of this kind of individualizable process, Drawing/Writing includes "the new hieroglyphics," a self-made symbol system that may be of general usefulness to all preliterate children, or it may be of especial usefulness to the language learning disabled child, as a transitional object on the way to the complete abstraction of written language. Drawing/Writing and "the new hieroglyphics" (Sheridan, 1985-1989) make imminent sense within a Ferreiro-like analysis (1979) of the psychogenesis of writing .

"The Thinking Child" provides a solution to the problem of evaluation by providing two indices for judging the child. The important aspect of this judging is that the child, informally, does it himself, with each drawing, and with each piece of writing. Judging is self-regulatory. Repeated reflection on drawing, in

response to the questions "How is your drawing like, and not like, the object?" builds the experiences of self-evaluation, and of constructive conflict (Piaget, 1960; Hofstadter, 1979) into the Drawing/Writing process.

"The Thinking Child" supports the conviction that, in connection with the larger world of the parent, or school, the child be judged only against his or her own drawing and writing, at any stage of development. Drawings can be evaluated for increasing realism, and/or coherence or aesthetic appeal; writing can be evaluated for increasing accuracy, and flexibility, and fluency in description, and in reflection (which could be called creativity). The use of words in simile, metaphor, analogy, prediction, hypothesis, flight of fancy, or logical conclusion all provide bases for evaluating levels of thought. Drawing and writing can be used in these ways to give some indication of where the child is intellectually. This means that the teacher and the child must learn to appreciate the child's ability to get close to, and to move away from a knowledge base. The evaluative question is, how good is the child at metacognition, at thinking about his thinking, at learning to learn? Initial drawings, and pieces of writing, and final ones, during any Drawing/Writing session, comprise the pre- and post-tests of the system.

"The Thinking Child" takes two bits of information from neurobiology that are useful in designing learning activities. One is the individuality of each child because of what is called the "irreproduceability" of the central nervous system (Changeux, 1985; Rosenfield, 1988). We should expect difference, not sameness in students. A second is the cross-modal nature of thought (LLinas, 1988; Kosslyn, 191983, 1984). The conclusion is this; if thought is cross-modal by nature, education should be cross-modal by design. Cross-modality is operationalized in interhemispheric, or spatial/linguistic activities. These kinds of "whole mind" activities work like the mind, and are, therefore, effective in developing mind (Levy, 1979).

"The Thinking Child" provides a way for the child and for the teacher to operationalize constructivism. The constructivist teacher's task is to help children develop intellectual skills, including interest, and undivided attention. Rather than trying to take exclusive advantage of spontaneous interest, devising a series of activities tailored to each child's perceived native interest, "The Thinking Child" suggests that children can learn that interest and attention are habits of thought. Although Howard Gardner suggests that the teacher should provide "crystalizing experiences" to develop what he calls multiple intelligences in the classroom (Gardner, 1983), the approach appears impractical. The approach might, in the long run, even prove counterproductive. An interdisciplinary learning environment allows and encourages multiple intelligences through practice and through choice. Educators who support "The Thinking Child" would be canny enough to conclude that the arts provide choice and practice in a wide variety of thinking skills, where attention and interest can be high. "The Thinking Child" follows the Paideia principle (Adler, 1984), constantly encouraging children's self-determination.

Other activities can be designed like Drawing/Writing by using the rule of thumb that they be spatial/linguistic, or non-verbal/verbal, or art/academic, or first order symbol/second order symbol processes, that can be individualized. The puzzle for the teacher to solve continually is how to make connections. The larger curriculum is, by extension, interdisciplinary - or as Malaguzzi describes it, complex horizontally.

Because cross-modality enhances interest, affect, and memory, this proscription for constructivist activities has larger ramifications.

It appears that no one has suggested that drawing and writing be used educationally as mutually accessible systems of language that communicate through "translation rules." Beyond the translations rules inherent in "langue" (Scinto, 1986)- the language that orders information below and above spoken and written language- the designer of "The Thinking Child" has devised a set of arbitrary translations rules by asking questions that drive the writing that is reflecting on drawing into inferential thought. These translation rules insist upon comparisons, and the rules mirror the descriptive/reflective inner human monologue that is uttered, and understood, first, in drawing.

"The Thinking Child" rests on the belief that thinking is a natural activity, and that it is a skill that can be developed. Like oral language, gesture, play, drawing and writing - thinking develops, and is learned.

Thinking is what Malaguzzi's complex, modern child needs to be able to do well. This child needs to be able to think fast and well, to adapt. He needs to develop Piaget's intellectual autonomy. He needs to be able to represent knowledge accurately and logically, in a variety of ways.

