Research Questions by chapters, appended to the forthcoming book:

The Scribble Hypothesis: How Marks Change Minds.

Toward an evolutionary theory of literacy and an applied science of parenting. SR Sheridan, copyright 2004.

"What we most need now.. is a fresh perspective on the masses of data that neurobiologists have gathered, and on the puzzles those data pose. ...How do brains makes sense of the world...a new general theory...requires new assumptions and new definitions. I believe that the idea of meaning, a critical concept that defines the relation of each brain to the world, is central to current debates in philosophy and cognitive science, and will become so in neurobiology."
Walter J. Freeman, 2000, *How Brains Make Up Their Minds*, p. 17. Columbia University Press.

"The most important implications of brain research ... is the continuity of the brain's language system with other processes. Language appears to be a ramification of the sensory-motor sytem; 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 ...cross-modality. The mind works in a variety of interconnected, interdependent ways. ...There may be a neurobiological processing link between the ability to draw and the ability to write. The link seemed feasible to neurobiologist Galaburda in correspondance. The link implies that functional drawing skills could be used to (improve) 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 affect another, increasing its attentional and informational capacities; if thought is fundameantally cross-modal in character, then it may indeed be sound educational practice to combine dawing with writing and reading to remediate language-related learning difficulties. Spatial modes of understandng may remediate dysfunctional linguistic modes of understanding"
S.R. Sheridan, "Drawing/Writing: a brain-based writing program designed to develop descriptive, analytical and inferential thinking skills at the elementary school level," 1990, dissertation, microfiche 9022744, Univ. of Mass., Amherst, MA.

Chapter Four: research questions.

1) Do both spontaneous speech and scribbling demonstrate bilateral excitation in both hand areas of the motor cortex in three year olds? I would predict stronger ight brain excitation to be much more pronounced in male children. If female brains are, indeed, more balanced bilaterally, we should see strong bilateral excitation in the hands areas of the motor cortex during early speech production in little girls, as well as during scribbling.

2) Research in AI, or artificial intelligence.
To model human intelligence including language abilities, it is probably going to be necessary to design a robot with eyes and hands which scribbles and draws, creating internal models from them. If the child's scribbles and drawings are driven by neural shapes of thought which already exist internally as neural organizers and templates, then those neural pre-conditons will have to be set, too, in the robotic brain.

The conundrum of modeling an intelligent system for whom some aspects of language and literacy are innate and resilient , it that the system will need to scribble and draw and can only do so if the programmer has tapped into the algorithms responsible for the neural shapes of young children's pre-verbal, babbling, scribbling thought.

Still, if humankind is becoming technologicl as a whole, then, since ontogeny both capitulates and modifies phylogeny, the pressure on the child's brain to adaapt will bring about chanes in line with the requirements of technology for its kind of motility, its kind of adhesion, its kind of

transduction. Clearly, technology requires quick eys and quick fingers. It needs the rest of the body only as a support system for the hands/eyes/brain as these three entities interact with a keyboard and a lighted screen.

If the emotions required for interaction with certain computer games are hyper-alertness to danger and triumphal killer-rage, then these emotions will be selected for as biologiclly useful. Still, if the conservation of energy remains a cellular requirement, and if the biological system is squandering energy emotionally by playingsuch games for long periods of time, while under using the rest of the body kinetically, then a neurobiological conflict should arise, resulting in break-down. Thereafter, the system should recover by making necessary evolutionary changes for a body/brain system appropriate to living in virtual worlds. Then, the only enemies we kill will be imaginary, but, by then, we might be imaginary, too.

Chapter Five: research questions.

1) Were marks of meaning found preserved near hominid footprints in lava dust? Especially beyond sight-lines for lakes, springs or groves where the mights would have been directional indicators and/or locators (maps) for water or more abundant food sources?

2) Did the sling-nursing position (which would have been horizontal in immature hominid neonates as opposed to vertical baby chimps' posture)in immature hominid infants create a swallowing challenge, helping to modify the organization of the throat, larynx, hyoid bone for speech? How do primate and human vocal apparati differ in childhood *and* in adulthood? (For instance, the hyoid bone descends in chimps as they mature, as it does in humans, 21).

