ARCHITECTONICS OF THOUGHT:

A SYMBOLIC MODEL OF NEUROPSYCHOLOGICAL PROCESSES

by

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Bachelor of Arts
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1975

Master of Science in Visual Studies
M.I.T.
1981

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ABSTRACT

The thesis presents a monistic theory of neuropsychological relations between two aspects of human neural-mental activity. My theory is expressed in the form of a discussion and a symbolic model, entitled "Thought Assemblies," which concentrate on the dynamics of intuition, reasoning and expression. I posit an equivalence between [mental] intuition and [neural] **"cerebral fusion"** and between reasoning and **"cerebral fission"**. Expression refers to artistic and scientific representations of knowledge. Both the theory and model describe and depict some of the brain processes involved in these two modes of mental activity.

My thesis is introspective to the extent that it is founded on my personal and professional experiences in the arts and the sciences. Also, it is based upon my own views and methods of representing neuropsychological processes. The investigations presented here are ideas and images towards a theory proper as opposed to being an opus of science. In discussing the nature of mental activity and the brain-mind relation, I consider the views of others such as James (1890), Kohler (1947), Hebb (1949), Bunge (1980), and Bindra (1980). This discussion serves to elucidate "Thought Assemblies" which explores the organically structured nature (the architectonics) of human systems.

Thesis Supervisor: Stanford Anderson
Title: Professor of History and Architecture

Thesis Supervisor: Stephan Chorover
Title: Professor of Psychology

I dedicate this book to my family.

ACKNOWLEDGEMENTS

First and foremost I wish to thank Professor Stanford Anderson of the Department of Architecture, co-chairman of my interdisciplinary studies, for helping me structure my program and for allowing me the latitude to research my subject as I deemed necessary. His guidance, together with the other members of my ad hoc committee, - Professor Stephan Chorover of the Department of Psychology at M.I.T., Professor James Ackerman of the Department of Fine Arts at Harvard University, Dr. Eric Schwartz of the Brain Research Laboratory at New York University Medical Center, and Otto Piene, Director of the Center for Advanced Visual Studies - has made my work at M.I.T. truly a privilege.

I am most grateful to Stephan Chorover whose sensitivity towards my work and perspicacity has not only provided radiant constructive criticisms, but he has stimulated me to develop new methods of interrelating disciplines and articulating these interrelations. Though he may not share all my points of view, he has nonetheless helped me to define my perspective, encouraging me to explore my questions and their implications. His open-mindedness, sense of humanity, and model as a teacher has secured my faith in the power of productive (creative) thinking in the field education.

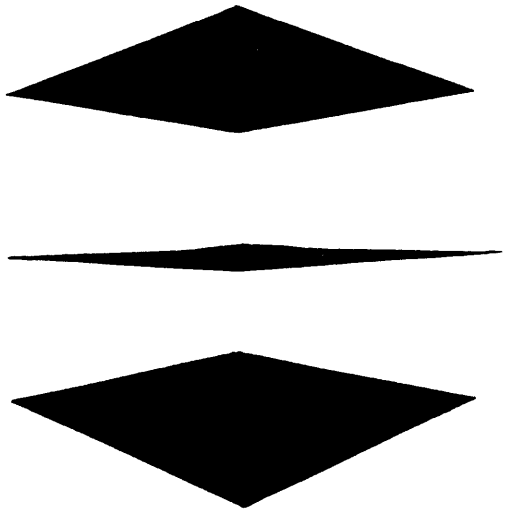
I wish to extend my appreciation to Dr. Walle Nauta and Dr. Gerry Schneider of the Fleischmann Center for Neurosciences at M.I.T. whose personal conversations on arts and humanities (and their interactions with the sciences) were invaluable to me. Both scientists are exemplars of educators who possess the flexibility of mind to make the process of learning a great experience. The opportunity to attend Dr. Nauta's lectures on human neuroanatomy and to observe his virtuosity (in combining artistic and scientific insight) in this subject has profoundly inspired me.

I would like to mention here Ronald Feldman, Director of the Ronald Feldman Fine Arts Gallery in New York. His continual support of my artwork over the last six years has been crucial for both my artistic and personal growth. As well, James Ackerman's views on the union of art and life (and the integration of the arts and sciences) contributed to the development of my methods of inquiry in a major way.

Finally, I want to thank Dr. Jerry Lettvin who first posed the seemingly simple question to me six years ago - "Physically, what is a thought?" - and Dr. Eric Schwartz who provided some important insights into this question (and its neuropsychological implications), helping me frame my answer in the form of a symbolic model.

The ideas and artwork presented in this dissertation originated from my research in the Masters of Science in Visual Studies Program at the Center for Advanced Visual Studies at M.I.T. The freedom of exploration I was permitted under direction of Otto Piene has been critical to all my efforts. Moreover, the projects undertaken as a Research Affiliate at this institute - involving scientists, mathematicians, philosophers, scholars, engineers, and artists - has helped my work and thinking move beyond the traditional boundaries. This has been a long-needed, long-desired complement to the nurturance and collaborative spirit I have enjoyed in the artworld.

To my friends cited here I, once again, express my gratitude for allowing me the freedom to challenge myself in pursuit of my studies. This is perhaps the most powerful agent in the realization of any dream - this applied freedom of mind and wonder.



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BIOGRAPHICAL NOTE:
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EDUCATION:

1983-1986 Graduate study towards Ph.D in Interdisciplinary Studies in Psychology and Art, Department of Architecture, Massachusetts Institute of Technology, Cambridge, Massachusetts
1981 Master of Science in Visual Studies, M.I.T.
1975 Bachelor of Arts, Bowdoin College, Brunswick, Maine

APPOINTMENTS:

1981-1983 Research Fellow, Center for Advanced Visual Studies, M.I.T.

AWARDS AND PROFESSIONAL ACTIVITIES:

1985-1986 Fulbright Fellowship to India
1984 Innovative Design Fund Award/ National Endowment for the Arts
1984 Invention: "Textile Machinery and Process for Producing Design Patterns on Materials," M.I.T. Patent Case #3922
1983 Council for the Arts, M.I.T.
1979 Seed Grant, Council for the Arts. M.I.T.
1979 Created designs for a new line of linens (called "High Tech") for the Martex Textile Company, New York
1975-1976 I.B.M. Thomas J. Watson Fellowship to Paris, France
1973 Invention: "Artists' Canvas Stretching Device," U.S. Patent No. 4,190,974
1972 The William Zorach Painting Scholarship to the Skowhegan School of Painting and Sculpture, Skowhegan, Maine

ONE-PERSON EXHIBITIONS: (partial list)

1986 **"Sive-sive" ("This as well as that")**, Centre Saidye Bronfman, Montreal, Canada
1985 **"Mind"** Installation, Galerie Noctuelle, Montreal, Canada
1983 **"Book Forms"**, Gallery Takagi, Nagoya, Japan
1983 **"Thoughts/ Thought Assemblies"**, Ronald Feldman Fine Arts Gallery, New York City
1983 **"Insights and Explorations"**, Compton Gallery, M.I.T.
1982 **"Cerebreactors"**, Galerie France Morin, Montreal
1982 **"Book Forms"**, The M.I.T. Museum and Historical Collections, Cambridge, Massachusetts
1981 **"Inquiries Into The Biomirror"**, Ronald Feldman Fine Arts Gallery, New York City

GROUP EXHIBITIONS: (partial list)

1985 **"Brainworks"**, Municipal Art Gallery, Los Angeles, California
1985 **"Brainworks"**, Festival 'Steirischer Herbst', Graz, Austria
1985 **"San Paulo Biennale,"** Brazil, South America
1985 Hokin Gallery, Miami, Florida
1984 **"Philosophies on the Art Process"**, Caidoz in Makkom, Amsterdam
1984 **"The Year One: 1984-2001"**, The Chrysler Museum, Norfolk, Virginia
1984 **"Politics in Art"**, Queensboro Community College/ The City University of New York
1983 **"Connections: Science Into Art"**, Summit Art Center, Summit, New Jersey
1983 **"1984 - A Preview"**, Ronald Feldman Fine Arts Gallery in conjunction with The Village Voice, New York City
1983 **"The New Culture"**, Center for Peace Through Culture, Toronto, Canada
1982 **"Alea(s)"**, Musee D'Art Moderne De La Ville De Paris, A.R.C.2, Paris, France
1982 **"Revolutions Per Minute (The Art Record)"** produced by Ronald Feldman Fine Arts and the Greene Street Recording Studio, New York City; art works and record presented at the following galleries and museums:

The Tate Gallery, London, England
Galerie Ursala Block, Berlin/ Documenta
Biennale De Paris, France
The Basement Group, Newcastle-Upon-Tyne
Bluecoat Gallery, Liverpool, England

1982 **"War Games"** and **"The Atomic Salon"**, Ronald Feldman Fine Arts Gallery in conjunction with The Village Voice, New York City
1982 **"Anti-Apocalypse: Artists Respond to the Nuclear Peril"**, The William Paterson College of New Jersey, Wayne, New Jersey
1982 **"Sky Art Conference"**, Center for Advanced Visual Studies, Ars Electronica im Rahmen des Internationalen Brucknerfestes Linz, Austria and Munich, Germany
1982 **"Drawing New Directions"**, Summit Art Center, Summit, New Jersey
1981 **"Collaborations One"**, Connecticut College Museum, New London, Connecticut
1981 **"Schemes: A Decade of Installation Drawings"**, Elise Meyer Gallery, New York City; national traveling exhibition
1980 **"Imaginary Voyages"**, Bronx Museum, New York
1979-1981 **"Reality of Illusion"**; national traveling exhibition

1978 O.K. Harris Gallery, New York City
1975 The Norton Museum of Art, West Palm Beach, Florida
1972 Colby College Museum, Waterville, Maine (The William Zorach Painting Scholarship)

PUBLICATIONS:

1985 "Neurocosmology: Ideas and Images Towards An Art-Science-Technology Synthesis" in LEONARDO Journal, Vol.18, No.1, pp.1-10; Oxford and New York: Pergamon Press.
1984 Photographs of my artworks published in P. Freeman, E. Himmel, E. Pavese, and A. Yarowsky (eds.) NEW ART. (pp.172-174). New York: Harry N. Abrams, Inc.
1983 The Biomirror. New York: Pilgram Press.
1982 Article entitled "Thought Assemblies" in ALEA, numero 3, pp.80-85. Paris: Christian Bourgois Editeur.
1982 Gates of Freedom: A Passover Haggadah by Chaim Stern with visual interpretations by Todd Siler. New York: New Star Press.
1982 Think Twice (a monologue on the brain processes of "cerebral fusion" - intuition and "cerebral fission"- analytic reason) in Revolutions Per Minute (The Art Record), released by Ronald Feldman Fine Arts Inc.
1981 Cerebreactors. Hartford: Bond Press.

REVIEWS AND ARTICLES: (selected)

1985 Photographs and text on artwork titled "Cerebrarium" (working model of the human brain) published in a book by Jurgen Claus ChippppKUNST. Berlin West: Verlag Ullstein GMBH
1985 "Where Art And Medicine Meet", MD Publications (February); article by Marguerite Feitlowitz (pp.65-78)
1984 "Art And Orwell", Port Folio, Vol.I, No.28 (February); review of Chrysler Museum Exhibition "The Year One: 1984 - 2001" by Linda McGreevy
1984 "Chrysler exhibit large on symbolism", Virginian-Pilot & Ledger-Star (February); review of Chrysler Museum Exhibition by Teresa Annas
1984 "Helping Designers Build Protypes", The New York Times, Thursday, January 26; by Angela Taylor
1984 "Todd Siler at Ronald Feldman", Express Magazine (Winter); review by Cyril Christo
1983 "Review: Todd Siler/ Ronald Feldman Fine Arts", Arts by Ellen Handy
1983 "Todd Siler/ Ronald Feldman", ARTnews Magazine (December)
1983 "1983-1984 Annual Guide To Galleries Museums Artists", Art in America Magazine (Sourcebook to the U.S. Artworld), (pp. 166, 276)

1983 "The Atomic Salon", DOMUS Magazine (review of Ronald Feldman Fine Arts "The Atomic Salon" Exhibition - 1982)

1983 Who's Who In American Art, Edited & Compiled by Jaques Cattell Press, Temple, Arizona

1983 "Artist Finds 'Cerebral Fusion' During Moment of Intuition" Tech Talk (M.I.T. Newspaper - September 28); article by China Altman

1983 "ARTLIT" - Amy Blumental Looks At A Renaissance In Thought", United Press International (UPI)

1983 "Exhibit by M.I.T. Artist Shows Brain Processes", The Hartford Courrier (October); Boston (UPI)

1982 "Exposition: Alea", Liberation (Mars 30); editorial by Herve Gauville and review of ARC, Musee D'Art Moderne "ALEA(S)" Exhibition by Jean-Pierre Thibaudat

1982 "Alea(s): Onze artistes jettent un pont entre l'art et la science", Latitude (Mai 7); review of "ALEA(S)" by Maiten Bouisset

1982 "Alea(s) au Musee D'Art Moderne: une partie de des entre l'art et la science", Le Matin (Mars 23), Maiten Bouisset

1982 "Esthetique, machine et reve scientifique", Arts (Avriel 1); review of "ALEA(S)" by Anne Tronche

1982 ""ALEA(S)" a l'A.R.C.", Le Monde (Fevrier 4), review by Genevieve Breerette

1982 "ALEAS"/ ARC - Musee D'Art Moderne", Les Cahiers De La Peinture No.130 - Premiere Quinzaine (Mars); Claude Lorent

1982 ""War Games": Of Arms And Men", ARTnews Magazine; review of Ronald Feldman Fine Arts Exhibition by Jonathan Crary

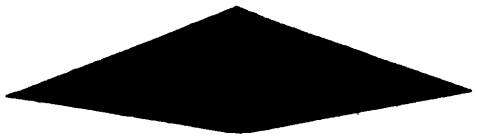
1982 "Painting - The Arts", OMNI Magazine, October Issue; article by Michael Schrage on my artwork "Cerebreactors"

1981 "The Brain as an Art Medium", DOMUS Magazine (Italy), December Issue

1981 "Todd Siler/ Galerie France Morin", Vanguard Magazine (December/ January); review by Martha Fleming

1981 "Chronique Des Arts: Six expositions prospectives", A Presse Journal, Montreal, Samedi 24, Octobre; review of "Cerebreactors" Exhibition at Galerie France Morin by G.T.

Artwork owned by various public and private collections.



In this dissertation I present my theory of intuition (**"cerebral fusion"**) and reasoning (**"cerebral fission"**). My theory seeks to describe certain physiological interactions in the human brain as they may correspond to these two mental processes. More importantly, it questions some of the distinctions traditionally made between the arts and sciences - including those propounded by cerebral dominance studies. It thus provides a new interpretation of the interactions between synthetic and analytic thinking, positing relationships of parity between the pairs of all such dichotomies.

My thesis considers the mergence of brain processes (i.e. the convergence of cognitive functions) in **cerebral fusion**. It suggests that intuitions are oriented toward neither art nor science; they inform both. They cannot be physically shown but can only be experienced. Conversely, analyses and expressions of knowledge are by convention either art or science; they are records of what is experienced by their producers. They include the spectrum of symbolization from mathematical logic to visual arts. My symbolic model ("Thought Assemblies") is one record or expression of my insights into the physical correlates and composition of both synthetic and analytic modes of mental activity.

The two parts that follow discuss the details of my theory of thought (Chapter II) and my symbolic model of neuropsychological processes Chapter III). Chapter I is intended to define

(and thereby to justify rationally) the dialectical position from which I plan to speak. Moreover, since my ideas about mental processes and the brain-mind relation have been influenced by various classical and current views (see Table 1), a brief account of these views and their influence on my work is also in order.

As any serious inquiry into neuropsychology soon reveals, knowledge of the brain entails entanglement in the philosophical doctrines of monism and dualism [1]. Philosophies, accordingly, have always played a critical role in shaping the course and scope of thought on mind-matter (i.e. "mind-brain," "mind-body") issues. Dualistic notions of immaterial reality were common among the ancient Indians, Chinese, Australian aborigines, and others [2]. In due course, along with early monistic notions of materialism (e.g. Epicurus, Hippocrates, Lucretius), these dualistic notions found their way into the vocabularies and world-views of modern physical sciences [3] and philosophies [4]. Further to the point, the notions of monism and dualism continue to provide theoretical constructs in the brain and behavioral sciences [5]. For instance, Wilder Penfield's (1975) neurophysiological study of consciousness and the human brain is steeped in dualism as are John Eccles' (1953) descriptions of the neurophysiological basis of mind. By contrast, Dalbir Bindra's (1976) neuropsychological study of intelligent behavior and Jean Piaget's

MIRROR
(Reality)

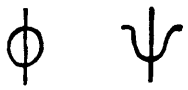
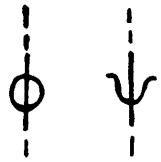
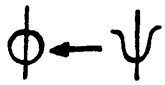
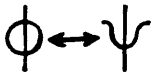
ϕ represents brain (or the physical) OBJECT	And	ψ represents mind (or the mental) IMAGE
Monism		**Dualism**
IDEALISM, PANPSYCHISM, PHENOMENALISM: Everything is ψ. All is mental.  Berkeley, Fichte, Hegel, Mach, James, Whitehead, Teilhard de Chardin		AUTONOMISM: ϕ and ψ are independent.  L.Wittgenstein
NEUTRAL MONISM, DOUBLE ASPECT THEORY: ϕ and ψ are so many aspects of a single entity. Mental and physical manifestations of unknown neutral substance.  Spinoza, James, Russell, Carnap, Schlick, Feigl		PARALLELISM or SYNCHRONY, PREESTABLISHED HARMONY: ϕ and ψ are parallel or synchronous.  Leibniz, R.H.Lotze, H.Jackson, some Gestaltists
ELIMINATIVE MATERIALISM, BEHAVIORISM: Nothing is ψ. No mind at all.  J.B.Watson, B.F.Skinner, A.Turing, R.Rorty, W.V.Quine		EPIPHENOMENALISM: ϕ affects or causes ψ. Brain secretes mind.  T.H.Huxley, K.Vogt, C.D.Broad, A.J.Ayer, R.Puccetti
REDUCTIVE MATERIALISM (PHYSICALISM): ψ is physical.  Epicurus, Lucretius, Hobbes, K.S.Lashley, J.J.C.Smart, D.Armstrong P.Feyerabend		ANIMISM: ψ affects, causes, animates, or controls ϕ  Plato, Augustine, Aquinas, S.Freud, R.Sperry, S.Toulmin
EMERGENTIST MATERIALISM: ψ is a set of emergent brain functions.  Diderot, Darwin, G.Edelman, T.C.Schneirla, D.Hebb, D.Bindra , V.Mountcastle		INTERACTIONISM: ϕ and ψ interact. Brain "basis" of mind yet controlled by it.  Descartes, W.McDougall, J.C.Eccles, K.R.Popper, J.Margolis
REFLECTIONISM: ϕ and ψ are one and the same thing. ϕ and ψ are so many aspects or manifestations of a single entity - mirror reflection  T.Siler		REFLECTIONISM: ψ mirrors or reflects ϕ. The properties of ψ are (literally and figuratively) opposite and reverse the properties of ϕ.*  S.Radhadkrishnan, B.Heimann, J.A. Arguelles, Chuang-Tzu, * T.Siler

Table 1. Twelve views of the brain-mind relation (a modified version of Bunge's [1977b] "Ten views on the mind-body problem."

(1971) psychological investigation of the relations between biological and cognitive processes are entrenched in materialistic monism.

My concept and philosophy of **"reflectionism"** considers how the world of matter might "mirror" [6] the world of mind. Reflectionism regards the brain and mind, like matter and energy, to be identical, equivalent, and interchangeable [7]; that is, they are two essentially complementary aspects of the same thing and process. The implication is: as the states of brain change so change the states of mind simultaneously. The concept of reflectionism introduces the idea that the "mirror" is the 'unknown **neutral substance**' (i.e. **relationship and process**) (see Table 1) which is responsible for the dual mental and physical manifestations. It points out that the dualistic descriptions of brain and mind processes set up the conceptual illusion that leads us to separate the physical body ϕ (material) from the psychical mind ψ (mental) (see Figure 1). The illusion can be explained away the moment one sees the human brain as only a 3 lb. complex with 10^{12} neurons and 10^{4} synapses/neuron. At the same time, reflectionism recognizes (what Bunge [1979, 1980] is quick to emphasize) 'that the brain, as a system, is not identical

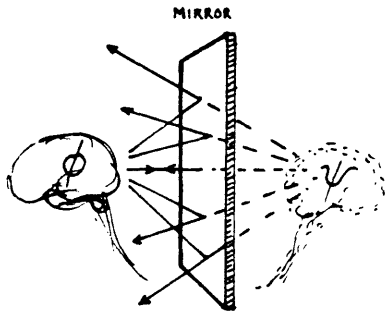


Fig. 1 Reflectionist dualism - perceiving the brain and mind as two separate but interdependent things. It is as if by introducing either a physical or an imaginary mirror we immediately create two separate worlds from one reality.

with the set of its components...that it is endowed with a structure (which includes the connections among its neurons) and an environment, not only a composition...and that it contains [mental] emergent properties, such as those of being able to perceive, feel, remember, imagine, will, think, and others, which its cellular components lack' (p.8).

Like emergentist materialism, reflectionism has the potential of becoming a theory proper, i.e. "a hypothetical-deductive system containing precisely formulated and detailed hypotheses accounting for a wide range of psychoneural facts" (Bunge, 1980, p.22). It may be thought of concomitantly as an edifying philosophy which relies on ordinary language as opposed to the logico-mathematical language of the physical sciences. Each language and system of thinking has its importance. In describing neuropsychological activity, reflectionism does not reify materialism, as for example, eliminative and reductive materialism do. Also, it does not attempt to explain mental phenomena or to define the mental correlates of brain processes. Unlike emergentist materialism which proposes that "mental states form a subset of brain states" (Bunge, 1980, p.24), reflectionism maintains that mental states may be more than a 'subset' of brain states; that is, they may form a set of the state of the whole human organism. This overall state is different from and greater than the exteroceptive and interoceptive stimuli of the

organism (which includes its interactions with the immediate environment). What is more, reflectionism concludes that in so far as a complete [scientific] description of the nature of thought is or could be attainable, such a description must implicate every level of material reality - from nucleons to molecules to cellular systems to societies. Every level and aspect of the human organism (and not just the nervous system) must somehow be factored into the mental process of thinking (imagining, knowing, understanding or learning), feeling (sensing, emoting), and doing (making, creating) [8].

It is to be remembered that for the mind to be the brain, all the abstract, ambiguous and undefinable properties of the mind must already (always) be present in the brain. That is, all the problematical, unquantifiable characteristics of mind (or rather those we tend to associate with the 'nature of mind') must somehow be related to the workings of the brain. If we cannot relate such things as aesthetic experiences and sensual feelings to the human brain then either our notions of brain-processes, B, are too narrow or they grossly undermine the nature of mental processes, A. I suspect that the more we try to match the nature of A with the nature of B, the larger or more inclusive will be the theoretical and empirical definitions of B (see Figure 2). Simply, our notions of material and immaterial reality will become increasingly blurred - perhaps in the same way our views

concerning the 'fundamental differences' between animate and inanimate matter have been rendered indistinct by molecular biologists and solid state physicists researching the growth of crystals [9].

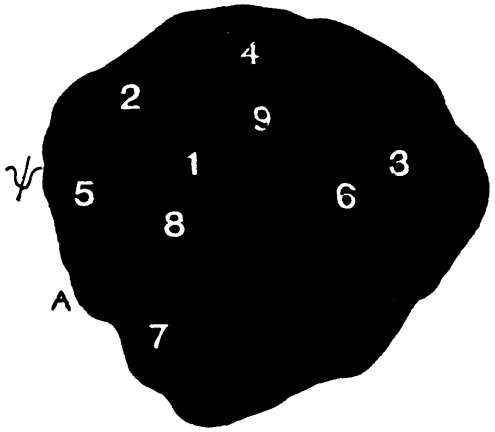


Fig. 2 Bridging the 19th century dichotomy between materialism, B, and spiritualism, A, science seeks to relate the events, states, and structures of brain to those of mind - thus relating two different geometries of of our notions of ϕ and ψ .

In this direction, the scientific and philosophical inquiries into the distinction between brain/mind processes and material/immaterial reality will be transformed by the realization that these terms are referring to two different aspects of one and the same reality [10]. Any prima facie evidence for the materiality (so-called "biological basis") of mind will also be evidence for the mind's ultimately irreducible immateriality. It is not contradictory to say, then, that the new definitions will permanently suture up the Cartesian division between the material **res extensa** ('extended thing,' i.e. the body) and the immaterial **res cogitans** ('thinking thing,' i.e. the mind) [11]. I would imagine that they will also add new meaning to the dialectic principle (i.e. the Platonic-Aristotlean and Kantian

dialectic, the t'ai chi Yin-Yang dialectic, and the traditional Indian Zero-concept dialectic [12]) that has wrestled our imaginations into a headlock since ancient times [13]. Where the concepts of complementarity, polarity, and parity (together with the object-mirror-image relation) separate matter into 'two distinct worlds,' the new definitions will no doubt shift our attention to the union or intersection of these worlds (see Figure 3) [14].

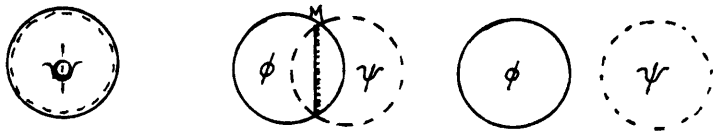


Fig. 3 Tracing the process of integration and separation - from monism to dualism - in philosophies of brain and mind.

Reflectionism is a compound concept. It draws on aspects of each of the other monist perspectives (with the exception of eliminative materialism), in establishing its viewpoint. For example, it basically accepts the premise of idealism - "everything is mind" - adding that the mind is identifiable with everything and disassociated from nothing in that it [the human mind] is the medium through which the world and its contents is comprehended. To look at and discover, to imagine and interpret anything (or everything) implies that the comprehending and looking is being done by someone and that his or her mind "touches and is touched by everything"[15]. Also, it accepts the notion of neutral monism - "brain and mind are so many manifestations of a single neutral substance"

(i.e. "the mirror" - my note). Furthermore, it marginally agrees with the view of reductive materialism - "mind is physical" - adding that the mind is physical in so far as one concurs with the tenet of the [brain-mind] identity theory.

The general philosophy of reflectionism is derived from both Western and Eastern philosophies. The latter influence has a significant entailment. For one thing, it does not put a premium on scientific and technical precision. Moreover, it equally values purposeful ambiguity and paradox. In a dilemma, the number and variety of its strategies for approaching brain (mind) questions are markedly larger and broader than those of most currently ongoing scientific research programs [16]. Finally, skepticism and relativism abound in Eastern philosophy. No one, single, definitive explanation or explanatory model or perspective is presumed to exist, and diversity of models regarding the workings of the mind are not unwelcome. All humans truly have are **notions** (general impressions and hunches) and **concepts** which we nurture and groom to become theories. Moreover, attempting to predict where these theories will lead is similar to forecasting the direction and fate of winds and clouds. These remarks aside, I do believe that eventually neurophysiology may define brain processes in the following way:

> "Organism **b** feels pleasure of kind K=αf. Subcortical system **s** of organism **b**, under stimulation by events occurring in **c** (another

> neural system, or sense organ...)
> fires according to pattern **p**"
> (Bunge, 1980, p.13).

The problem with this definition of Bunge's should be obvious. To hypothesize about the subtle variations of the human neurochemical-electral system and its "cerebral language" (using our present state-of-the-art) is a bit like trying to tether a pup-tent in a hurricane of information. The number of unknown variables is staggeringly great (so great that I cannot share the optimism of Sellars, 1965; Bogen, 1969; Minsky, 1974; Bindra, 1980; among others) [17]. Simply, it is a case of **ignotum perignotius** ("the unknown explained by the still more unknown"). The number of disciplines, research techniques, and experimental strategies that must be integrated (or at least coordinated) to form one multi-interdisciplinary study is overwhelmingly large. What is more, the kind of networking of information that would be required in communicating the findings of such an enterprise (given the labyrinth of subdisciplines) is immensely complicated.

It should be self-evident that a strictly physiological approach to the thought process is a cul de sac. I share the view of the late psychologist Donald Hebb (1980) who says that "thought must be known as theoretically as a chemist knows the atom"...that "physiological methods can deal with part systems...but a further fundamental feature is missing, namely, how these part systems are coordinated in the ordinary behavior of the intact unaesthetized animal" (p.80).

Understanding this whole-part relationship is essential if one is to learn about the nature of thought processes (e.g. insight-perception, reasoning and expression).

To summarize: reflectionism explores the notion that the brain-mind reality is one (multifarious) process. It examines the implications of this notion with respect to the thought process. It employs the various perspectives (specified in Table 1) in this exploration, using the plane mirror as both a model and metaphor for describing states of brain (and mind). According to the application and context of my mirror concept, one may perceive it as either a mechanical [inorganic] device or an "amorphous principle" and philosophy [18]. Either way, I think it demonstrates why we need both types of philosophies (those **with and without mirrors**) [19], emphasizing the fact that **with the mirror we split reality** - thus creating the mimetic relation of the actual object and its virtual image, the subject. **Without the mirror we fuse reality** integrating these two realities, i.e. the worlds of the object, observer, and the subject, observed. The former philosophy represents the 'systematic' dualistic tendency (see Figure 1); whereas, the latter represents the 'systemic' monistic tendency (see Figure 3). My contention is that both of these philosophies are necessary for comprehending the nebulous nature of mind and thought through the dialectic perspective.

CHAPTER 1 NOTES

1. The doctrine of **monism** states that there is only one ultimate "substance" or "principle" which may be physical (matter) or nonphysical (mind) or something other than these things; also, reality is considered as a whole without autonomous parts. Read S. Radhakrishnan and C.A. Moore (ed.) A Source Book In Indian Philosophy, (Princeton: Princeton University Press, 1957).

   Cf. the doctrine of **dualism** holds that the world (the universe, nature, life, etc.) is composed of both matter and nonmatter or mind. For a sensitive account of the mind-body (matter-mind) relation, read Jack H. Ornstein, The Mind and the Brain (Netherlands: Martinus Nijhoff, The Hague, 1972), Chapter 1: "Descartes - The Mind and the Body"; Chapter V: "The Physical and the Mental"; and Chapter VI: "A Multi-Aspect Theory of Mind"; read also, Sidney Hook, Dimensions of Mind; A symposium (New York: New York University Press, 1960).

   Cf. **pluralism** maintains that reality consists of a multitude of "ultimate principles." Read S. Sambursky, The Physical Work of The Greeks (Translated from the Hebrew by M. Dagut.) (London: Routledge & Kegan Paul, 1963); Chapter V: "The World of The Atom," pp.105-131.

   The literature on this topic is particularly expansive, presenting a variety of analyses and interpretations; note, for example: Blanshard (1955); Feigl (1958); Quinton (1965); Corning (1968); Hess (1968); Borst (1970); Grene (1971); Harman (1973); Ornstein (1974); Balasubrahmanian (1976); Zangwill (1976); Uttal (1978); Jusczyk (1980); Cohen (1980); Bunge (1980); Fodor (1983).

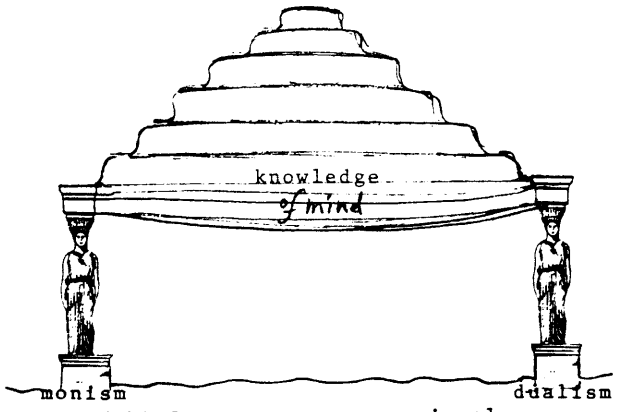
2. Ancient Greek mythology and, for example, Ionian cosmogony, are redolent of dualism, i.e. notions of immateriality and and spiritualism. Consider Plato's mythical Timaeus which describes how the "soul is prior to body" and how "the world's body is fitted to its soul." Read Milton K. Munitz (ed.) Theories of the Universe; From Babylonian myth to modern science (New York: Free Press, 1957), pp.21-31; pp.67-88.

3. I call your attention to the dualistic vocabulary in P.A Buser and A. Rougeul-Buser Cerebral Correlates of Conscious Experience (North-Holland and New York, 1977) and W. Penfield The Mystery of the Mind (Princeton, New Jersey: Princeton University Press, 1975); the dualistic perspective in J.C. Eccles The Neurophysiological Basis of Mind (Oxford: Clarendon 1953) and in K.R. Popper and J.C. Eccles The Self and Its Brain (Springer International, 1977); also, note the presence of the dualistic world-view in R.W. Sperry "Mental phenomena as causal determinants in brain function." In G.C. Globus, G.

Maxwell, and I. Savodnik (eds.) Consciousness and the Brain: A Scientific and Philosophical Inquiry (New York: Plenum Press, 1976): cf. the monistic perspective in E.R. Kandel and J.H. Schwartz (eds.) Principles of Neural Science (New York: Elsevier/North-Holland, 1981) and E.L Schwartz "Computational anatomy and functional architecture of striate cortex: A spatial mapping approach to perceptual coding" (Vision Research 20, 1980).

4. Note especially the dualism of L. Dewitt's "Consciousness, mind, self: The implications of split-brain studies" (Brit. J. for Phil. Sci. 27, 1975) and R. Ziedins's "Identification of characteristics of mental events with characteristics of brain events" (Am. Phil. Q. 8, 1971).

5. Some major 'buildings' (important theories of the mid-19th - 20th century) in the neurosciences and psychology include: Weber and Fechner's (1860) psychophysical theory; James's (1890) explanations of psychological processes; Freud's (1895) interpretation of dreams; Watson's (1920) behaviorist theory; Kohler and Wertheimer's (1947) Gestalt theory; Hebb's (1949) cell-assembly theory; Lashley's (1949) mass action or equipotentiality theory; Cajal's (1954) neuron theory; Chomsky's (1965) syntactic langauge and computational psychology theory; Paivio's (1971) dual-coding theory of imagery and verbal processing; Sperry's (1969) and Kinsbourne's (1974) laterality or cerebral dominance research in commissurotomy; Gibson's (1950), Luria's (1966), and Kosslyn's (1980) componential analysis theory of visual perception and spatial cognition; Regan's (1972) and Davidson's (1978) evoked-potentials (or brain potentials) research, to name a handful. Each of these theories is founded on either monist or dualist views.



car·y·at·id (kar'ē·at'id) *n., pl.* -ids, -i·des (-i·dēz') [pl. *caryatides* < Gr. *karyatides*, priestesses of the temple of Diana at Karyai, in Macedonia] a supporting column that has the form of a draped female figure which represents Nature.
T.F.

. . . visual metaphor

6. I am not using the term "mirrors" or "reflects" in the same way the 17th century systematic philosophers used the term to denote Isabella's "Glassy Essence" or Locke's "mind as mirror" which reflects reality (Rorty, 1979). Instead, the term connotes identicalness or equivalency as in the

relationship between mass and energy (note the connotation of reflectionist dualism, Table 1). To be clear, my mirror conception is not based on the notions of Platonists, Kantians, positivists or other analytical philosophers who maintained that "our chief task is to mirror accurately...the universe around us" (Rorty, 1979, p.357). Nor is it based on the complementary notion of Democritus and Descartes, for example, "that the universe is made up of very simple, clearly and distinctly knowable things, knowledge of whose essences provides the master-vocabulary which permits commensuration of all discourses" (p.357). As if the purpose of the mirror was to "reflect" these 'simple things,' thus revealing the "foundations of knowledge" while bringing us closer to a "theory of representation."

7. According to psychoneural identity theory "every mental state (or event or process) is a state (or event or process) of the central nervous system (or part of it)" (Bunge, 1980, p.6). An important variation (and extension) of this definition is emergentist materialism. As Bunge explains:

> "The emergence claimed for the mental is double: the mental properties of a central nervous system (CNS) are not possessed by its cellular components but are 'systemic properties' and moreover, non-resultant ones; and they have emerged 'at some point in time' in the course of a long biotic evolutionary process...Consequently, although physics and chemistry are necessary to explain CNS functions, they are insufficient. Nor does general biology suffice: we need to know the specific emergent properties and laws of the CNS, not only those it shares with other subsystems of the animal, such as the cardiovascular and the digestive systems." By contrast, "reductive materialism...holds that the brain is nothing but an aggregate of cells, so that knowing the latter is not only necessary but also sufficient for knowing the former and thus explaining the mental" (pp.6,8).

What I would like to emphasize here is that the brain is indeed a "multilevel system." So depending on which level one wants to describe or hypothesize the functions of the CNS, one can employ the reductionist-physicist line of thinking and say something meaningful (albeit, limited) about the the brain's quantum reality. Or one can follow the emergentist-physiologist line of thinking and say something meaningful (though limited) about the brain's organic reality. The point

is, no one definitive theory or explanatory model reveals the whole "Truth" or that tells the whole story. Each theory - with its systematized assumptions, tests and experimental results - must be looked at as a piece of an ever changing puzzle, where the evolution of brain processes marks the evolution of some aspect of human behavior and some advancement in our understanding of the behavior of humankind.

8. The expression **thinking-feeling-doing** is Stephan Chorover's (1982) interpretation of the integrative nature and multi-level system of the brain (from personal conversation). These three words linked together represent the interrelation and integration of the Cortical-Limbic-Brain stem systems. The advantage of this scheme is that it does not set 'exclusive' boundaries between one region and another; instead, it recognizes the free exchange and flux of information within the human nervous system - using the semi-permeable membrane as a model for the neurobiological reality of cerebral processes. Chorover's view is expressly formulated in the following chart.

Organism (biological)	Person (individual)	Group (sociological)
CORTEX	Thoughts (cognition)	Beliefs
LIMBIC SYSTEM	Feelings (affect)	Values
CORE (Brain stem)	Acting (doing)	Practices

The dotted lines imply that there are extensive conceptual transformations of each of these entities which involves the interpenetration of their respective anatomical boundaries. Chorover's diagram also suggests that the association, auditory, cerebellar, motor, and visual cortices - despite their different locations in the human cerebrum - all share common means (i.e. pathways) for communicating with one another. Whether this communication involves the short or long association fibers in the neocortex of the temporal, occipital, parietal, or frontal lobes, or whether it involves the comtact with the deeper allocortex (or archicortex) of the hippocampus (in the Limbic system), the physiological and anatomical fact remains that they do communicate via their labyrinthine neuronal connections. This means that when the afferent fibers from the entorhinal region (in the lower portion of the Limbic system) "speak," various higher regions of the neocortex "listen" and respond.

9. Regarding the nondistinction between animate and inanimate matter, I quote the following passage from an article by Harold J. Morowitz which appeared in The New York Times (June 23, 1980). The Yale psychologist wrote that the U.S. Supreme Court Justices decided that in patent law no distinction exists between the living and nonliving - that is, between naturally occurring and non-naturally manufacture or composition of matter.