One of the theories behind "The Thinking Child" is that "the spontaneous activity of independent thought" that Piaget so prizes in the child can be structured in open-ended ways, allowing for error, and for self-correction. This open-ended structuring allows the child to build mind through art-related activities. Drawing/Writing uses drawing to engage the child's spontaneous interest. In Drawing/Writing, the errors and conflicts so important to Piagetian theory about how and why children think, are found in distortions and omissions in drawing, or in meaning expressed in writing that is perceived by the child to be wrong or incomplete. Error and conflict are implicit in Drawing/Writing, not only because young students are beginners in both kinds of mark-and-meaning-making activities, but also because, in the most general sense, Drawing/Writing underscores the approximate nature of any symbol system. The child-the natural artist-already knows that there are several possible ways to describe things. Things can be talked about, sung about, danced about, drawn about. Drawing/Writing allows children to explore and to express this understanding, allowing them to understand, as well, that no single dance or song can tell the whole story.

Embedded in "The Thinking Child" is the idea that two symbol systems, if they are used in complementary ways, are better than one, to get close to and to gain distance from a knowledge base. Part of the deep understanding of Drawing/Writing is that writing holds the promise for the preliterate child of being as readable as drawing. Writing will be a first-order symbol system, too, standing for the thing itself, just as drawing does. Writing will be as intelligible as drawing and the marks in general will carry more meaning, in economical ways.

Mastering the truth by oneself is the kind of mastery that will transfer (Vygotsky, 1978). "The constructivist child will be able to travel and explore by himself" (Malaguzzi, 1988). "Through drawing, the child discovers that the world belongs to him, and that he belongs to the world" (Malaguzzi, 1988). Drawing-like, writing-like systems are two useful ways to travel, to explore, and to belong. As Piaget writes, "Only this (spontaneous activity), oriented and constantly stimulated by the teacher, but remaining free in its

attempts, its gropings, and even its errors, can lead to intellectual autonomy...It is in learning to master the truth by oneself at the risk of losing a lot of time and of going through all the round-about ways that are inherent in real activity" (Piaget, 1948/1973, pp. 105-106).

5.13 Conclusions

A literature search has been conducted to try to explain the success of a regular classroom activity called Drawing/Writing. Brain research provides several possible explanations for this success, including cross-modality and the remedial usefulness of spatial problem-solving activities. As outlined in Chapter 11, the literature search provides two assumptions; one relates to cross-modality; and the other to the general usefulness of remedial strategies. There are developmental parallels between the slower learner and the young learner. Drawing/Writing reflects these assumptions and incorporates these explanations.

Drawing/Writing appears to model how the brain works in general ways. Other feasible explanations for the success of Drawing/Writing are provided by the larger combined field of cognitive science, including neuroscience, artificial intelligence, anthropology, linguistics, and psychology. It appears that the mind knows and learns in densely interconnected, modular, selective, self-generative, self-constructing ways. The overall intent of the mind is to interpret inner, and outer experience, using a battery of cognitive strategies that are both spatial and linguistic. Educational activities that model these innate strategies should be effective.

The research suggests that drawing may be used in three ways educationally; drawing can be used to move a broad range of children through increasingly abstract levels of symbolic representation; drawing can show children how to dissect and use the analytical process; drawing can be used as an attentional hook, helping children to learn how to give sustained consideration to a body of data.

If drawing is to be used educationally, it is important for educators to be knowledgeable about children's drawings. To quote Norman Freeman, "the child knows more than he can show." It is apparent that the young child, as a draw-er, not only knows more than he can show, but knows more than he cares to show. Young children use drawing more schematically than older children. Their intent is not to communicate the idea, but to think about it (Feinberg, 1989). Educators must be respectful of developmental considerations if they attempt to combine drawing with writing with children. The motives of the third grader may be very different from those of the kindergartner. For the older child, decentering and perspective-taking are relevant while they may not be to the younger child (Feinberg, 1989). For the older child, a realistically detailed drawing that is comprehensible to the observer is a common goal. This goal is often that of teachers who do not themselves draw.

Both neurobiological and educational research support the suggestion that the relationship between spatial and linguistic symbol systems is intimate. Neurobiology clearly suggests that language is a transformation of a spatial system, while educators are coming to understand that the relationship is, at least, not a dichotomizing one. Recent brain scans reveal that mature reading skills do not depend upon phonetic linguistic analysis (Rubin on Michael Posner, 1989) but involve skills that could be more fairly described as

spatial. Researchers into the "psychogenetics" of writing add that early attempts at writing are not a transcription of spoken language, but are much more truly an off-shoot of drawing (Ferreiro, 1979; Vygotsky, 1979). In fact, teaching writing as if it were a transcription of spoken language may be troublesome for many children, creating learning disabilities (Ferreiro, 1979).