3) Did hoot-pant primate laughter (16)---in hominins--- increased through mother/child exchanges in response to the extended childhood of dependent, vulnerable offspring, modify the lungs and breathing appartus to accommodate the explosive sounds necessary to consonants in human speech? How do the lungs and other breathing apparati of primates and humans differ today?

4) What discontinunities do fMRI's identify in brain waves/oscillations/locations in primate and human brains when we focus on the first two to three years of life when very young primates (including humans) start to vocalize, gesture, scribble? fMRI's of mother/child vocalizations among primates, and verbal exchanges between human mothers and children around scribbles and drawings should provide information on differences in the locations of neural substrates dedicated to language-use in primates and humans, as well as their metabolic profiles, electical frequencies, wave sines.

5) In young children who scribble and talk at the same time,
what happens to the neural substrates examined in the Illiteracy /literacy studies (7,8)? Do scribbling and drawing organize the child's brain for attention, memory, and articulation, and are the first four tenets of The Scribble Hypothesis valid, as well?

6) Controling for contrast, luminosity and spatial arrangement, design experiments *with infants*, rather than with adults, using human faces, ape faces, and objects, and extend these experiments by presenting *abstract* versus representational art to infants: how does their N170 response differ when they look at Mondrian's "Boogie Woogie" versus his earlier painting of a willow tree? Do infants look longer at Picasso's "Demoiselles D'Avignon" than a "more realistic" blue period painting of acrobats? How about a Cezanne still-life versus a Dutch still-life? Like mature abstract artists (48) and toddlers (15), do newborns show a preference for abstract geometric shapes? What might this mean for embedded geometric systems? And, if all notational systems derive from a child's earliest marks, for literacy?

7) If infants are shown geometric shapes in two-dimensional arrays,
say the triangle and the square as objects with 3 and with 4 sides, do infants associate 3 sounds or 4 sounds with such shapes, extending the research with the counting of objects in conjunction with hearing a similar number of sounds? (49). If so, such research might suggest that not only is numeracy but number-of-sides-sense, or appreciation for the two-dimensional arrays we call geometry, exists as an additional category in an embedded mathematical system in the human brain. The fact that toddlers scribble 3- and 4-sided shapes spontaneously (3), using the same basic line invented by Ice Age notational carvers to describe the lunar-based passage of time on bone and stone (6), might help to extend the notion of embedded systems in children's brains to include marks of meaning as embedded systems in humankind.

8) What happens to speech and language in a baby's whose limbs, especially the hands, are restrained from birth?
(A thalidomide-type baby who is born without hands and feet would provide data.) Is the acquisition of speech impaired? Delayed?

9) If a child is prevented from doing any kind of mark-making throughout early childhood, is there any effect on its brain patterns for speech or on its capacity for emotion? Would such a child exhibit some of the symptoms of autism? Attention deficits? Learning disabilities? Acting out? Oppositional behavior? Inability to make human contact?

10) Laura-Ann Petitto's research with babbling infants (Holowka, Siobhan & Petitto, Laura- Ann 2002 Left Hemisphere Cerebral Specialization for Babies While Babbling, *Science*, Vol 297, 30 August, 2002 pp. 1515) distinguishes between two kinds of babbling, which can be identified by infant mouth position or infrared spectroscopy.

When infants babble in a non-speech-directed manner, there is bilateral hemispheric activity, indicating that this kind of babbling is motoric - that is, an oro-facial organizer. On the other hand, when infants are practicing the sounds of language, or doing speech-directed babbling, the right sides of their mouths are more open, indicating left hemisphere activity, that is, linguistic activity.

Logically, scribbling should mirror these two distinctions. That is, there should be motoric scribbling, and notation-directed, left hemisphere scribbling.

Because scribbling turns into both drawing and numbers and the letters of the alphabet in youngsters, scribbling may not be as easy to compartmentalize.