> "Millennia of awe and respect for the special character of life, dating back to biblical times, or before, are being discarded if that life has any element of biological or genetic engineering in its synthesis. The refusal to draw a sharp distinction between animate and inanimate matter is the ultimate in reducing life to physics, a viewpoint that has been forcefully advocated with the scientific community since the mid-1800's."

The ultimate dangers of this notion may involve a similar nondistinction between, for example, rational and irrational behavior. I believe this is what Morowitz feared most when he said that the Court's decision in the Diamond v. Chakrabarty case 'goes beyond the confines of patent law and ultimately, may find its way back to our view of humanity.'

10. In Bunge's (1980) history of the mind-body problem, we learn of several contemporary philosophers who sensed this same single reference. For instance, the materialist Herbert Feigl who straddled between the notions of identity and neutral monism, felt that "no matter how much the concepts of psychology may differ from those of neurophysiology, they have the same referents. Moreover, he believed that a mere critical reflection upon the meanings of the terms 'physical' and 'mental' should eventually solve the mind-body problem (Feigl, 1960)."

    Bunge objects to this view stating that "the various languages employed to describe mental events - in particular, Mentalese, Behaviorese, and Neurophysiologese - are not mutually translatable on the whole. This is because their sentences do not express the same propositions."(p.94) I tend to side with Feigl on this matter.

11. For an in depth account of the implications of the Cartesian interactionist dualism and/or mechanistic world-view, read Fritjof Capra's Turning Point (New York: Simon & Schuster, 1982), Chapter 2.

    Read also Paul Feyerabend (ed.) Mind, Matter, and Method (Minneapolis: University of Minesota Press, 1966).

12. In Facets of Indian Thought (New York: Schocken Books, 1964), Betty Heimann writes: "The Zero-concept is not only a mathematical discovery, but was originally conceived as a symbol of Brahman and Nirvanam. Zero is not a single cipher, positive or negative (growth and decay) but the unifying point of indifference and the matrix of the All and the None. Zero produces all figures, but it is itself not limited to certain value. It is "sunya," the primary or final reservoir of all single shapes and numbers (p.24)...Zero is the transition-point between opposites, it symbolizes the true balance within divergent tendencies (p.97)...Zero is the falling-together of all numbers...the sum of all numbers, positive and negative combined." (p.112)

R. Balasubrahmanian writes (in Advaita Vedanta [Madras: Centre for Advanced Studiy in Philosophy, University of Madras, 1976], pp.116, 117): "The **Upanisad** says that Brahman is 'one only without a second.' The advocates of plurality argue that sruti speaks of the ultimate reality as one in the figurative and not in the real sense. On the basis of such an interpretation they argue that plurality is real...According to Advaita, oneness alone is real, and plurality, whenever mentioned, is used figuratively. The world of plurality is not real as it is dependent on maya"...and "our perception of plurality is not real, but illusory."

My hope is that, with the coalescence of this thinking and Western thought, there will emerge a "new vision" (Moholy-Nagy, 1938) and a "philosophy in a new key" (Langer, 1963) - one that will speak in terms of "inseparable relations" (**Aprthak-saddht**) and "relations of identity-in-difference" (**Tadatmya**). Perhaps this new philosophical view will deftly apply the Indian expression "not this, not that" (**neti-neti**) or "this as well as that" (**Sive-sive**).

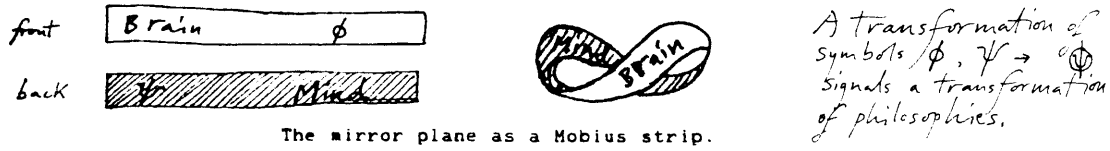
13. The concept of the dialectic, like the notion of "mirror reflection," has inspired, seduced, provoked and perplexed humankind throughout recorded history. In reading the history (of the evolution) of this concept, one is bound to inquire: What aspect(s) of "reflection" (thesis, antithesis?) attract and repel us so? Is it the physical characteristics of light-radiation and specular reflection (i.e. "speculative" philosophy) that touches us or is it the metaphysical and metaphorical potentialities that move us?

In the case of mirror reflection, it seems strange that something as rigid and static as a plane mirror would be compared to something as flexible and dynamic as a human mind. Apparently man's interest in the mirror lodged itself in his imagination long before his fascination with optics, in particular, his discovery of physiological optics (Helmholtz, 1896). Certainly, the mirror's illusory properties - and

visual illusions in general (e.g. Mueller-Lyer figures, Hering illusion, Jastrow illusion, the "moon illusion," mirages, etc.) - have intrigued humankind. I suspect that man's **awareness of the reality of illusions prompted insights into the illusions of reality.** Where the former relies primarily on visual perceptions, the latter relies on mental conceptions. At some point in our history we twisted and then connected the ends of this awareness thus creating a Mobius strip (i.e. a topological melding) of perceptible and conceptual reality. Hinduism and Buddhism seem to confirm this thought by saying: "Reality is one thing but the learned call it many things." Once one has accepted this world-view - concerning the connectedness of, for example, the perceptual and conceptual process - no aspect of reality or nature or life is seen (and believed) to be "problematic," "separate," and "unrelated." Neither the universals nor the particulars of matter and mind, or mass and energy, are seen to be in opposition to "one another." Rather, "they" (I really mean the singular case) seem to **fulfill their complementarity through unification.**

Somehow, in the course of analyzing this 'unification' and the 'problematical' nature (of our understanding) of reality, some Western philosophers such as Ryle (1949) were led to believe that "a mentalist must be a dualist; in particular, that mentalism and materialism are mutually exclusive" (Fodor, 1975, p.4). I hope I have convinced my reader that this route of thinking leads to a dead end. In fact, it clearly confuses 'the mind's knowledge of the mind,' by thinking in terms of "exclusivity" and "either-or" (as in the Law of the Excluded Middle). History shows that Descartes, Locke, Kant, and other members of the Western regime followed this line of thought to its logical conclusion (Rorty, 1979).

14. The simplest way to show this shift in perspective - from the Cartesian-Newtonian world-view to holistic world-view - is by relating, for example, the gist of the neural identity theory to the one-sided surface of a Mobius strip.



The mirror plane as a Mobius strip.

We must credit this 'broadening of notions' and 'shift in perspective' largely to the research efforts of high-energy physicists (e.g. Bohr, Chew, Bohm, Kaluza) and cosmologists (e.g. Hawkings, Edelman) who are not just curiously uncovering the mysteries of matter but who are curious about the human mind which is doing the 'uncovering,' i.e. making the discoveries. Although current textbooks on quantum

mechanics and nuclear physics still have not factored the influences of the mental processes into the observations, measurements and related experimental techniques, some authors maintain that such references are inevitable (Capra, 1982; Wilber 1982).

One of the ramifications of this view involves correcting the 19th century notion (of Wundt's and of Avenarius's) that psychology deals with "immediate experience" while physics deals only with experience "mediately" (Boring, 1962). The psychologist Edwin Boring presents an interesting account of this issue in The Physical Dimensions of Consciousness (New York: Dover Publication, 1962):

> "Avenarius's position is that there are two ways of regarding experience. Psychology...regards experience as dependent upon the experiencing individual, whereas physics regards it as independent. Here we seem to have two coordinate points of view and to have avoided the derivation physics from psychology. However, psychology has now become factually mediate. Experience, instead of being prior to physical entities, like the nervous system, is now held to be dependent upon the experiencing individual; and the experiencing individual is, for all practical intents, the nervous system.
>
> Thus we come out with a circle. Experience is the cognitive ground of those inferences which yield the material of physics (Wundt). The brain is a physical entity. But the brain is actually the essential condition of experience" (pp.4,5).

15. I relate this statement to William James's (1890, p.46) statement: "The point which as evolutionists we are bound to hold fast to is that all the new forms of being that make their appearance are really nothing more than results of the redistribution of the original and unchanging materials. The self-same atoms which, chaotically dispersed, made the nebula, now, jammed and temporarily caught in peculiar positions, form our brains; and the 'evolution' of the brains, if understood, would be simply the account of how the atoms came to be caught and jammed." In this sense, we touch on and are touched by everything.

    See Image 77, "A Lateral View of The Evolution of Human Brain Processes," p. 98.

16. On the subject of scientific research programs, read Quine (1953), Popper (1957, 1965, 1972), Kuhn (1959, 1970), Lakatos (1970), among other scientific historians and philosophers.

17. On a similar note: one may recall that scientific definitions of the laws of thought (to borrow George Boole's [1854] phrase) have proven to be as fragile and tenuous as the analytic techniques and experimental strategies used to define these 'laws.' Consider the research of: **atomists** or neuronists (intent on tracing ideation back to individual neurons; e.g. McCulloch and Pitts, 1943), **holists** (intent on investigating the brain as a whole - "mass action" [Lashley, 1929] and "field physics," [Kohler, 1947]) and **systemists** (intent on describing the integrative functions of neural systems as a means to understanding thought processes; e.g. Hebb, 1949 and Bindra, 1976). Although many valuable insights and hypotheses have emerged from these studies, one is still left wondering what thought is. It appears as though we need some larger atomistic-holistic-systemistic approach for integrating the various schemes and data in a comprehensive way.

18. Heimann (1964) refers to the "Brahman" in Indian philosophy as the 'amorphous principle, active within the potential without the empirical facts and factors' (p.112). Although this reference does not exactly characterize my mirror concept, there are some curious similarities between this philosophical principle, which involves "transition, transformation, and reflection," and my notion of the process of mirroring which resembles the synthetic actions of Brahman (instead of the actions of the plane mirror). "The Brahman," Heimann writes, "is not bound to such or such definition and arbitration...It defies all prediction and discrimination. It is constant, and yet dynamically changing in visible existence...It is in-divisible in its unity - even when manifesting itself in the Universe through particles of its essence" (p.118)...Thus the sum of all [its] manifest forms comprises only a small, or even negligible, part of the Whole" (p.119)

    I regard the "Mirror" as Reality's **ideal mechanism** for penetrating Reality itself. The history of mathematics illustrates brilliantly how one principle of mirroring - namely, the equality sign - can be used forcefully to no ends (e.g. mathematical induction - Dantzig, 1954).

19. For a discussion on "philosophy without mirrors," read Richard Rorty, Philosophy and The Mirror of Nature (Princeton, New Jersey: Princeton University Press, 1979). The author offers a cogent polemic against the 17th-century systematic philosophers, pointing out the strengths of those Western "edifying" philosophers (such as [the early] Wittgenstein, Heidegger, Dewey, Sellars) who avoided what the author calls "the self-deception which comes from believing that we know ourselves by knowing a set of objective facts" (p.373).

My theory of **cerebral fusion** ("intuition") and **cerebral fission** ("reasoning") is an amalgam of theories: for example, theory of thought (Bruner, Goodnow, & Autin, 1956); productive thinking (Wertheimer,1959); cell-assemblies (Hebb, 1949, 1980); imagination and creation (Kohler, 1947; Koestler, 1964); intelligent behavior (Bindra, 1976); mindfulness (Edelman and Mountcastle, 1978); and stream of thought (James, 1890, 1910). What separates my conjectures from those authors are the multitude of philosophical perspectives (some contrasting) I maintain, as well as the way I express and conceptualize my ideas through art. My visual conceptualizations of human neuropsychological processes (e.g., "Thought Assemblies") are not cast in diagrammatic 'statement-picture' form (Rom Harre's [1961] term); that is, they do not follow the conventional procedures of scientific investigation and illustration. Instead they are abstract and suggestive (interpretive) rather than instructive (illustrative) or explanatory. My theory has emerged from a phenomenological study of insight-perception and expression and not from experimental studies (unless one considers the experiences upon which introspection is based).

In many respects, the writing and research presented here are **ideas and images towards a theory proper** as opposed to being an opus of science. Moreover, my investigations are based on my introspective analyses [1] and the introspections

of professional artists, scientists, engineers, mathematicians, writers and scholars with whom I have been fortunate to work in the last six years. In the course of my own investigations, I have reviewed reports of research in the neurosciences and psychology as a way of tempering my conjectures. For example, in examining the details of my theory, I have reviewed some research which investigates the states of brain and cerebral functions: e.g., evoked-potentials (Regan, 1972; Bodis-Wollner, 1982), positron emission tomography (Heiss & Phelps, 1980), nuclear magnetic resonance (Pieniadz, 1983; Tsai, 1983) and lateralization (Gazzaniga, 1972; Sperry, 1968a, 1969, 1976; Trevarthen, 1980). This fact aside, my thesis is philosophical and personal in so far as it considers my own views and methods of researching and representing neuropsychological processes.

There are many different ways of describing human mental activity. Most observers would agree that there are many different types or forms of thought (e.g. images and propositions [Paivio, 1977]; "preperception" [James, 1890]; "perceptual inference" or "conscious conclusion" [Helmholtz, 1962]; problem-solving, insight, and productive thought [Selz, 1927; Koffka, 1935; Wertheimer, 1945; Kohler, 1947; Osgood, 1953]). As well, there are many varieties of expression (of feeling) (e.g. poetic, pictorial, and musical compositions [Langer, 1953; Bronowski, 1956; Sircello, 1972]).

My research concentrates only on two processes of thought [2]: **intuition** (which I call **"cerebral fusion"**) and **reasoning** (which I call **"cerebral fission"**) (see Figure 4) [3].

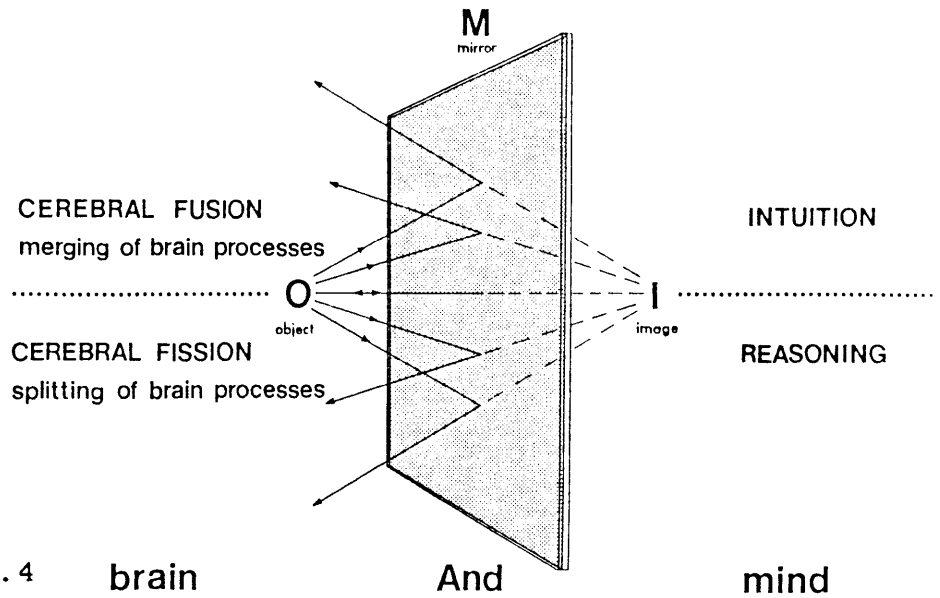


Fig.4 brain And mind

Here **reasoning includes both analytic and affective reasoning** in artistic and scientific expressions (representations) of knowledge, experience, etc. Virtually every form or aspect of reasoning is represented in artistic expression including sequential, feature by feature reasoning (as in spatial cognition) and emotional or affective reasoning (i.e. reasoning about and with emotions as in the discrimination of feelings).

The following drawings, notes and diagrams (Figures 5 - 10, pp.25-31) are my interpretations of the physical basis and distinction between **cerebral fusion** and **cerebral fission**.

Cerebral Fusion

functional and electrochemical unity

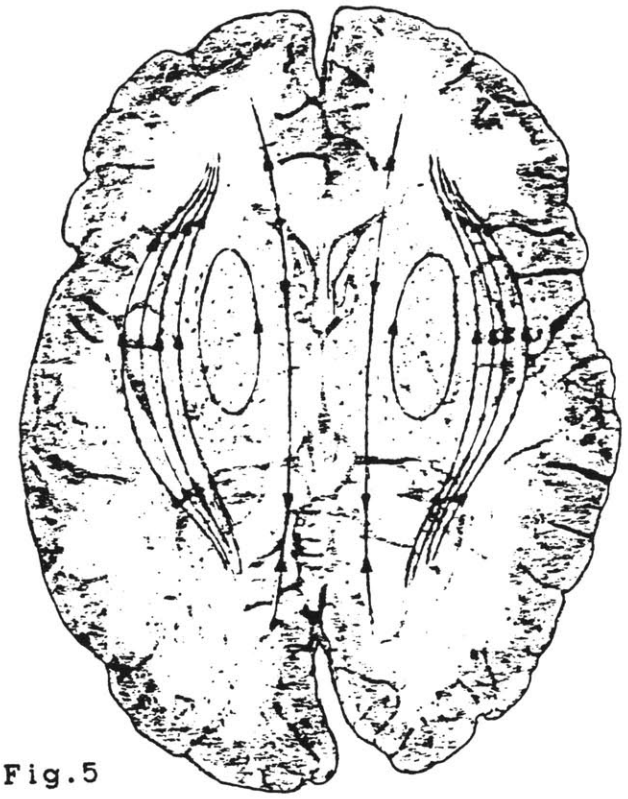


Fig.5

I posit that **cerebral fusion** (Figure 5) involves the merging of vast streams of mental impulses from the three principal subsystems of the brain: the brain stem, Limbic system, and cerebral cortex (see Figures 7, 9a&b). At the instant of intuition, both hemispheres function conjunctively in focusing information; for tens of milliseconds or less, there is an electrochemical unity between cerebral hemispheres. In **cerebral fusion**, many different cell-assemblies (in the different regions of the brain) would form or be activated simultaneously. This sudden activation would represent the convergence of differnt thoughts and feelings (reasonings, memories, sensations, perceptions, judgements, motives). Depending on whether one is experiencing a visual, or aural, or tactile, or olfactory intuition, certain regions of the nervous system (see Figure 7) will be activated either simultaneously or sequentially.

Cerebral Fission

functional and electrochemical disunity

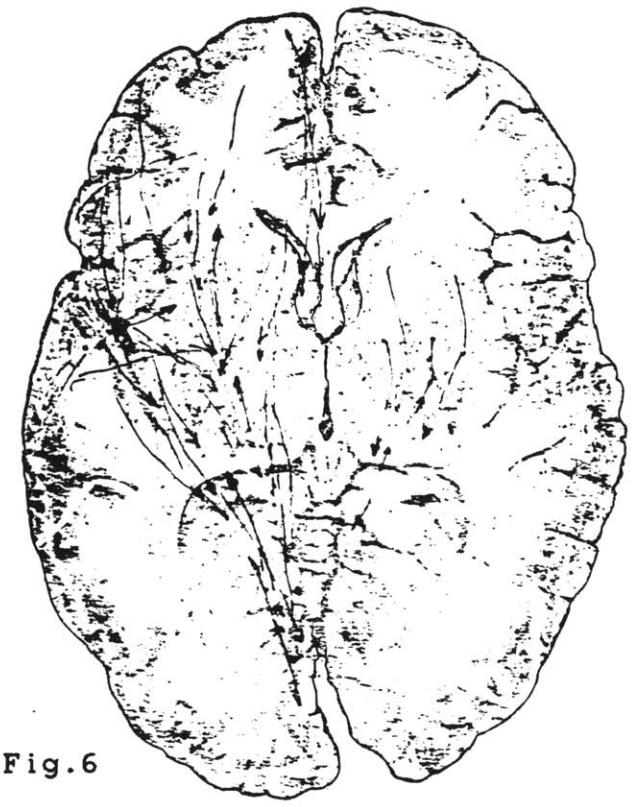


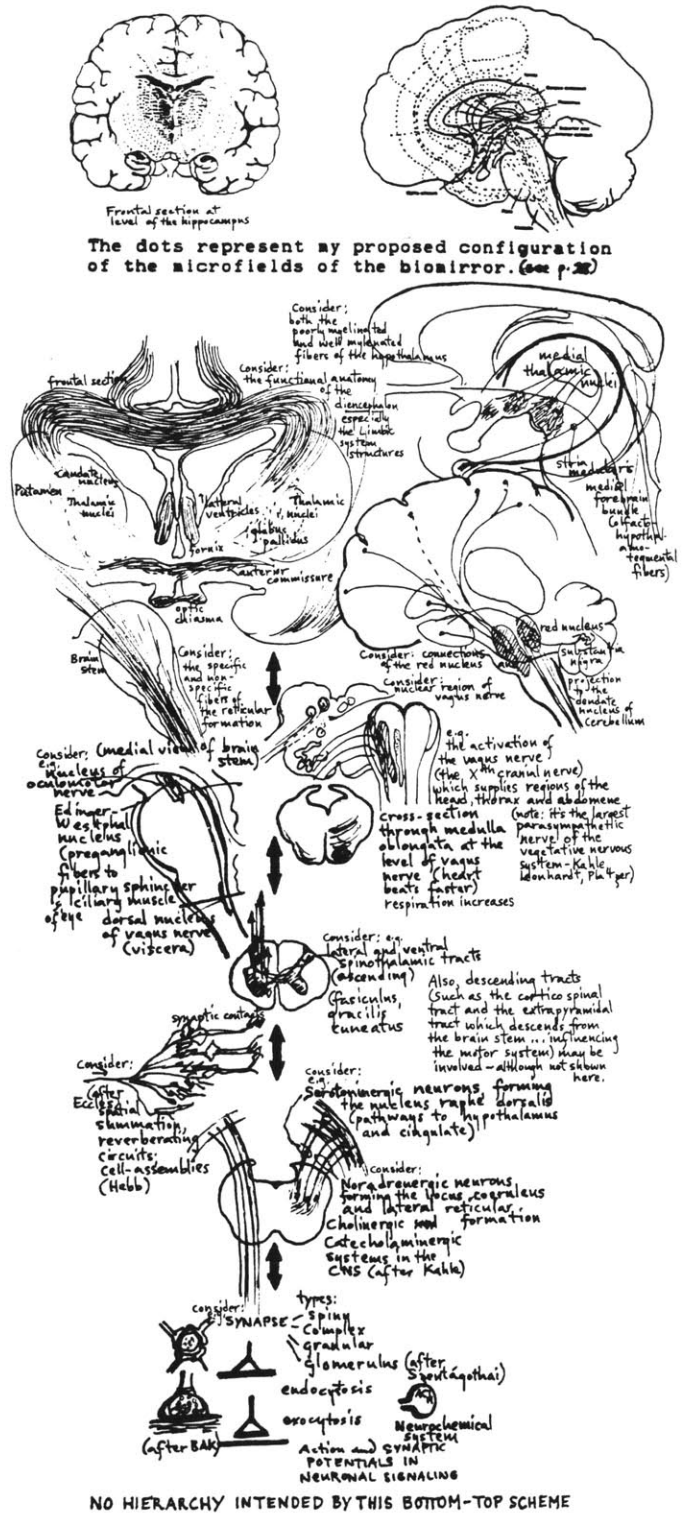
Fig.6

By contrast, in **cerebral fission** (Figure 6) one hemisphere is "more prominent than" the other; implying that there is an electrochemical disunity between hemispheres (see Figures 8, 10a&b). By dominant I mean that the cerebral functions **in either hemiphere** momentarily exceed those of the other. I do not mean that the language functions of the left hemisphere permanently dominate or govern the the nonverbal functions of the right cerebral cortex (as the word implies in its current usage). **Cerebral fission** occurs the moment one subvocalizes or analyzes an intuition (in one's mind's voice or eyes); it marks the next phase of physiological events. That is, the cell-assemblies involved cease being excited in the area in which the intuition originated.

CEREBRAL FUSION

Neuroscientific Analysis

anatomical and physiological correlates



INTUITION

Introspective Analysis

... the having of, or experience of, an idea, 'insight or sudden inspiration ... regarding intuition; I think ... that different degrees of "intensity" determine (or are determined by) different anatomical regions affected by changes ... Intuition is not just an activity of the telencephalon but involves the diencephalon and rhombencephalon; as well, it may involve just about every type of nerve cell (spiny, complex, glomerulus) in the CNS and PNS; or a few cell-assemblies in both cerebral hemispheres (not symmetrically related) create a symmetrical field which has a ... large resonance - making it seem that the whole nervous system and sensory organs are activated; the same stimulation of the parasympathetic and sympathetic nervous system (which is responsible for sustaining / regulating the internal state of the organs and their coverings) may be affected when one experiences an intuition; one or all of these parts of, for example, the sympathetic nervous system (involving the heart and lungs) is stimulated with the stimulation of the hypothalamus (the main integrative organ of the autonomic [or vegatative] system; cell-assemblies in the reticular formation of the brain stem (controlling heart rate, respiratory frequency and blood pressure - note drawings) activate cell-assemblies in the peduncle of the mamillary body - from the medulla to the ... rostral midbrain ... some stimulation reaches the reticular formation as well, and so forth ... There are a set number of pre-established (fixed) cell-assemblies (making up specific "chains" that are activated at the instant of intuition [as distinguished from analytic reason]; there is not a set number of pre-established cell-assemblies ... there are, instead, loosely connected, 'temporary' cell-assemblies that are ... connected instantaneously and are then broken up (returning to whatever state they were in before being 'assembled'); depending on the ... scope (or focus) and content of the intuition, different regions are activated for different lengths of time; all in all, there is a directness in intuition that is not present in analytic reasoning and expression ... there is an immediacy (in reaching from one region of the CNS to another, in reaching from one part of a problem [to be solved], or idea [to be ... explained], or feeling [to be expressed] to another part) .. it seems as though a number of steps in the process of thinking are by-passed thereby abbreviating the thought process (i.e. neurophysiological processes of ... thought and feeling); I sense that intuition may be an immensely accelerated form of reasoning in which whole sections of the reasoning process are omitted [as if they were inefficient] - in leaping from the beginning to the end of a problem, idea, awareness, etc. - without intention.

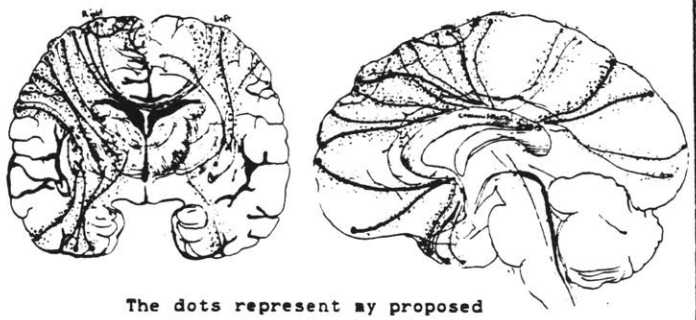
MIRROR (IN REALITY, THERE IS NO DIVISION)

Fig.7

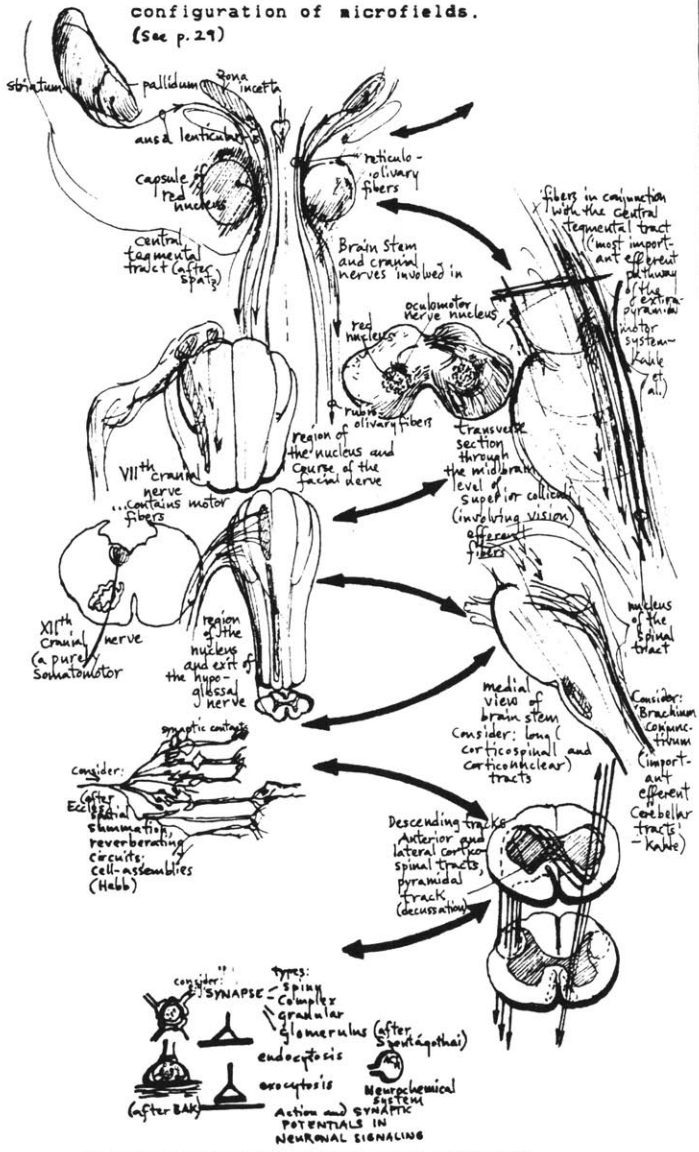
CEREBRAL FISSION

Neuroscientific Analysis

anatomical and physiological correlates



The dots represent my proposed configuration of microfields.
(See p. 29)



NO HIERARCHY INTENDED BY THIS BOTTOM-TOP SCHEME

REASONING

Introspective Analysis

...on analyzing and
...on expressing an idea, experience, insight-perception
or sudden inspiration... regarding analytical and
emotional reasoning (ie. reasoning about/and
with emotion - as when you think about your
feelings - though not necessarily reasoning
emotionally)... I think that different degrees of "intensity,"
in reasoning logically
or irrationally (with dream-like logic), are determined by
different [anatomical] regions... just as
specific associations or conceptual connections"
'involve specific areas of the cerebrum...
...Consider the idea that forumating concepts
about one's sensations (ie. how one feels at any given
moment) originates in Areas 3-1-2 (PB-PC-PD)
- the principal sensory areas of the cerebrum
(note Brodman and von Economo's map)
...or that the "thought of movement" and motion
originates in Area 6 (FB), Area 4 (FA) and Areas
18-19 (OB-OA) - the visual association areas...
as one thinks about moving one's body or
rotating an image in one's mind's eye
or associating a particular work of art
with slow or rapid movements
(think of Moholy-Nagy's "Space Modular" sculpture
and Takis's telemagnetic sculpture, vibrating)...
would the thought of these and other
objects actually originate in the region of the brain
specialized for visualization and motion?
Or, do specific thoughts come to be by
the combination of several regions...
how is this known...
how is this 'combination' known
without disrupting the experience
of the individual?
How?
Does reasoning - either analytical or emotional -
work other than by putting parts (of things, ideas,
sensations, impressions) together... after naming them
and defining their functional dimensions...? Does
logic and discursive thinking begin, in say,
the Putamen or the internal and external
capsule or some other subsystem/part
of the diencephalon? How can one
come to Know the thought (the brain processes - my note)
through which all things are moved through all
things' [as Heraclitus contemplated]?
What "moves through" human kind with
the movement of information during
specific moments of 'thinking-
feeling-
acting'? Is it possible,
that in the lines and gestures,
forms and expressions of
the things we create -
from poetry and mathematics
to advanced technology - we can
glimpse our brain processes
and learn the dynamics
of thought,
especially productive
thinking?!
Do we need to Know the
specific author (ie. the specific
neural pathway) or title of the book
(ie. the content of the information communi-
cated 'inter-neuronally) or the date/time the book was
written (ie. the moment of transmission of the information)
in order to understand the writing on the ways and means
of the central nervous system? Do we just need the
page number (ie. the nerve cells targetted) and a chapter
(without an author) in order to construct a picture of
the working brain? ... Do we need to know the publisher
(the neurochemical systems) or distribution?
How does the neural language
reflect the mental language?

MIRROR (IN REALITY, THERE IS NO DIVISION)

Fig. 8

Bio-Electric-Magnetic-Chemical Mirror
in
CEREBRAL FUSION

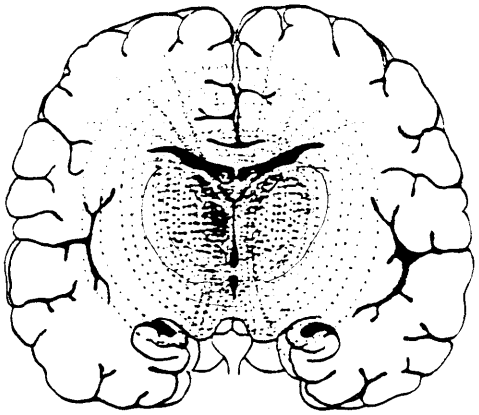


Fig.9a Front view of human cerebrum. The dots represent the proposed **symmetric microfields** in cerebral **fusion.** (Drawing [without microfields] adapted from Kahle, 1976).

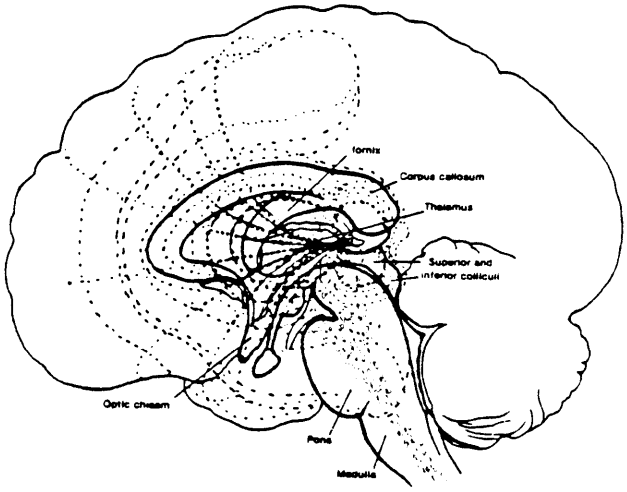


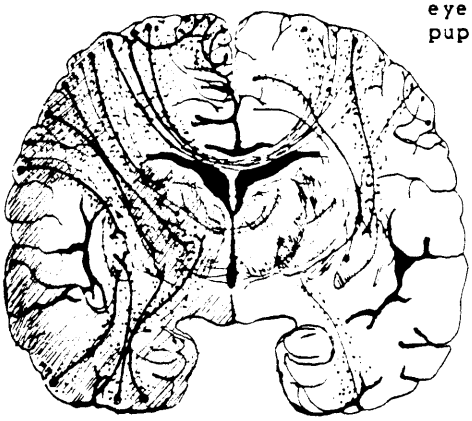
Fig.9b Sagittal view of the brain showing the regions and proposed configuration of the **symmetric microfields** indicated by the dots. (Drawing [without microfields] adapted fro Kahle, 1976).

The **biomirror** is a term I coined to refer to a certain state of brain or level of neuronal activity in **cerebral fusion.** If one were able to observe the physiology of one's own brain as this 'fusion' occurs, one would probably notice some resonant electrochemical activity between the cerebral hemispheres. To me, this indicates the convergence of many different sources and forms of information. The details of this 'convergence' (i.e. the specific structures or regions of the brain activated and the sequence of their activation) go beyond the scope of my thesis.

Conceivably, the **biomirror** has biolectrical, biochemical, bioelectromagnetic aspects, but the specific details are unimportant to me. The fact that it may exist is what interests me. At present, I think of it not so much as a structure but as an electrochemical event linked to the stimulation of a specific structure - perhaps the diffuse and nondiffuse fibers of the reticular formation (in the rhombencephalon and mesencephalon) which connect the thalamic nuclei and other main cell groups (in the diencephalon). Or perhaps the **biomirror** involves the Papez circuit (one of the 'principal mechanisms of emotion') [4].

In cerebral fission one part of the brain (for example, either the left or right hemisphere) momentarily 'dominates' or 'excels' over another part. One's eyes may be focusing on an intricate pattern (involving Area 17) while one's fingers are feeling the material on which which the pattern is printed or woven (involving Areas 5-7, or Areas 3-1 [PB-PC-PD]). In this instance, one receives and analyzes diverse sensory and perceptual bits of information without necessarily integrating any of them. Here "analytic reasoning" includes various forms of sensory discrimination (involving, for example, Areas 18-19 [OB-OA] and Area 8). One may also be comparing this information without making specific conceptual connections or associations.