A search of the literature on the history of writing suggests that drawing is part of the prehistory of writing (Montessori, 1912/1964; Vygotsky, 1978; Luria, 1979; Ferreiro, 1979; Scinto, 1987). Except for the work of Joan Kasner (1985), who used children's drawings as a mnemonic device for learning vocabulary, there does not appear to have been an overt and deliberate connection of training in drawing to the development of thinking expressed in writing. Although a search of the educational literature reveals the usefulness of drawing in education (art education, early education, the sciences), and in art therapy, and in subjective or projective psychological assessment (Goodenough, 1926; Koppitz, 1963; Rorschach, 1922/1942), drawing has not been incorporated as a formal discipline in elementary education. Drawing as idea-mapping has been integrated in writing programs which focus on writing as a process. (Graves, 1983; Calkins, 1986; Rico, 1983). As mentioned above, drawing, in one instance, was discovered to be useful to dyslexic students in acquiring vocabulary (Kasner, 1985). However, an extensive search of educational literature does not provide direct, general support for the usefulness of drawing to developing mind, nor specific support for the useful relationship that may exist between drawing and early and/or maturing writing skills.

If the relationship between drawing and writing is developmental, and functional-if oral language, symbolic gesture (including play), drawing, and writing do describe a continuum, as the research suggests-training in drawing should be an appropriate activity to connect children with the process of writing.

The question educators need to address is whether writing can be understood, initially, as a first-order symbol system. If writing can or should be understood as an extension of the drawing process, might this kind of understanding keep writing close to - keep it touching meaning - never letting it move away into unintelligibility? There is agreement that eventually writing becomes a first-order symbol system (Montessori, 1912/1964; Vygotsky, 1978; Ferreiro, 1979; Scinto, 1986). It may be possible, educationally, to start where the writing and reading process ends, if we can accept drawing as an integral part of children's acquisition of written language. This study suggests that "yes" is the answer to the questions asked above. Drawing can be used to encourage the understanding that writing is a first order symbol system, standing for the thing itself.

Drawing/Writing appears to provide training in how to interpret experience effectively, using visual/spatial, and linguistic means. Drawing/Writing may help to develop a complex, interconnected, efficient mind. The research maintains that this kind of thinking will be reflected on a neural level.

5.14 Speculations

Speculations encouraged by the preceding research range from specific questions that can be explored, to larger philosophical questions.

One of the specific questions of the study is whether Drawing/Writing provides a remedial approach to writing. One of the intents behind Drawing/Writing is to provide a remedial approach to language even before it is necessary for children who may be at risk for language-related problems. The supposition is that, if Drawing/Writing were used K-6, many potential developmental writing and reading problems might be remediated before they could become pronounced enough to persist. The study also suggests, based on the research, that an area that is functional may impact a dysfunctional area. In the case of a congenital or genetic defect, an activity like Drawing/Writing may provide a processing link, where the successful area, like drawing, may impact an unsuccessful area, like writing or reading. The general supposition in this instance is that one method of encoding and decoding information may prime or remediate another. The treatment makes the explicit suggestion that writing is simply a more abstract form of drawing. If a child with brain language-related anomalies understands this, that child might be able to process language in an area that is generally used more exclusively for spatial operations.

The verbally powerful child appears to improve his or her drawing skills dramatically, over time, with little or no instruction. It is difficult to get at the level of development of the thinking skills behind this change in drawing skills. From the researcher's previous teaching, it is evident that children with less competent verbal skills can draw with a high degree of sophistication. The question is whether that level of sophistication can be used to impact another. Another specific question that arises from the research is whether we can test for intelligence in spatial as well as linguistic ways that are meaningful. Is it possible to devise ways to use spatial tests to evaluate changes in levels of thinking skills? This study suggests that, with the right design, this kind of testing should be possible in an organic, non-invasive way by building the testing into regular classroom activities that are used longitudinally. The kind of integrated testing that is both spatial and linguistic might eliminate the negative side effects of dissociated testing situations. Drawing/Writing could be used as a teach-test-teach approach (Feuerstein, 1981), measuring a child's ability to learn over time against his or her own initial performance, and in this way allowing children to show their intelligence in non-verbal ways, where changes are often dramatic and are therefore extremely encouraging. Being able to appreciate intelligence in children who have poor language skills is a help to teachers and to parents. Without these informal "tests" in spatial understanding, it is hard for teachers and parents to be patient and supportive with children who have poor verbal skills. Success in drawing helps the students and their teachers and parents to appreciate other effective levels of intelligent thought.