Early scribbling activity (which would correspond with Stage 1 scribbling as described in the book *The Scribble Hypothesis: How Marks Change Minds. Toward an evolutionary theory of literacy and a science of parenting*, in process)may indeed be motoric, and bilateral. Scribbling destined to turn into drawing might correspond with mouths more open on the left, indicating right hemisphere activity, while notation-directed scribbling, or "pretend-writing" might correspond to a more open mouth on the right, indicating left hemisphere excitation.

If however, scribbles initially represent the shapes of thought (as theorized in the paper "The Neurological Significance of Young Children's Drawings" 2001, 2001way before they are proto-drawings or proto-writing or proto numbers, then we actually do not know what to expect from mouth positions or from infrared spectroscopy. Just because the area on the sensory-motor cortex dedicated to hands is engaged in speech does not necessarily mean that the area on the sensory-motor cortex dedicated to the mouth is involved in mark-making, although anyone watching a child draw or do other challenging manual activity knows that changing mouth positions seem to help the hands. Adults who sew know that the mouth helps the hands to thread a needle.

The truth is that we have no idea what happens in the child's brain or with its mouth when it scribbles because the research does not exist. The field is open.

11) Can scribbling and drawing be used diagnostically with language delayed children, and remedially with children identified as Specific Language Impaired?

Susan Goldin-Meadow's research with deaf children provides powerful openings for the importance of marks to the development of spoken language. As you read the following passage, substitute the word "marks" for "gestures." Goldin-Meadow writes, " Gesture can be an excellent predictor of later langauge development in children who are delayed language-learners. Late talkers who performed poorly on gesture tasks, and who made little use of gesture for thepurposes of communiction, continued to exhibit delays in langauge development one year later" (2003, p. 229). Does the same hold true for scribbling and drawing as predictors? Only research with mark-making will tell us.

Goldin-Meadow adds, "Children diagnosed as Specific Language Impaired (i.e. children who fail to acquire age appropriate langauge skills yet have no other identifiable problems) are able to express in gesture ideas that they are unable to express in speech. Gesture is a medium within which children can display their linguistic knowledge. It is therefore an ideal lace to look for skills that children have but may have difficulty expressing in the veral modality. I am suggesting that, in certain cases, we can use gesture to discover linguistic capabilities that, for whatever reason, a child is unable to display in speech" (ibid). Again, only research with scribbling and drawing will tell us whether mark-making helps children develop expressive skills intrinsic to language in other modalities, in this case, the visual modality.

12) Since primates will scribble, can they be trained to draw, and if so, might they then be able to "bootstrap" signed language onto drawings in such a way that they acquire a large enough vocabulary for original statements, plus an organizational grammar, along with a demonstrable understanding of the signs they use, as expressed by the drawings they make to accompany them?

It is my opinion that other primates do not scribble spontaneously as part of their normal develomental unfolding, and that they can not draw, nor learn to draw, and that therein lies the critical deficit in connection with the acquisition of human language. Since apes and chimpanzees do not need human language to flourish, this should not matter *to them*.

Chapter Six: research questions.

1) If we compare young primates including chimpanzees and bonobo apes with young pre-verbal humans, say, neonates of each species through species-comparable "one year-olds," how do brain scans of gesturing, vocalizing youngsters in each species compare, as well as endochrine profiles for opiods and endorphins, especially in connection with the limbic system?

2) If we compare young vocalizing/gesturing primates with young humans when young humans begin to babble (often alone in their cribs), practicing vowells and consonants, how do brain scans of gesturing, vocalizing youngsters in each species compare, as well as endochrine profiles for opiods and endorphins, especially in connection with the limbic system?

3) If we compare young primates who, under lab conditions, have learned to sign, push buttons, and vocalize in response to human instruction, how do their brain scans and endochrine profiles for both opiods and endorphins, especially in connection with the limbic system, compare with those of 1-2 year old human children who are able to speak one-two word sentences?

4) If we compare young primates who, under lab conditions, have learned to sign, push buttons, and vocalize in response to human instruction, how do their brain scans and endochrine profiles for both opiods and endorphins, especially in connection with the limbic system, compare with those of 1-2 year old human children who are scribbling?