CEREBRAL FISSION



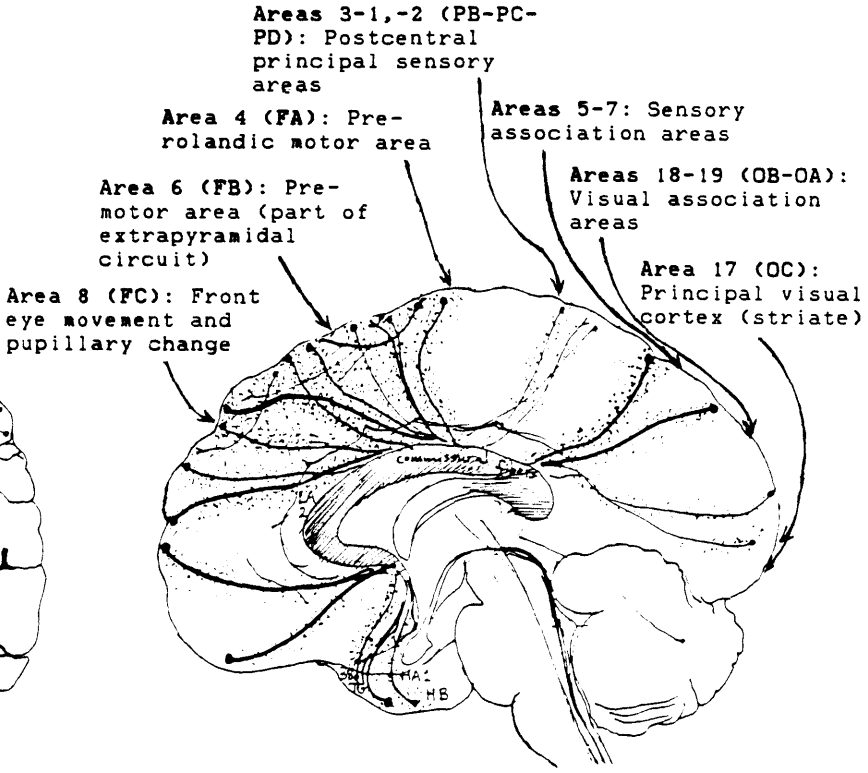
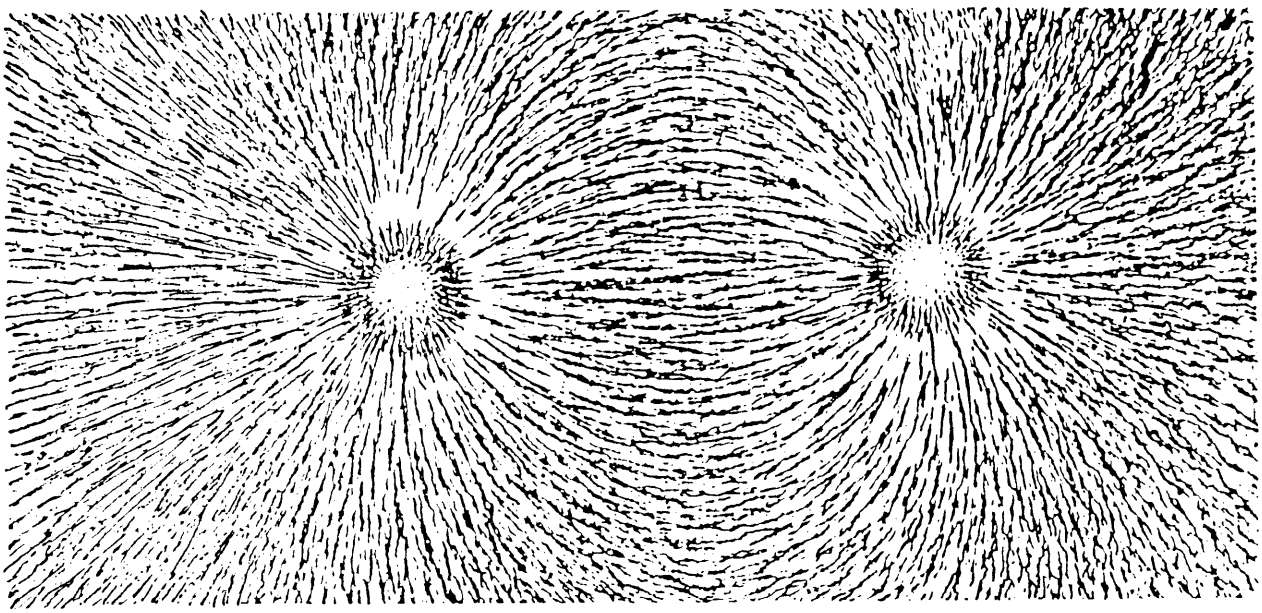


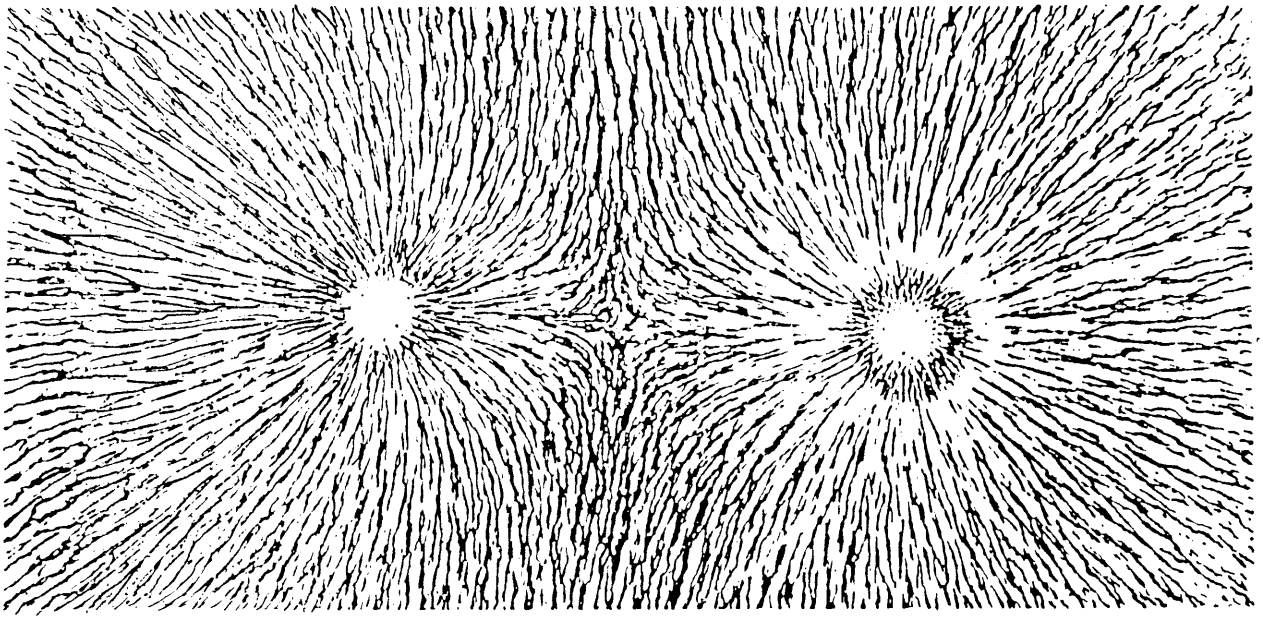
Fig.10a Front view of the human cerebrum. The dots (surrounding the pathways) represent the proposed **asymmetric microfields** in cerebral **fission**. First the right side organizes the idea - partly visualizing it (note: Areas 17-19, Fig.10b) - and then the left side articulates the idea, i.e. verbally or in writing (note: fibers or main pathways for the cerebral hemispheres are not shown well in this drawing). (Drawing [without microfields] adapted from Kahle, 1976).

Fig.10b Sagittal view of the brain showing the cortical areas according to Brodmann (numbers) and von Economo (letters), specifying functional locations. The dots surrounding the pathways represent the proposed **asymmetric microfields**. (Drawing [without microfields] adapted from Kahle, 1976; the Brodmann and von Economo map adapted from J.G. Chusid, Correlative Neuroanatomy and Functional Neurology, 16th ed., New York: Columbia University Press, p.12)

CEREBRAL FUSION



CEREBRAL FISSION



'Magnetic "lines of force" revealed by sprinkling iron filings onto a sheet of card below which magnets are concealed. (Top) The case of two unlike poles; (Bottom) two like poles: here the lines of force "repel" each other.' (J. Yule Ted.] Concise Encyclopedia of the Sciences, 1978)

Fig.11 A visual metaphor:

When magnetic fields are traveling in reverse directions it is like two opposite poles of a magnet being brought in proximity; they attract each other. This is essentially what occurs during **cerebral fusion**. Conversely, **cerebral fission** implies that the fields in both hemispheres of the brain are traveling in the same direction, at somewhat different rates. This is similar to bringing like poles of two magnets together so they repel one another. Thus, **cerebral fission** is the "splitting" of thought processes and **cerebral fusion** is the "merging" of these processes. Both are needed, like the two poles of a magnet, to make the mental system work.

My concept of **cerebral fission** is generally consistent with the notions that others have advanced regarding the complementarity of hemispheric specializations (Dimond & Beaumont, 1974; Milner, 1974; Teuber, 1975). However, it specifically opposes the concept of cerebral dominance or "major" and "minor" hemispheres (Geschwind, 1965a&b, 1984; Gazzaniga, 1972, 1978; Berlucchi, 1974; Sperry 1974; Zaidel, 1978b; Heilman, 1979; Puccetti, 1981) and lateralization (Whitaker and Ojemann, 1977; Kinsbourne, 1974a). Where my views on the dynamics of 'dominance' and 'laterality' differ from the scientists' cited above are on the specification of cerebral functions and their role in thinking-feeling-doing. My belief is that the right (so-called "mute") hemisphere is as calculative and analytical in its **holistic** abilities as the left (so-called "dominant") hemisphere is in its reductive abilities. Similarly, the visual, auditory, motor, and sensory cortices of the left hemisphere are as unitary and synthetic in their **analytic** abilities as their right hemisphere counterparts. Another contradistinction (which is perhaps the most important) is that I identify "synthetic insight" or intuition with the convergent, coordinated activities of **both hemispheres** as opposed to only the right cerebral hemisphere.

The instant of intuition signifies the fusion of the cerebral hemispheres like two light atomic nuclei uniting in a great concentration and confinement of temperature. In this instant, two opposite forces overcome (or fulfill) their

complementarity, forming one greater force. Reasoning, by contrast, signifies the division of the cerebral processes like the nucleus of an atom splitting apart into two nuclei, one heavier than the other [5].

Thus **cerebral fusion** and **cerebral fission** correspond to two phases of thought: (1) experiencing an intuition or sudden inspiration and (2) expressing the intuition using various processes of reasoning [whether consciously or otherwise] (see Figure 12). Both processes of thought are needed to sustain each other. Intuitions are oriented toward neither art nor science; they inform both. Analyses and expressions are by convention either art or science. They are records of what is experienced (see "Thought Assemblies," Chapter 3).

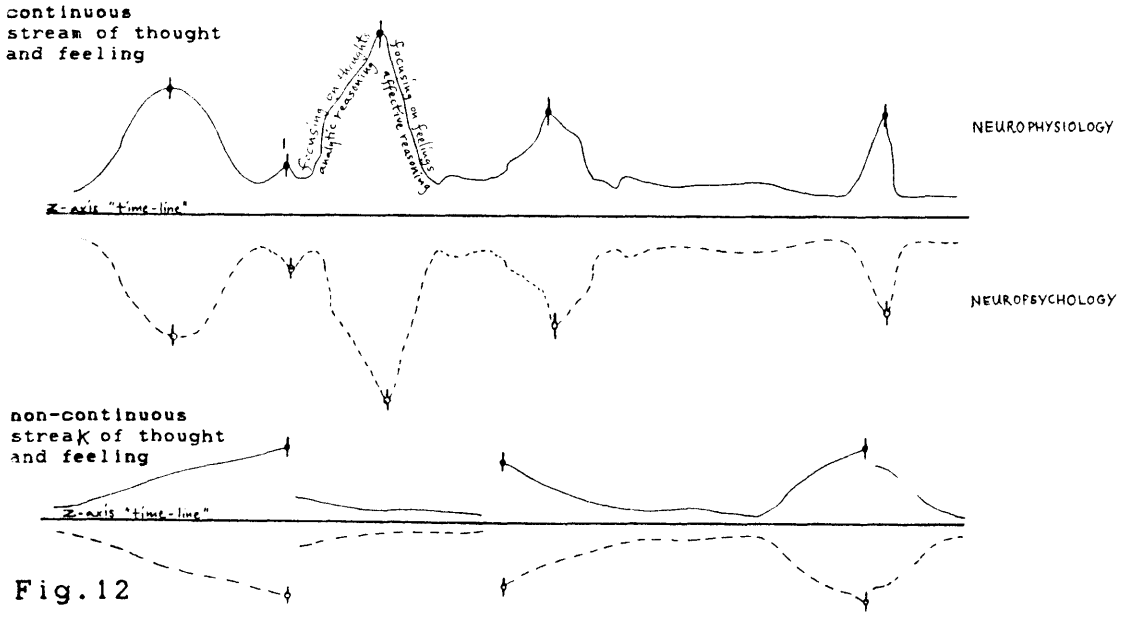


Fig.12

points of "cerebral fusion" (insight-perception, intuition)

lines of "cerebral fission" (analytic reasoning and expression)

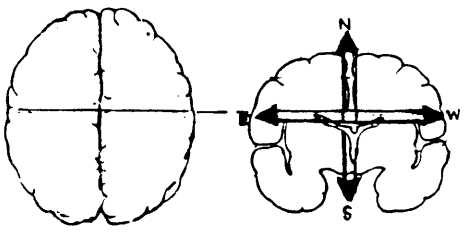
James (1980, p.279) writes: "Let the horizontal line represent time. Every part of it will then stand for a fraction, every point for an instant, of the time. Of course the thought has time-parts...They [time-parts] melt into each other like dissolving views, and no two of them feel the object just alike, but each feels the total object in a unitary undivided way."

It is important to outline the basis of my **cerebral fusion-fission** concept so as to distinguish it from one mainstream notion in particular - that creative thinking involves at least two processes, convergent and divergent thinking (Guilford, 1967). Like Guilford, I am leery of equating creative thinking with divergent (indirect) thinking. As he rightfully warns us: although 'we might arbitrarily define creative thinking as divergent thinking, it would be incorrect to say that divergent thinking accounts for all the intellectual components of creative productions' (p.160). Also, I am in agreement with the idea that creative thinking - as a 'connective' and 'productive' act - involves a multitude of cognitive processes (Gallo, 1983, p.150) [6]. Without question the cognitive processes, in combination with environmental and social or cultural influences (Helu, 1983), are responsible for all acts and artifacts of expression. But how is thinking related to feeling and acting? What is the link between cognition, affect and action (making or doing)? This is a mystery that invites the full participation of our imagination [7]. Even more mysterious is how artistic and scientific creations manifest our feelings and thoughts, dreams and intentions. Are works of art and science exemplars of these brain (cognitive) processes? If so, in precisely what sense and to what degree?

Implicit in my concept of **cerebral fission** is the

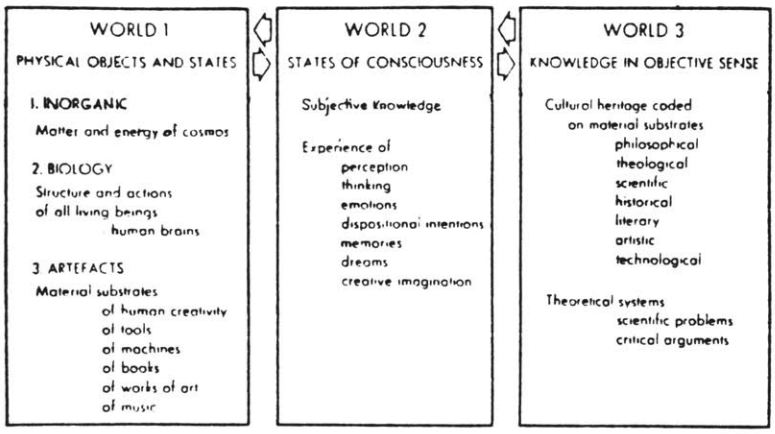
notion that acts of expression (artistic and scientific representations of knowledge) result from various forms of **reasoning**. Whether or not artistic representations such as Ch'en Shun's (1483-1544) cursive calligraphy, or Arp's automatic drawings, or Pollack's drip ["action"] paintings appear to be "spontaneous," or "feelingful," or instantly emotive, their production involves reasoning. They consist of design decisions and calculations (involving spatial and temporal matters). As these works show, the processes of **reasoning** can be both cool and calculative or hot and impulsive (which is not, to my mind, antithetical); reasoning can involve the cognitive processes of both cerebral hemispheres as well as the affective processes of the Limbic system (Papez, 1937) [8]. My **cerebral fission** concept intimates that the process of **reasoning** (in the work of art and of science) is driven or sustained by intuition (with its [intuition's] accompanying inspiration). Furthermore, it implies that there are not only "longitudinal" aspects of reasoning (east or west of the prime meridian, i.e. left or right of the midline) but "latitudinal" aspects as well (north or south of the equator, i.e. the Limbic system structures) [9].

I mean to say that the brain must also be stem functions acts of reasoning factored into mean to suggest (Note: I do not that the brain is a sphere.)



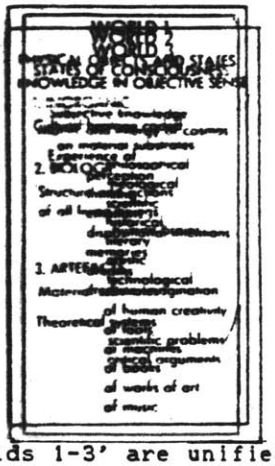
front view
(cross-section)
(bilateral and
hierarchical)

Reasoning is no more a synonym for restraint, limitation, or mental regulation than intuition is. Intuition may not have references to the rational processes, but it may nonetheless involve these processes. Similarly, rational reasoning (in its present lexical definition - 'drawing conclusions or inferences from observation, facts or hypotheses') may not refer to instinctive knowing or synthetic insight, but it may nonetheless use this form of knowledge. I believe there are at least **two sides to the plane of reasoning**, just as there are conscious and subconscious types of logic associated with states of wakefulness and dreaming or imagining. **Intuition is the edge of this plane, connecting the two sides.** What has come to be known as left-right [major-minor] cerebral processes (see Figures 13a&b) [10]) is now being challenged by cognitive scientists and psychologists who favor the notion of complementary processes. As I have stressed, the cerebral processes, which involve everything from arithmetical operations to abstract, perceptual operations, may be **unified** during moments of intuition (see Figure 14). The detection and study of this unification (or the existence of this hemispheric coordination) will require considerably more sensitive tests than cross-modal visual and tactile tests (Franco and Sperry, 1977), or composite face stimuli tests (Levy et al., 1972). The development of new tests and task analyses seems imperative.



'Tabular representation of the three worlds that comprise all existents and all experiences as defined by Popper (Eccles, 1970).'

Fig.13a



'Worlds 1-3' are unified at the instant of intuition; all distinctions between 'Worlds' are blurred.

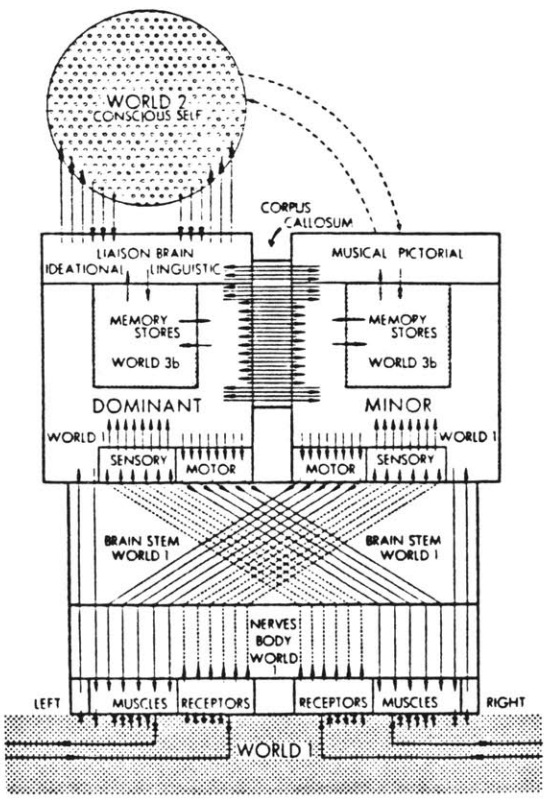
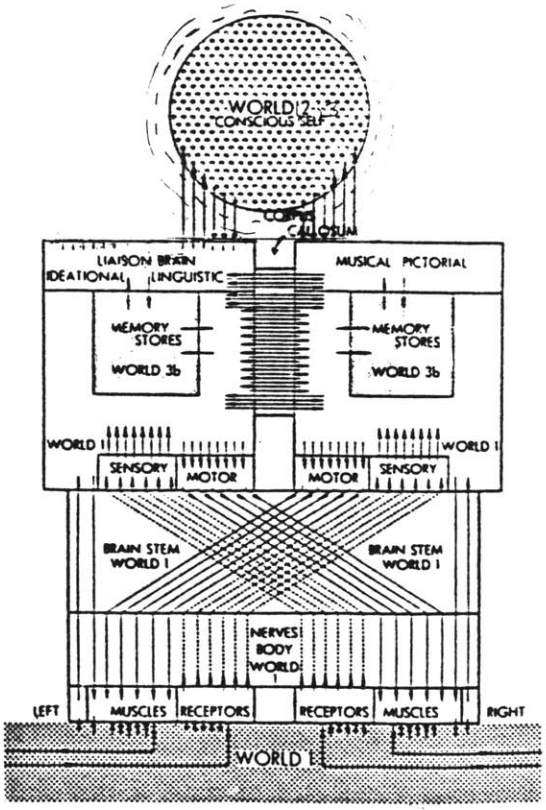


Fig.13b



(Figures 13a&b from Eccles and Popper, The Self and Its Brain [Springer-International, 1977]).

Fig.14 **No 'dominant' hemisphere in cerebral fusion.**

My diagram (Figure 14) suggests that there are instances in which the 'three worlds that comprise all existents and all experiences' (Eccles, 1970) come together as "one world." I refer to these instances as the moments of **cerebral fusion** which mark the convergence of specific hemispheric functions.

In the context of Eccles's and Popper's diagrams (Figures 13a&b) this act of **coming together through intuition** implies that there are not 'dominant' and 'minor' hemispheres. Rather, there is a sort of **cerebral parity** (as opposed to predominance) between the cognitive functions and functional anatomy involved in memory, ideation, linguistic and pictorial representation, etc. At the instant of intuition, 'subjective and objective knowledge' seem to merge as one **simultaneously feels and thinks** about a particular object, event, process, idea, etc. [11]. In **cerebral fusion**, there may be a momentary convergence of language and manipulo-spatial activity - combining cognitive functions of both hemispheres (see Figure 15). Although there is no physiological evidence to validate (or invalidate) this conjecture, I would venture to say that in this instant of unrestrained thought, both the cortical and subcortical systems ('Brain stem,' World 1, in Figure 13b) involved in **thinking**-perceiving-reasoning [analytically] and **feeling**-sensing-reasoning [emotionally] are briefly integrated [12].

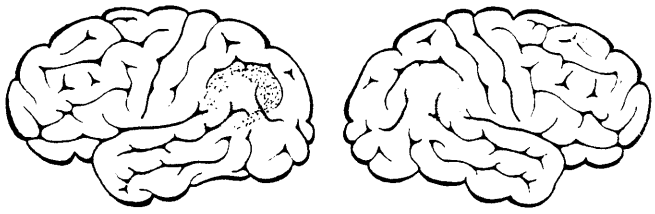


Fig. 15 Language versus manipulospatiality in the human cerebrum. In the right half-brain, the presumed neural substrate of manipulospatiality (the inferior parietal lobule) is shaded. The shaded area in the left hemisphere represents the language-comprehension regions of the parietotemporal junction (see text for explanation). (From Gazaniga/LeDoux, The Integrated Mind, 1978, p. 59.)

With this shift in view away from the traditional **left**-(analytical, logical, words) **right** (intuitive, spatial, images)

notion of cerebral functions, it is important to inquire: is it a myth or a fact that works of art represent only intuitive expression [13] - as though "spontaneity" and "intuition" are the sole ingredient for creative (productive) expression? This notion implies that for a creative product to be truly "expressive" and "feelingful" it must be intuitively felt. Conversely, one must ask: is it a fact or a myth that works of science represent only analytical expression [14]? Is compulsory, necessitated and analytical reasoning the qualifying element of scientific representation? The notion that it is implies that intuition is somehow extrinsic to science and that its entry into scientific discourse must have an enervating rather than an invigorating effect on it.

The myth of spontaneity and intuition seems to have emerged out of the concept of 'anima' (Jung, 1964) [15] (i.e. the animal spirit). According to Jung, the anima was thought to be as mysterious and opaque as the pitch black, most distant regions of deep space. Apparently, it was associated with some other space (or world) other than that which is inside the human brain; that is, the anima was not derived from or based on bodies, nerve cells, or other biological matter. It was **something** other than these things. Notions of intuition, like anima, have a **spiritual** significance attached to them which notions of analytical mind do not have. In this context, to say that a theory is born from intuition is to say that it originated from the mind (the mind outside the brain). Simply, these

notions are redolent of dualism (note "Animism," Table 1).

More troublesome, these dualist notions are indirectly responsible for dividing our society into artist-**types** and scientist-**types** - so-called "right-brain thinkers and left-brain thinkers" [16]. These preconceptions have their roots in the philosophical positions I listed in Table 1, Chapter 1 and have become so deeply entrenched in common parlance that it is difficult to challenge them. Moreover, they have been carried over into the interpretations of split-brain research. Thus, for example, the idea of a "mute," "minor" hemisphere versus a "dominant," "major" hemisphere is formed in part from this dualistic perspective.

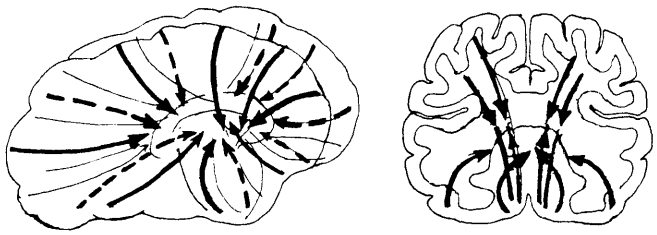
As I pointed out in Chapter 1, some philosophers of science (e.g. Bunge, 1980) argue that the dualist dogma continues to influence the analysis and interpretation of hemispheric processes. One is led to believe that a natural dichotomy exists between the side that reasons and the side that intuits. A fact that seems to add credence to the notion of "natural dichotomies" is that humankind has been thinking in terms of dichotomous (complementary) relations for more than four thousand years of recorded history. For example, descriptions of **reasoning** rarely refer to fire, or the 'pneuma'[17], whereas intuition has always been associated with great heat - as if its processes were the nonphysical counterpart of the sun's. The "coolness" of reasoning and

cognition is frequently contrasted with the "heat" of intuition and **affect**. For me, the experience of intuition is one of heightened feeling and willing, intending and imagining, perceiving and sensing. As Figure 7 intimates, the whole central nervous system is involved in a way that it does not appear to be involved in acts of reasoning and expression. In cerebral fusion, the whole-part (or universal-particular) relation is seen in full light and resolution. In other words, the process of intuition pulls together the functions of the three principal subsystems: the brain stem, Limbic system, and neocortex.

It is to be remembered that there is no "integrated mind" without an **integrated brain** [19]. When one speaks speaks of dominant or major versus minor hemispheres, one is not talking about "integration." And one is certainly not thinking in terms of **cerebral parity** or **equality**. Integration begins with seeing the interconnectedness of the parts of the brain and its connections with the things it creates. It begins with understanding that in the 'act of creation' one not only can 'connect previously unconnected frames of reference and experience reality on several planes at once' (Koestler, 1964), but one can experience in the deepest sense the connection between one's self and the universe at large. I mean that one can see the relationship ["connection"] between the neuropsychological processes of **cerebral fusion-fission** and the fusion-fission processes of the physical universe [20].

One way to test this fusion-fission concept is in terms of its relationship to the literature on hemispheric specialization (e.g. Galin & Ornstein, 1972; Dewitt, 1975; Bradshaw & Nettleton, 1981; Bryden, 1982). For instance, studies involving the direct examination of cognitive functions in both right and left cerebral hemispheres could be helpful (Nebes, 1978); also important are studies of: 'cerebral asymmetries, emotional experience, and [mental] imagery' (Ley, 1979); 'right hemisphere dominance for mediating cerebral activation' (Heilman & Van Den Abell, 1979); 'lateralized cognitive processes and the electro-encephalogram' (Davidson & Ehrlichman, 1980); 'bilateral hemispheric, alpha activity during visual imagery' (Barrett & Ehrlichman, 1982); and the unity of consciousness (Eccles, 1970; Nagel, 1971; Penfield, 1975).

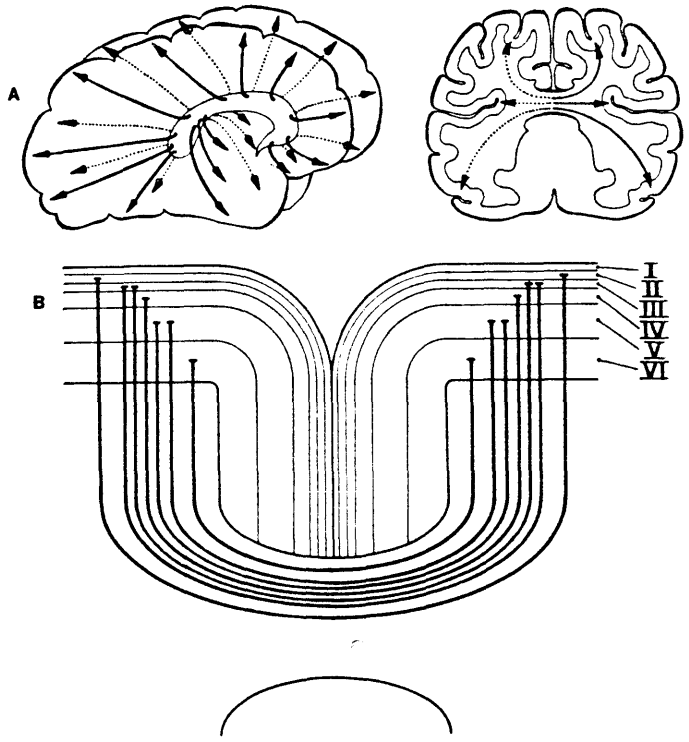
My strategy would be to use as many different techniques and paradigms for discerning hemispheric specializations and differences, with the understanding that each paradigm has its inherent bias. I find, for example, most hemispheric studies do not mention the possibility that other subsystems (particularly subcortical systems) may be contributing to supposedly "strictly cortical" responses. Figure 16 on the following page explores the idea that subcortical systems are involved in the "merging" of brain functions (in cerebral fusion).



Cerebral fusion

involving the convergence of information in the Diencephalon

Fig. 16 Could there be a merging of brain functions (»cerebral fusion«) at the instant of intuition and a splitting of these functions (»cerebral fission«) in moments of analytical reasoning and self-expression?... Fig. 14
Are the electromagntic fields in the brain »prints« which naturally demonstrate these functional relationships between and within cerebral hemispheres?
Do the changes of these fields coincide with the changes in the two modes of thinking: »cerebral fusion« (intuition) and »cerebral fission« (reason)? How can this be shown scientifically?



Cerebral fission

Fig. 17 "Homotopic nature of commissural connections. Interhemispheric fibers largely interconnect homologous areas in the two half-brains (Part A). In addition, they mostly terminate in the cortical laminae from which they arose in the opposite hemisphere (Part B)." (Gazzaniga & LeDoux, The Integrated Mind, 1978, p16.)
(Fig. 16 is my complementary drawing to Fig. 17)

Gazzaniga and LeDoux (1978) write: "It is characteristic of bilateral nervous systems, which all vertebrates have, that sensory information concerning one half of space is isomorphically mapped onto one half-brain, while the other half-brain receives information concerning the other half of space. By way of interhemispheric communication, the lateralized maps are duplicated contralaterally. Each half-brain is thus provided with nearly simultaneous representations of both sensory spheres, and interhemispheric perceptual equilibrium is achieved. Therefore, we view interhemispheric communication as the mechanism by which the illusion of a single, complete psychological space is created from two separate neural representations of the same information" (p.17).
What are the implications of cerebral fusion effect in commissurotomy?

Some of the most promising research in this area of the neurosciences are the positron computed tomography (PCT) studies of human sensory stimulation and deprivation (Phelps & Mazziotta, 1983) and the event-related potentials studies which utilize powerful psychophysiological techniques in distinguishing 'responses to conscious and unconscious stimuli' (Davidson, 1978). With the PCT technique one is able to see the changes in brain physiology associated with changing states of mind (states of brain) [21]. Using ^{18}F-fluorodeoxyglucose (FDG) and PCT in humans, scientists have examined the relationship between glucose metabolism and cerebration. For example, Phelps and Mazziotta (1983) have studied [in their words] 'the effect of cerebral glucose metabolism of (1) selective or combined forced auditory and visual sensory deprivation...(2) visual stimulation of progressively increasing complexity...(3) visual stimulation in patients with lesions of the visual pathways...and (4) monaurally and binaurally presented verbal (factual story) and nonverbal (music, tone sequences, chord pairs) auditory stimuli...' (p.139). Figures 18 and 19 provide a clear picture of the types of studies needed to examine the proposed **cerebral fusion-fission effects**, along with the event-related potentials studies. Doing these studies requires the input of the brain sciences and cognitive sciences and other researchers (in both the sciences and arts) [22].

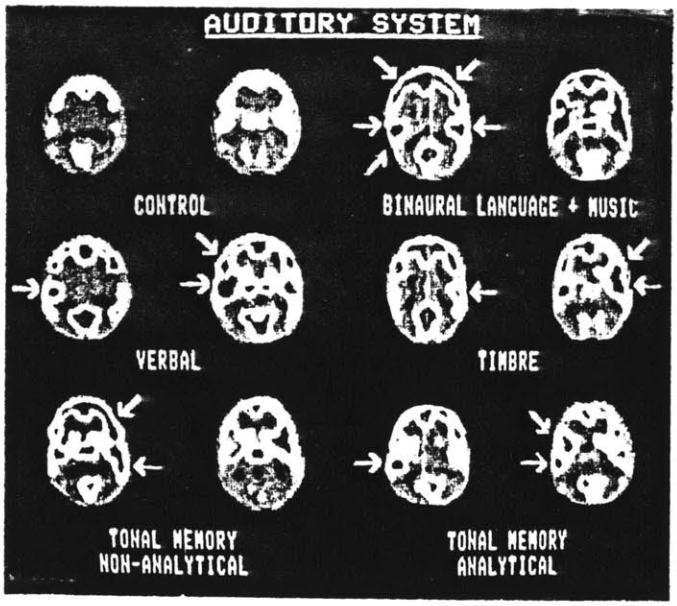


Fig. 18 "Composite set of examples for individual subjects imaged in a variety of states of auditory stimulation. Note that the areas of asymmetry correlate with the stimulus content and/or the analysis strategy of the subjects. No correlation was found between the ear of stimulation and the metabolic response. While the complex nature of the auditory stimuli employed in this study resulted in complex metabolic responses, it also demonstrated the feasibility of studying primary and higher order central processing of auditory stimuli using PCT techniques. Note in particular the bilateral activation of the frontal and temporal cortical zones with combined language and music stimulation, whereas verbal stimuli produced predominantly left-sided asymmetries and activations. Chords (timbre) produced predominantly right-sided asymmetries and activations. Results of stimulation with the tonal memory test produced two subgroups which differed by their analysis schemes in interpreting the auditory information. Analytical individuals who used visual imagery and/or were musically sophisticated had left-sided activations and asymmetries of the posterior temporal zone. Musically naive individuals who used subjective strategies without visual imagery had predominantly right-sided asymmetries and activations similar to subjects who listened to pairs of chords (timbre)." (Mazziotta et al., 1982b) (from Phelps & Mazziotta, 1983, p. 146)

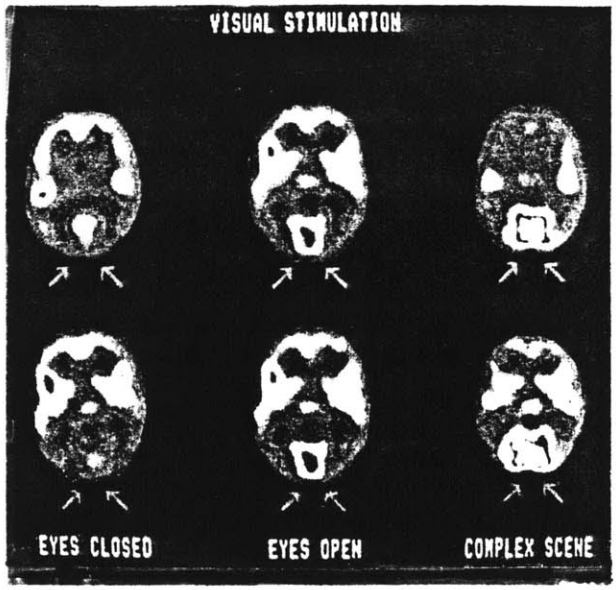


Fig. 19 "Cerebral metabolic activity of the primary and associative visual cortex in the eyes-closed state compared to white light stimulation and the complex stimulation of an park. Note the progressive increase in metabolic activity in both AVC and PVC as the visual stimulus complexity increases." (Phelps et al. 1981b) (from Phelps & Mazziotta, 1983, p. 143)

My interpretation of this 'bilateral activation' is that some form of **cerebral fusion** is occurring in which conceptual "connections" are being made bilaterally and hierarchically. In **cerebral fusion**, one connects and associates; by contrast, in **cerebral fission**, one compares and discriminates [23].

The PCT studies do not explicate **how** or even **when** one thinks and feels and creates, although they do offer concrete evidence that a change in brain activity occurs when a person is in fact

thinking and feeling and acting or creating at a particular moment. Perhaps when the visuospatial nature of a task is understood more fully - and when more sensitive tests are devised - this investigatory technique will come nearer to this explication [24].

Phelps and Mazziotta's (1983) description of the methods of visual stimulation in normal volunteers indicates that, conceivably, the results would have altered if more complex and specific stimulation had been used. Suppose, for example, that the subjects were asked to study the 'surface and symbol' of an artwork. The task could be structured in such a way that the subject could imagine the steps an artist took in realizing the work of art (testing the ancient re-creation hypothesis [25]), while exploring the possible meanings of the artwork. One might ask: would this exploration indirectly reveal the brain processes involved in the search for and creation of meaning? I think so. Depending on how the task was structured and presented, I suspect there would be noticeably different metabolic rates and brain regions activated by this task versus the original one. As it turns out, there is an increase in metabolic rates. Phelps and Mazziotta (1983) report that "progressive increases in both the primary (PVC) and the associative (AVC) visual cortex were demonstrated with visual stimuli of increasing complexity" (p.142) [26].

The types of questions experimenters would ask depend largely on the cognitive functions or abilities they wish to test. In addition to studying the so-called "global" (or holistic) versus "local" (or analytic) processing of information in the cerebral hemispheres (using, for example, a tachistoscopic recognition paradigm - e.g. Boles, 1984), I think it is essential to develop experiments which test as many different functions simultaneously [27]. In terms of testing my theory of **cerebral fusion** and **cerebral fission**, a number of strategies may be employed that rely on NMR, PCT and event-related studies. One is to concentrate only on commissurotomy (split-brain) patients, focusing on whether or not there is some sort of momentary convergence of information in the diencephalon as determined by these electromagnetic, metabolic, cerebrovascular, and electrophysiological studies.

Experiments which incorporate more "realistic or natural" situations - combining relatively complex, multi-modal stimuli (e.g. visual, auditory, and tactile) - might be best for studying the cerebral fusion-fission phenomena. Consider, for example, a subject looking at videotapes (on an assortment of topics) in special environments designed to be touched or physically explored. Anyone who has experienced one of Nam June Paik's large-scale video installations, or one of Stan VanDerBeek's steam screen film projections with sound, or one of Piotr Kowalski's time-reversed, audio-visual, interactive television productions, knows what I am talking about. Devising

"curious" situations or environments to test specific cognitive abilities holds much promise for PCT research. I would think that the experimental results obtained from subjects experiencing different environments (both "ordinary" and "unusual") would be significantly different from those obtained from more steadfast laboratory conditions. For example, the difference between a subject 'viewing the surroundings of a park' [presumably from a room] (Phelps & Mazziotta, 1983, p.140) and actually **being** in a park - experiencing the environment directly - has to be more "meaningful" in terms of the wider sensory experiences (which naturally affect stimuli-responses) [28]. To me, the **natural** environmental conditions or settings are the most promising, although they are considerably more complicated to interpret. As I mentioned before (p.41), there is no one paradigm that can single-handedly explain information processing in the human nervous system.