One of the most fascinating observations in this study has to do with the lability, or the easy changeability of the mark-making systems called handwriting and drawing. If the writing samples were not numbered, it would be nearly impossible to group these handwriting samples. A child who writes a few words on the pre-test in a disorganized, ill-formed, irregular way may turn out many more words in flowing,

well-organized printing, or even in script on the post-test. Because there is no "pure" control school, it is impossible to conclude that training in drawing is affecting handwriting skills. But the inference is there.

The intriguing question is whether thinking skills are as labile at this age as mark-making skills. Can training in drawing affect, as the major hypothesis suggests, thinking skills expressed in writing? Only longitudinal studies may show whether levels of thinking skills can be impacted at the elementary level in the same ways that handwriting and drawing skills appear to be influenceable. Furthermore, a longitudinal study may show what it is in terms of word-use, and in word-construction that change when an approach to thinking skills like Drawing/Writing is used consistently in the regular classroom. The study suggests that numbers of words, and noun- and adjective-use and simile-use change the most easily.

Along with these future observations, it will be important to note changing numbers in referred populations over time. Do the numbers of referred children go down? How do the changes in numbers relate to schools in which the arts are integrated with academics as they are in Drawing/Writing?

A further question of interest in connection with the study is this: if observations from a longitudinal study about changes in levels of visual and verbal thinking skills for a variety of populations of students are organized and codified developmentally, how do these observations relate to Piagetian stages? How early do children demonstrate higher order abstract thinking skills? How does the concrete operational stage relate to the formal operational stage? Is there a kind of simultaneity, even an indivisibility in some instances?

Another more general question for discussion has to do with the degree to which, as human beings, minds are alike. Careful records with Drawing/Writing over the past eight years suggest that, across age, sex, culture, and educational level, the way in which people draw is more alike than it is not. This suggests that, given the lines of argument suggested by the literature search, including an attempt at an intertheoretic integration, although natural languages may differ, the fundamental ways in which humans represent space may be the same. If the ways in which human beings represent space underlie how they represent language, then, on a fundamental level, humans may represent language in the same ways. What this researcher has described as "the Form of the form" or "the syntax of intelligent thought" may be analogous to Changeux's "templates" (1985), and to Chomsky's "generational grammar" (1968/1972), and to Leonard Scinto's "langue" (1986). There appears to be some innate predisposition to order in the human brain. This predisposition may be both intrinsic, hard-wired into human neuroanatomy and human neurophysiology, and it may also be in some way extrinsic (Jerrold Katz in Bever et al., 1984), taking a Platonic-like Form responsible for ordering signals, or matter, or energy in "meaningful" or highly organized ways that ultimately prove useful to mind. If an argument for Platonist grammar rests on mathematics, rather than on psychology, as Katz suggests, it may be mathematics in the largest sense that has relevance for the study of language. A particular appreciation for a branch of math called fractal describes and computer-generates images of the world in ways that are both intrinsic and extrinsic. Just as fractal math is able to describe and to generate images of other dynamical systems with astonishing verisimilitude, it may be able to describe language. Unless human language is discontinuous with other human neurobiological systems and with other dynamic systems having to do with growth as well (clouds, populations, particle aggregates, crystals, trees, alveoli, dendrites), the relevance of

fractal math for linguistics seems logical. It is unlikely that language is disconnected from other evolved dynamic systems.

It is possible that humans think as they do because, in some sense, mathematics exists, rather than that math exists because men have thought it up (Bever et al., 1984). Something like mathematics may be responsible for neural structure and neural events. Should a fractal program be designed that simulates brain growth and even thought itself, this connection between math and mind will no longer be speculation. The suggestion and prediction is that the formal study of syntax in connection with human language might fruitfully be combined with the study of fractal math and of physics in connection with dynamical systems. It is possible that a fractal-like process is responsible for neural brain growth, and for the processes of thought itself. Both growth and language are dynamical processes.

In a theoretical vein, this study predicts that the syntax of intelligent thought, whether it is expressed in the written form of some natural language or not, has two fundamental characteristics, which it shares with all dynamical processes: one is a random function, the other is a self-referential or self-reflective or mirror function. These two functions occur at some level or levels of neural activity and/or thought and result in meaning.