5) If we compare young primates who, under lab conditions, have learned to sign, push buttons, and vocalize in response to human instruction, how do their brain scans and endochrine profiles in connection with both opiods and endorphins, especially in connection with the limbic system, compare with those of 1-2 year old human children who are scribbling and talking about their scribbles at the same time?

6) If we compare young primates who, under lab conditions, have learned to sign, push buttons, and vocalize in response to human instruction, how do their brain scans and endochrine profiles in connection with both opiods and endorphins, especially in connection with the limbic system, compare with those of 3-4 year old human children who are drawing?

7) If we compare young primates who, under lab conditions, have learned to sign, push buttons, and vocalize in response to human instruction, how do their brain scans and endochrine profiles in connection with both opiods and endorphins, especially in connection with the limbic system, compare with those of 3-4 year old human children who are drawing and talking about their drawings at the same time?

8) If a child at the scribbling stage is crying or raging, how does the child react to the possibility of scribbling, and, if the child enters into scribbling, how does the act of scribbling affect behavior, brainwaves, and endrochine levels, especially in the limbic system?

9) If a child at the scribbling stage is crying or raging, how does the child react to the possibility of scribbling and talking about scribbling, and, if the child enters into scribbling and talking about scribbling, how does the act of scribbling affect behavior, brainwaves, and endrochine levels, especially in the limbic system?

10) If a child at the drawing stage is crying or raging, how does the child react to the possibility of drawing, and, if the child enters into drawing, how does the act of drawing affect behavior, brainwaves, and endrochine levels, especially in the limbic system?

11) If a child at the drawing stage is crying or raging, how does the child react to the possibility of drawing and talking about drawing, and, if the child enters into drawing and talking about drawing, how does the act of drawing affect behavior, brainwaves, and endrochine levels, especially in the limbic system?

12) If we compare the "babbling" gestures of hearing children with deaf parents with the vocal babbling of hearing children with hearing parents, how do the brain locations and waves differ?

13) If we compare "babbling" gestures of deaf children with hearing parents with the traditional vocal babbling of hearing children with deaf parents, how do brain locations and waves differ?

14) If we compare the "scribbling" gestures of blind children with sighted parents with the scribbling of sighted children with blind parents, how do the brain locations and waves differ?

15) If we compare the "scribbling" gestures of blind children with blind parents with the scribbling of sighted children with sighted parents, how do the brain locations and waves differ?

In connection with the research of Laura-Ann Petitto at Dartmouth with low-frequency hand-"babbling" in hearing children with deaf parents, the following questions are of interest:

16) Is the cadence/rhythm of the hand-babbling in hearing children with deaf parents, and of motherese as spoken with hearing children analagous or even identical in terms of low-frequency waves/oscillations?

17) How do such low-frequency hand babbles compare with the frequency of toddlers' first scribbles, and young children's first drawings, as both scribbles and drawings unfold in a more or less invariant order?

It is logical that babbling, scribbling and motherese serve the same purpose; the regulation of the brain via frequencies appropriate to language acquistion as both speech and literacy as these two aspects of speech continue to co-evolve in the human species. Literacy may gain ascendancy over speech via media technology.

My aim is to naturalize the natural unfolding of marks and mind for parents, children, and teachers for the sake of emotional health and quality of life. It looks as if the early gesturing we call scribbling and the early vocalizing we call babbling are important human activities. Braille"scribblers" will thus prove to be important tools for blind children, just as hearing aides and/or touch-substitutes for sound will prove to be important babble-encouragers in deaf children. Motion, connection, communication are biological requirements. The body/brain of the child is part of biology.

18) Laura-Ann Petitto's research with babbling infants (Holowka, Siobhan & Petitto, Laura- Ann 2002 Left Hemisphere Cerebral Specialization for Babies While Babbling, *Science*, Vol 297, 30 August, 2002 pp. 1515) distinguishes between two kinds of babbling, which can be identified by infant mouth position or infrared spectroscopy.