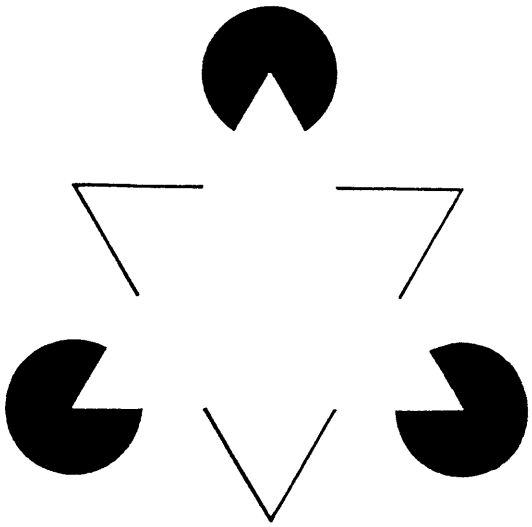
Another strategy is to use clinically normal male and female subjects in multi-modal stimulation studies. Subjects ranging in ages from 21 to 61 years (although volunteers could be younger or older) would participate in more interactive tasks (if possible) [29]. One task might require that the subject comment on a series of color slides shown in rapid succession on a projection screen. Or the subject might be asked to reconstruct an image from memory of a short film shown in the laboratory prior to the FDG injection. Selecting

the content of the slides, tapes, films, and sounds is as important as selecting the questions to be asked by the experimenter. Some questions should be highly abstract, avoiding any direct answer. Likewise, the content of the stimuli should be symbolic and nonrepresentational to avoid immediate recognition of the stimuli [30]. Other tasks might involve a more passive participation in which several different stimuli are presented in a specific sequence. For instance, as the subject is lying supine and relaxed on the scanner bed, s/he first receives a verbal stimulus (i.e., the experimenter reads a brief statement about a sculpture); then the subject receives a visual stimulus (the experimenter presents a slide or short videotape on the making of the sculpture); and then, s/he receives a tactile stimulus (the experimenter presents the actual sculpture; a small, abstract, bronze or marble form. Finally the subject is asked if this form resembles anything s/he has ever seen before or imagined. That is, the subject is invited to free-associate the artwork at hand. Although I am suggesting the use of traditional works of art in scientific studies of cerebral functions, I mean to include a broader spectrum of art and artmaking in these studies.

One study involves reinterpreting a variety of pictures and diagrams such as the ones in Figures 20 - 25. The task is partially constrained in so far as the subject is asked to consider the metaphorical meanings of a particular image and to look beyond these meanings. Some of the images presented

here (Figures 20 - 23) originally appeared in the the heyday of Gestalt psychology in which the study of perception involved studying the five principles of shape-pattern recognition. Other images (e.g. Figures 24a&b, 25) are more abstract and implicit. I selected these visual stimuli because they seem to show the transition point between logical and analogical aspects of productive thinking [31].

ORGANIZATION IN PERCEPTION



ORGANIZATION IN CONCEPTION

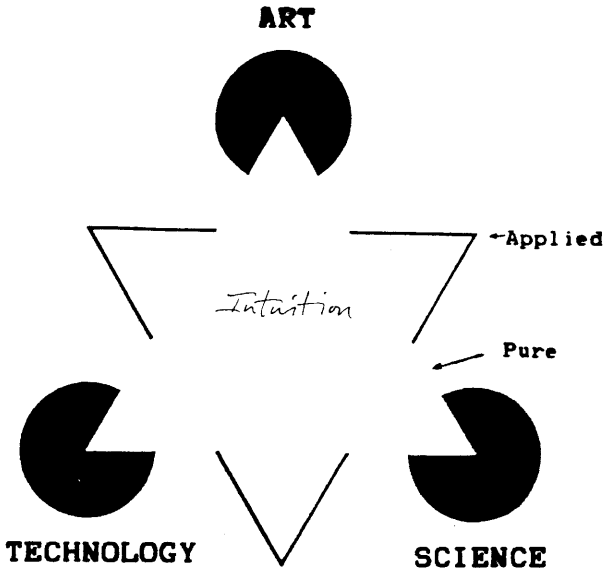


Fig.20 (Koffka, 1935)

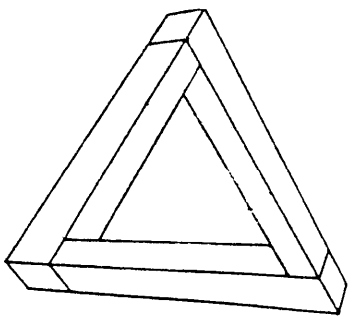
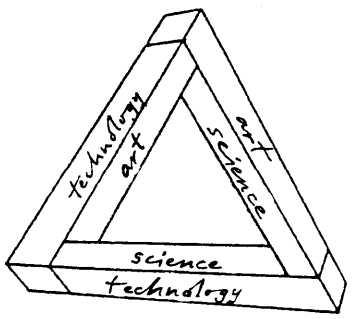


Fig.21 (Penrose & Penrose, 1958).



[32]

The Multi-dimensional Triangle of Intuition

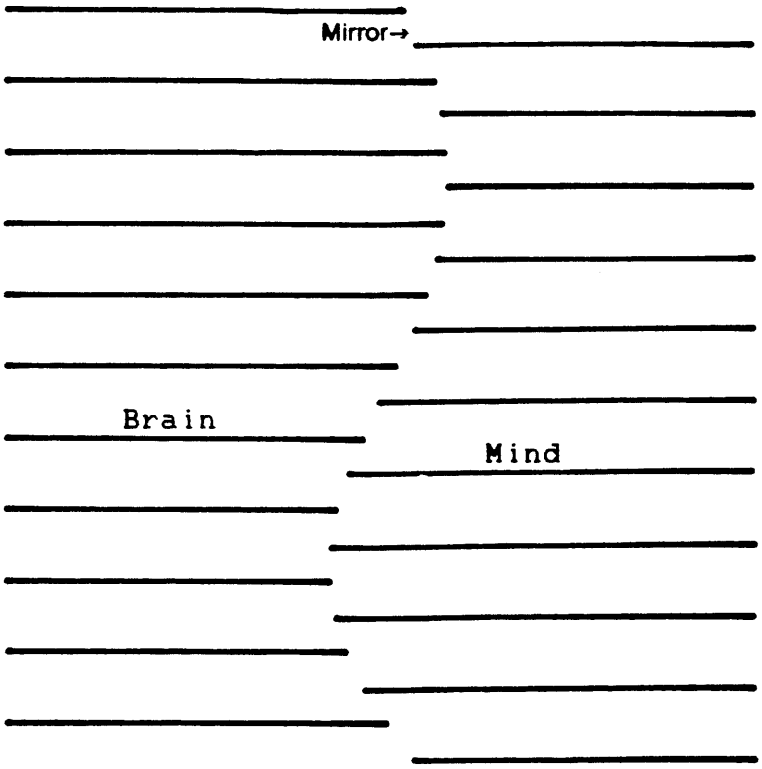


Fig.22 (Modified drawing from Jusczyk & Klein, 1980)

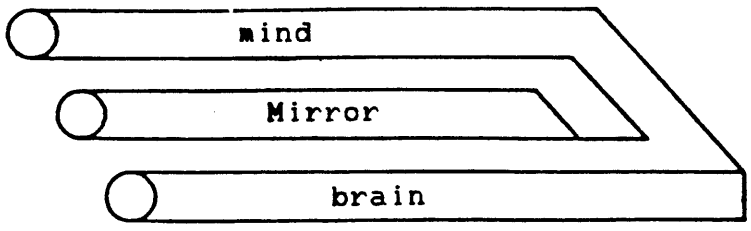


Fig.23 "Unthinkable" figure (L.S. and R. Penrose 1958).

Is only the middle column "illusive"?

Visual Metaphor involving "Sight and Insight-Perception"

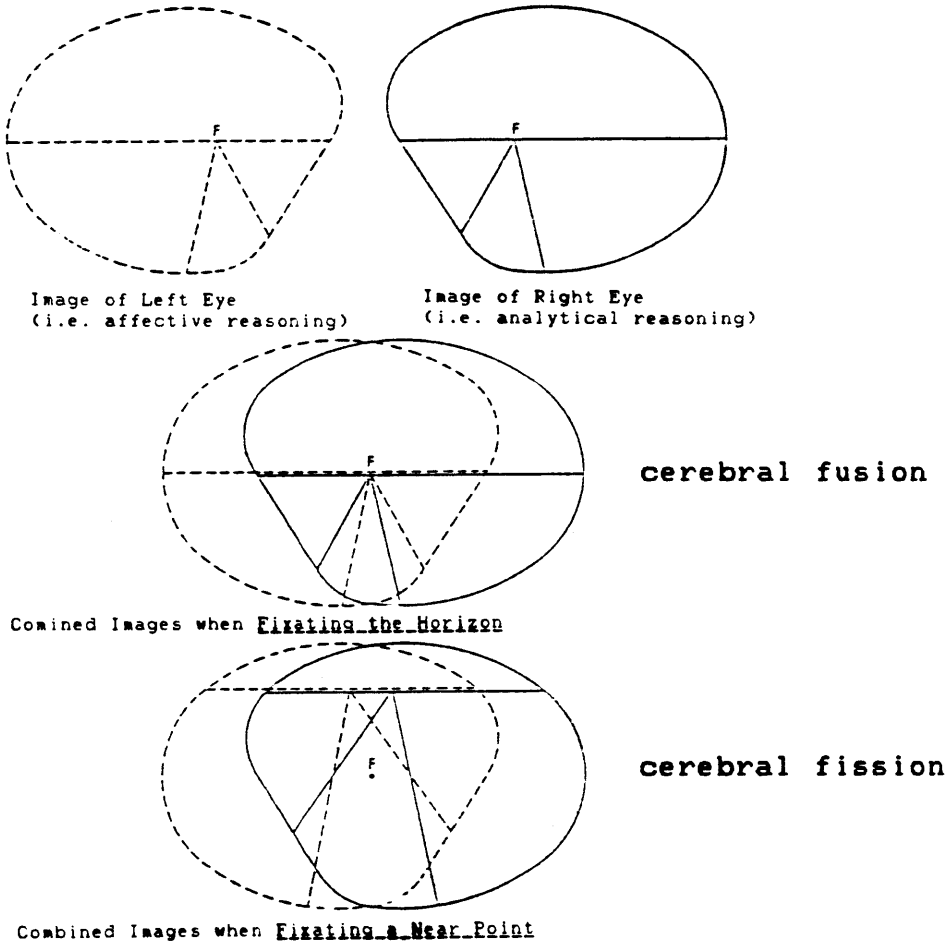


Fig.24a "Schematic Projections of the Retinal Images of the Two Eyes and their Combination, showing Disparity" (Modified from J.J. Gibson, 1950).

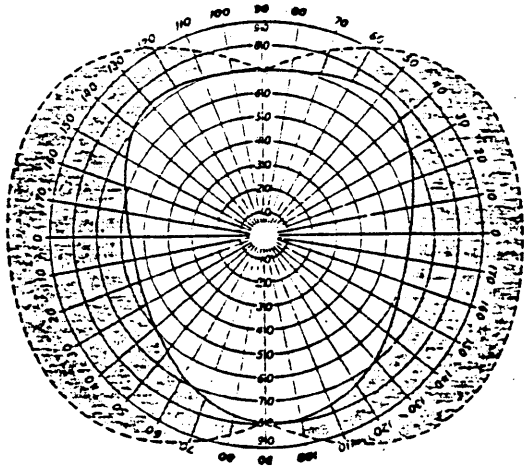


Fig.24b "The Visual Fields of Each Eye and the Binocular Field, as Measured with a Perimeter." (Modified from J.J. Gibson, 1950).
The "Conceptual Fields" of Each Hemisphere and the "Unifield," i.e., their combination

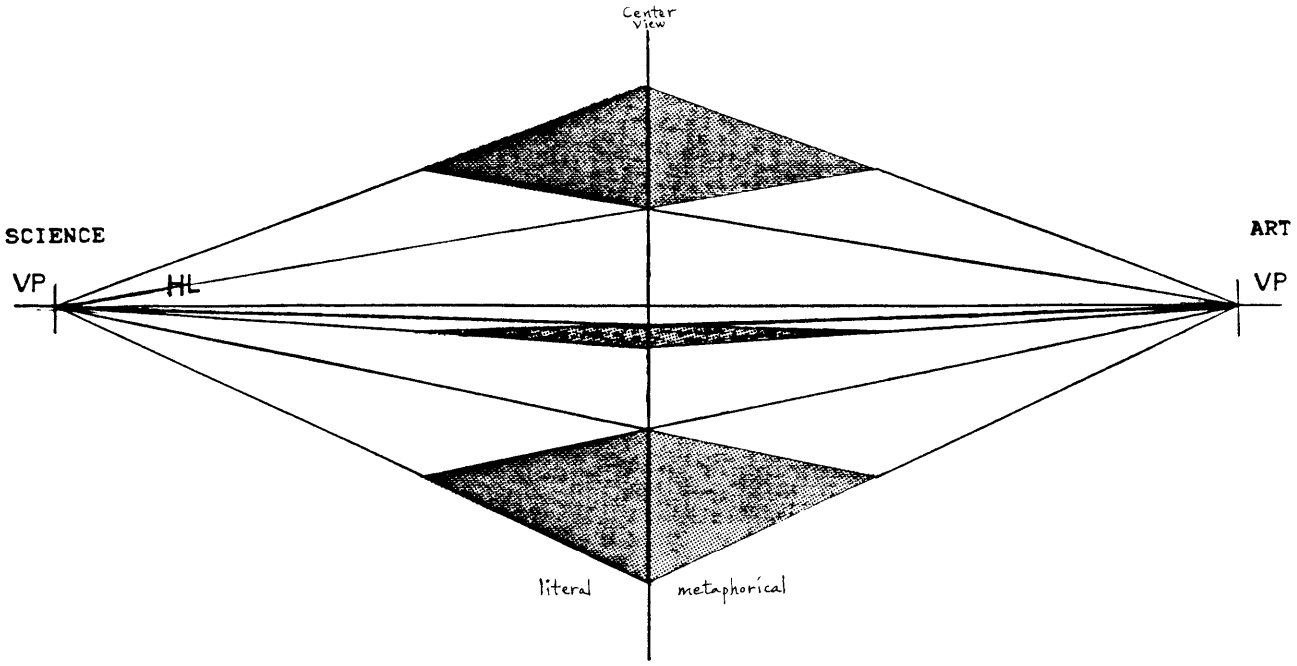
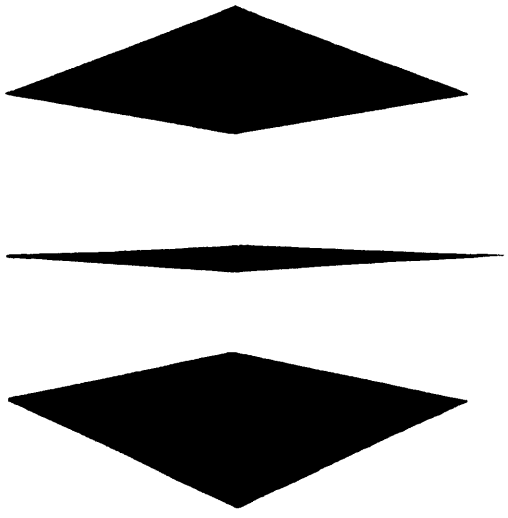


Fig.25 The same square seen from three different angles.

ARCHITECTONICS OF THOUGHT: A Symbolic Model of Neuropsychological Processes



Chapter 3. Visualization of Theory of Thought;
"Thought Assemblies" - a symbolic model

Chapter 2. Theory of Cerebral Fusion and Fission

Chapter 1. Views On Brain-Mind Relation: "Reflectionism"
(a monist/dualist philosophy)

Irrespective of the task and [stimulus] paradigm, the subjects would not be told in advance that the aim of the stimulation studies is to observe the proposed **convergence** or **fusion effect** (as indicated by certain cerebral metabolic activities). However, they would be informed that the tests are designed to study the organization of perception and conception; specifically, the way one organizes one's thoughts in examining Figures 20 - 25. Concerning the issue of secrecy: my feeling is that if the subjects knew what was expected of them - namely to try to experience intuitions under controlled circumstances - this knowledge would interfere with their performance; that is, the subjects' own expectations could produce inhibition. Of course the contrary can be argued. My interest, here, is to consider this particular strategy.

Whether or not the "organic structure" (or architectonics) of intuition will ever be grasped like the atom remains uncertain. No one knows on what level of material reality intuition lies or how to describe its constitutive events and processes. Can human mental activity (i.e. the thinking-feeling process) be explained entirely in terms of the cell-assembly theory, or molecular theory, or atomic theory, or nuclear theory, or the combination of these theories? Where is the line drawn between physical reality and the reality of these mental processes? (Or is there no such "line" when it comes to defining the dimensions and boundaries of human thought [33]?)

How do all the details of cerebral processes - from the neurochemical activities to the architectonics of thought - converge to form one coherent system? **Do they even need to converge** in order to form a coherent system? Expressed another way: what does one need to know in order to form a comprehensive view of thought processes? Does one need to know the physics and physiology, the psychology and philosophy of the human organism, to understand (i.e. to "explain") the nature of thought? (That approach seems excessive [34].) Or can one focus on one or two aspects of thinking - dividing and differentiating the acts and artifacts of creation - in the manner of Descartes? (That approach seems to lead to an infinite regression [35].)

I think **the answer** lies somewhere in between these two extremes (and it **consists of many answers**). On the one hand, it does not seem possible that in order to attain some understanding of human artifacts (such as art and architecture, literature and music, science and mathematics) one needs to understand the brain processes responsible for their creation. On the other hand, it does not seem possible that knowledge of neural-mental activity is <u>not</u> necessary for understanding the relationship between the dynamics of the creator (the brain) and the created (the artifacts). This knowledge seems to be necessary for grasping the relationship between mind and matter [36] which is an analogous relation.

I cannot hope to answer any of these questions with certainty; for that matter, no one has been able to answer these and other related questions concerning the dynamics of thought processes - neither Wundt's group, nor James' group, nor the Wurzburgers, nor Watsonians, nor the Gestaltists, nor the Computational psychologists, nor any other group in more recent times. In attempting to grasp the underlying order of 'things thought' (Humphrey), some aspect of thinking always seem to be missing from the analysis presented [37]. For example, one author will replace the classic notion of "mental mechanics" with "mental chemistry" (Mill, 1892) without explaining how this new notion improves upon the Associationists' concepts of atomism and mechanism (from which it emerged). Another author may intend to write on his investigation of "thinking" (Ach, 1905) only to discover that he needed to include "will" and "directed thought" (Humphrey, 1948) in order to support his arguments. A more current example would be the Constructivist theory of perception and pictorial representation (e.g. Gombrich, 1972, 1982) in which the theorist must decide on a particular explanatory device for describing the acquisition and representation of knowledge.

Putting aside the specific concerns, these examples illustrate the problem of **inclusion versus exclusion** (i.e., what subjects and research strategies are and are not needed for a particular [scientific] theory and experiment) [38].

So far this problem has not been resolved; if it were resolved in favor of inclusion, then cooperation between disciplines and approaches, rather than competition, would be the prevailing dictum. Also the line of demarcation between approaches would be permeable rather than solid and confining. Consequently, the picture of the human nervous system and mental process would be markedly different [39] as would the "picture-making" techniques.

Although some scientists insist that knowledge of the general principles of thinking-feeling-creating is in the offing [40], I do not share their confidence. I think the neurosciences have a number of seas to explore (regarding the physiological, and psychological organization of the human brain) before even one principle can be named and articulated. I would like to believe that through the combined resources of the sciences and the arts, one can ultimately discover [in Klee's words] "the nature of nature" which includes the nature of mind. To me, this 'discovery' is contingent upon the development of more flexible systems of thinking in researching and representing brain (mind) processes. In this direction, we stand to learn about the interactions of analogical and discursive thinking in insight-perception, reasoning and expression. As well, we come to understand the evolution of theories of thinking - from those involving association (James, Watts) trial and error (Selz), structural

reorganization and insight (Kohler, Wertheimer) to propositional representation (Anderson).

The reason for including this section on experiments is to emphasize my position that many different strategies and techniques are necessary for relating neural-mental activity. By weighing the advantages and disadvantages of the different experiments, one increases the possibility of observing the cerebral fusion and fission phenomena. That is, through the creation of more selective experiments, one might at least glimpse the workings of the material substrate that generates these phenomena.

CHAPTER 2 NOTES

1. In discussing "introspection" (Essay on Mind, 1980; Chapter 2: "Self-Knowledge and the Self," p.16), Donald Hebb writes that the term is frequently used to refer to 'any form of private knowledge, such as sensation of muscle tension, or imagery... as a technical term, **introspection** is direct observation by the mind of its own activity...One does after all know something of what is going on in one's mind at any particular time, and until one can explain that fact it must constitute a strong argument in favor of the existence of introspection. If one's self-knowledge is inferential, how is the inference made?' This knot (in the question of the introspective method) remains as tight as ever. Many have tried to loosen it, as Hebb relates:

> George Humphrey in his book Thinking (1951) showed that when the classical introspectors at Cornell thought they were describing a sensation they were really describing the external event or object that had given rise to the sensation. He generalized his conclusions as follows - tentatively, it is true, but the case he made was convincing and has not been refuted: **"We perceive objects directly, not through the intermediary of 'presentations,' 'ideas,' or 'sensations.'** Similarly, **we imagine objects directly**, not through the intermediary of images, though images are present as an important part of the whole activity" (p.129). What one is aware of in perception is not a percept but the object that is perceived; what is given in imagination is an illusory external object, not an internal mental representation called an image. This latter notion and the percept are inferred (but they undoubtedly exist, as atoms do likewise.)

Humphrey's conclusion that 'we imagine objects directly, not through the intermediary of images' is inconsistent with the past 90 years of modern art. A number of artistic movements have concentrated specifically on "image thought" (as opposed to Oswald Kulpe's "imageless thought") and dreams - from the Suprematist studies of the **"idea and image of pure feeling,"** and the Surrealists' studies of the **"images of irrationality"** to the Conceptualists' visualizations of the void.

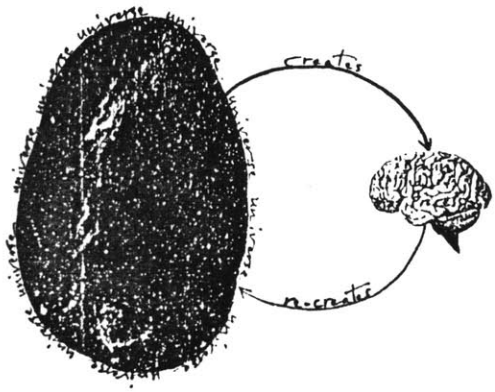
Cf. the notion that 'what is given in imagination is an illusory external object') with Dali's "The object as revealed in Surrealist experiment" (1931), De Chirico's "Meditations of a Painter" (1912), Breton's "Surrealism and Painting" (1928), and Carra's "Quadrant of the Spirit" (1919).

2. "Thinking," Mario Bunge (1980, p.155) writes, "is one small subset of **mental states** which, in turn, is one small sub-set of **brain states**....Thinking can be visual (in pictures), verbal (in words), or abstract (in formula) [or none of the above - my note]. It can be chaotic or orderly, creative or routine. Thinking of any kind is, we assume, an activity of some plastic neural system."

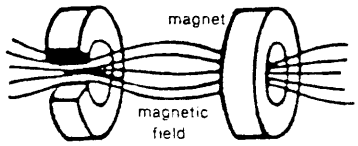
Legend: the dash marks represent the brain; the space in between these marks represents the mind. Note the amodal completion of the brain-mind line.

3. I coined the terms "cerebral fusion" and "cerebral fission" to make a comparison (and an analogy) between sets of concepts involved in contemporary scientific ways of thinking and talking about the human brain and the workings of the physical universe. The idea is that the brain neither evolved out of a void nor functions independently of the cosmos on which it depends. It is, so to speak, **a product of the producer (of "the cosmos")**. And as such it bears the marks of its production. This implies that the cognitive processes have a dynamic resemblance to the fusion and fission processes have form and shape our universe. The acquisition of knowledge regarding this internal-external consistency will surely test the limits of science and advanced technology. More specifically, probing the connections between this biological and physical system will require the collaboration of the nuclear and neurosciences among other disciplines in the natural sciences.

   "Cerebral fusion" and "cerebral fission," then, suggest connections between the mental processes of intuition and the physical processes of nuclear fusion, and between analytical reason and nuclear fission.



4. The idea for this biological mirror was inspired by the basic magnetic mirror developed for controlled plasma fusion reactions. The mirror reactor is based on the concept of confining plasma (an extremely hot gas - like lightning) in a straight tube. The magnetic field is externally imposed and is particularly strong at the ends of the tube, reflecting the plasma back into the tube like a mirror. I do not mean to suggest that in **cerebral fusion** the hemispheres of the brain act as 'magnetic mirrors' that focus and direct neuronal information back and forth at some great concentration, confinement and speed. Instead, I am suggesting that the reflection symmetry of flux fields generated in this fusion reactor are related in some material and conceptual sense to those generated in the human brain. Unfortunately, this idea cannot be tested at this time as there is no adequate equipment to detect and measure these fields in the central nervous system. Perhaps between recent developments in neuromagnetism, which makes use of magnetoencephalography (MEG), and current research in evoked potentials averaging which uses more sophisticated electroencephalographic (EEG) recording techniques, some answers will emerge. Where the ultrasensitive superconductor MEG can detect extremely small magnetic fields associated with ionic movements in and out of nerve cells, the EEG can detect the electrical changes associated with the movements of ions in the more scattered conducting fluids outside the nerve cells. While both technologies have their disadvantages, they may yet prove to be invaluable in mapping higher brain functions such as those involved in **cerebral fusion** and **cerebral fission.**

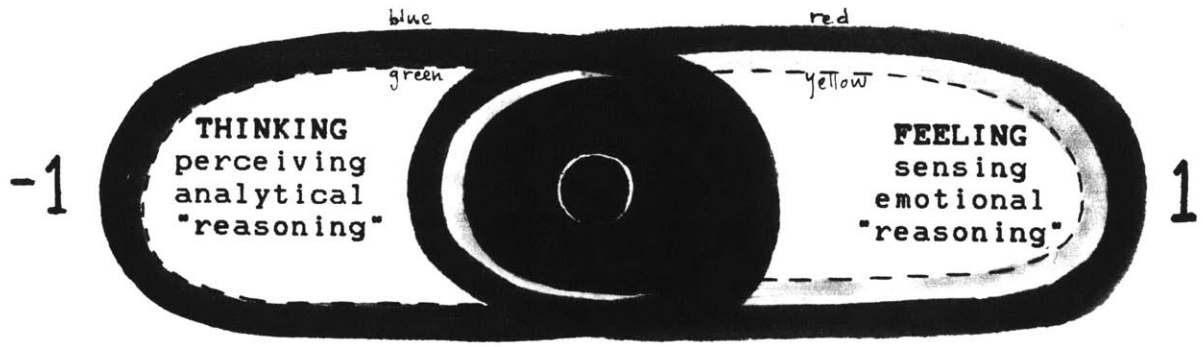


5. The fusion-fission metaphor might have been elaborated on the atomic or molecular level. In physical reality, we have an invertible transformation from one system to another such that the physical processes in one are transformed into approximately the physical processes of the other. In the case of nuclear physics and neurophysiology the velocity of light is transformed into the velocity of the spike potential in synapse - because each is the 'barrier' to the transmission of information in its system. This implies that nuclear events are analogous to neural events on some relativistic scale.

   Concerning the fusion-fission of brain processes: in describing the "ways" of the brain I find that, whatever metaphor I use, my vision and feelings are moved by pairs of interlocking complementary ideas. Things either diverge or converge, split or merge. My mirror analogy suggests how this occurs (see Figure 2, Chapter 1).

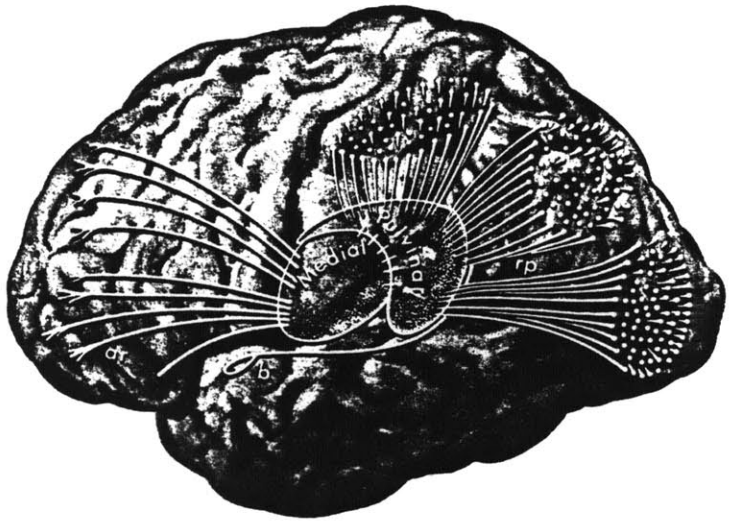
6. In an article entitled "Educating for Creativity: A Holistic Approach" (1983, p.158), Gallo writes that "convergent thinking is characterized by an ability to focus one's thoughts on factors relevant to the given situation; it moves toward a single, uniquely determined response, highly dependent upon the reproduction of the previously learned and upon the categorization of new experiences as examples of familiar ones...Divergent thinking is less direct and appears less measurable...[it] invokes the capacity to range flexibly in the search for factors relevant to a specific task; it leads to large numbers of varied responses and to the generation of new ideas and "logical possibilities."
   The problem with this definition has less to do with its clarity (I think it is as lucid as can be) and more to do with the elusive nature of the thing being defined - namely the creative process. Defining the processes of creativity is like trying to put your figure on a loose ball of mercury. In studying the mental activity involved in intuition, one ultimately must review speculations on creative thinking as it is intimately connected. As a side point, the meanings and associations I attach to the words "convergence" and "divergence" in discussing **cerebral fusion** and **cerebral fission** are different from those expressed by Gallo; in addition, the neuropsychological implications are different.

7. See Chorover's (1982) interpretation of the integrative nature of the brain; footnote 8, Chapter 1. Also, read Paul MacLean's "The triune brain, emotion, and scientific bias," in F.O. Schmitt (ed.), The Neurosciences, 1970, pp.336-349. The symbolic drawing below is my interpretation of this 'integrative nature.'



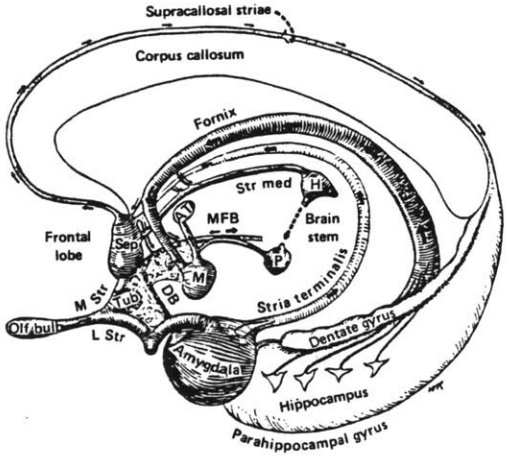
Note: the ancient Indian Zero-concept (footnote 12, Chapter 1) in which the symbol "0" represents 'the transition-point between opposites...the sum of all numbers' (Heimann, 1964, p.112).

8. As MacLean (1976) writes on Papez's discovery of the mechanism(s) of emotion: "The experience of emotion, he [Papez] argued, must depend on cortical function. He then directed attention to the afferent systems leading to the diencephalon, and from there to structures of the forebrain. The stream of afferents to the corpus striatum he referred to as the "stream of movement." The stream to the neocortex he called the "stream of thought," and, finally, the stream to the midline cortex - the cortex of the limbic lobe (including the cingulate gyrus and hippocampal formation) - he referred to as the "stream of feeling." This last inference was based on the large connections of the midline cortex with the hypothalamus which, as mentioned, was considered essential for the expression of emotion" (p.4).



(from MacLean, 1978, p. 9)

9. Shown here are the Limbic system connections (after Krieg; from MacLean, 1949).



Although the processes of reasoning are generally not discussed in the context of neurophysiological studies of the Limbic system, the 'stream of afferents' [as Papez referred to them, 1937] leading to the neocortex (from the diencephalon) seems to suggest that cortical function is very much involved in emotion (and vice versa).

10. Popper's (1977) notion of dominant and minor hemispheres is based on [in his words] 'the conceptual developments of Levy-Agresti and Sperry (1968) and Levy (1973)' (p.353).

DOMINANT HEMISPHERE	MINOR HEMISPHERE
Liaison to consciousness	No such Liaison
Verbal	Almost non verbal
Linguistic description	Musical
Ideational Conceptual similarities	Pictoral and Pattern sense Visual similarities
Analysis over time	Synthesis over time
Analysis of detail	Holistic — Images
Arithmetical and computer like	Geometrical and Spatial

11. See diagram in footnote 7, Chapter 2.

12. I cannot be more specific here about the neuroanatomical substrates of **feelings and emotions in insight-perception** without jeopardizing the intentional generality of my symbolic model of thought (Figures 7 and 8). Even though I have indicated some of the functional anatomy that I believe are involved as mechanisms of insight-perception, I have done so at great risk of being misunderstood as trying to diagram (flow chart style) the paths of information that are involved in this thought-feeling process.

    It is neither in the scope of my thesis nor in the spirit of my research to say, for example, that there is a group of multipolar cells "behind the deep or initial portion of the stria medullaris of the thalamus, ventral and medial to the dorsal nucleus (Cajal, 1966, p.132) which I suspect is the key to the process of insight-perception. Such a statement would be made way out of the bounds of my expertise; and most likely, it would be off the mark. The purpose of this exercise in speculative psychology is to suggest the possible combinations of different systems and subsystems in the human brain which are probably involved in thinking-feeling-creating.

13. I am not suggesting we reject the notion that artworks represent intuitive expression or that some works of art are more intuitive than others. (By "intuitive" I mean to include emotion.) I only urge that we place in check notions such as 'artistic intuition is lyrical'...that 'what confers coherence and unity upon the intuition is emotion'... that 'an intuition is truly such when it represents an emotion, and can rise only from it and above it'...that 'not the idea, but the emotion is what confers upon art the ethereal lightness of the symbol...' (Croce, 1922). Unlike the philosopher of art, Benedetto Croce, I do not agree that 'art is an attempt to express emotion.' I think art **expresses** a lot of things (aside from emotion, e.g. ideas) and uses analytical reasoning (albeit a more relaxed type of analysis than that employed in formal logic or mathematical theorems) in its expressions.

14. My comments in footnote 10 apply here as well.
It may be argued that there is only one mode of thought consisting of intuitive and analytical thinking. This implies that intuition is just another form of analytical/emotional reasoning (and vice versa). Also, verbal and non-verbal languages may be two different aspects of spatial abilities and calculation; and "**scientia**" (knowledge) and "**prescientia**" (foresight and intuition) may involve one and the same process.

15. In Jungian terms, the unconscious is associated with the "forces of darkness" and the "spirit world." The word **anima** - meaning, 'the woman within a male's psyche' (Man and His Symbols, 1964, p.) - was applied to affective behavior, alias "feelings." And feelings, we know from experience (like dreams), often do not make immediate sense. In a society that values the ability to verbalize and articulate one's thoughts, it is understandable why feelings could be dismissed or interpreted as non-sense. **Anima moods**, for example, have a disturbing feeling to them that leave one momentarily disoriented - drifting about in the gravity-free environment of the imagination. Cocteau's film "Orphee" explores this sense-disorientation in a beautiful way as does Mozart's "Magic Flute" - where the Queen of Night personifies the dark anima...the unpredictable side of man that resists the comforts of logic, the clarity of thought, and order of mind. Why is this '**unpredictable side of man**' **identified as the predictable side of woman and Nature**? Here we are, again, dealing with the classic confrontation between the male and female complementary forces of life. These forces govern our relationships with others and with ourselves; they also influence our self-expressions (which includes our artistic and scientific acquisitions and representations of knowledge).

16. Although this left-brain (analytic reason) and right-brain (intuition) notion is not conceptualized in terms of the dualists' **brain-mind relation**, the implication is there. It is as if we assume that by using analytic reason in "scientific thought" we are using our brains, whereas to think intuitively (in "artistic thought") we must use our minds. About 86% of the introspective accounts (of both scientists and artists alike) contained these sorts of references. This suggests to me that the sorts of preconceptions I have mentioned are at the helm in our physiologizing and psychologizing, in our philosophizing and theorizing, about cognitive processes.
How do we properly (i.e. fairly) test or falsify a theory such that there is a minimum of bias in the interpretations of the experimental results and a minimum of bias in the construction of the experiments, the psychophysiological

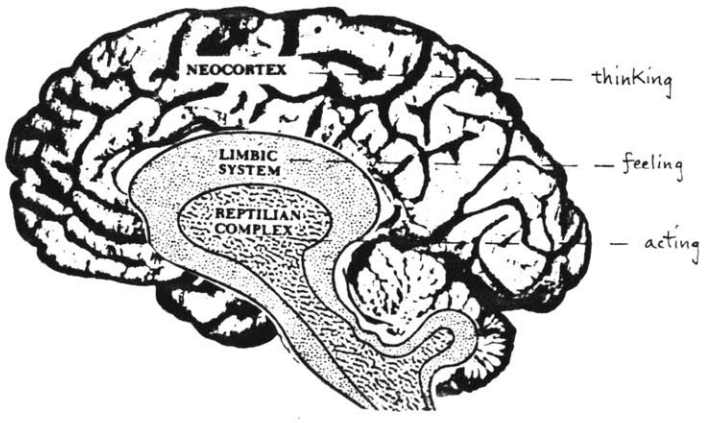
tests and test analyses? How can all the parties concerned be well-represented if, for example, the tests and their analyses are composed by scientists alone (as opposed to an educated ad hoc committee consisting of professionals from a wide variety of disciplines including the humanities and social sciences)?

17. The Stoics notion of the continuum is founded on the concepts of "tonike kinesis" (tensional motion) and **pneuma**tikos tonis" (tension of **pneuma**). These concepts are based on the notion of the **"pneuma"** (the vital spirit or soul). Inherent in the pneuma is this essential tension (to use Thomas Kuhn's phrase) produced and sustained by the connection between opposites. In the mind of Heraclitus, the **pneuma** referred to ether which, in turn, is associated with the "cosmic fire" sustaining starlife.

    The word **pneuma** dates back to Anaximenes of Miletus who used it to explain how the earth 'rides on air' or why it 'floats in space' (from Kirk and Raven, The Presocratics [1957], p.153). I say probably because this thought was not explicitly stated in the written records; it can, however, be inferred from the extant fragments. The Stoics, on the other hand, used this word to describe the melding of fire and air, where the process of heat was seen as the common denominator so to speak of these two elements and their activities. Recall, the process of heat functioned as the nexus through which the properties of fire, air, earth, and water share a likeness. In S. Sambursky's The Physical World of the Greeks (1963), we learn that 'the phenomenon of organic growth and biological development were regarded as inseparable from thermic processes' (p.133).

    According to these concepts, the **pneuma** penetrates and permeates everything, while preserving the individual properties of all that it permeates. It connects all things to one another such that there exists 'in everything a portion of everything' (Simplicius - from Kirk and Raven, 1957).

18. Paul MacLean's "triune brain" concept establishes the following relationship between the organization of the human brain and its mental organization. One of his controversial postulates is that mankind 'shares' his brain stem and its functions with the reptiles and primitive mammals. MacLean refers to this part of the central nervous system as the R-complex (where "R" stands for reptilian). I imagine Neo-Freudian psychiatrists might label this model, **Super-Ego**, Cortex; **Ego**,



Limbic system; and **Id**, Brain stem. In any case, I think his point is clear: the brain has a natural hierarchy of systems which are responsible for the creation and maintenance of information (which includes connecting thoughts and sensory impressions). Note Chorover's **thinking-feeling-acting** notion. See footnote 8, Chapter 1.