In a vein both theoretical and practical, this study suggests that we can train the young human mind in the syntax of intelligent thought by facilitating the move from the concrete into increasingly abstract levels of thinking by providing strategies for using systems of comparison, and by allowing children to make these moves and to use these strategies in activities that are characterized by randomness and by self-reflection. Specifically, we can use drawing and writing in open-ended, non-judgemental activities that allow children to move in self-determined ways from the concrete to the abstract, and from the literal to the metaphorical. Besides using a drawing process, we can provide children with knowledge of and practice in the grammatical constructions that are useful to making positive and negative comparisons, and to making predictions and hypotheses. These grammatical constructions which occasion changes in levels of thought are, at base, systems of comparisons, and bear on Hofstadter's suggestion that the basic question of intelligence has to do with how things are alike, and how they are not. What the child compares things to does not really matter. That the child compares things in self-reflective ways that make sense to that child's personal, developing system of logic, does. The process of comparison results in the construction of habits and strategies of effective thought. The syntax determines the semantics; meaning follows form.

The extent to which language is biologically inherent, and the degree to which the environment, including society and culture, play their part in the development of language, may be indeterminable.

Whether language drives cognition, or whether certain levels of cognition must be achieved before certain levels of language-use are possible, may also be indeterminable.

Whatever the exact nature of the relationship between biology and environment, between nature and nurture, between cognition and language, the development of language is related to the development of thought, and the environment may play an enabling, or a crippling part in the development of both. Furthermore, whatever the exact relationship between language and cognition, the development of language

distinguishes the development of human thought, and the level of language use reveals and may even determine the level of thought.

Leonard Scinto (1986) writes about "langue" as an innate predisposition to language, analagous to Chomsky's transformational grammar (1968/1972). According to Scinto, "langue," under the right social, cultural conditions, gives rise to spoken language. At first, written language is directly related to spoken language but then it becomes independent and nearly, if not entirely autonomous (Scinto, 1986).

Howard Gardner feels that language is one of several independent, discrete multiple intelligences (1983). Just as the bird is predisposed to song, so humans are predisposed to language. It can be inferred from Scinto's work that a system described as "langue"- a language beneath and above natural languages- would be the basis for all seven of Gardner's multiple intelligences. Gardner's multiple intelligences would be aspects of an innate predisposition to make meaningful order out of experience. As such, one kind of intelligence would not preclude another. Those intelligences that could be understood as spatial, and those that could be understood as linguistic would, in fact, if the theory of cross-modality is correct, serve to complement and enhance eachother.

It may very well be that there is a syntax of intelligent thought. This syntax could be called "the Form of the form." This syntax or fundamental predisposition and/or template for order may be some neural-based kernel program that results, at higher levels of organization, in meaning. Some of the rules of a syntax for intelligent thought that are teachable, learnable are these: 1) Examine the givens; 2) apply deductive reasoning (analagous to the first four steps in the Drawing/Writing process); 3) then apply inductive reasoning (analagous to the fifth step, or composite abstraction); 4) use these strategies of thought to develop systems of comparisons. That is, use similes, metaphors, analogies, predictions and hypotheses to further the process of knowing in ways that are logical to the system.

If language is approached from the point of view of neurobiology, then language is a system for translating ordered stimuli in the form of a categorical overlay on a coordinate system. This description of language makes language continuous with other functions, and it insures its intimate connection to them.

Furthermore, within the context of neurobiology, the relationship of touch to language is clearly defined. Language is a seeking, order-making system; language is the ultimate pseudopod, the outpouching of a central nervous system that thinks about itself because the number of its neurons reached whatever critical mass is necessary to consciousness and self-reflection and meta-cognition.

Training in drawing, when drawing is deliberately followed by descriptive and reflective writing based on the drawing, underscores the relationship of touch to language. Drawing also appears to elicit and to enhance three of the conditions said to be necessary for higher psychological functioning (Luria, 1979). These higher psychological functions are voluntary attention, deliberate recall, and logical thinking. Both thought and language depend on these higher psychological functions, and language is apparently critical to their development (Luria, 1979). Combining drawing with writing appears to enhance the complementary development of language and thought in connection with attention, recall, and logical operations. The

combination of drawing and writing enhance knowledge informed by touch, while, at the same time in some way, the combination reflects "the Form of the form," or the syntax of intelligent thought.

It is not unreasonable to believe that educators can design curricula that deliberately focus on attention, memory, logical operations, by dissecting effective sequencing processes, providing strategies for intelligent thought. Today, many educators champion children's thinking skills. Tomorrow, more educators may be able to teach children how to learn to think in better ways.