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Chapter Six: additional questions

Research in connection with babbling, motherese and scribbling as attractive frequencies.

What is the developmental aim of the changing frequencies in gestures, sounds, marks in mother/child interaction during early childhood, as well as in the child's solitary gesture/speech/mark-making self-interaction?

First steps in conducting such comparative research around brain frequencies:
Establish base-lines for the frequencies of normal, fluent child-speech, and normal, fluent child-drawing, and normal, fluent child-writing, say at 7 years of age. Establish the same base-lines with adults.

Establish base-lines for the frequencies in hand-babbling in hearing children with deaf parents, hand-babbling in deaf children, babbling in blind children, babbling in sighted-hearing infants.

1) How do manual babbles of hearing children with deaf parents and manual scribbling in normal toddlers compare in terms of frequencies and morphology, or shapes in space?

2) Do manual "babbles" trace Kellogg's taxonomy of scribbles? If so, we can assume they function as neural organizers/timers for overlapping language areas necessary for speech production, comprehension, and mark production and comprehension, or writing and reading.

3) When fetuses move energetically in the uterus in response to loud music, should we infer delight or distress? Presumably, the fetal brain is receiving new frequencies for which its brain is not yet ready? If whales beach themselves with hemorraged ear-drums due to the hyper-sonic sonar from submarines, for which whale hearing systems are not organically prepared, should there be studies about the frequencies appropriate for fetal hearing? Is Mozart good for fetal and infant brains? If so, why is it in terms of frequencies useful to brain organization in very young, developing language areas? Emotional areas? Association areas?

4) If we compare the changes in frequencies from babbling to early speech in sighted-hearing infants, how do these changes compare with changes in frequencies from hand-babbling to signing? If we compare these changes to the changes in frequency in motherese as it modulates into more "nomal" speech patterns in hearing-sighted dyads, what do we find? Do mothers' and children's speech and mark-making co-regulate toward higher-frequencies, in tandem?

5) To what degree do gestured babbles, spoken babbles, and motherese frequencies overlap across all the possible sighted-non-sighted, deaf-non-deaf categories or, in fact, map onto each other developmentally? Can we distinguish successive developmental stages in gestured babbles, spoken babbles, signing, and motherese which encourage/force incremental increases in the frequencies in each of these behaviors within the context of mother/child interactions around gesture and speech?

If we cannot map these develomental frequencies onto teach other, how do the frequency maps differ, and what can we conclude about the trajectory for developmental frequencies for speech and literacy in very young humans?

6) Are the cadences/rhythms of the hand-babbling in hearing children with deaf parents, and of motherese with hearing children analagous or even identical in terms of low-frequency waves/oscillations? How do such low-frequency sounds and signs compare with the frequencies in toddlers' first scribbles? Sighted? Blind? Deaf? Hearing?

7) If we track the changes in (visual/linear) frequencies in toddlers' scribbles as they work through a more or less invariant repertoire (Kellogg, 1970; Fein, 1993, 1976), and if we also track the changes in the frequencies of children's early drawings (Kellogg, 1970; Fein, 1993, 1976)....which also take more or less invariant forms, and if we compare these frequencies with the frequency changes that occur as babbling becomes early speech, what do we find?

8) In the human brain, speech centers and signing centers and mark-making centers must be interdependent. Do fMRI's support this interconnection beween speech, gesture, sign, and literacy, say, in the association cortex?

9) Part Three of this book proposes that parenting includes mark-making with very young children. There has been no research on how mothers scribble and draw in dialogue with toddlers. Do they scribble in "motherese?" The evolutionary possibilities of a visual, non-verbal, marks-based dialogue between hominid mothers and children has not been considered phylogenetically. Marshack, 1991, for instance, explored pre-Ice Age hominid males' incised marks on bone but he did not explore the possibility of hominid mother/child contributions to the gradual unfolding of human literacy/art, nor "art's" contribution to the elaboration of speech.

10) Research in connection with babbling, motherese and scribbling as attractive frequencies.