19. For a discussion on the "integrative nature" of human mental processes, read Gazzaniga and LeDoux, The Integrated Mind (New York and London: Plenum Press, 1978); Chapter 3: "Cerebral Lateralization and Hemisphere Specialization: Facts and Theory," pp.45-72. Also read Sherrington, The Integrative Action of the Nervous System (London: Macmillan, 1906 [reprinted]) and Konorski, Integrative Activity of the Brain (Chicago: University of Chicago Press, 1980).

20. See footnote 3, Chapter 2.
The way to understand the general principle of fusion-fission as applied to human mental activity is not to look at the details of cerebral functions and to try to discern the functional anatomy involved at any given moment of ideation. Rather, the way to understand this principle is to recognize that the human brain is both divided and unified. Anatomically, aspects of its **form** (e.g. structures of the brain stem, Limbic system, right and left cortices) **converge and diverge**. Functionally, aspects of its **content** (e.g. sensation, affect, perception, cognition) **converge and diverge**. Understanding the neural mechanisms of this convergence and divergence ought to provide a general picture of the working brain.
Gregory Bateson's (1977a) statement on the brain-universe relation I find especially relevant here. Bateson writes, "If our explanations or our understanding of the universe is in some sense to match the universe, or model it, and if the universe is recursive, then our explanations and our logics must also be fundamentally recursive" (p.242). I would like to add that the neuropsychological processes (responsible for 'our explanations and our logics') might also be 'recursive.'

21. In discussing how PCT research reveals functional anatomy, Phelps and Mazziotta (1983) write that 'stimulation studies using visual, auditory, or tactile inputs can define in humans the stimulus-response characteristics for the brain previously obtainable only from animal studies using the invasive neurophysiological techniques. Once a stimulus-response data base has been developed in normal subjects these same studies could then be performed in patients with known or suspected neuropathology to look for subtle aberrations in cerebral metabolism, blood flow, or other physiological parameters which might be overlooked during simple resting studies [i.e. sensory deprived states]' (p.139).

22. See footnotes 36 and 37, Chapter 2.

23. Cf. Koestler's (1964) notion that "dual manifestation of emotions at the moment of discovery is reflected on a minor and trivial scale in our reactions to a clever joke. The pleasant after-glow of admiration and intellectual satisfaction, gradually fading, reflects the cathartic reaction; while self-congratulatory impulse - a faint echo of the Eureka cry - supplies added voltage to the original charge detonated in that laughter" (p.89). Note Figure 12: "**points of cerebral fusion.**"

    Cf. James's (1890) views on discrimination and comparison: "thought is always interested more in one part of its object than in another, and...chooses, all the while it thinks"(p.60) ..."Out of what is in itself an indistinguishable swarming continuum, devoid of distinction or emphasis, our senses make for us, by attending to this motion and ignoring that, a world of contrasts, of sharp accents, of abrupt changes, of picturesque light and shade" (pp.284, 285). Note Figure 7: "**points of cerebral fission.**"

24. Although positron tomography was not originally developed for discerning mental phenomena (such as cognition, cogitation, ideation, etc.), it proves to be an invaluable tool for these studies on normal subjects and the neurologically impaired.

25. In Science and Human Values (1956), Jacob Bronowski considers the re-creation hypothesis from a unique perspective. He concerns himself with the "single creative activity, which is displayed alike in the arts and in the sciences" (p.27). According to Bronowski, "the act of creation...is original; but it does not stop with its originator. The work of art or of science is universal because each of us re-creates it. We are moved by the poem, we follow theorem because in them we discover again and seize the **likeness*** (my emphasis and astrix) which their creator first seized. The act of appreciation re-enacts the act of creation, and we are (each of us) actors, we are interpretors of it" (p.27).

    *Bronowski writes: "The scientist or the artist takes two facts or experiences which are separate; he finds in them a likeness which had not been seen before: and he creates a unity by showing the likeness" (p.27).

    It is this meaning of 're-creation' I would like to see applied to the PCT task under discussion. Using abstract works of art in complex visual stimulation studies should provide innumerable insights into cognitive processes.

26. In the section on "Auditory Stimulation" (in this same report entitled, "Human Sensory Stimulation and Deprivation as Demonstrated by Positron Computed Tomography," 1983),

Phelps and Mazziotta explain that it was virtually impossible to interpret the 'specific relationship of the stimulus-cognitive processes to metabolic changes' (p.150), because of the complexity of the stimuli. Apparently the subject had to use several cognitive functions (perhaps simultaneously) in order to make sense of or react to the verbal stimuli. I am not discouraged by the fact that the complexity of this stimuli - for example, its symbolic content - made the task analysis especially difficult. And the degree of difficulty plainly reflects the selectivity of the experiments. Rather than abandoning the idea of using cross-modal visual, auditory, and tactile tests, the results of the PCT studies suggest that scientists need more selective experiments.

27. For an in depth discussion of hemispheric differences in processing information, peruse Sperry, Gazzaniga, and Bogen, 1969; Lehmann and Lampe, 1970; Berlucchi, 1974; Kinsbourne, 1974a; Nebes, 1974; Franco and Sperry, 1977; Whitaker and Ojemann, 1977; Heilman and Van Den Abell, 1979; Puccetti, 1981; Moscovitch, 1979, 1983; Geschwind and Galaburda, 1984).

28. Perhaps the most important consideration in presenting these new types of stimuli is the method of presentation. One has to consider how the design of a more elaborate environment (with more selective stimuli) will be capatible with the current scanning procedures. There are at present definite physical restraints regarding the types of environments that can be constructed for subject testing. Whatever the final design is it must incorporate (but not interfere with the operations of) the scanning equipment. Tomographic equipment such as the ECATII (EG&G/ORTEC, Oak Ridge, Tennessee) PCT device (Phelps et al., 1978) and the NeuroECAT PCT device (EG&G/ORTEC, Oak Ridge, Tennessee) (Hoffman et al., 1981) are not easy instruments to work around. Also, details concerning the subject's preparation (e.g., the injections of F-fluoro-deoxyglucose (FDG)) must be factored into the overall design of the experiment.

29. There is a clear limit to the types of interactions one may consider in the experiment-formation, as I intimated in the previous footnote. The experimenter has to concern him/herself with the technical limitations of the state of the science. Phelps' and Mazziotta's (1983) account of their materials and methods speaks soberly (though indirectly) about these obstacles. They write: "Regardless of the paradigm to which they [the subjects] were assigned, they were asked to lie supine on the padded scanner bed in a room with low ambient light and were asked not to move or speak. They were not spoken to...All intravenous lines and scalp electrodes for

EEG monitoring were put in place 10-15 minutes prior to FDG injection. The subjects were not touched and did not know the exact time of the FDG injection" (p.140). Even though other studies may be slightly more flexible in terms of the subjects' movement, the experimental conditions for the most part restrict the full (uninhibited) motion of the body. The upshot is that one must anticipate the added complexities of more sophisticated experimental arrangements and plan accordingly. Interactive tasks (either between the experimenter and the subject or between the subject and some physical or metaphyical stimulus) are feasible though they require some high-level engineering and thought behind them.

30. Equally important as the selection and presentation of the stimuli is the sensitivity of the tomographic device. I would imagine that to observe the functional anatomy or neurophysiology of **cerebral fusion**, one would need a faster and more "sensitive" tomographic device. I am thinking in terms of a device which would have an image spatial resolution greater than 1.6 0.1 cm. and would be capable of more than 2-3 million counts per image in 5-10 min. (Phelps et al. 1978).

    If interested in research in this area, read E.J. Hoffman, J.B. Barton, M.E. Phelps, and S.-C. Huang, "New Design Concepts for Quantitive Positron Emission Computed Tomography of the Brain," in W.-D. Hess and M.E. Phelps (ed.), Positron Emission Tomography of the Brain, (New York: Springer-Verlag, 1983), pp.30-39. The authors present design concepts which are directed towards 'improving the quality of measurement of each event rather than attempting to increase the number of actual accumulated events' (p.31).

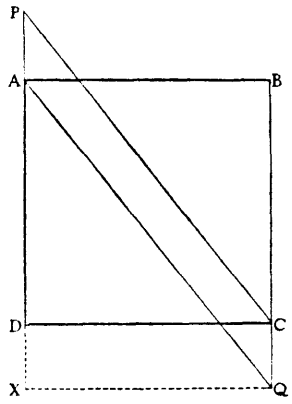
31. The idea for this neuropsychological test was inspired by one of Wittgenstein's (1953) ideas about the interplay between ambiguity and context. It was also prompted by my observation that other tests and studies of intuition were generally reduced to a discussion of the psychology of "insight" (Kohler, 1929), "problem-solving" and "productive thinking" (Selz, 1927; Wertheimer, 1945, 1959) and the "Eureka effect" (Koestler, 1964; see footnote 24, Chapter 2). Although these studies are indeed related, my focus is different in that **I would like to study directly the neurodynamics of two interconnected modes of thought (cerebral fusion and fission) using current technology**. It may well be that the introspective tests of Watt, Titchener, Willwoll, and others are applicable to my study. Or, it may be that Selz's and Wertheimer's strategy for problem-solving (note diagrams on the following page) are still vital for my area of inquiry. I believe they are and that they should be explored further.

Wertheimer

Figure 3

The first "step" is to draw the figure (see Figure 3) (1)
Then: area required = area of △ PDC + Area of △ ABQ (2)
= PD.DC = DA.DP (3)
Alternatively, the construction in dotted lines may be drawn. (2*a*)
Then: area required = area of ABCD + Area of CDXQ (3*a*)
= area of ABQX (4*a*)
= PD.DC (5*a*)

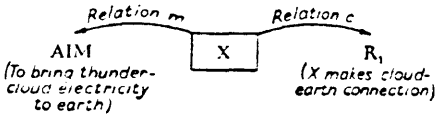
(from Humphrey, 1963, p. 157; on "The Gestalt Theory of Thought")



SELZ

Figure 1

Schematic anticipation in the operation of abstraction of means.



Franklin's aim was to bring thunderstorm electricity to earth. (AIM.) He knew that he needed to make a connection between the cloud and the earth, i.e. that he needed something (X) ***the result of which would be that such a connection was made.*** (R_1 or partial result.) This *something*, X, is not explicitly given in the data; but it is known (*a*) that it is a means towards the aim (relation *m* to the aim), (*b*) that it will cause (*c*) the partial result of making the connection, etc. (relation *c* to R_1). Thus the data include Aim and R_1 explicitly, together with the relations *m* and *c* in which the missing X stands to these. The solution is found when this complex is completed by filling in X.

Figure 2

Figure 1 completed by "kite".

The determining tendencies inherent in the *Aufgabe* bring a tendency towards the completion of the schematically anticipated complex ("complex with a gap") of figure 1. This is effected by the operation of *Abstraction of Means* (abstraction, from the sight of kites flying, of the fact that they may serve as a link from earth to the cloud). Thus this operation is effected as the result of the process of the determined completion of a complex. The "solution" (kite) may, as often happens, follow from a chance sight of a flying kite after the incompleted complex is set up.

(from Humphrey, 1963, pp. 141, 142)

32. See footnote 23, Chapter 2; re: Koestler's notion of insight.

33. In writing about the lack of boundaries in 'unformulated' (intuitive) thought, the German psychologist, B. Erdmann (1908) stated: "...in our actual thinking there is no clear line of demarcation between formulated and unformulated thought...There are continuous intermediate stages and many kinds of transition between the two. One might regard as limiting cases on the one side a thought in fully formulated propositions with clear consciousness of meaning, and on the other a lightning reflection and recognition, with no trace of a word..." (p.186).

34. The implication of this all-or-nothing approach to the analysis of thought is that a researcher interested only in higher mental processes would have to consider the lower ones as well (as they influence the higher processes). And those researchers systematically investigating the psychology of thought would have to investigate the physiology of thought as well only (as they are an integral part of one another). I mean to extend my comments to fields of research outside psychology or philosophy. My point is that, regardless of what one is examining or the techniques one uses in their examination, both the method and the object studied is never enough. There is always some crucial information missed because of one's scope.

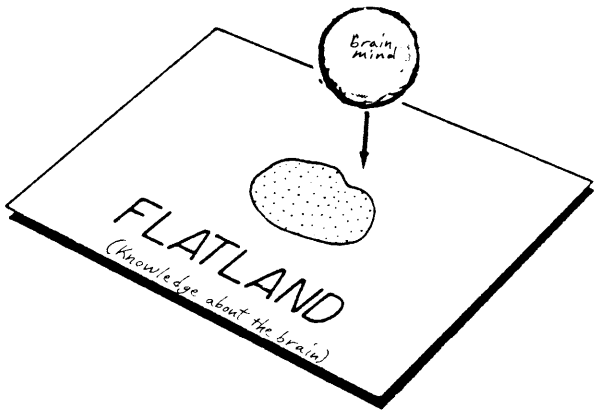
35. Cf. Capra's (1982) thoughts and discussion on Descartes' analytic method, pp.58-60.

36. This notion of **The Interconnectedness of Everything** is particularly unsettling to scientists who insist that one need only isolate and analyze the properties of something (e.g. the human **mind**) apart from the thing or environment it was taken from (e.g. the human **brain**) to understand totally the thing analyzed. I am not advocating that this [divide and differentiate] analytic technique be challenged for its validity as an investigatory tool. I am only recommending that - after the analysis is made - the researcher try to see the material which was isolated in the largest possible context possible (i.e. vis-a-vis the physical **universe**).

    One psychologist pointed out to me that this **T.I.E.** notion is difficult to defend scientifically (and unnecessary). He explained: "To study anything scientifically, you have to omit many things - otherwise you'd be studying everything when you studied anything." My corollary to this view is: After you 'omit,' stand back and 'include.' (Cf. footnote 40, Chapter 2.) I contend that interpreting the dynamics of the human brain without referring to the larger world (of which it is a part) is comparable to speaking 1-dimensionally about a multi-dimensional entity (e.g. brain processes)...and imagining that one has described all the processes and

potentialities of this entity. The diagram of 'Flatland' (where I think we are "knowledge-wise") and its relation to the sphere (i.e. the human brain) is one visual metaphor for this idea.

One may do well to follow the example of the Nobel physicist Theordor Kaluza who saw beyond the four-dimensions described by the theory of relativity. By adding a fifth-dimension to the concept of space-time (a four-dimensional structure) - that is, by expanding our vision (and notion) of the universe - the unification of the different interactive forces (which hold the universe together) was made possible. A good exposition of Kaluza's theory and interpretation of the 'Flatland' concept is presented by Davies, Superforce (New York: Simon and Schuster, 1984); Chapter 10: "Do We Live In Eleven Dimensions?" and Chapter 13: "The Unity of the Universe."



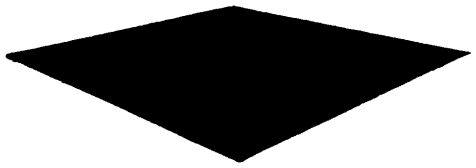
Two-dimensional universe. A pancake-type creature living in 'Flatland' has no perception of 'up' or 'down'. The ball about to penetrate his surface world will be perceived as a changing two-dimensional shape within the surface. (from Davies Superforce, 1984) (Modified)

37. Granted: one cannot include everything (i.e. every aspect of thought) in their inquiry into "thinking". I mean the general complexity of the subject seems to prohibit a single, comprehensive survey of thinking. The problem of coordinating the different (often conflicting) approaches used in the study of thought is further compounded by the different nomenclatures complicates matters ten-fold.

38. This problem of inclusion versus exclusion may be known and spoken of in different terms and circles. What it comes down to is **knowing what to select** (regarding sources, methodologies and procedures) for conducting experimental and theoretical research. Concerning the research on thought: the tradition has been to select a subtheme in order to avoid the entanglement of what was [and still is] considered **different aspects of thought** - namely, thinking, feeling, imagining, willing, judging, generalizing, abstracting, learning, trial and error, discrimination, motivation, conception, expression, ad infinitum. To me, a more productive (and perhaps, more realistic) view is to see the many aspects as being completely interrelated. This means that in discussing one aspect of the thought process, you invariably overlap on other aspects.

39. I cannot say for certain what this "new picture" of neuropsychological processes would (or would not) include in terms of data. I can say, however, that the neurosciences' "picture-making" technique would most likely include a strategy of analysis which would complement the traditional strategy (see footnote 39) - whether it be holism or syncretism.

40. To be fully knowledgeable of the **details of thought** - from "determining tendencies" (Ach, 1905; Watt, 1905) to neural principles (Kandel & Schwartz, 1981) - one would first need to construct a system of communication that would allow, for instance, the exchange of insights between different disciplines. Feigl (1958) raised the point that, although the methodologies and procedures differ in the investigation of 'the mental and the physical,' the referents are essentially the same (see footnote 10, Chapter 1). Until it is recognized that the areas of interest on matters of **brain** (mind), **mind** (brain) **processes** not only overlap but must be investigated together the neurosciences will continue to limit its perceptions and representations to neuropsychological processes.



The first two chapters of this thesis represent the design and the building materials of my symbolic model of thought processes. The ideas presented in these chapters are now discussed in the context of a large-scale, multi-media collage (Figures 26a&b). Entitled **"Thought Assemblies,"** it expresses a composite artistic and scientific conception of neuropsychological processes. In it, cerebral fusion and cerebral fission are interactively depicted, along with their ostensible mental counterparts: intuitive and analytical thought processes [1].

The artwork consists of 515 constituent images, each one of which depicts a more or less distinct mental image [2] and state of mind superimposed upon a substrate. The substrate is intended to represent the concomitant brain states and neural processes corresponding to the creation of the images. In effect, my model represents a single moment of inspired thought; it unfolds, so to speak, and freezes in Cartesian (XYZ) space various elements of imagination [3]. Within it, the shifting origins of an idea (cerebral fusion) is given both artistic and scientific expression (cerebral fission) (see Figures 27a&b). Like any artwork, this one is inescapably self-referential; it presents the personal lexicon, free-associations and perceptions of its creator. As well, it is introspective in that it traces my thought patterns, their contexts, and the perceptual pieces from which these 'patterns' were constructed [4].

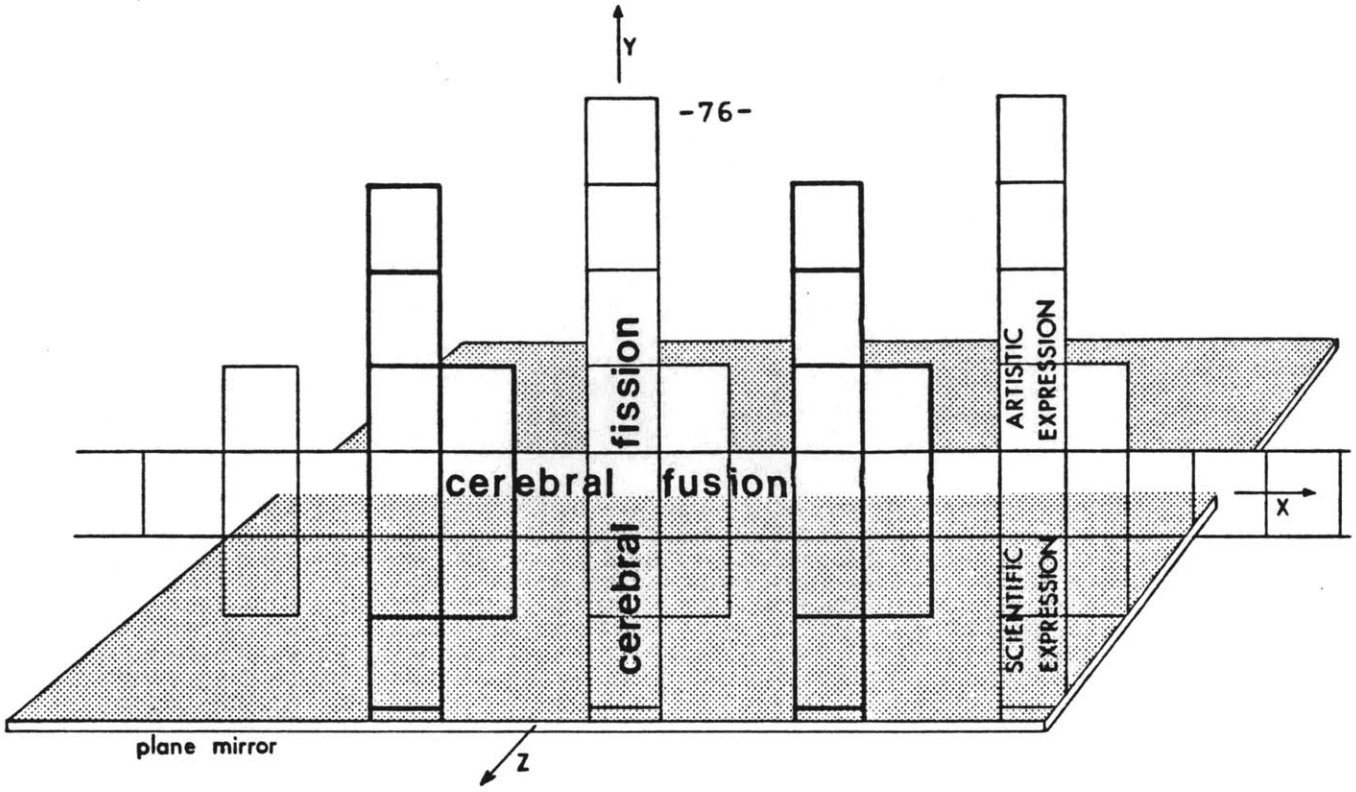


Fig.27a A diagram indicating the information portrayed in the artwork "Thought Assemblies" shown in Fig.26. The work consists of three interactive axes. Presented on the X-axis is information based on intuition and perception about the brain. Intersecting this plane is the plane mirror, or Z-axis, which reflects vertically above and below the X-axis. Above the X-axis, the information is abstracted and implied, thus entering the realm of art. Below the X-axis, qualifying and quantifying information is added, entering the realm of science. "Thought Assemblies" indicates that analytic and artistic thought can proceed from the same frame of insight-perception and that these two modes of thought converge. As an exercise in topology, if the artwork were folded to form a tube and then the ends of the tube were brought together to form a torus, the farthest points at both ends of the X- and Y-axes would be contiguous.

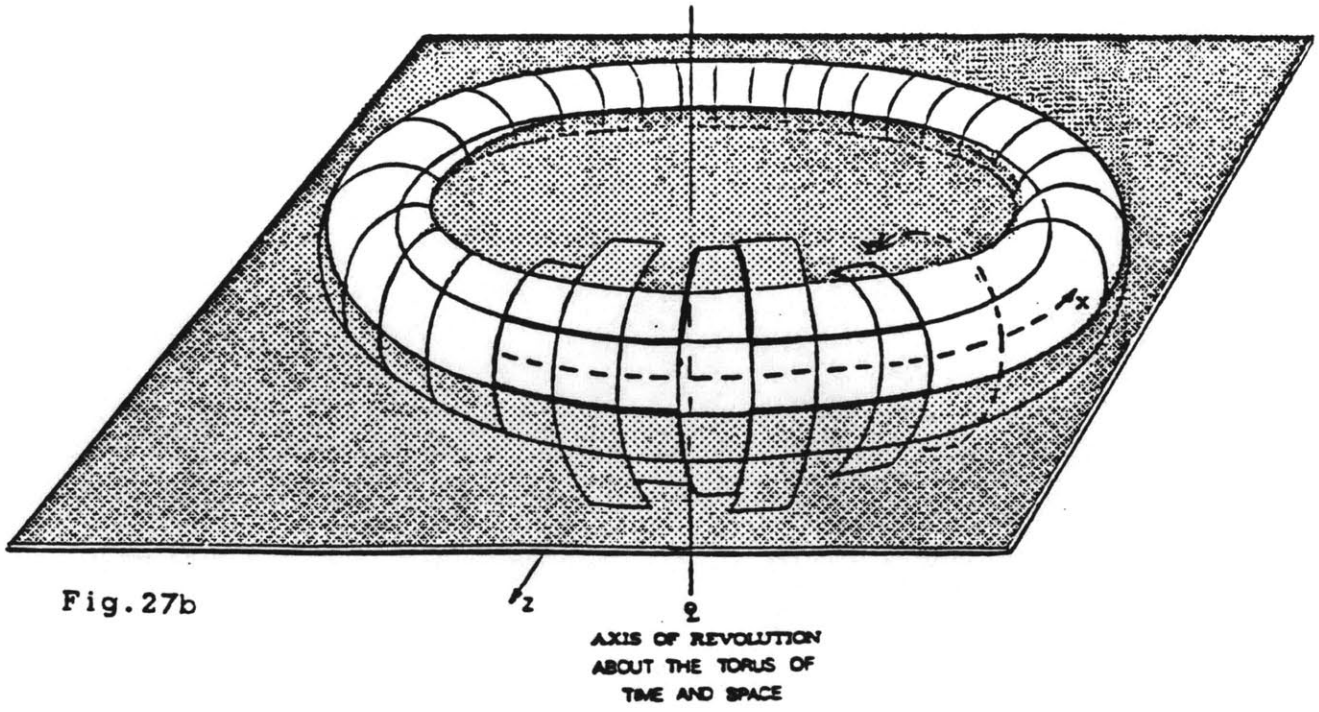


Fig.27b

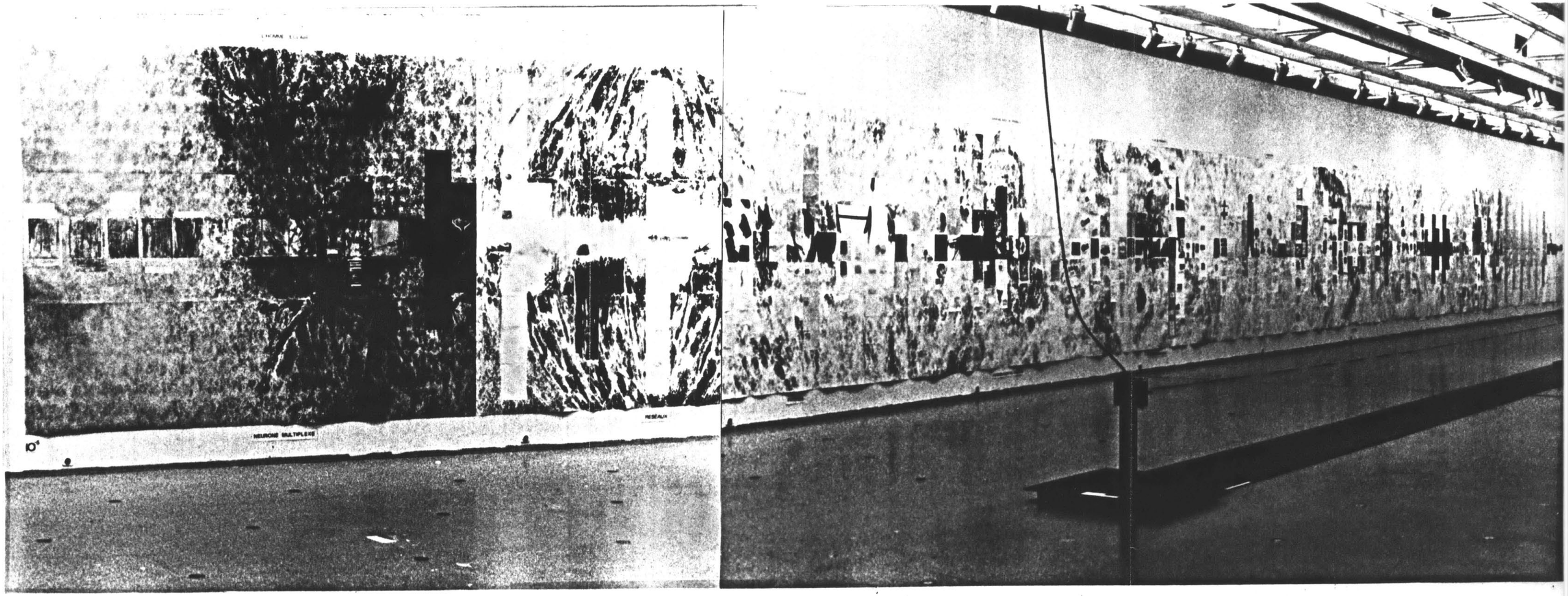


Fig. 26a **"THOUGHT ASSEMBLIES"**, mixed-media, 9 x 127 ft., 1981-82.
Installation view: Musee D'Art Moderne De La Ville De Paris, A.R.C.2,

Fig.26b *Thought Assemblies,* spunbonded olefin paper, latex paint, enamel, ink, graphite, air brush, conte crayon, collage, 9 × 127 ft, 1981–1982. Installation view.

I conceived of "Thought Assemblies" after reading Donald Hebb's "cell-assembly" theory in his book, Organization of Behavior (1949). Hebb posited "that repeated exposure to a given sensory stimulation will organize an assembly (a number of neurons in the cortex that become interconnected)...If thought is a series of cell-assembly activities, these must ordinarily be excited both sensorily and centrally" (p.88) [5]. These lines provided the **fons et origo** (source and origin) of the artwork's conceptual form [6]. In my model, each image is a cell-assembly. Any change in a 'series of cell-assemblies' corresponds to some change in the direction and content of a thought. The waxing and waning of images (see Figure 29b) exemplifies this 'change' and 'correspondence.' The diagram below shows the whole-part relationship of brain processes explored in my symbolic model.

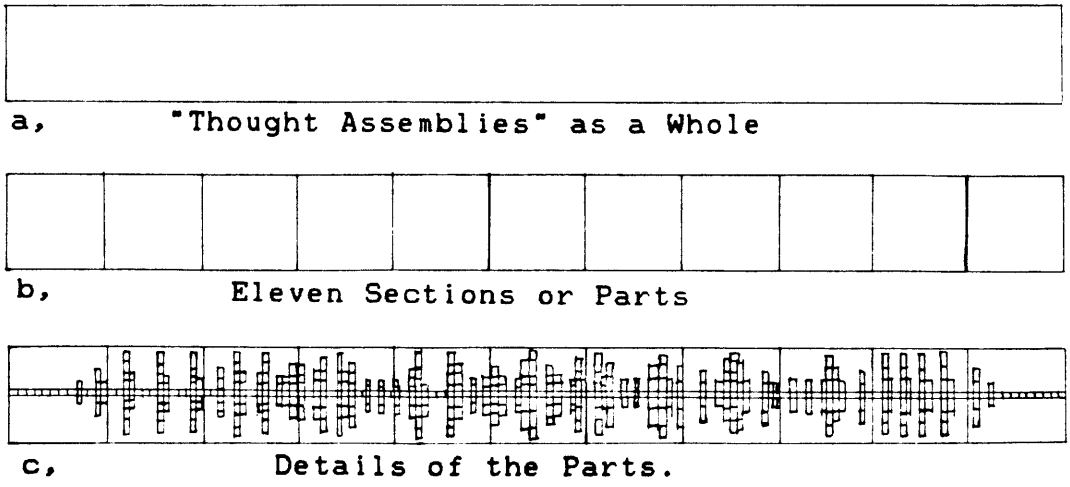
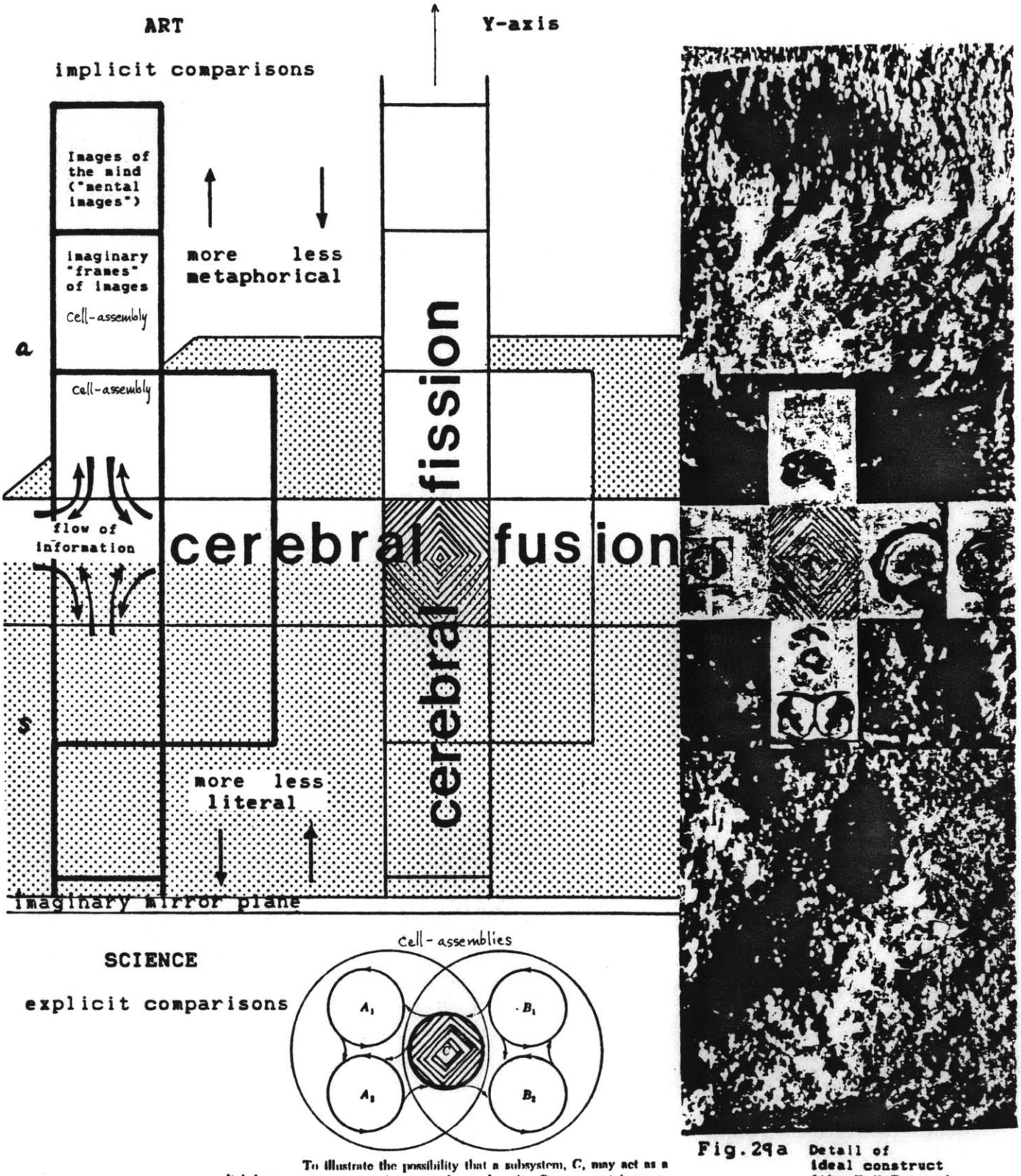


Fig.28

The overall design of "Thought Assemblies" might be likened to an electroencephalographic (EEG) recording in the sense of implying that the patterns of human mental activity reflect the brain's electrical activity (note Figure 28c).



To illustrate the possibility that a subsystem, C, may act as a link between two systems (conceptual complexes). One concept is represented by A_1, A_2, and C; the second by B_1, B_2, and C. The two systems have a subsystem, C, in common, to provide a basis of prompt association. (From Donald Hebb, Organization of Behavior, 1949, p. 130).

Fig. 29a Detail of ideal construct (the X,Y,Z axes) underlying the "Thought Assemblies" (symbolic model).

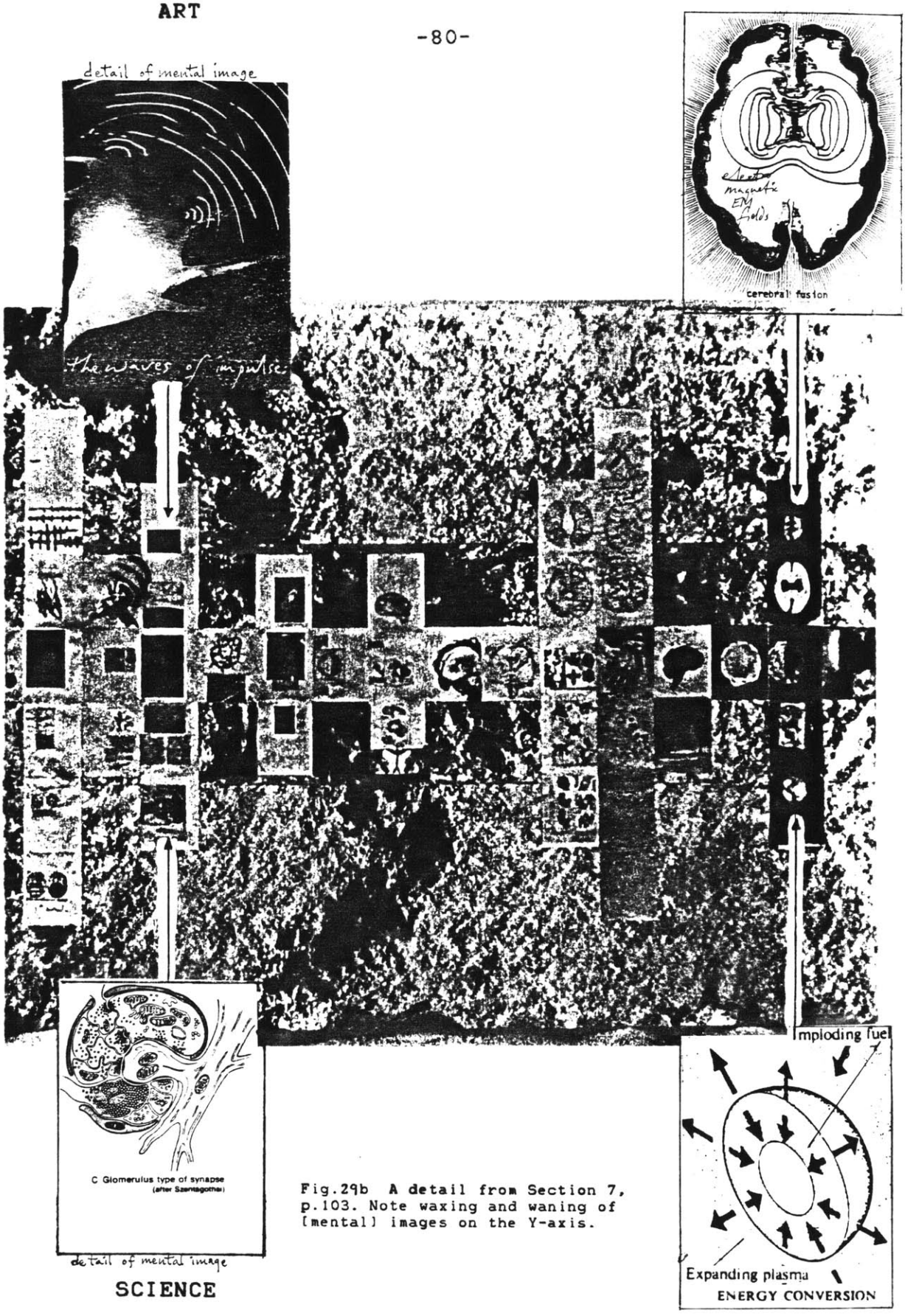


Fig.29b A detail from Section 7, p.103. Note waxing and waning of [mental] images on the Y-axis.