The questions confronting this research have been both theoretical and practical. Are drawing and writing connected skills? if drawing and writing are connected skills, and if the two mark-making and meaning-making activities are deliberately connected in a learning experience having to do with observation and inference, how broad might be the effect of the activity be? Would an activity like Drawing/Writing be effective across a range of abilities? How would teachers respond to the experience of Drawing/Writing? Could Drawing/Writing be used as a model for other spatial/linguistic or art/academic activities where the intent was the development of the general thinking skills of observation and inference?

As children grow, they need to learn to show what they know with increasing accuracy and completeness. The research suggests that if children learn to combine two or more symbol systems, they will communicate fuller understanding. The use of two symbol systems in tandem appears to mirror mind, allowing children to make comparisons between systems of representation.

Luria writes that effective thinking involves not only the ability to compare, but to remember (1979). The ability to remember information and to use it, depends upon mental representations. For reflection to be possible, information must take some organized form. Some kind of representation is necessary for the consolidation of information, for its analysis, its modification, its integration, its transformation. Representation of meaning can take many forms. Two of these forms are drawing and writing.

Many people believe that drawing and writing are unrelated skills. Because people believe that drawing and writing are different, they do not believe in nor understand as yet, the transfer that is going on constantly between spatial and linguistic processing systems in intelligent thought. The operative basis of an activity like Drawing/Writing is the on-going transfer of meaning between symbolic realms.

There are practical reasons for changing this divisive point of view about the arts and academics. There are some children for whom the written aspect of language can not be the final test of the child's thought and ideas. Other languages must be available to that child as equally valid tests of thought. Tests that combine drawing with writing might be successful for this kind of testing, being humane as well as evaluative and therefore doubly useful.

In the long run, an activity like Drawing/Writing may perform a generally remedial function with older children, and a preventative function with younger ones. Sequin suggested that the act of learning can move "from the education of the senses to general notions, from general notions to abstract thought, from abstract thought to morality" (Montessori, 1912, p.41). The fact that Montessori adds that there "is a parallel between pathological linguistic defects, and those of normal children in the process of developing" (p. 45), makes even clearer the possible usefulness of remedial strategies that work equally well for the dyslexic child and for

normal, young children. The suggestion is that there are parallels in normal and abnormal linguistic development that may be illuminating to the educator. As Montessori suggested almost seventy years ago, elementary education needs a complete re-structuring if educators hope to develop children's minds in ways that are, if not uninspired, at least non-injurious.

It is possible that a growing number of contemporary elementary school children need to re-learn how to think using their five senses to describe the physical properties of the world around them. They need to re-learn how to use spatial understanding as well as linguistic understanding; they need to learn how to break a whole into its parts and then to reassemble the parts again into a new knowledge base.

Young children are as good as older ones at learning by looking (Davies et al., 1984). If it is important and rewarding to conduct visual searches in non-verbal ways, it may become far more interesting to do the same thing, later, in verbal ways, searching for meaning in words in texts.

There are two issues involved in making sure that the educational experience is interesting. The first issue is to determine what is inherently interesting to children. The second issue is to teach children how to be interested. The second is the easier problem to resolve, and it is the more important one.