Petitto has also observed the hand movements of babies learning to speak and to sign. Both groups made hand gestures at about 3 hertz in frequency. Babies exposed to sign language made a second kind of hand gesture at about 1 hertz. Speech-directed babbling occurs at 1 hertz, too.

A baby "finds delicious and is powerfully attracted to, anything that has these rhythmic undulations" (Mary Duenwald, "The Power of Babble," *Discover* magazine, 2003, p. 32). The fact that babies are attracted to such frequencies and create them in connection with language supports the idea that certain tissue in the left hemisphere may be producing these frequencies as a pattern, a cue. Petitto has her sights set "on the planum temporale, a piece of the superior temporal gyrus, a chunk of the brain about the size and shpae of an index finger that curves over the top of the ear" (32). "Hearing and deaf adults use the planum temporale to process syllables, whether signing or speaking aloud" (32).

Because it allows her to measure brain activity in babies who are awake and learning to talk, Petitto uses infrared spectroscopy to find out where the brain is using the most oxygen. When the infant Rebecca (not yet five months old) watches "a hand held palm up flat like a traffic cop, then rhythmically rotated it - palm, back of the hand, palm, back of the hand- every second and a half", her planum temporale was activated. The same held true for 10 other babies (32).

Babies under five months find the sight of a hand moving at 1 hertz "delicious," and "powerfully attractive." It is not the sight of the hand that is attractive. It is the speed at which the hand is rotating back and forth that attracts the child. The back and forth frequency is the attractor. If the 1 hertz frequency is a "Strange Attractor" in the mathematical sense for the human brain , then as a frequency 1 hertz must be instrumental in organizaing chaotic neural patterns in the infant brain, at least necessary for speech, and perhaps, by extension, for literacy.

Is 1 hertz the frequency of early motherese and stage 1 of scribbling? If, it is, then, we can ask another question. Do motherese and scribbling register in the planum temporale? If they do, then we would have more evidence for the connections between babbling, motherese and scribbling as neural organizers for speech and for literacy, as well as for the rhythmic

connections between them as common frequencies. We would also have more evidence that the planum temporale is the bit of neural tissue from which the heart beat of speech and literacy arise.

Chapter Nine research questions

1) When young children scribble, what happens to their brain waves?
When young children talk about their scribbles, what happens to their brain waves?

DRAWING AND TALK RESEARCH
2) When young children draw, what happens to their brain waves?
When young children talk about their drawing, what happens to their brain waves?
How do these brain waves differ from children talking about someone else's drawing, say, an illustration in a book?

DRAWING AND WRITING RESEARCH
3) When young children write about their drawing, what happens to their brain waves?How do these brain waves differ from children writing about an assigned illustration? How do normal writers and ADD (attention deficit) and LD (learning disabled) writers differ on the same tasks?

DRAWING AND READING RESEARCH
4) When children read their own writing about their own drawing, what happens to their brain waves? How do these brain waves differ from children reading from an assigned text? How do normal readers and ADD and LD readers differ on the same tasks?

DRAWING AND MATHEMATICS RESEARCH
5) When children scribble and talk about scribbling, do they generate proto-geometric shapes, Euclidean and non-Euclidean? If they learn the names of such shapes, do they show an "innate" interest in the geometry of shapes around them in the world?
How do the brain waves of such children differ from children who do not scribble nor draw who are taught, say, triangles, squares, circles and spirals as external to their experience?

DRAWING AND CREATIVITY RESEARCH
6) Do young children who scribble and draw and who talk about their scribbling and drawing on their own terms with an interested listener produce more unusual, inventive phrases and "turns of speech?" Is this effect due to the drawing and talking done by the child alone or is it an effect of the responsive listener, or both? Does interested listening without scribbling or drawing elicit the same kinds of talking and interaction?