SCIENCE

"Thought Assemblies" is based on a principle of symmetry [7]: i.e., there is an exact correspondence or equivalence between the **a, artistic and s, scientific expressions** (representations). Accordingly, the mirror plane (or Z-axis) divides the mental images into equal numbers above and below the X-axis; note $\underline{a}^{1\rightarrow 4}$, $\underline{s}^{1\rightarrow 4}$. However the content, composition, and expressive nature of the images intentionally break this ideal symmetry. That is, the images arrayed along Y-axis differ from top to bottom (see for example Figure 29b).

One implication of broken symmetry [8] in this context is that there is no precise equivalence between one type of analysis or expression and another [9]. Although I present my mental images in a frame-like format, there is no clear line of demarcation either between the images on the Y-axis (which follow one another consecutively) or those on the X-axis (which do not necessarily follow one another in any set order). The rectangular shapes, which separate one mental image from another, suggest only that each image has its own distinct structure aside from its collective structure within the "Thought Assemblies" model as a whole [10].

In its physical and conceptual structure, "Thought Assemblies" emphasizes that the process of reasoning (Y-axis) is essentially **one process with multiple manifestations** [11]. As Figures 27a and 29a&b show: reasoning involves artistic, analogical (metaphorical) thinking and scientific, analytical (inferential) thinking [12]. My model evinces this notion of

the composite unity (or "many-in-one" view) of mental activity, by overlapping and superimposing different images (see Figure 30). Then, **'multiple manifestations'** are represented by the images themselves and the **'one process,'** represented through the process of superimposition [13], is explored in the act of observation and interpretation; as one viewer explores the work, separating/connecting one thought or feeling or association with another and examining the possible meanings of the connections. In my view, an understanding of the interplay between separateness and connectivity (as in the act of superimposition: see Figures 31 - 33) is essential for comprehending the constitutive events and processes of cerebral fusion and fission.

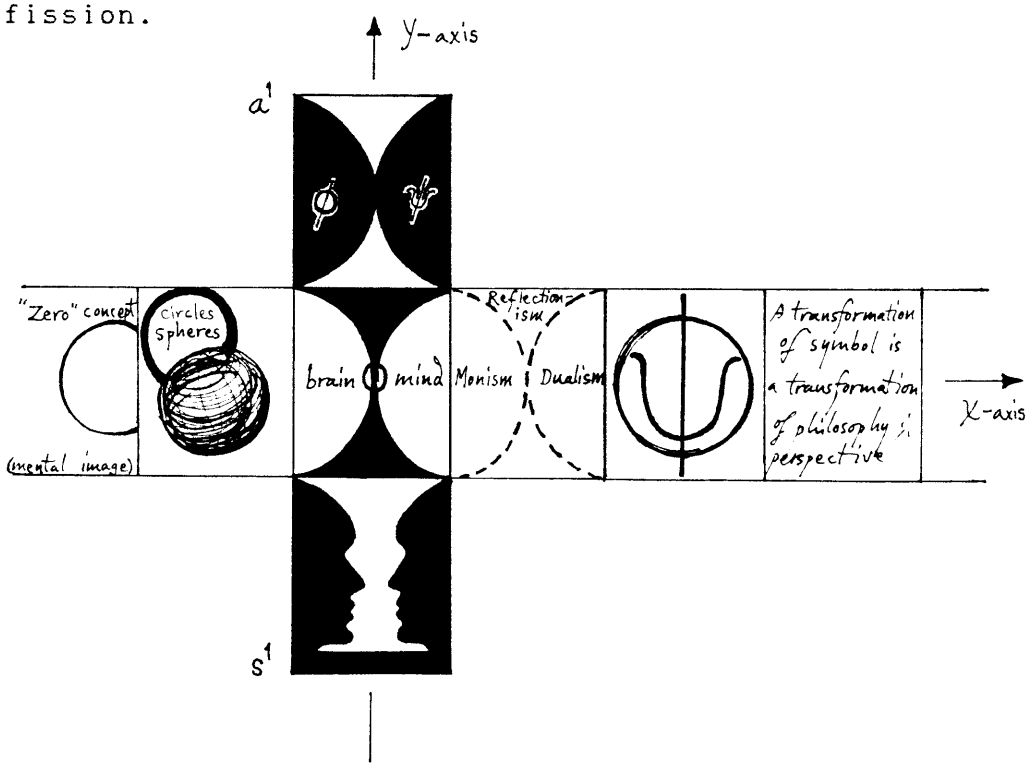


Fig.30

Note: the direction of thought (along the X-axis) is arbitrary. One can, for example, "read" this diagram from right to left. The diagram shows my stream of thoughts and feelings as I move from the thought of spheres (of reality) to the synthesis of monistic and dualistic views on the brain-mind relation ("reflectionism") to the conception of a new symbol which represents reflectionism.

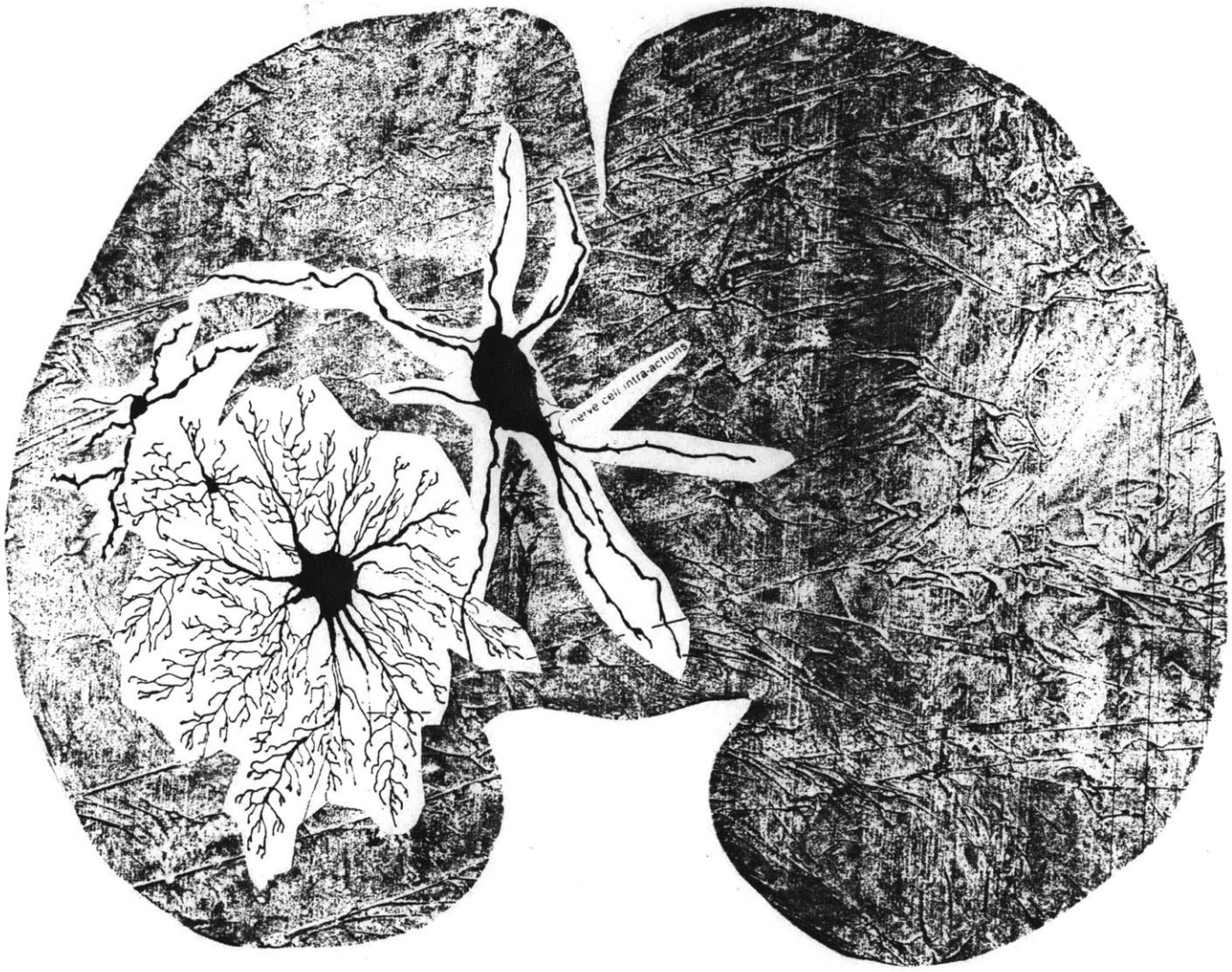


Fig.31 Mental image on the Y-axis in a[1] position (indicating the kind and degree of artistic abstraction). Imaginary cross-section of the human brain showing neural-like tissue.

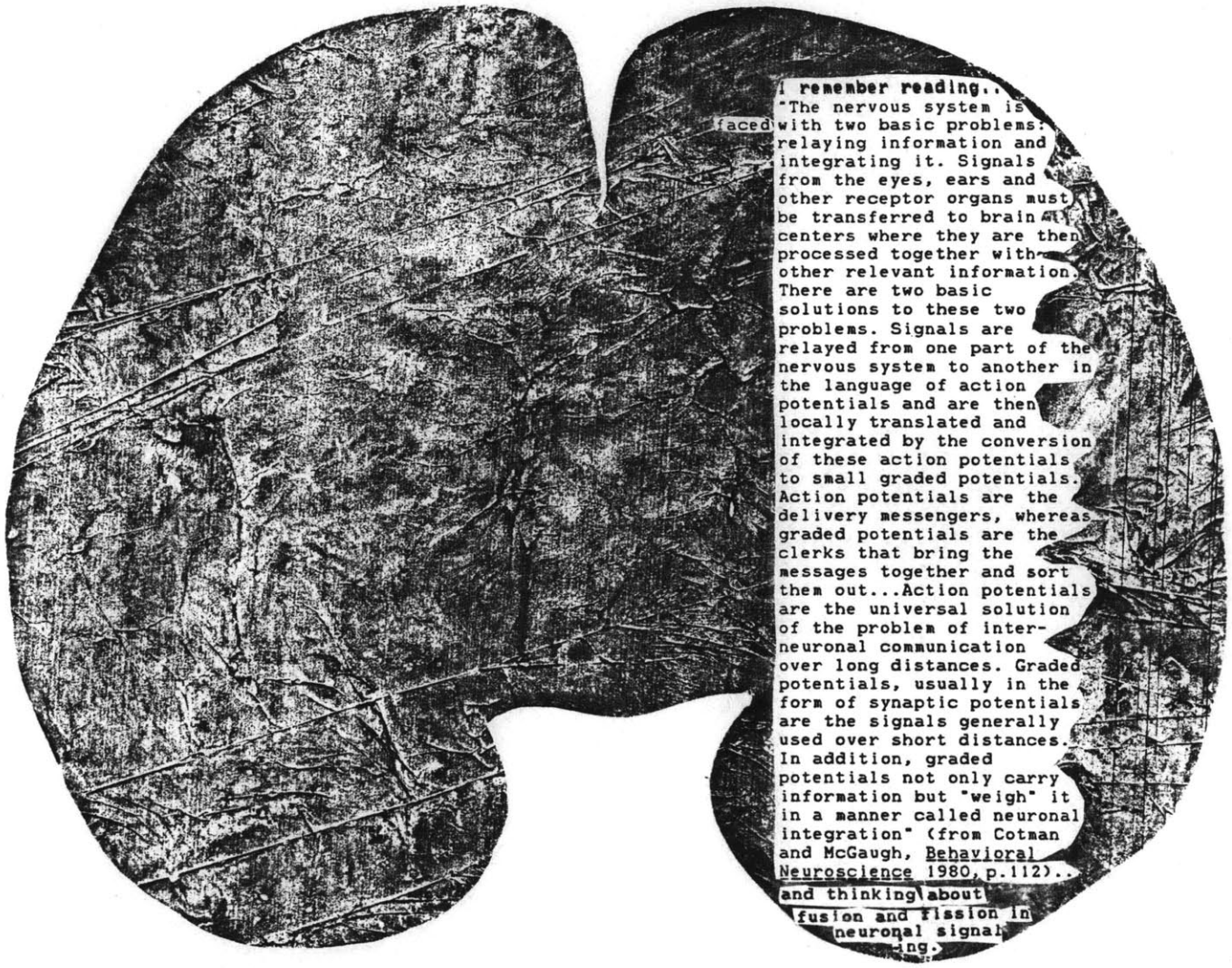


Fig.32 Mental image on the Y-axis in s^1 position (indicating the kind and degree of scientific qualification and quantification). Imaginary cross-section of the human brain, symbolizing the mind thinking about the means by which neuronal information is "relayed" (via action potentials) and "integrated" (via synaptic potentials) in the human central nervous system.

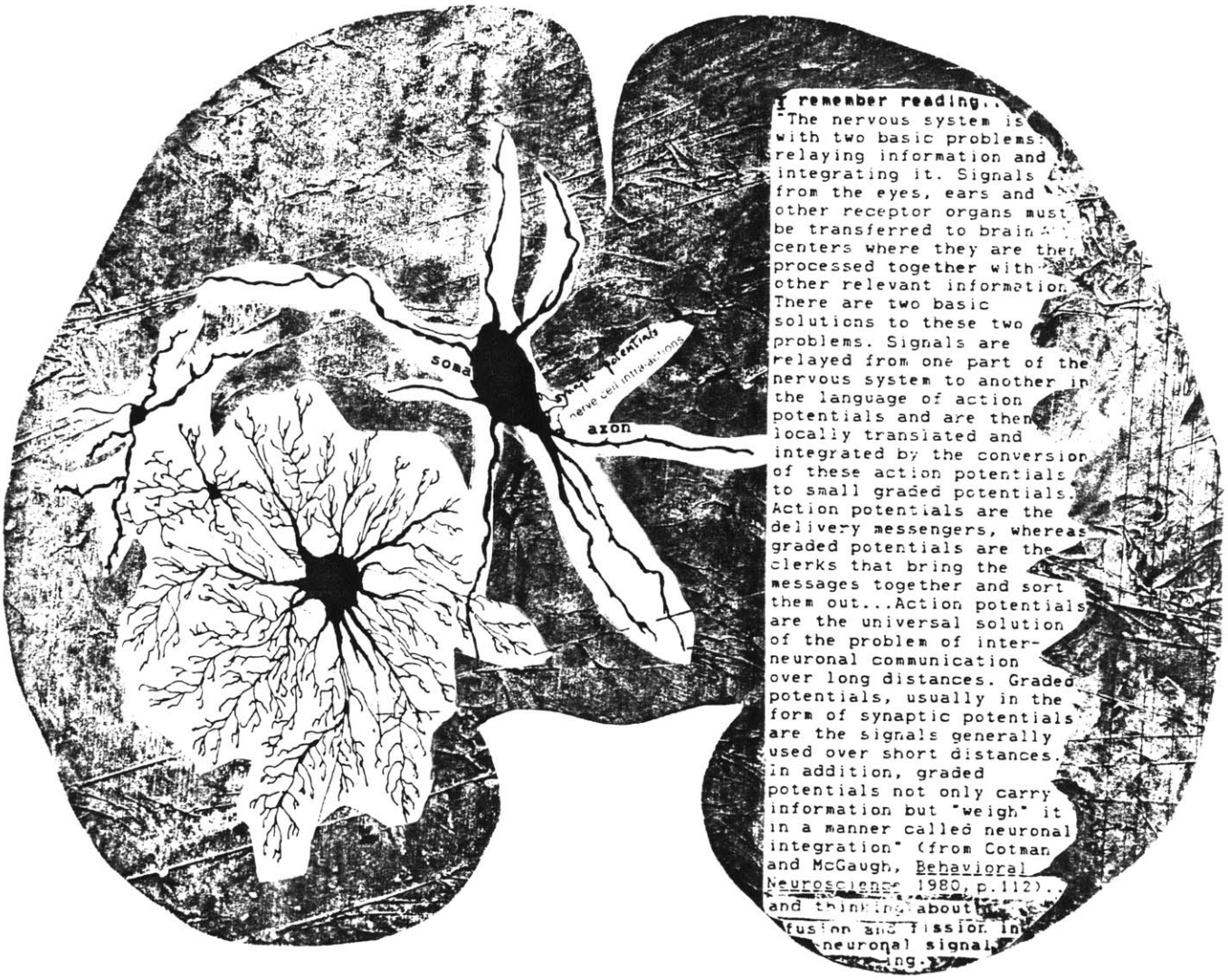


Fig.33 Mental image on the X-axis in which the images a^1 and s^1 are combined (superimposed). Imaginary cross-section of the human brain, symbolizing the mind thinking about "fusion and fission" in neuronal signaling, where both processes are represented in the integration and relay of neuronal information. That is, in synaptic potentials there is exocytosis (fusion) and endocytosis (fission); and in action potentials there is fusion (releasing of chemical transmitter substances at nerve endings) and fission (transmitter substances transforming or "splitting" the signals into graded potentials at the neighboring nerve cell). Synaptic potentials and action potentials, then, are cellular models of cerebral fusion and cerebral fission.

In the context of my mirror concept (Reflectionism, Table 1, Chapter), the X and Z axes represent the coalescence/ fragmentation of ideologies and methodologies among, between, and within the arts and the sciences. Here, coalescence is represented along the X-axis, and fragmentation (i.e. the breaking down or division of the arts and of the sciences) is represented along the Y-axis. The Z-axis (mirror plane) may be interpreted as the "time-line" [14]. Although "Thought Assemblies" divides and differentiates the process of reasoning on the Y-axis, it "re-integrates" artistic and scientific expression on the X-axis (see Figure 34).

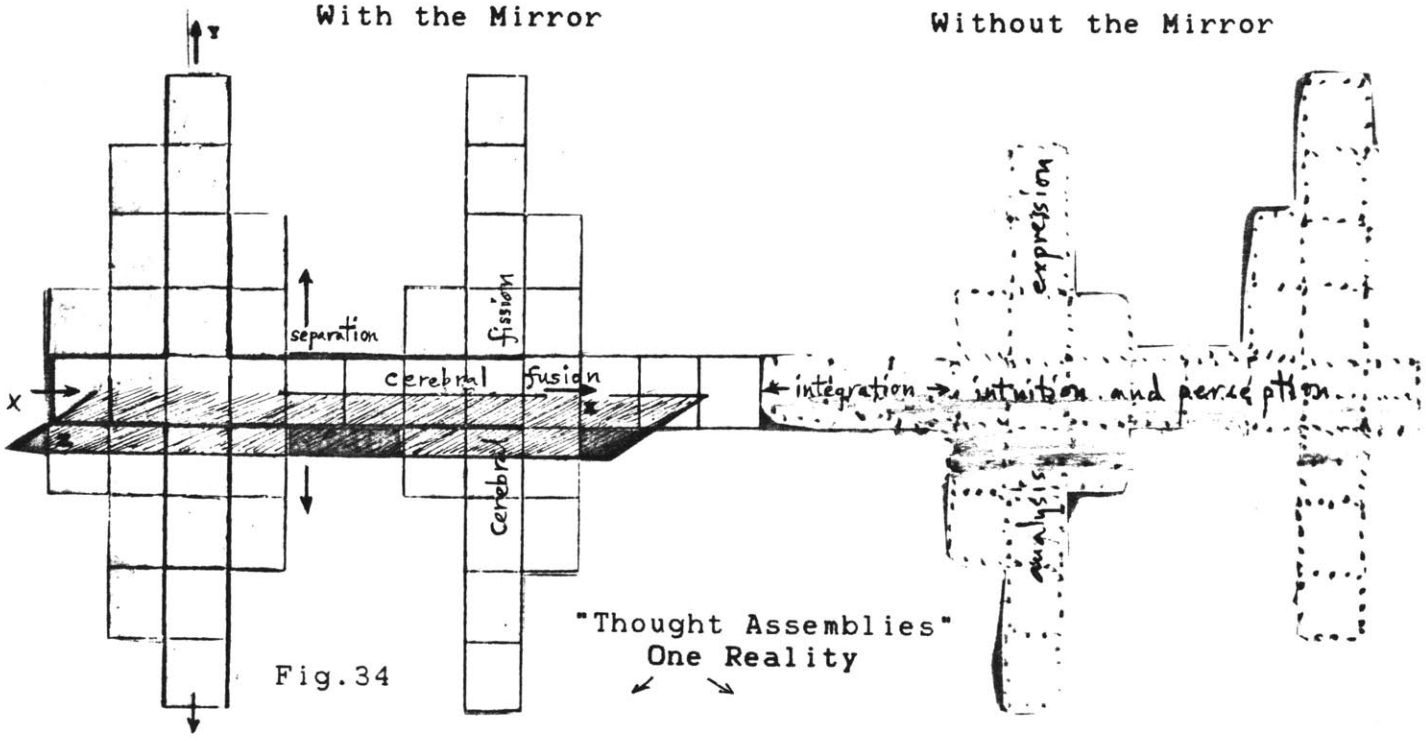


Fig.34

Mechanical Reality
Note the remnants of Newtonian-Cartesian thinking (based on concepts of predictability, locality or "local connections" causality). The structure shown here may be thought of in classical terms as consisting of "particles" and "waves" where the 'particles' make up distinct patterns (e.g. the grid-like shapes which represent my mental images).

Organic Reality
Note aspects of modern physics (based on notions of probability, nonlocality and statistical causality). This structure may also be regarded as a 'dynamic web of relations' and 'energy patterns' (Capra, 1983) which are linked instantaneously.

In the following pages I discuss the organization of "Thought Assemblies" and describe its conceptual and physical form. My aim here is not to explain the art or to elaborate upon the scientific status of the cell-assembly theory. Rather, what I am trying to present is a verbal account of "Thought Assemblies": its scope, intentions, and realizations. About the subject matter (i.e. the human thought process) all I can say is that I find it necessary to express it in both words and images. I trust these depictions/descriptions will help my reader understand more fully **the points (of intuition) and lines (of expressions) which comprise the architectonics of "Thought Assemblies"** (see Figure 12, Chapter 2) [15].

I have decided to select one or two images from each of the eleven connected sections of "Thought Assemblies" to serve as a focus for this discussion. These images are key to understanding my intentions as well as the specific form of the work. To reiterate, my intention was to exemplify a moment of thinking-feeling-creating: a prototype of intuitive and analytical (expressive) thought processes. In the resulting work, my own experiences (i.e. impressions, insights, and questions about the workings of the human brain) are encapsulated. In it, the constitutive elements and events of my own mental processes may be traced, following the **'streams of thought and feeling'** [16] as they form from sensations, perceptions, etc. I envisioned the artwork as a record of

these events and of this conceptualization, representing both the "act of experiencing" and the interpretation of the experience [17].

Just as my theory of cerebral fusion and cerebal fission avoids any specific explanation of its hypotheses, "Thought Assemblies" (as a symbolic model) invites an open-ended interpretation of its "pictographic ideology" (content) and topology (form). In trying to discover meanings in this art work, the viewer/reader is encouraged to think in a 'new key' (Langer, 1963): that is, one must think in a lateral or 'horizontal'way (de Bono, 1977); in a circuitous or 'paradoxical' way (Bateson, 1980); and in a connective or 'bisociative' way (Koestler, 1964). In order to embark on this search for meaning, one must must be willing to suspend one's judgement of "what art/science is and is not," "what thought is and is not," "what mind or consciousness is and is not." Without actually rejecting one's notions, one must momentarily put them aside - to see anew. The artist and author, Gyorgy Kepes, would refer to this process of 'seeing anew' as the "education of vision" (1965). With the education of [one's] vision, one learns that separating (epistemologically and ontologically) the physical and nonphysical aspects of the same reality (e.g. neural and mental processes) is like distinguishing the "two-sides" of the one-sided surface of a Mobius strip or the "inner-outer" world of a Klein bottle.

Thus, "Thought Assemblies" represents at least two stages in the process of education: division and synthesis or comparison and connection. To interpret the artwork and to evaluate one's [aesthetic] experience (Dewey, 1934; Mysore, 1954; Langer, 1958, 1968), the viewer is urged to think introspectively about his or her own processes of thinking (Reeves, 1965), as s/he tries to reconstruct the thoughts expressed in my model (Neville, 1981). The idea is that the viewer may have insights into the structural organization and the use of symbols (Cassirer, 1953) in this artwork, as a result having insights into his or her own thought processes. In this direction, one gains knowledge of the relationship between [to borrow Wittgenstein's phrase] "the picture, the pictured, and the picturer" (1958) [18].

The following schematic, Figure 35 (pp.90 - 100), is presented to show the whole/part relationship of "Thought Assemblies" and to give the reader a sense of its organization and scale. I have outlined certain parts of each section to indicate the images I discuss in the text. These selected images are shown on pages 101 - 111.

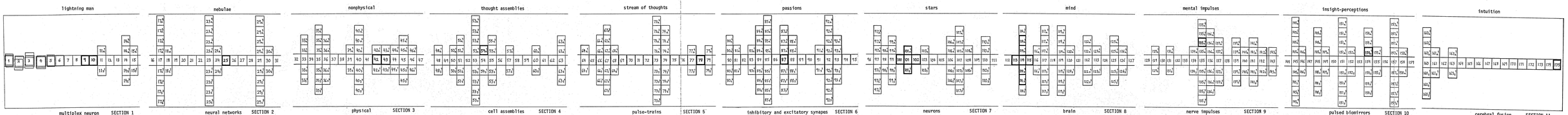

lightning man
multiplex neuron
SECTION 1
nebulae
neural networks
SECTION 2
nonphysical
physical
SECTION 3
thought assemblies
cell assemblies
SECTION 4
stream of thoughts
pulse-trains
SECTION 5
passions
inhibitory and excitatory synapses
SECTION 6
stars
neurons
SECTION 7
mind
brain
SECTION 8
mental impulses
nerve impulses
SECTION 9
insight-perceptions
pulsed biomirrors
SECTION 10
intuition
cerebral fusion
SECTION 11

Figure 35

IMAGES 9, 10

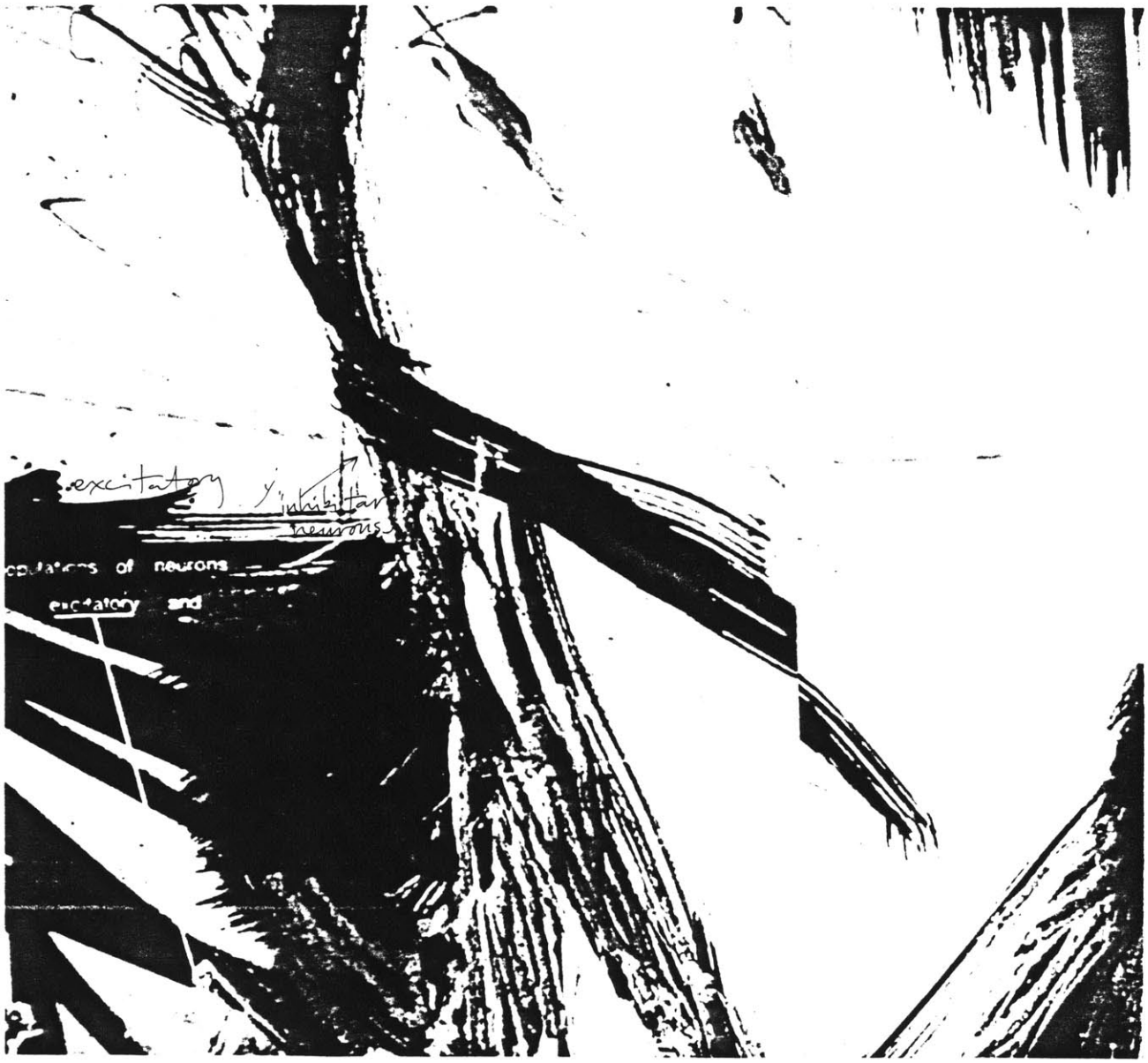
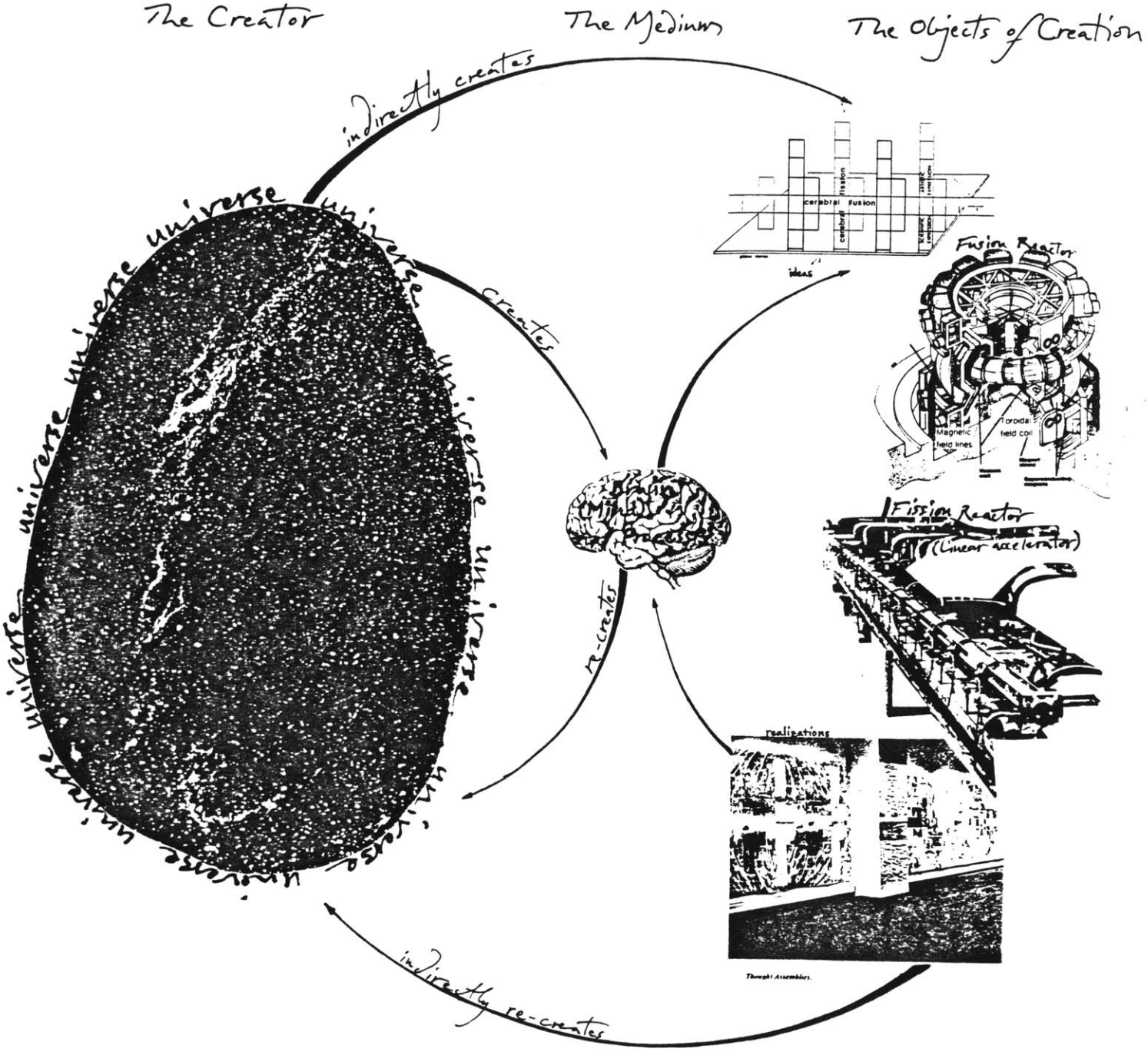


IMAGE 25

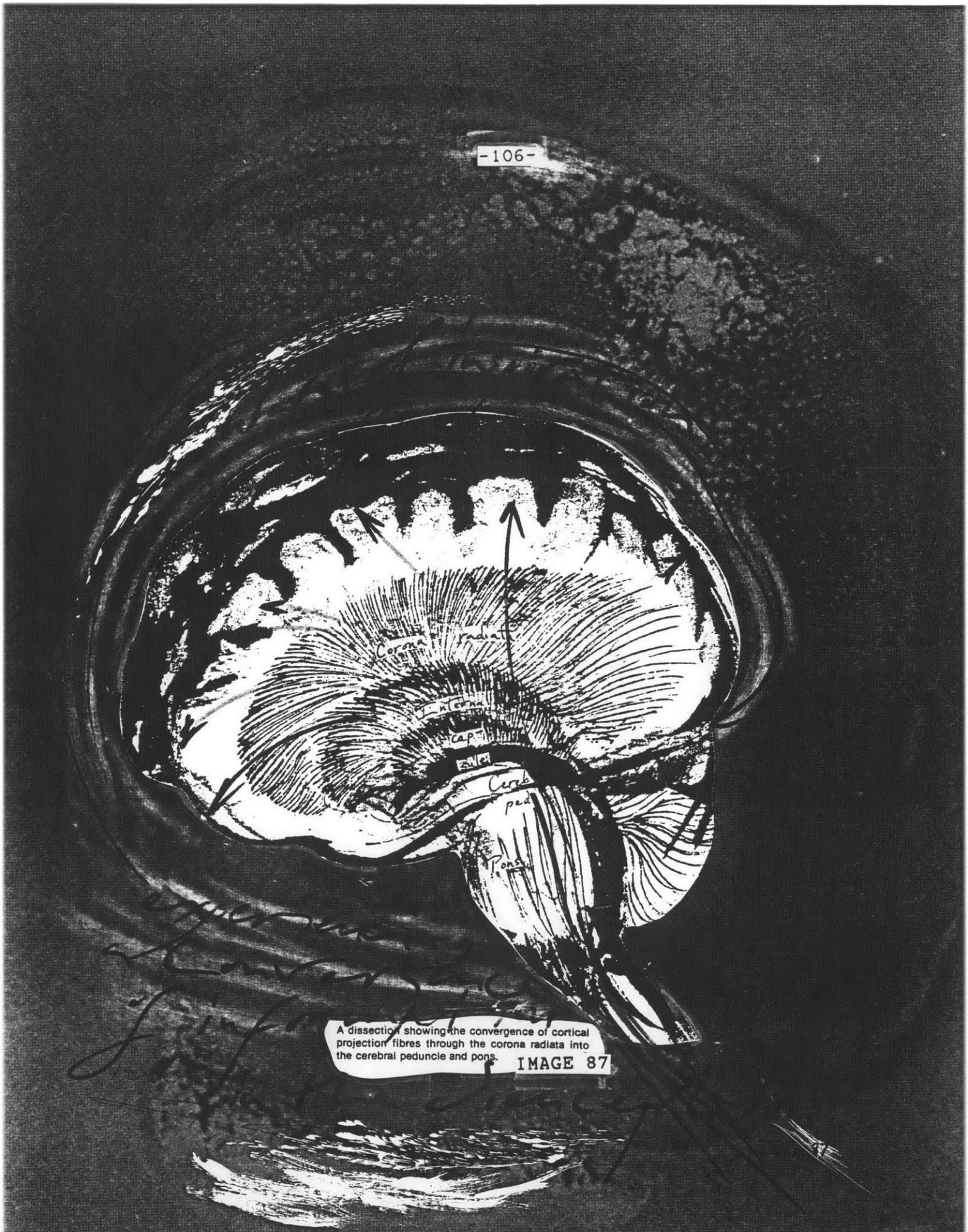
IMAGES 42, 43

IMAGE 54a[1]



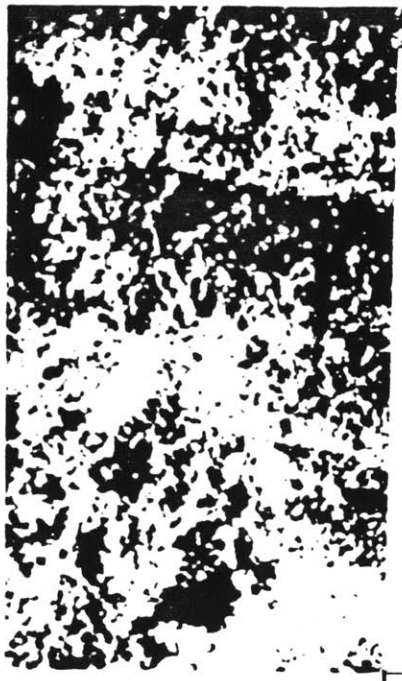
"A lateral view of the origin and evolution of human brain processes" T.J.S. 1985

IMAGE 78



A dissection showing the convergence of cortical projection fibres through the corona radiata into the cerebral peduncle and pons.