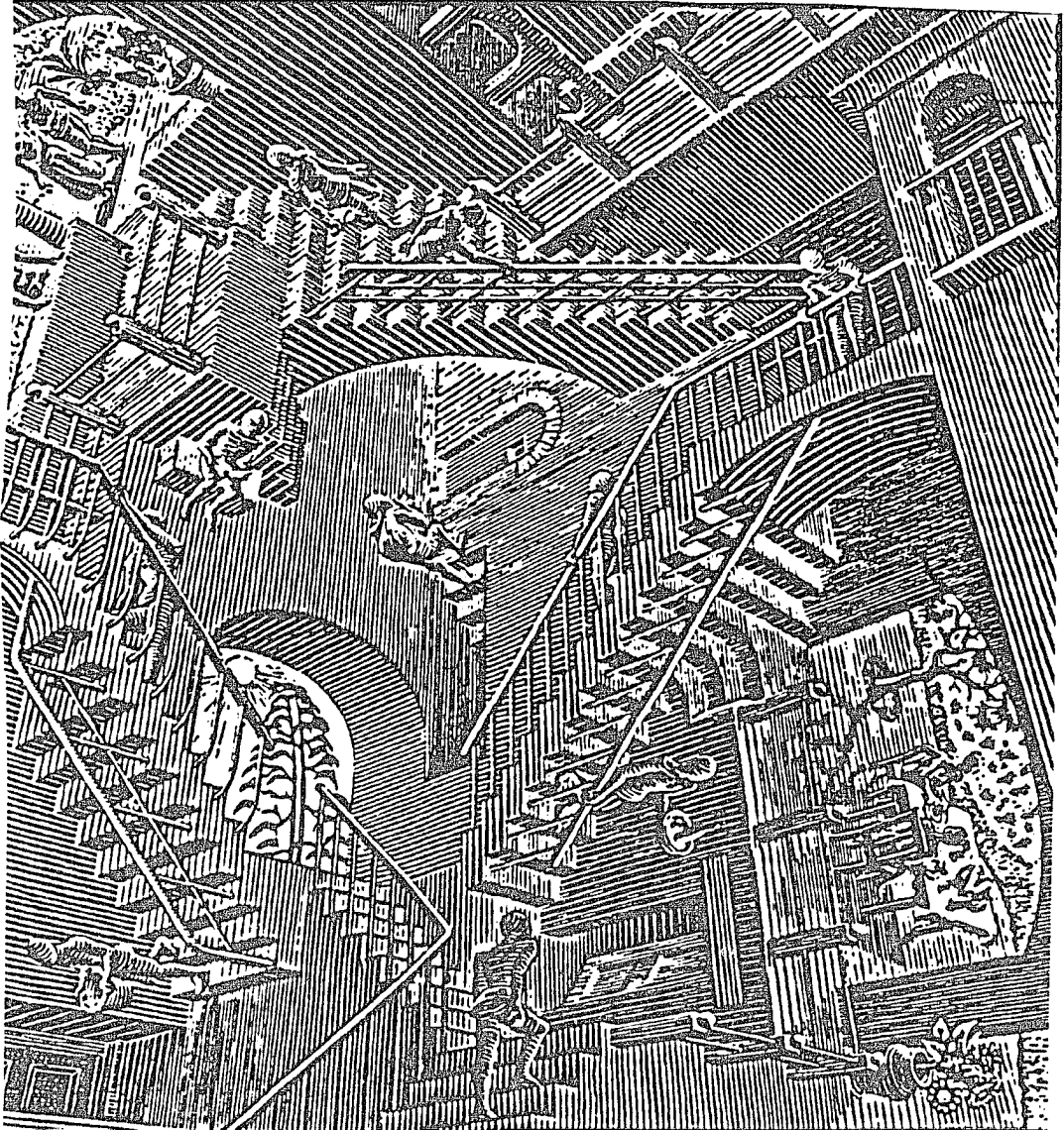
Students need to be shown how to be interested. They need to learn how to stay interested. They need to know that they have control over their own attention so that they can sustain it. They may have to work to discover what is interesting in the world. They may need to learn that the world can not always put on a three-ring circus for their benefit. Children need to be shown that they must be actively involved in the process of learning. They knew this in effortless ways as young children. Sometimes experience, including educational experience, teaches them to forget this.

Neurobiological research suggests that the processes of learning and of thinking are cross-modal by nature. This study suggests that, to encourage and to develop attention, motivation, and cognition, educational experience should be cross-modal by design.