DRAWING AND EXPERT MODELS
7) How do the brain waves of very young children who are scribbling and drawing compare with the brain waves of experts working with abstract mathematical models of brain functions? How do children's scribbles compare with the abstract mathematical models of brain functions, including strange attractors? Also, how do very young children's scribbles compare with the scribbles and doodles mathematicians describe as: Finite-order invariants of closed plane triple point free plane curves both smooth and immersed curves (Vassiliev, V.A., "On finite order invariants of triple point free plane curves,"Differential topology, infinite-dimensional Lie algebras, & applications,.Amer.Math.Soc.Transl.Ser.2, 194, Providence RI, 1999); and with proper immersions of the real line including invariants of smooth triple point free plane curves (Tabachnikov, Serge. "Invariants of smooth triple point free plane curves" J. Knot Theory Ramifications 5 (1996), no.4, 531-552); and with collections of piecewise linear closed curves without triple intersections on a closed oriented surface, including "doodles on the 2-sphere" and "thick doodles" (Khovanov, Mikhail, "Doodle Groups," Trans. Amer. Math. Cos. 349, (1997), no.6, 2297-2315); and with the

“dipsy-doodle,” (or what SR Sheridan calls “googley eyes” in the paper “The Scribble Hypothesis) or double strange attractor (Newton, Tyre A. “A double strange attractor,” Dynamical systems approaches to nonlinear problems in systems and circuits, Henniker, NH, 1986, 117-127, SIAM, Phila, Pa, 1988); and with Jordan curves lying in the 2-sphere with no triple intersections including isotopy and cobordism (Fenn, Robert;Taylor, Paul, “Introducing doodles,” Topology of low-dimensional manifolds (Proc. Second Sussex Conf., Chelwood Gate, 1977) ppp.37-43); and with marks which solve points on a plane” (Heacock, Larry, “A doodling problem involving the density of segment-generated sets of points in regions of a plane,” Math Mag. 42, 1969, 60-66); and with many other geometric combinations which can be classified as nondegenerate quasiperiodic curves on the 2-sphere” (“Geometric combinatorics,” Satellite Conference, Kotor, August 28-September 2, 1998, ed. Rade et al, Publ. Inst. Math. (Beograd) (NS). 66 (80) 1999.Institut Mathematique, Belgrade 1999, pp 1-189). Children’s scribbles are classifiable, neurally and mathematically.

8) Neurochemical benefits for fathers?
) Are there any cognitive, neurochemical benefits for house-husbands who spend a lot of time nurturing small children in any way analagous to the cognitive benefits of pregnancy and birthing and nursing to the female brain in terms of better responses to stress, less fearfulness in strange situations, a hyper-alertness to environmental cues combined with an improved spatial memory (longterm benefits of having to forage and get home quickly to dependent young).

Chapter 10 Research questions

1) Consciousness and marks.
Does scribbling relate to human consciousness, and is research on scribbling relevant to understanding human language-use in the context of consciousness? Scribbling is important only if we think reading and writing symbols including words, mathematics and music are important for communication beyond time and space, (as extensions of human speech as Carlton's "displacement language" invented to deal with discussions of past and future and absent individuals when hominid clans became complex enough to split up into hunters, and gatherers, and to move from one gathering or hunting ground to another)! Only if we recognize the act of scribbling and drawing as **motor organizers** for speech in children, which mark-making activities operate additionally as neurochemical **motivators** for (symbol-based linguistic) SEEK and PLAY behaviors (Panksepp, 1998). Only if we accept the fact that literacy allows a refinement of feeling or "consciousness" which gives human beings a very broad range of reactions to our creaturely emotions.

The question of why children scribble is important to a comprehensive understanding of the gradual unfolding of human consciousness which includes not only speech but literacy. It is my position that marks of meaning drove elaborated speech, speech beyond one and two-word utterances, that is, beyond the here and now and the present listening audience, allowing not only a complication in vocabulary and grammar, but a refinement in feeling and action.

As Falk suggests, mother-child interaction around the "putting down" of children, as well as women's foraging interaction, put strong pressures on verbal language. But I would like to add that the *put-down child itself* drove language as speech and literacy, too. The very fact that children still babble and scribble suggests that hominid toddlers were talkers and mark-makers. It is probable that the solitary little hominid used both speech and marks to teach itself how to calm and direct and organize its now radically separated-off self, including its own mental, emotional, physical and linguistic behavior as important dimensions of its consciousness or feelings about its inner body states, or emotions.