IMAGE 87

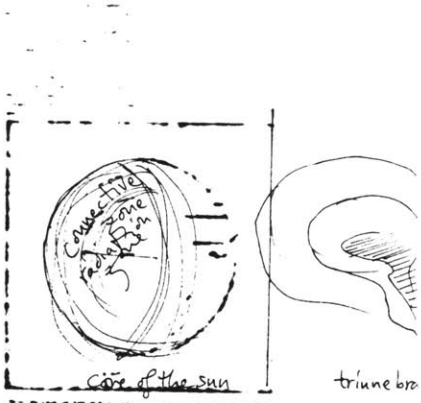


jets of subatomic particles

Synapse

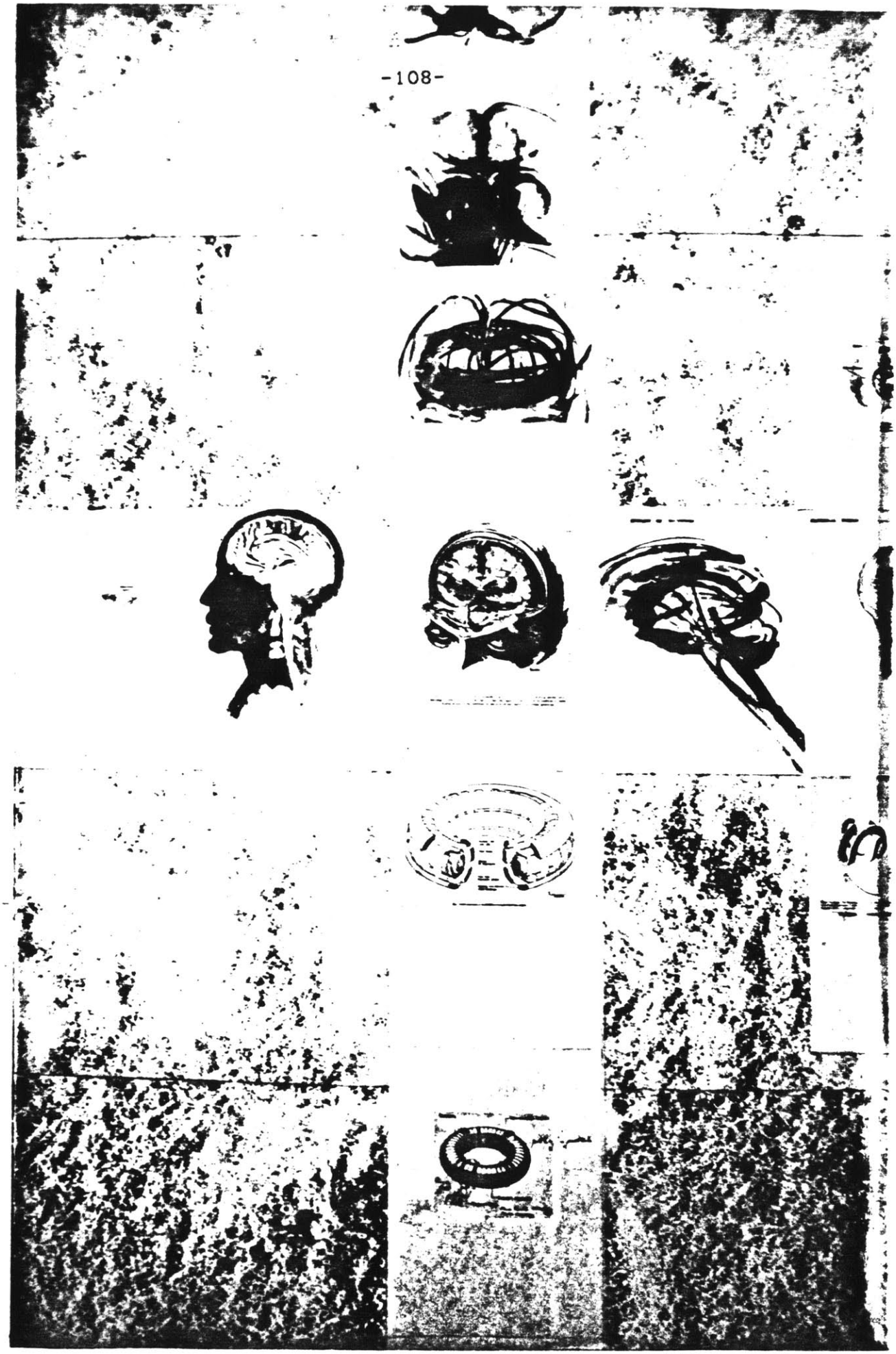
stonehenge

Bubble Chamber



Analysis of the high-energy experiment (above)... Image 101s' (See p. 119)

IMAGES 100, 101, 101a', 101s', 102



IMAGES 113, 114, 114a$^{1\rightarrow4}$, 114s$^{1\rightarrow4}$, 115

IMAGE 135a[2]

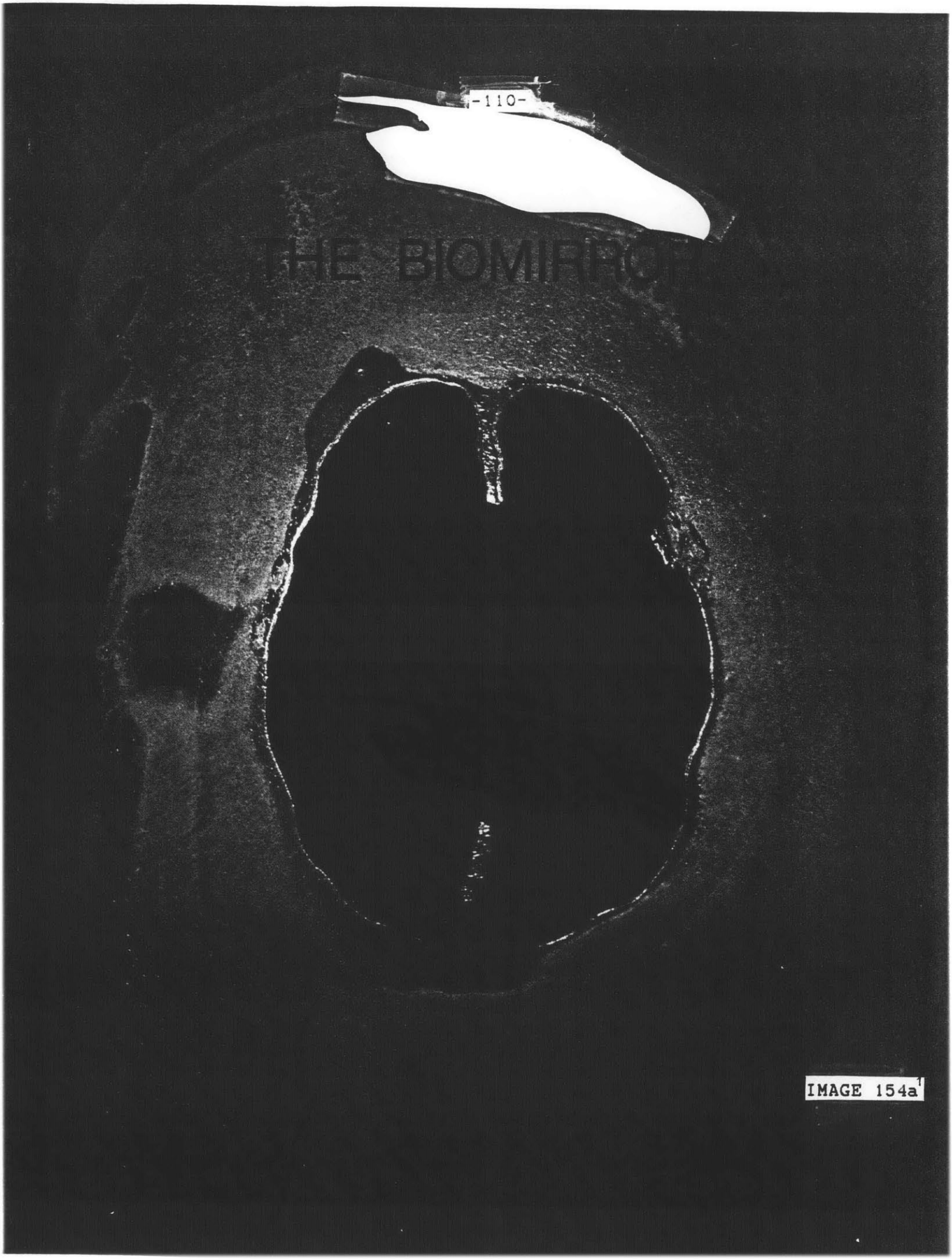
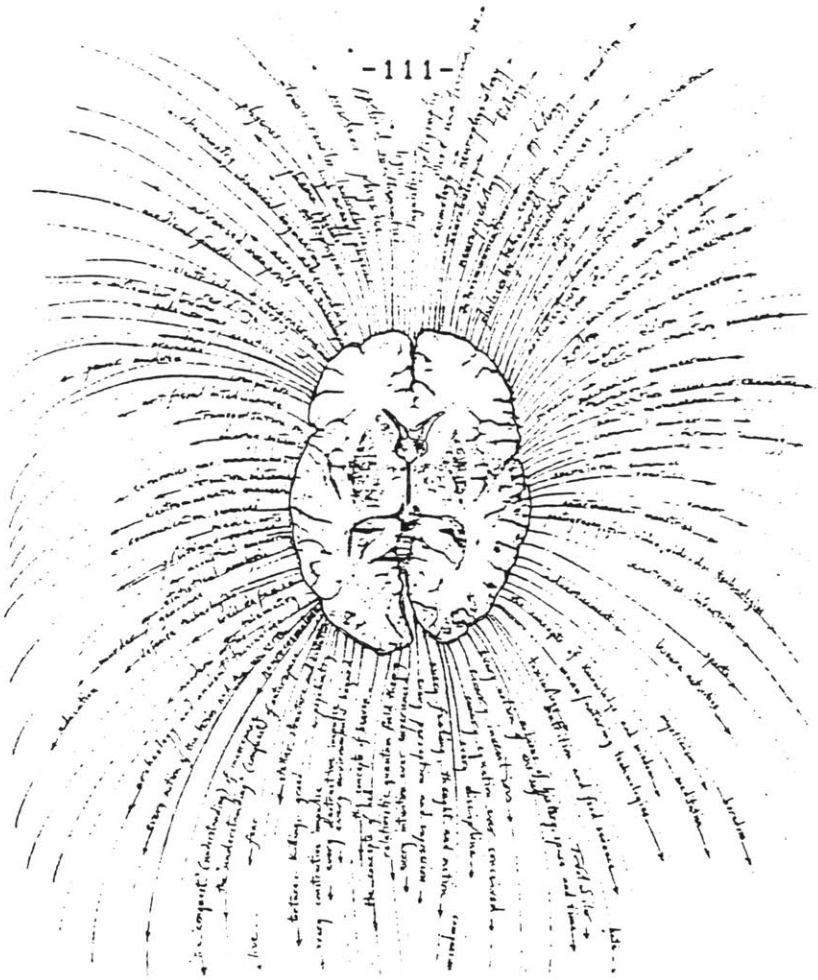


IMAGE 154a



My interpretation of a holistic (systemic) approach to the study of the human brain (mind), thought processes, and symbolic forms of expression. Shown here is a cross-section through the source of creation and the objects and expressions created that reveal the nature of the source itself.

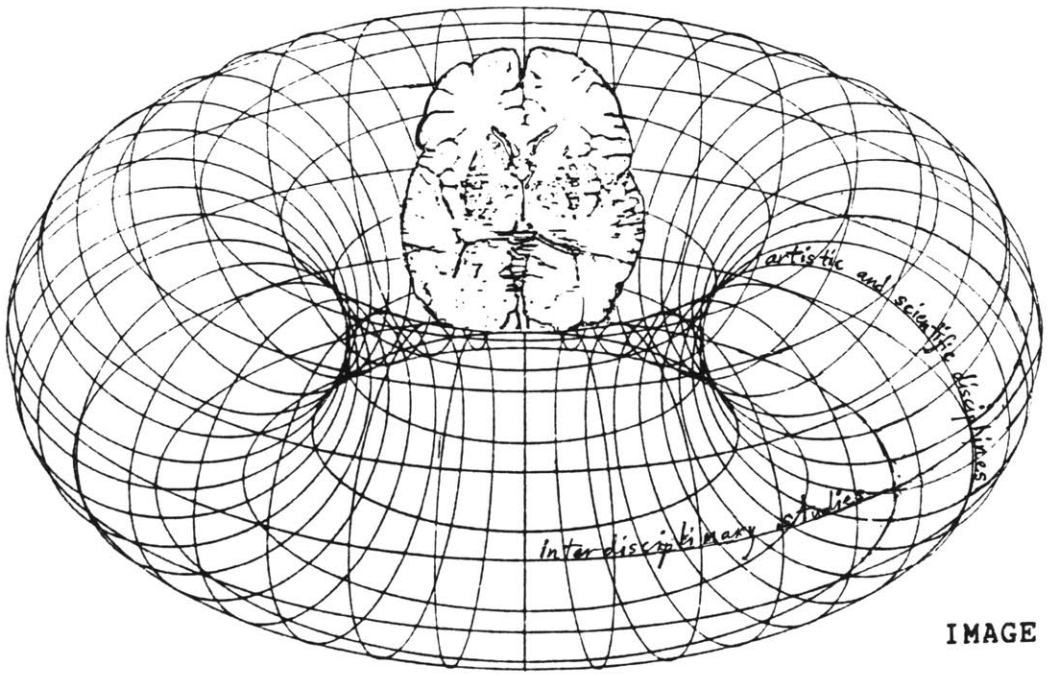
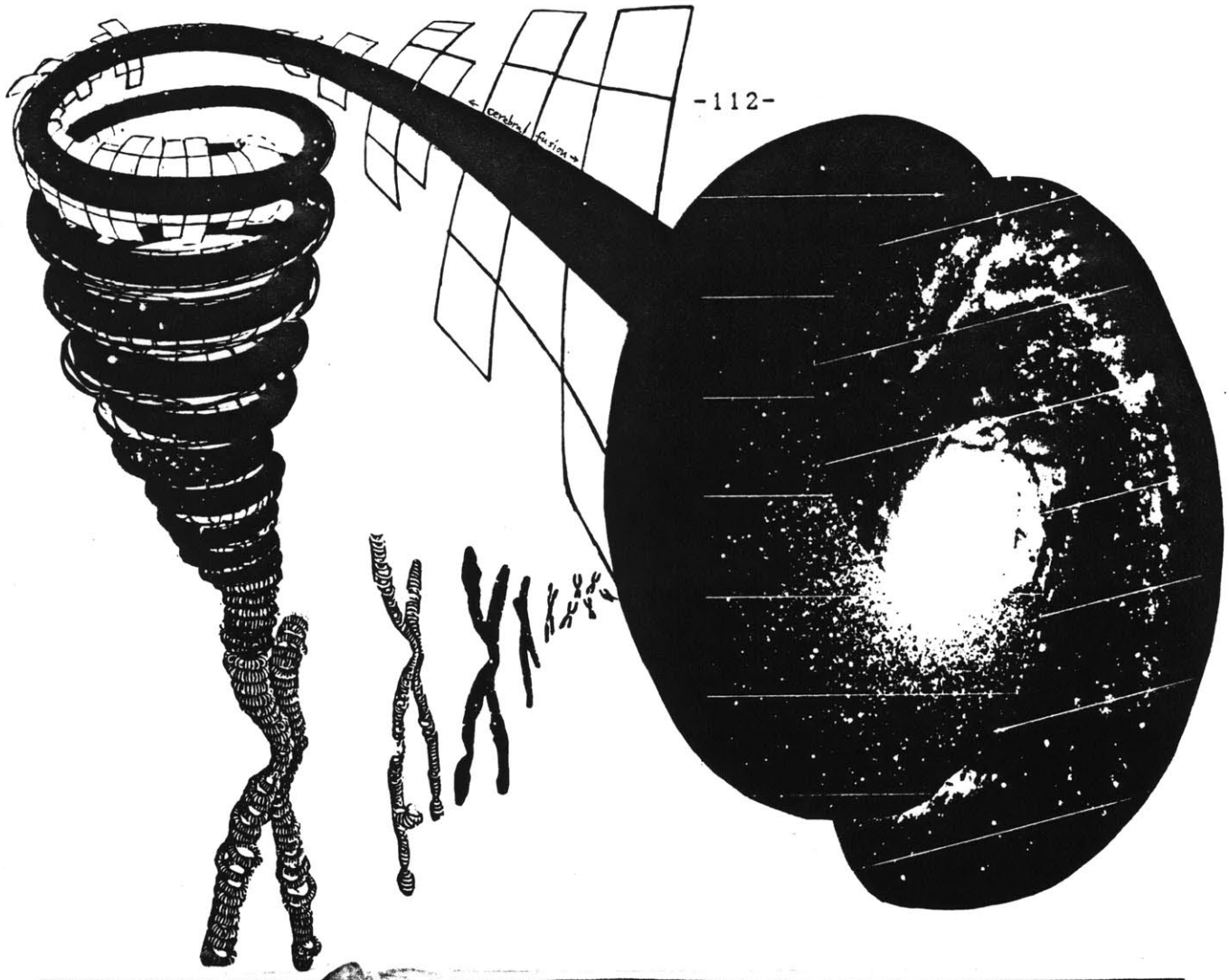


IMAGE 175

Ideally I would like to connect and interrelate as many artistic and scientific disciplines and perspectives as possible, providing new insights and information on the relationship between the human brain and the things it creates - "things" which may be used to understand the workings of the brain.

The brain is what the brain creates



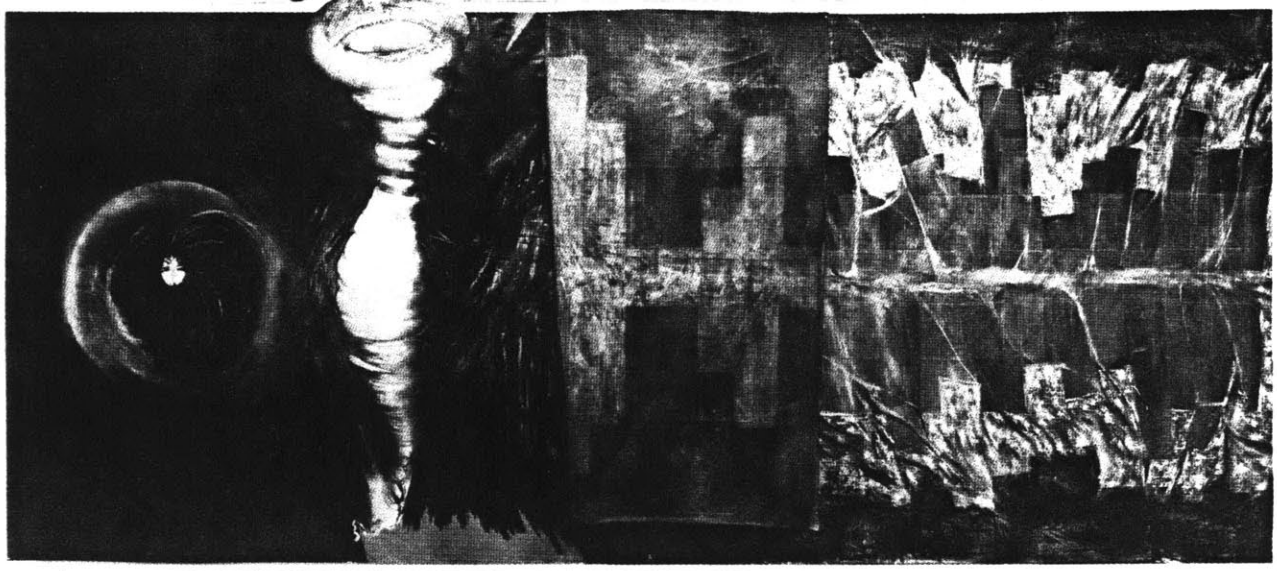


Figure 36b "Emerging Thought Assemblies," spunbonded polypropylene, synthetic fibers, paper, wool, latex, oil enamel, ink, airbrush, conte crayon, computer generated drawings (CAD graphics), graphite, 9 x 26 ft., 1983. The spinning circular image on the far left is a view looking into the vortex of a spiraling thought, generated in part from the molecular and cellular 'strife' seen on the right side of this painted equation.

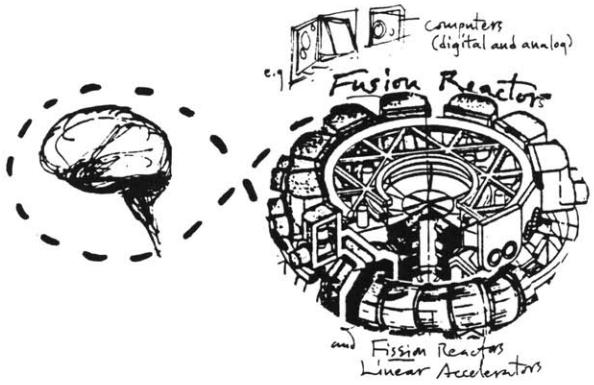
To end at the beginning: shown here is the original form of my "Thought Assemblies" model - before I unraveled it in my analysis. It represents its primordial state - a state of emergence - in which thoughts, feelings, sensory impressions ideas, etc. are taking form (from left to right and back again...from the cosmically small to the cosmically large events occurring in the human nervous system...that is, from the synaptic and action potentials in neuronal signaling (Fig. 36b, right-side) to the architectonics of thought and mental representation (Fig. 36b, left-side); note the transition-point (Fig. 36b, middle) in which the X- and Y-axes emerge.

Ignotum perignotius ("The unknown explained by the still more unknown")

The brain thinking about brain processes and discovering that it needs more clues to understand its own nature.

The brain thinking about its origin and evolution in the relation to the origin and evolution of the universe (a sort of "neurocosmology")

For the brain to understand the brain, it must understand this relationship (i.e. its own dynamics and the dynamics of the things it creates)...



the ojects of the brain's creation

and this relationship...

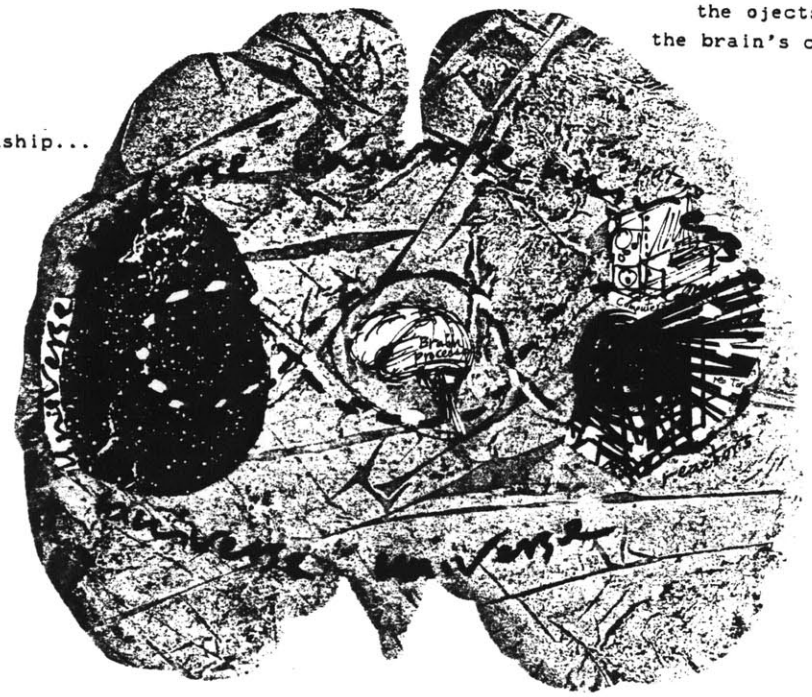


Fig.37 "A Simultaneous Inward And Outward Observation: A view of the human brain viewing the brain."

Odilon Redon once expressed his desire "to instill in the spectator...all the evocations and fascinations of the unknown on the boundaries of thought" [19]. The "Thought Assemblies" artwork attempts to fulfill a similar desire, in exploring the paradoxical nature of the real yet undefinable 'unknown on the boundaries of thought' (see Figures 36 and 37). Of course, neither "the unknown" nor 'the boundaries of thought' can be defined; indeed, they are neither perceived nor experienced. (One cannot **know the "the unknown"** without "the unknown" remaining unknown.) For one to 'instill in the spectator' the excitement of entering 'the unknown' - of crossing the borderline between 'logical thought and nonsense' [20] - it seems I must **know** something of what it is I wish to know or discover, **before knowing or discovering it.** This paradoxical topology of semantics is not quite as convoluted or topsy-turvy as it sounds. As one learns from the history of 17th-century Western thought, the whole issue of knowing and representing something begs the question: how do intuitions (of something never before seen or experienced) work without some inapparent, previous knowledge of the thing first seen? And, how do the representations of one's insights manage so skillfully to match or convey the thing, event, experience represented [21]?

These are the types of questions I contemplate in my symbolic model. None of the questions I draw, regarding the

origin or direction of my thoughts and feelings, is meant to be answered definitively. Instead, the work as a whole is intended as inspirational and provocative; a way of gripping the imagination of the viewer as it might be gripped by the remembrance of an intriguing dream or the apprehension of an anomalous sentence [22]. My descriptions of "Thought Assemblies" serve only to explore such things as preperceptions, the 'duende' of intuition [23], and the unpredictablity of the human spirit in letting go of rules [24] and in following them (from heuristics to formal logic), rather than elucidating these things scientifically.

In developing the imagery for "Thought Assemblies," I frequently envisioned whole passages of images (of ideas) long before I had any knowledge of either what I wanted to express or the order and language in which I wanted to represent my thoughts. For example, my ideas regarding the relationship between brain processes and the fusion-fission processes of the physical universe - **Images 100, 101,** and **102** - anticipate the **Images 14, 15,** and **16.** Technically, however, **Images 100 - 102** precede the **Images 14 - 16.** The mystery is immediately resolved as soon as one recognizes that **along the X-axis** (on which all of these images of intuitions lie), **there is no linear movement of a thought or an insight.** The usual notion and influence of "linear time" (and space) disappears. Similarly, such notions as forward

and backward, after and before, up and down become relatively insignificant in relation to the flow of images on the X-axis. Thus, an image on this axis in Section 1 may or may not take logical precedence over an image on the X-axis in Section 10. Each group of images along the Y-axis (e.g. $17a^{1\rightarrow 4}$, $17s^{1\rightarrow 4}$, including **Image 17** which represents the synthesis of the images **a** $\rightarrow$ **s**) constitutes a single thought or idea or association. According to this scheme, the elements of any given thought are self-consistent [25].

On the microscopic level, each of the eleven sections of this model may contain hundreds of thoughts, in the same way a sunflower plant contains hundreds of smaller individual flowers. By contrast, on the macroscopic level the whole of "Thought Assemblies" may be interpreted as a single insight-perception with a proliferation of visual notes and representations of this one intuition. **This organization of the model permits one to view the artwork on many levels simultaneously.** Moreover, depending on the viewer's perspective and powers of reasoning, the artwork may have a beginning and an ending or a focal point. Like a book without page numbers - and in which each page is a self-contained chapter - the artwork may be seen as eleven separate chapters of ideas on the human thought process. In the context of this book analogy [26], the 'pages' or sections of "Thought Assemblies" may also be viewed as if they are related to one another in so far as

they represent a variety of ideas on the same subject. The sections are then seen as one stream of thought and feeling [27] in which there are numerous momentary breaks in the stream (excursions of the mind on the Y-axis) [28] which ultimately lead back to the mainstream thought, i.e. the changing insight-perception on the X-axis.

Concerning the order and content of specific images in "Thought Assemblies": I chose to represent my ideas and questions about brain processes by **juxtaposing** different sources and forms of information on the human brain. This was soon expanded to include other sources and disciplines outside of the neurosciences. Many of these images are intended to be conceptually **jarring** and unsettling. Others are **jesting** (to provide humor). Some images combine all three intentions. Where, for example, I juxtapose **Images 102 and 103**, one might wonder what a medial view of an adult human brain has to do with a cross-section of the sun. To me there appeared to be both a figurative and a literal association in the corona radiata: the neuronal connections and projection fibers bearing a family resemblance to the radiation and convection zone around a star.

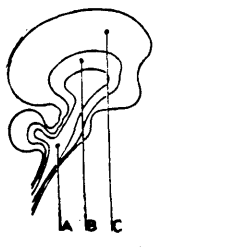


Image 102

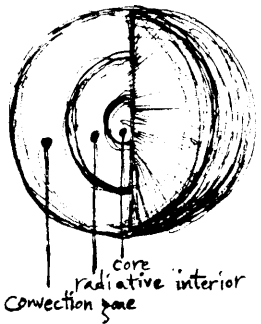


Image 103

The aim of such juxtapositions is to invite the viewer to go beyond the apparent similarities and differences of terminology and physical properties - to discover the inapparent relations. That is why I juxtapose depictions of biological processes with depictions of physical [fusion-fission] processes of the universe [29]. Directly above **Image 103** (i.e. **Image 103a^1**), I ask the question: **Is the brain a star, an energy burning "star of consciousness"** (whose "mental impulses" constitute energy)? There is no answer intended. Only the question is essential. Below this drawing, in the scientific expression [side] of reasoning (on the Y-axis), a medial view of the brain points out the functional anatomy of the three cerebrotypes. What does this mean or imply? One implication is that this triune organization of neural/mental processes is in some meaningful (material and conceptual) sense a counterpart of the organization of the sun. Does the "core," "radiative interior," and "convection zone" correspond to the "brain stem," **"corona radiata"**, and connective tissue of the "neocortex" respectively? Perhaps so. Maybe not. But, in any event, I present these images in photocopies (of a stellar body and the brain, see p.117) to stimulate associations like electrodes implanted in Areas 39-40 and Areas 18-19 of the brain. My **Images 102 and 103** [and their collateral **Images 103a^1, 103s^1**] are intended to rouse the association cortex of the viewer. If these associations evoke a particular

feeling or impression (be it positive or negative), this involves an activation of the sympathetic nervous system in one moment - raising the viewer's heartbeat and respiration - with (in the next moment) an ensuing calm.

What do I know of my own creative process? How are my decisions made, regarding the images I care to include, exclude or juxtapose? How does one choose, if not through intuition? In the shadow of intuition stands trial and error (and other related processes of reasoning); simply, one must first **know [through intuition]** what to try. Also, how can one experience and express an intuition simultaneously, where the expression itself represents something of the dynamics of the intuition, i.e. its constitutive events? As I stated in Chapter 1 (p.1), intuition cannot be physically expressed, it can only be experienced; whereas, reasoning and representing (through artistic or scientific perspectives) are by convention the sole expression of this experience. "Thought Assemblies" is one painted expression (representation) of the unknown and of humankind's inexplicable curiosity to know the nature of the unknown. That is <u>to know</u> (as Paul Klee [1973] wrote) "the nature of nature." To know Nature is to know ourselves (see Figure 37) [30]. **Images 78** (p.105) and **100 - 102** (p.107) show my inquiry into nature.

As a complex visual metaphor, the meanings or interpretations of "Thought Assemblies" have no boundary. And yet, the biology of its creation (i.e. the physiological and psychological events and connections that occurred inside my head as I

was creating this artwork) have a very specific "boundary"... providing one accepts the general principle of cell-assembly theory (Hebb, 1949) or a materialist's theory of mind (Armstrong, 1968; Bunge, 1980).

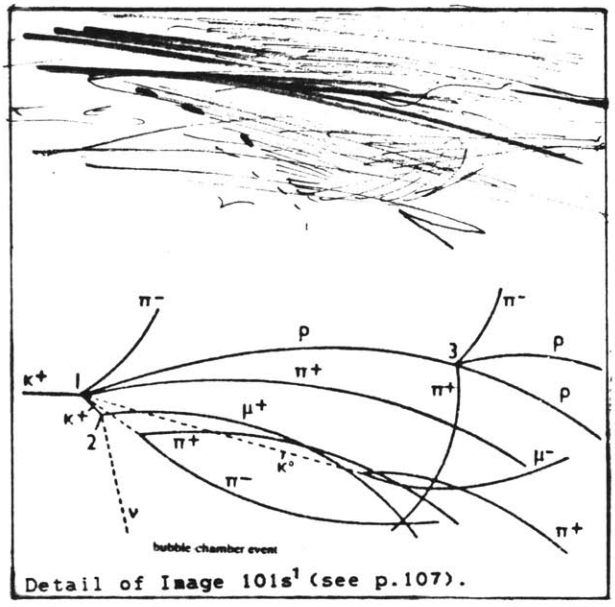
One question persists: just how much does the visible form or "outer intuition" of this artwork (and any other work of art) **reflect** the 'inner intuition' (Cassirer's term which I take to mean the neuropsychology of intuition)? What is **the relation between the thought process of creation and the thing created** [31]? Is it possible to trace the course of specific activities in the human nervous system by scrutinizing the actual physical products of this system (i.e. inventions of humankind)? By examining this artwork - by analyzing its formal elements one image at a time or section by section (see Figures 26a&b and 28) and reasoning through its purported intentions - is it possible to determine the groups of neurons which have contributed to the creation of the work (from its conception to construction)? I would say it is not. And even if it were possible to understand the neurodynamics of thinking-feeling-creating that underlie the creation of, for example, **Image 4, what ultimately is achieved** [32]? Will we have a greater understanding of our mental life and the nature of thought processes - resulting in the creation of more complex and subtle artistic and scientific expressions? Will this knowledge provide a deeper appreciation for the

creative impulse, the expressive act, and the nature of the symbolic language? Or will the 'primal world of the unconscious' (Jung, 1965, p.200) continue to elude examination. No one can say. The whole problem of relating these things - given their inherent complexity - seems insurmountable at this stage in the evolution of the sciences of the mind. I mean, where and how does one begin (at what level of matter and mind) [33]? I want to stress that this line of research need not begin at the level of the physical senses - where one is forced to quantify one's responses to various stimuli. Instead, this research can start with introspective accounts of thought processes, as the Introspectionist school of psychology practiced. It can start with the analysis of a single image - take, for example, **Image 42** (p.103) - tracing its influence on other images which either precede or follow it (note p.115). Through this analytic technique one sees not only the pictorial elements and symbols of this particular image but also its recursive pattern in other images and other sections.

For me, the idea of looking critically at these mental images means attempting to grasp their "projective" nature, including the waves of impulses that moved through my mind as I conceived of the artwork and as I made my drawings. In a sense, the graphical marks and pictorial elements of my drawings appear to me as the secondary effects of subatomic

particle interactions manifest in spark and bubble chambers. That is, they directly show the events and structures (or architectonics) of **cerebral fusion** and **cerebral fission.**

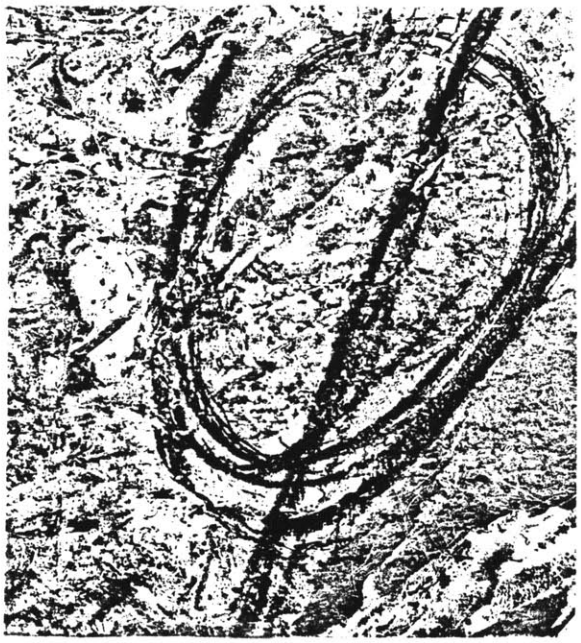
Regardless of the content of the pictorial elements, I believe **the artwork indirectly shows the brain processes responsible for the realization of the art work.** That is, the form of the image and the individual brush marks which comprise the form suggest to me that different neuropsychological activities are involved in the creation of both the general features and the details of the image [34].



Detail of Image 101s[1] (see p.107).

I have yet to discover even "the basics" of my artwork's symbolic language and form or to discern the brain processes involved in my cerebration. (By basics I mean the 'deep structure' of the work of art - the structure which ties it together and connects it with every other human-made and natural form - as distinguished from its most apparent physical features.) I have yet to discover a minute fraction of the events that took place in my brain as I experienced intuitions and made visible these experiences [35]. When I

think of the levels and layers and veils of information in **Image 135a**[2] I feel as though I am looking directly into my brain through the window of this image. I sense that the lines imprinted and painted on this synthetic neural-like tissue are manifestations of mental phenomena; that is, they map brain functions. The key to understanding the expressive nature of these lines and their conceptualization relies as much on intuiting the whole architectonics of "Thought Assemblies" (which includes its neurobiological aspects) as it does on analyzing the 'symbolism and meaning' (Panofsky, 1955) of this particular image [36]. At present, this idea is (qua science) unfounded and undemonstrable.



Detail of **Image 135a**[2] (see p.109)

"Thought Assemblies" allows the viewer to observe the formation of specific **thoughts and feelings together** - showing the conditions under which various perceptions and sensations may be [in the words of Paul Gauguin] 'condensed... and summarized in one instant' [37] (the instant of **cerebral fusion**). In such a moment the sensory, perceptual and conceptual processes interwine. The lines (and symbol) of

Image 115 (p.108), for example, seem to show the transitions of emotion and will in this process of intuitive thinking-feeling; as well, they seem to show the moments when various mental (neural) processes feel as though they are separated from one another as in the process of syncretic thinking [38]. In this sense, **Image 115** intimates things about the 'biology of the mind' (Hess, 1968) and about the 'life of the mind'(Arendt, 1978; Grene, 1971). Whether this painted image captures the physical instance of an intuition, or whether it simply represents this instance as a symbol represents something else by association, **rests with the interpretation of the viewer.** What matters is that this image is a record of my intellect - where "intuition is the basis of intellect" (Langer, 1967, p.141) - in the act of self-discovery. The energy of the lines (i.e. the way the image is drawn and painted) reflects the intensity of the motivating impulse and feelings; it also reflects the speed in which I was analyzing (discriminating and comparing) my thoughts about my symbolic model. The gestural lines of **Images 25** (p.102), **42 and 43** (p.103) are similar in that they show the same sort of aggressive, restless

Detail of **Image 115** (see p.108)

energy that seems to break the sense barrier of reason in reaching for the outer limits of the imagination. At first glance, the pace of the brush strokes and graphite marks appear to be sprinting. And yet, on closer inspection, one may see that I reasoned my way through this drawing - stopping and starting, questioning and answering myself - at a blindingly rapid rate. In creating these images I felt as though I was nearing the edge of objectivity and sense (Gillispie, 1960; Strawson, 1966; Antin, 1976); at the same time, I sensed that I was crossing the dashed (-) line which divides **emotional spontaneity** and **mental restraint** and which separates 'unconscious inferences' (Hochberg, 1981) and [in Helmholtz's words] 'conscious inferences' respectively.

In sum, the **Images 25, 42 and 43** (and especially **Image 115**) are interpretations of the relationship between thinking and feeling, perception and conception. Their forms imply that at the instant of **cerebral fusion**, cognition and affect interpenetrate, overlap and combine; one thinks and feels resonantly and interactively [39]. By contrast, in moments of **cerebral fission**, one's thoughts and feelings seem to be relatively independent, hence there is an emphasis and primacy of either cognition or affect. **Images 25, 42, 43, and 115** are exemplars of both synthetic and analytic thinking in so far as they metaphorically represent the dynamics of intuition. At the same time, their physical representation (of these dynamics) required analytical and affective reasoning

(in deciding the composition of the image). In effect, **Image 115** is an artifact of this act of thinking-feeling-creating. If it is permissible to regard it as an extension of my body, then why not consider it as an objectification of the neuro-dynamics of my mind presented in symbolic form? Its "form," in the words of Wassily Kandinsky (1947), "is the outer expression of the inner content."