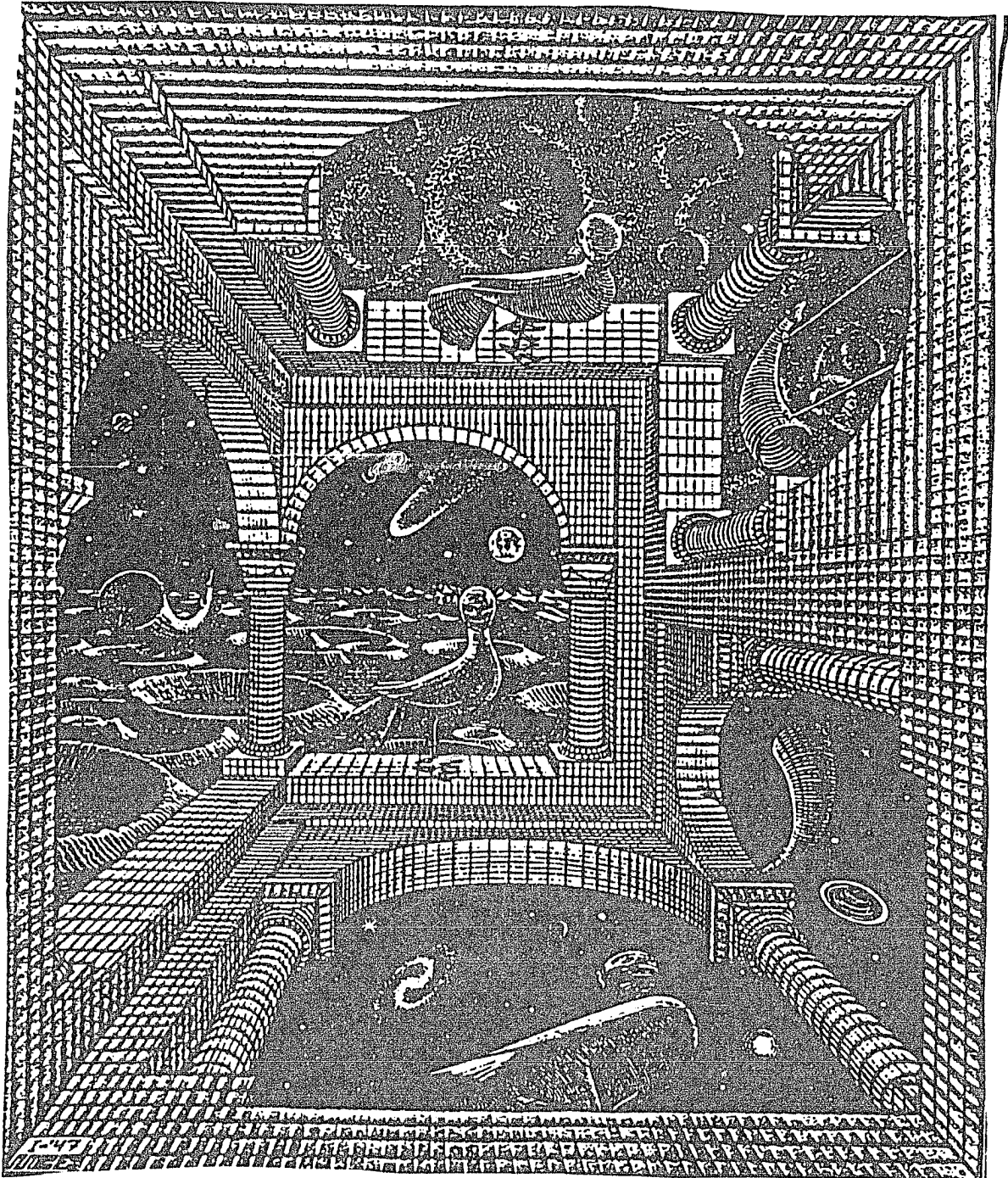
APPENDICES

APPENDIX A
ESCHER PRINT

1 "Relativity"



#2 "Other Worlds"



APPENDIX B
LETTERS OF RELEASE
Letter #1

APRIL 30, 1989

TO: All Kindergarten, and Third through Sixth Graders
Gill Elementary School, Gill, MA 01342

FROM: Susan Sheridan, Doctoral Student, School of Education,
University of Massachusetts, Amherst, MA 01003

RE: Participation in a Study on Elementary Students'
Response to an Activity Combining Drawing with Writing.

You may know me as the mother of Jessica, Sam, and Sarah, or as a volunteer in your school, or as a teacher at Eaglebrook. I am in school, too, like you, at the University of Massachusetts. To earn a degree called a doctorate, I need to do a study.

I grew up drawing and writing. I am wondering if drawing helps all of us write better. I am hoping that you will let me use your drawings and writings as part of my study. If drawing DOES help writing, drawing might become an important part of what you do in the classroom. What do you think?

I will not use your name, or the name of any other student in my study. I will refer to your school only as " a public elementary school in western Massachusetts."

To be part of the study, one of your parents, or your legal guardian needs to sign this paper. If your parent or guardian has any questions, he or she can call me in the evenings, after 8 p.m. at 772-0935, or between 7 and 8 a.m. in the morning.

By signing this form, you and your parent or guardian are agreeing that you will be in my study. Thank you very much for being part of my research!

Susan R. Sheridan

DO NOT DETACH. PLEASE SIGN AND RETURN THIS FORM.

Student's Consent: I, _____, have read the statement above and agree to be part of Mrs. Sheridan's study .

Signature of Participant Date

Parent or Guardian's Consent: I, _____ have read the statement above and agree to my son or daughter's being part of the study.

Signature of Parent or Guardian Date

Letter #2

APRIL 30, 1989

TO: All Kindergarten, and Third through Sixth Graders
Old Deerfield Elementary School, Deerfield, MA 01342

FROM: Susan Sheridan, Doctoral Student, School of Education,
University of Massachusetts, Amherst, MA 01003

RE: Participation in a Study on Elementary Students'
Response to an Activity Combining Drawing with Writing.

You may know me as the mother of Jessica, Sam, and Sarah, or as a volunteer in your school, or as a teacher at Eaglebrook. I am in school, too, like you, at the University of Massachusetts. To earn a degree called a doctorate, I need to do a study.

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Signature of Parent or Guardian Date

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