2) Consciousness in humans requires more than surface qualia. Children's "x-ray" drawings showing they know about more than they can see, and want to represent the invisible. This knowledge of the child about things known but hidden must have put extra special evolutionary

pressure on the hand and eye, encouraging the brain to figure out other ways to represent hidden information, like quarks. I call this kind of thinking and representing quidditas or essential-whatness thinking and representing, as opposed to qualia, or sensory, surface thinking about the world. Quidditas thinking is marks-based.

1) Practical research for parents and teachers:
What happens when parents and teachers allow children to scribble and draw and talk about their scribbles and drawings and write about their scribbles and drawings, exploring them geometrically, as well as figuratively (my scribble/drawing looks like a cloud), and narratively (the firetruck is going down the street)? What kinds of thought, emotion, and action do parents and teachers observe? Does this behavior in thought, emotion and action differ from other children in the family, in the town, in the classroom? If there is a change, or a difference in thought, emotion and action, to what do parents and teachers attribute these changes? To the quality of their attention as parents and teachers, or to the effect of scribbling and drawing on human thought? Or both? If working with scribbling and drawing helps children and parents and teachers interact with more mutual interest and enthusiasm in ways that enhance the use of words, we do not have to know what the brain waves are doing, do we? The language gap is what separates the advantaged from the disadvantaged child. A child needs to know a certain number of words to be able to read new words in context - 95%, in fact (E.D. Hirsch, Jr., American Educator, vol.25, No. 2, p.4 Summer 2001). A child's scribbles and drawings can be used to build a vocabulary that will even the playing field for all students. The articulate child is understandable, to him/herself and to others.

2) When schools include drawing for all children the way they include writing, it may be possible to tease out gender-based differences for drawing and writing. A recent article in *Science* magazine suggests that women writers use language in identifiably different ways from men writers ("Your Words Betray You," describes the research of computer scientist Sholom Argamon, Bar-Ilahn University, Ramat Gan, Israel, Vol 300, April 25, 2003). Whether women *draw* differently from men in gender-specific ways has not been determined.

Certain images do recurr in female artists' work, ovals for instance. But the almond-shaped mandorla has been a standard shape used by male artists to enclose a male god.

If you were an art history expert, you might be able to identify the work of Artemesia Gentileschi as female, while identifying the work of Peter Paul Rubens as male. But, apart from subject matter, focussing on technique alone --- how the paint is applied, the brush is held, color is used, form is defined, line is executed --- could we say *for sure?*

Until all little boys and girls receive equal training, encouragement, support and opportunity in drawing and writing, we can base our speculations on children's actual drawings and writings, and on our observations of ourselves as male mark-makers or as female mark-makers.

More women are becoming architects and engineers. Does this mean that women are gaining visual/spatial skills? Or does it mean that women are now free to express an innate potential for visual/spatial skills *because the work-place has opened up* for women? To become active, a gene must be expressed. "Expressed" means mobilized, called into action, given a chance to operate. When we encourage a child to scribble and draw, the gene for art (if such a gene exists) is "expressed." The same is true for writing, and reading; when we encourage a child to talk about his drawing or agree with him that his wavy lines are writing, we're helping the genes for writing and reading to be expressed. Whether or not there are genes for special kinds of mark-making, one thing is sure: if we isolate the brain of the child from images and words, we isolate that child from literacy.

3) While there is some research around drawing and remediation, the idea of training the child to draw as an *alternative* to speech or writing as a *transitional* strategy, or, in some cases, as with the seventeen year old autistic boy you'll meet at the end of Part Two, as a *final* strategy, there is

not enough substantive research to make training in drawing part of the basics from kindergarten through college, a jewel in the crown of core curricula.

Parents and children who work with the program Marks and Mind can provide the missing research, and the impetus for including training in drawing as an important part of the educational experience.

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