Although I cannot apply Hebb's cell-assembly theory in accounting for the content (the representation) or direction of my thought in either, for example, **Image 115** or **Images 42 and 43**, I can take a "hard" materialistic line and argue that there are certain neurons and neurochemical systems that caused their realization. For instance, in the process of actually making these images, I distinctly remember looking over my notes from a course on The Human Nervous System in which the neurotransmitter serotonin was discussed and diagrammed. As I was reviewing in my mind the ascending pathways of the serotonergic nuclei and recalling a discussion (from yet another course on Behavioral Neuroscience) about its psychological implications, I had an intuition. My intuition considered the serotonergic system as one of the possible neurochemical systems involved in **cerebral fusion**. In expressing this intuition, I felt as though I was suddenly connecting several thoughts that I had (about the influence of serotonin on the mental system) over various periods of

time. My notes and recollections from these courses served as catalysts, providing a sort of forum for gathering these ideas. The point is, this information or history is somehow locked in the lines of the image; it is integrated in the pencil marks and patterns of paint which reflect my design decisions. Interpreting this history involves examining my intentions.

Discussing the details of the relationship between Image 115 and the neuropsychological activity that produced this image - assuming that "only neurons draw pictures of neurons" - goes beyond the scope of this dissertation. The purpose in concentrating on this relation is to communicate the idea that **integrated in 'the surface and symbol'** [to borrow Oscar Wilde's phrase] **of a work of art are the physiological marks of the mind.** Whether neuroscientists can distinguish the contributions of the raphe nuclei (in the midbrain) or the entorhinal cortex (in the Hippocampus) [or any other subsystem] in these marks remains to be seen in the future.

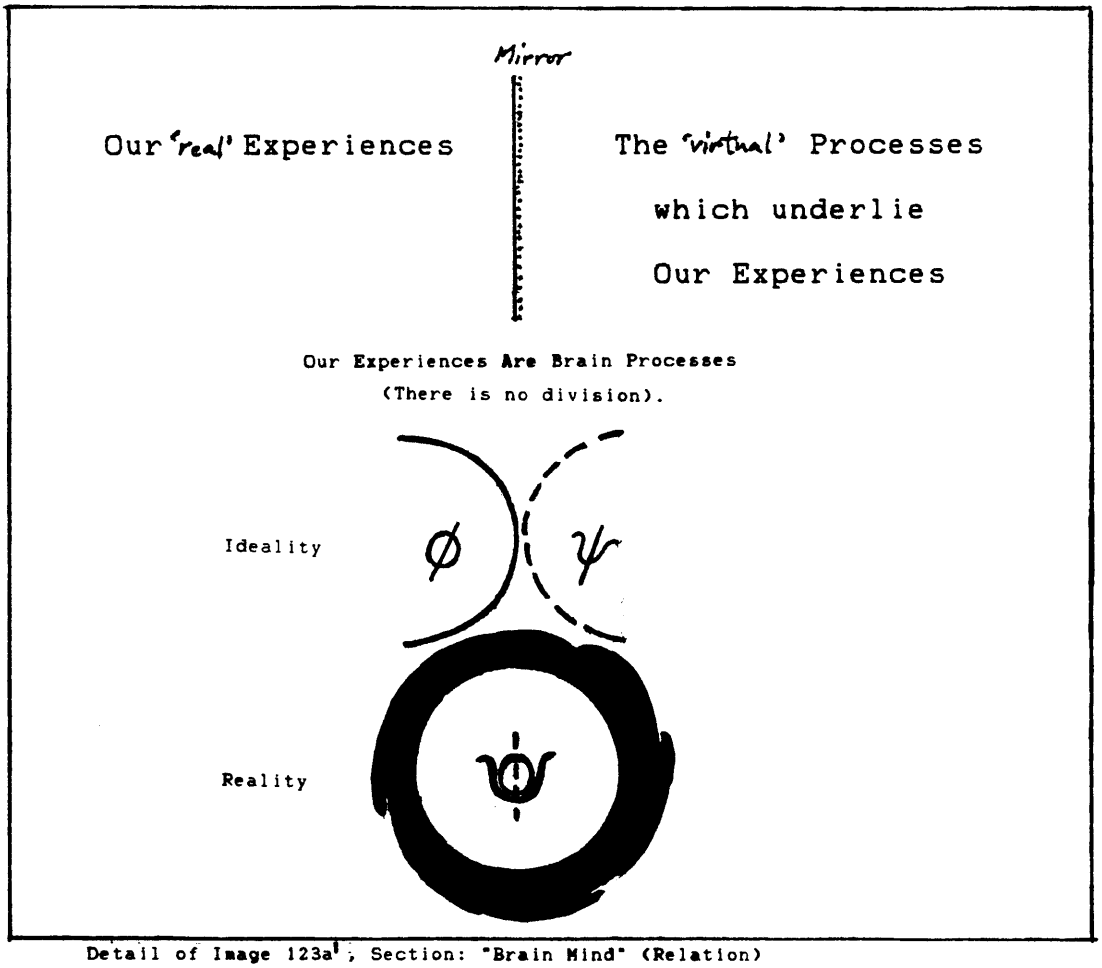
Image 116 "neocortex stimulated by raphe nuclei"

Although the symbolic imagery of "Thought Assemblies" may not appear to be as analytical and logical as the symbolic language of the physical sciences, in the deepest sense it is. The **Images 135s**$^{1\rightarrow4}$ attest to the analytical nature of art; for example, they exhibit lines that were once erased, redrawn, and then erased again, evincing the way in which certain design decisions were exercised. Note, for example, the difference between the top and bottom half of the composition - where the heavier, rigid lines contrast with the more fleeting lines. These gestures and graphic marks were meant to underscore the reality that the neuropsychology of art-making and the languages of art are indeed analytical. In fact, they involve an absolutely staggering number of calculations, trial and errors, problem-solving strategies which, to my way of thinking, are "equal" to the most rigorous mathematical and scientific analyses. Moreover, so called 'artistic thought' [40] and 'artistic expression' most likely results from or activates (depending on which end of cause-and-effect one looks from) the same cell-assemblies as those responsible for works of science and the scientific language. The way the **Image 135a**^{2} (p.109) is drawn - with the **psi** ψ [mind] and **phi** ϕ [brain] **symbol** sketched in loose washes of ink and charcoal - vaguely suggests that the processes (i.e. cell-assemblies) of intuition are probably anatomically "ambiguous" at first [41]...until

the intuition is articulated or expressed, i.e. represented artistically or scientifically. Even then, a fair amount of 'ambiguity' lingers, as something is always lost in the translation (Russell, 1914; Polanyi, 1958; Harre, 1961; Popper, 1965). Finally, it is in the expressions (or representations) of what we call "science" that intuitions take their discursive, discrete form. The symbolic language of science (Foucault, 1972; Fodor, 1975) manifests itself as a highly structured, crystalline form of rational thought.

I cannot claim that the "Thought Assemblies" model understands either the dynamics of pictorial information or the nature of the symbolic language. I can, however, say that its representations show how both artistic and scientific methods of inquiry - when applied together - are the key to understanding the "neuropsychology of symbolic forms" [42]. Through this combination of perspectives and methodologies a new understanding will emerge which will reveal the relationship between certain neural activities and their artifacts. Whether or not the realization of this goal will involve relating every line or pictorial element to some experimental study in the behavioral neurosciences (or the reverse) is unknown. I suspect that such a strategy is inevitable [43]. "Thought Assemblies," then, is as much about exploring the process of self-knowledge and the expression of world-knowledge as it is about examining

the relationship between the 'field of experience and brain processes' (Kohler, 1947) (see Image 123a[1], below), between the knower and the known (Maslow, 1966; Balasubramanian, 1976) between the human creator and the objects of creation (note Image 78, p.105).



Detail of Image 123a[1], Section: "Brain Mind" (Relation)

To avoid misunderstanding the monistic/dualistic implications of my mirror analogy, I urge my reader to review my arguments in defense of this analogy (Chapter 1). What I imply here is that "our experiences and the processes which underlie these experiences" are "two different aspects aspects of the same thing." I do not mean that they 'parallel' one another or are somehow 'synchronized' in their material/immaterial properties (as two different things). In reality, there is no physical "mirror" that divides and differentiates the physical from the nonphysical. The two are ontologically one. What is important to understand is that the mirror analogy permits us to visualize this point - to demonstrate, so to speak, how and why we happen to see "the many" (processes and properties) in "the one." Furthermore, in discussing the field theory as it applies to our experiences (above), "reflectionism" allows us to describe the physical dimensions of the 'field of the object and self' (Kohler, 1947, p.345) as one thing or process.

> **A certain fire, an impulse to create, is kindled, is transmitted through the hand, leaps to the canvas, and in the form of a spark leaps back to its starting place, completing the circle - back to the eye and further (back to the source of the movement, the will, the idea).** - Klee, "Creative Credo"

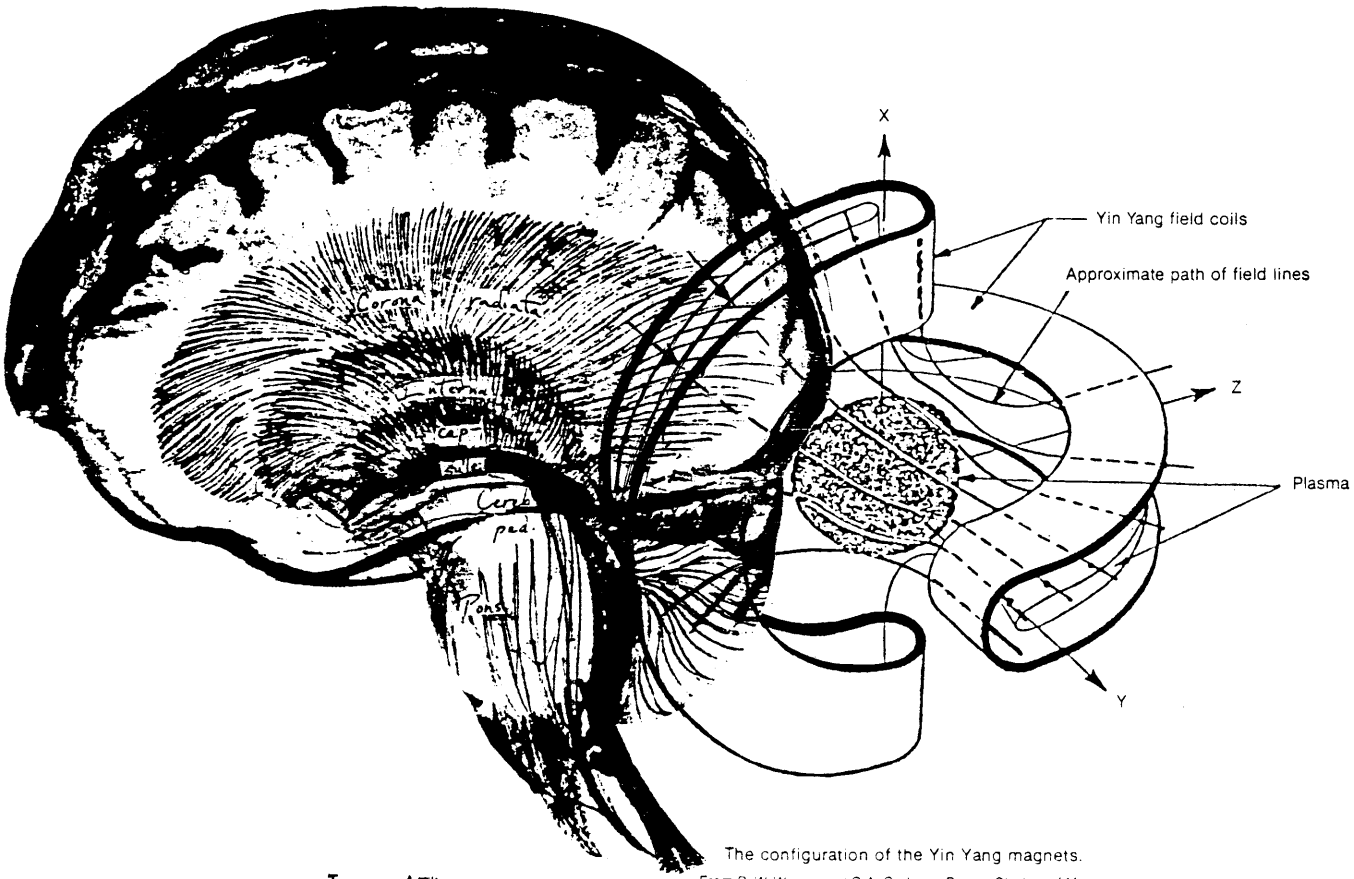
This seems to be the credo for any individual ablaze with an idea or insight which demands to be expressed. Irrespective of the individual's background, or interests, or intention, the impact and surge of a sudden inspiration can be as moving as Klee suggests. The dynamism of this 'certain fire' [44] is the subject of **Image 81a**[1] (Section 6: "Passions"). This image represents my view of the forces and conditions that drive my will to create; at the same time, it shows the mental inversions I experienced in attempting to know and represent my creative process. It sketches and lists, for example, some of the neurodynamics that are known to occur when a person feels depressed and overwhelmed, energetic and euphoric [45]. It imagines the movement of neuronal information from one part of my nervous system to another as I lift my hand with a piece of charcoal in it and create a large arc-like image. The image is not meant to suggest that there is literally an arc-like pathway of cell-assemblies which are involved in this voluntary act. Its complementary sketch, **Image 81s**[1], presents a photocopy with a diagrammatic illustration and scientific description of a cell-assembly. The two images are physically and conceptually combined in the **Image 81**.

"Thought Assemblies" shows that each image contains a a library of fiction (and nonfiction). The sole owner and organizer of this "library" - and the author of this material - is, as one might expect, the artist. Although some artists provide a sort of catalogue and indexing system to their thoughts and symbolic language (Kandinsky, Klee, Moholy-Nagy), I have chosen to cue my viewers as to the direction and content of my thoughts by presenting a collection of related images in each section of the symbolic model. For example, **Images 145, 145a$^{1\rightarrow4}$, 145s$^{1\rightarrow4}$** with their the vertical and horizontal strokes of paint - interpret **cerebral fusion** and **cerebral fission** in terms of **stillness** and **motion** respectively. The implication is that in the former, time seems to "stand still"; whereas, in the latter time seems to have a specific direction or course. To be sure, there are traces of the complementary action in both these thought processes, i.e. in motion there is stillness and in stillness, motion [46]. Given that the vertical and horizontal lines in **Images 145, 145a$^{1\rightarrow4}$, 145s$^{1\rightarrow4}$** are markedly different in terms of their content, composition, medium, etc. (and in terms of their different fictional and nonfictional picture statements), how is it still possible to see some similarity in their energetic qualities (i.e. the affective aspects of these mental images)? Here the "Thought Assemblies" model encourages one to inquire on what grounds this similarity

rests? How can one glance at two different images and conclude automatically that they carry a similar mental and emotional impact even though their symbols, contents, and compositions appear to be different? Are there hidden "expressive elements" that are not immediately recognizable (intellectually) in the representation or expression - elements that remain concealed because they lie outside of discursive thought? What is it that our whole bodies seem to detect like sorcerers yet our critical (trained) minds seem to miss in viewing such works of art? If the material monists and Identity theorists are correct about the **'sameness' of states of mind and states of brain** then the philosophical and psychological study of aesthetics can provide as much vital "outside" (behavioral) and "inside" (physiological) "information" regarding the architectonics of thought (in art making) as the neurobiological study of thought processes. Whether any of these studies can reveal the structure and dynamics of the human mind engaged in certain types of ideational and expressive acts remains in check. How can the artist invent and command this symbolic language - in communicating his or her most subtle and obtuse, abstract and obvious views or "imaginings" - without some internal law and order to assist in these acts of insight, invention, discovery, and expression? Indubitably the "codes" of pictorial languages and the "systems" of representation must

be founded on neuronal interactions. This view is anything but startling when you consider that the human nervous system is, afterall, the mechanism through which the world is perceived, intuited, felt, experienced, etc. Even when this "mechanism" invents other mechanisms such as computers and nuclear and plasma fusion reactors for artificially manipulating matter (energy and information), these devices for the most part behave like (or share a similar dynamicism to) their inventors [47].

Brain Magnetic Mirror Reactor



The configuration of the Yin Yang magnets.
(From R. W. Werner and G. A. Carlson, Design Studies of Mirror Machine Reactors, in *Fusion Reactor Design Problems*, IAEA Vienna, 1974, p. 172.)

[48]

Image 154

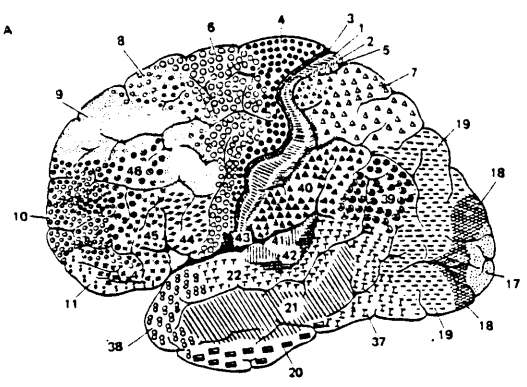
...the process of superimposing...

Certainly art, like any other cerebral activity, can be discussed in terms of nerve-cell interactions. But whether one can infer from this discussion that such and such neural activity occurs at such and such a time and that this occurrence produces a specific cognition is not at all clear. Nor is it clear how certain visual forms and one's experience of these forms relate to specific brain functions [49]. Intimately connected with this issue is one's response to and interpretation of these experiences (Ackerman, 1982); that is, how are the processes of responding to and interpreting visual forms (which invariably involve synthetic and analytic thinking) differentiated in terms of functional anatomy? Can we learn about the dynamics of the interactions of thought processes (and neural processes) by observing the products of these interactions (i.e. works of art and of science) or by analyzing our own responses to these products? This remains uncertain.

My observational notes on the "Thought Assemblies" art work have been directed towards constructing a picture of human brain (mind) processes which is as large as this subject demands. My symbolic model expresses the belief that in order to come to a more complete understanding of the neuropsychological processes of thought, it is imperative that one first re-evaluate the different approaches and theories, definitions and descriptions of these processes. By

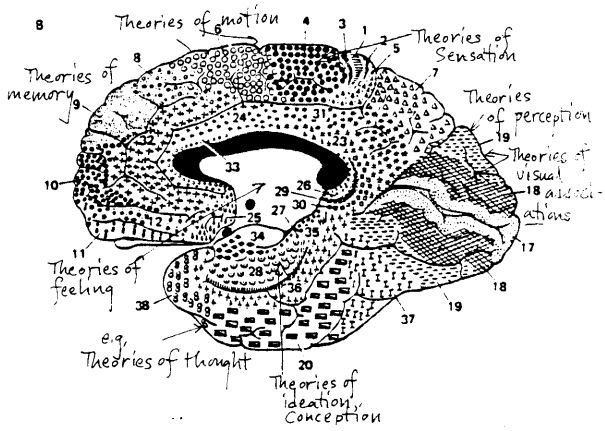
stressing **the contiguity and unity of "different" forms and sources of information** through its structure, my model suggests why it is critical that we consider **the complementarity and interconnectedness** of artistic and scientific descriptions of the thought process. The various topologies of "Thought Assemblies" emphasize that our descriptions and theories of thought are, in reality, as tightly interrelated as the material to which they refer (i.e. the organization of the brain and mental system). Although our disciplines, epistemologies, conjectures and representations of brain processes appear to be different from one another on the surface, I believe that they are as naturally integrated with one another (in the deepest sense) as the cytoarchitecture of the brain itself. I am convinced that in time we will recognize and connect the "inapparent connections" [50] which, as Heraclitus observed, "are stronger than the apparent ones."

"Only connect"
E.M. Forster



Map of cerebral cortical cytoarchitectonic regions. A. View of lateral convexity of cortex. B. Medial view. (Adapted from Brodmann, 1909.) (Modified...)

A cytoarchitectonic map as visual metaphor and symbol for the unity of 'diverse' theories.



Each cell represents a theory (or a group of related theories) about the cells outlined in particular or the brain (mind) processes in general.

CHAPTER 3 NOTES

1. See the "brain And mind" diagram, Figure 4, Chapter 2. Note the art-science axis of interaction (the Y-axis) in the Cartesian Coordinate System for "Thought Assemblies," Figure 27a.

2. By 'mental image' I mean **images generated by the human mind** or **images of the mind** which represent specific ideas, thoughts, associations and awarenesses. Note: even though I am employing the word "mind" in an abstract, metaphoric sense, in no way have I separated it from its underlying neural substrate. My view on such intangible things as "mind" and "mental image," then, is much closer to the monistic view (of a 'mindful brain' - Edelman & Mountcastle, 1978) than it is towards the dualistic view (of 'the self and its brain' - Popper & Eccles, 1970). The words **mental image**, in the context of "Thought Assemblies," suggest that I share Aristotles's belief in 'mental pictures,' along with [in more recent times] the British empiricists' and introspective psychologists' (e.g. Wundt and Titchener) beliefs in **images as ideas** and **images as units of consciousness** respectively.
   For further reading on the subject of mental imagery, I recommend: Allan Paivio, "Images, Propositions, and Knowledge," in J.M. Nichols (ed.) Images, Perception, and Knowledge (pp.47-71) (Dordrecht-Holland/ Boston: D. Reidel, 1974); J.T.E. Richardson Mental Imagery and Human Memory (New York: St. Martin's Press, 1980); R.N. Shepard "Externalization of mental images and the act of creation," in B.S. Randhawa and W.E. Coffman (eds.), Visual Learning, Thinking, and Communication. (pp.139-189) (New York: Academic Press, 1978); G.E. Hinton and L. Parsons "Frames of reference and mental imagery," in A. Baddeley and J. Long (eds.), Attention and Performance IX (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1984); and A. Paivio, Imagery and Verbal Processes (New York: Holt, Reinhart and Winston, 1971); J. Morais, "The two sides of cognition," in J. Mehler, E.C.T. Walker, M. Garrett (eds.), Perspectives On Mental Representation (pp.277-309) (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1982).

3. As I stated in my introductory remarks to this artwork (in Alea [Paris: Christian Bourgois Editeur, 1982], pp.80-85), I aspired to document a moment of productive thought, interpreting and representing everything I was experiencing, analyzing and expressing at a given moment. In describing imagination, I expressed the idea that:

> The "light" of the mind is the medium of imagination. It's the virtual fluid in which mental images form at first in flat relief like the shadows of afterimages.

> In this medium floats Everything - or any part of Everything previously seen or imagined in some physical environment. In my mind, there's no single perspective connecting one point or thought or concept...to another. There's only one's audio-visual memory which pointlessly erases itself from the path of concentration, leaving at most traces of one's perceptions and intuitions. Through analytical and affective reasoning these perceptions can be expressed symbolically and arranged according to their order of occurrence.
>
> Consider: the brain as science and the mind as art. That is, **the content of the mind represented by mental pictures is the message of art. And the medium in which these pictures are created and realized is the brain. An "artwork" constitutes a single mental picture. The term 'work' implies the interpretation of the interaction between the messages and the medium which influences the behavior of a person in creation of thoughts.** What happens at the instant of creation - when the brain "becomes" the mind and vice versa?

4. In the jargon of cognitive science, "Thought Assemblies" is intended to represent both bottom-up and top-down modes of information processing. In Cognitive Psychology and Its Implications (San Francisco: W.H. Freeman and Comp., 1980), John Anderson defines **bottom-up processing** in terms of 'information flowing from little perceptual pieces (features), which serve as the foundation of perception, to larger units built from them.' Conversely, **top-down processing** is defined as 'high-level general knowledge determining the interpretation of the low-level perceptual units' (p.43).
   The Y-axis in "Thought Assemblies" (see footnote 1, Chapter 3) exhibits both types of information processing.

5. According to Hebb, a **percept** consists of assemblies excited sensorily, a **concept** of assemblies excited centrally. Assuming that that any **thought consists of both percepts and concepts,** one ought to inquire how the momentary emphasis of either sensory or central 'excitement') affects the content of thought. Also, how are cellular differences factored into the content of thought - given that the mechanisms of thought (i.e. cell-assemblies) influence a thought's content and form? Do the cells making up the fiber bundle of the fornix and those comprising the ventral tegmental area differ in the quality of their "contribution" to the thought process, or in the way they affect thought? These and other questions are contemplated in the imagery of "Thought Assemblies."

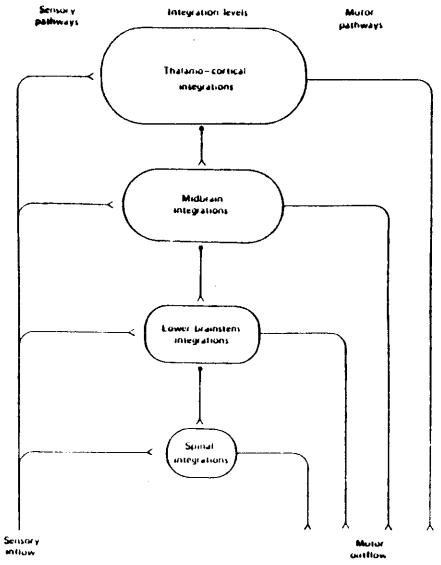
6. I should also mention that other ideas, theories, works of science and works of art added to the conceptual foundation of "Thought Assemblies." For example, I considered:

   William James's view that "experience is remoulding us every moment, and our mental reaction on every given thing is really a resultant of our experience of the whole world up to that date...whilst we think, our brain changes, and that, like the aurora borealis, its whole internal equilibrium shifts with every pulse of change. The precise nature of the shifting at a given moment is a product of many factors...Every brain-state is partly determined by the nature of this entire past succession...Each brain-state is a record in which the eye of Omniscience might read all the foregone history of its owner" (p.234). Note: **Images 1-5** in Section 1 of "Thought Assemblies."

   Wertheimer's (1945) views on the main operations of association: "acquiring connections...on the basis of repititions; the role of frequency, of recency; recall from past experience; trial and error, with chance success; learning on the basis of repeated success; acting in line with conditioned responses, and with habit" (p.9). The whole issue of "association" (including the Lockean sense of 'association as mental atoms or molecules combined to form 'simple ideas') is dealt with specifically in **Images 17 - 29**, Section 2 of "Thought Assemblies."

   Hebb's (1980) notion that 'an image is a percept occurring in the absence of the thing that seems to be perceived, and images like percepts occur one by one; so using the term **idea** to comprise both percept and image, thought appears to be a linear series of ideas - that is, ideas one after another in single file' (p.112). The design of the "Thought Assemblies" artwork explores this notion of a series of ideas as lying in tandem on a straight (Figure 26a) or curved (Figure 26b) line. Note: **Images 1-175** in Sections 1-11 of "Thought Assemblies."

   Dalbir Bindra's (1976) theory and model of 'the level of integration in human brain functions' (note the figure below and in footnote 45, Chapter 3). **Images 112 - 127** in Section 8 of "Thought Assemblies" expand on this model in attempting to specify the level(s) of integration involved in **cerebral fusion**.



Level of integration or the hierarchiacal model of brain function. [Reprinted from *A Theory of Intelligent Behavior* by D. Bindra. New York: Wiley, 1976. Copyright 1976 by John Wiley and Sons, Inc. Reprinted by permission.] (p. 21)

Jean Piaget's (1965) notion that 'the concept of "the whole of reality" involves three components. Firstly, it refers to the whole of the higher activities of man and not exclusively to knowledge...Secondly, from the point of view of knowledge, it implies the possibility that, underlying phenomenal appearance and individual knowledge, there exists an ultimate reality, a thing in itself, an absolute, etc. Thirdly, that a reflection on the whole of reality can give an insight into the realm of possibility (Leibniz, Renouvier, etc.)' (p.39). Note: **Images 63, 63a$^{1\to2}$, 63s$^{1\to2}$** in Section 4 of "Thought Assemblies" depict "Knowledge" as an assemblage of representations which may be abstract and concrete (or clear and ambiguous). These images intimate that there is **no special knowledge which correctly or accurately represents 'the foundations of knowledge'** (as Kant envisioned) or an 'ultimate reality' (as Piaget contemplates here).

Fritjof Capra's (1980) view of the universe as 'a dynamic web of interrelated events where none of the properties of any of this web is fundamental...they all follow from the properties of the other parts, and the overall consistency of their interrelations determines the structure of the entire web' (p.87). To me, the brain is a dynamic web of interrelated events where neither the elements of neurons nor constitutive events of information processing (i.e. synaptic and action potentials in neuronal signaling) are 'fundamental'; their overall consistency determine the **process** of the brain. **Images 106 - 111** in Section 7 of "Thought Assemblies" explore this 'bootstrap philosophy' (used in high-energy physics).

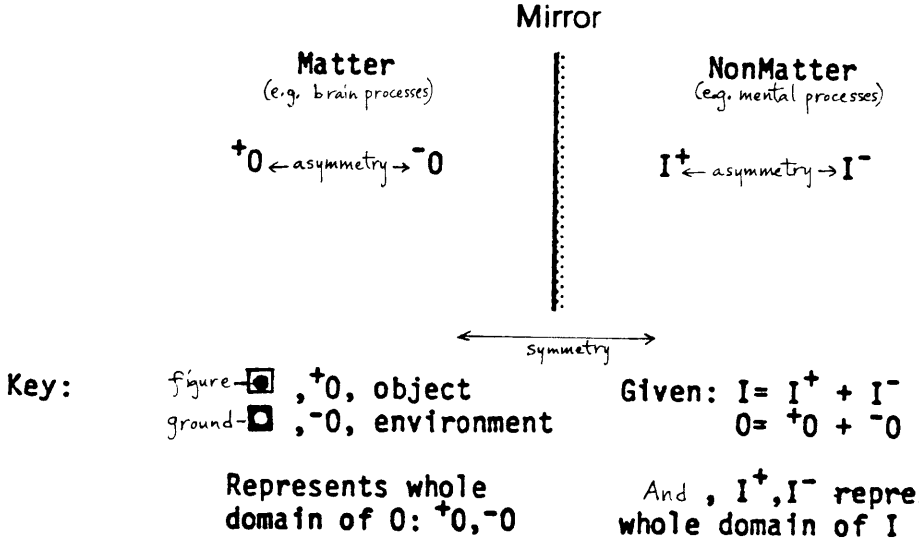
In general, the materials I have chosen for annotation and quotation (e.g. James, Wertheimer, Kohler, Hebb, Bindra, to name some) are those of my precursors. As such, they reveal my philosophical kinships and predilections - concerning the description of mental activity. Although they anticipate certain aspects of my concept of the thought process, in no way do their theories or experiments eclipse my theory and symbolic model. For one thing, their expressions or representations (of ideas) are noticeably different than mine. For instance, they are much less holistic and open-ended, favoring the principle of "exclusion" (rather than "inclusion"); moreover, they rely heavily on inductive inference. For another thing, since the scientific approach to thought, learning, and creative expression differs from mine, the scientific answers are not mine. And yet, if one were to X-ray the body of the theories and compare them with my theory, one would probably find that our "bones" share a similar architecture despite the fact that our outer appearances (i.e. our conceptualizations) do not.

7. "Symmetry," Heinz Pagels (1982, p.262) writes, "has to do with how objects remain unchanged if we transform them."
Gerard't Hooft (1980, p.104) explains: "Symmetry can be defined as an invariance in the pattern that is observed when some transformation is applied to it." Asymmetry would then imply a variance in the pattern. In the context of "Thought Assemblies," one can physically twist it or convolute the work, like a toplogical form, without disturbing either the relationships between the images or their positions (i.e. the order they are currently shown in [as indicated by their numbering]; see schematic, pp.91-111). Recall the adage: "The more things change, the more things remain the same."
Cf. Hermann Weyl, Symmetry (Princeton: Princeton University Press, 1952). Also, cf. Cyril Stanley Smith, A Search for Structure (Cambridge, MA: The M.I.T. Press, 1981); Chapter 3: Structure, Substructure, and Superstructure," pp.54-68.
Philip Morrison (1979, p.57) writes: "The principal, most important symmetry of the world, in the sense of Leibniz...is the fact that the world is modular. I mean this: the particles that make up all our world are supplied to us in a few models, but in incredible numbers, all of each type identically the same. You cannot distinguish any single electron from another...There is no tag, no marker, nothing at all that we know to distinguish one electron from another. Allow the possiblity of a spectrum of states in which each of these structures can be found...but all states with labels. I can say, "Yes this hydrogen atom is in state number seven," and then I won't confuse it with any other which is in state number five, but all the fives and all the sevens are enormous populations of identical objects within which I can never distinguish...That is the most profound symmetry in the entire canon of symmetries."

The passages above are especially meaningful to me in that they indirectly refer to the structure of my "Thought Assemblies" model which explores one of the four types of symmetries - namely, mirror reflection (the other three are rotation, translation, and glide reflection) - together with the notion of asymmetry. Morrison's explanation of the 'state numbers' I relate to my organization of information along the Y-axis, for example, in which **every implied comparison occupies a certain state along the Y-axis (denoted a^1, a^2, a^3, a^4,...a^n)** and **every explicit comparison occupies a certain state along the Y-axis (denoted s^1, s^2, s^3, s^4...s^n)** This gives the "Thought Assemblies" model its Periodic Table-look, although this artwork is not specifically about the assemblage of atoms and molecules in constructing 'aggregates' of thoughts (in the Lockean sense). It is more about creating images and describing the process of creation, forming mental connections and describing the process of formulation and formation, questioning the nature and dynamics of thought processes and examining the role of mirror reflection (symmetry) in these brain processes.

8. Read Philip Morrison's article entitled "On Broken Symmetries," in J. Wechsler (ed.), On Aesthetics In Science (Cambridge, Mass.: The M.I.T. Press, 1979) pp.55-70.

9. What I mean here is that analyzing the differences between one perception or thought and another is analogous to defining a figure-ground relation when both the object and its environment respectively are constantly changing.



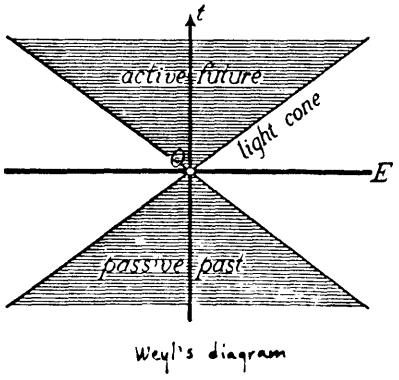
In this sense, there is no constancy of symmetry observable; there are only arbitrary, artificial boundaries between one point of view or one thought and another. The diagram implies **there is an "asymmetry" within a thought and between thoughts, as opposed to a "symmetry" between neural and mental processes.**

10. "Thought Assemblies was originally conceived of as a spiral-shaped painting (see Figure 36b, p.112), designed to gradually unfold over several hundred feet in the exhibition space. The viewer would be free to move around the work, tracing the progression of a particular line of thought and its interactions with other thoughts. Also, in the original design, the shape of the mental images were mostly irregular and amorphic (like pieces of a giant puzzle that overlapped each other), as opposed to the rectangular format in the current model. Moreover, each image would contain information which would be relevant to the whole artwork; that is, the whole would be represented in the parts (the images) comprising each section of "Thought Assemblies."

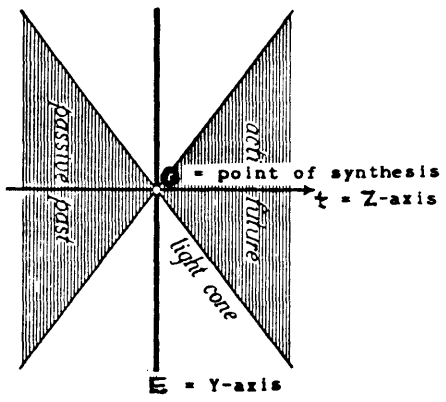
11. The **"oneness" (of the process of reasoning)** is implied by my placing both artistic and scientific forms of expression on the same axis - though at opposite ends or poles - which come full circle and are joined together (see Figure 27b and Figure 36a). It [oneness] is also implied by the statement that **there are at least two sides to the plane of reasoning (the analytic and the emotional or affective), where intuition represents the edge of the plane connecting the two sides.**

Another visual metaphor for my concept of "oneness" is Weyl's (1952) notion of 'the world point O'. The zero is shown here as the cross-section of **present**, the horizontal plane t = const. going through O. (See "Light Cone" Diagram, below.) As Weyl explains: "The active future of a given world point O, here-now, contains all those events which can still be influenced by what happens at O, while its passive past consists of all those world points from which any influence, any message, can reach O' (p.1836). I have modified Weyl's diagram by interpreting the 'events on a **(horizontal) plane E'** as the events on the vertical Y-axis of my "Thought Assemblies" model and 'a **vertical t axis** on which time is plotted' as the horizontal X and Z axes on "Thought Assemblies." The implication is [as Weyl pointed out] that 'active future and passive past are separated by the part of the world lying between these cones, and **with this part I am here-now <u>not</u> at all causally connected** (my emphasis).

See also footnote 46; re: the idea of motion in stillness.



Weyl's diagram



12. Cf. Geoffrey Vicker's (1979) notion that 'the human mind has available to it at least two different modes of knowing... One of these modes is more dependent on analysis, logical reasoning, calculation, and explicit description. The other is more dependent on synthesis and the recognition of pattern, context and the multiple possible relations of figure and ground. The first involves the abstraction and manipulation of elements, irrespective of the forms in which they are combined. The other involves the recognition or creation of form, irrespective of the elements which compose it...They are often referred to as rationality and intuition...The main difference to which I refer is that a rational process is fully describable, whereas an intuitive process is not. Because our culture has somehow generated the unsupported and improbable belief that everything real must be fully describable, it is unwilling to acknowledge the existence of intuition; and where it cannot avoid doing so, it tends to confine it to the area where the creative process is least constrained and most in evidence - namely the narrow contemporary concept of Art - so much so that when this ubiquitous faculty appears in the practice of "science," it is greeted as a strange incursion froma foreign fields called "aesthetics" (p.145). Read pp.38, 39 and footnote 15 (Chapter 2) on the subject of "anima" and intuition in my thesis.
    Cf. Henri Poincare's views on the importance of intuition in scientific research (in The Value of Science [Translated by G.B. Halstead] [New York: Dover Publications, 1958], p.19).

13. For a perspicuous analysis of superimposed figures and the diagnostic use of superimposition, read Aleksandr Luria's Higher Cortical Functions In Man, 2nd Ed. New York: Basic Books, 1973; Section 3: "Methods of Investigating The Higher Cortical Functions In Local Brain Lesions (Syndrome Analysis)," Chapter 6: "Investigation of higher visual functions," pp.451-468.

14. See James's description of the "time-line" in caption for Figure 12, p.32.

15. Read legend for Figure 12, concerning the **points** (i.e. the images depicting insight-perceptions on the X-axis) **and lines** (i.e. the images depicting analytic reasonings and expressions on the Y-axis) **in "Thought Assemblies."**

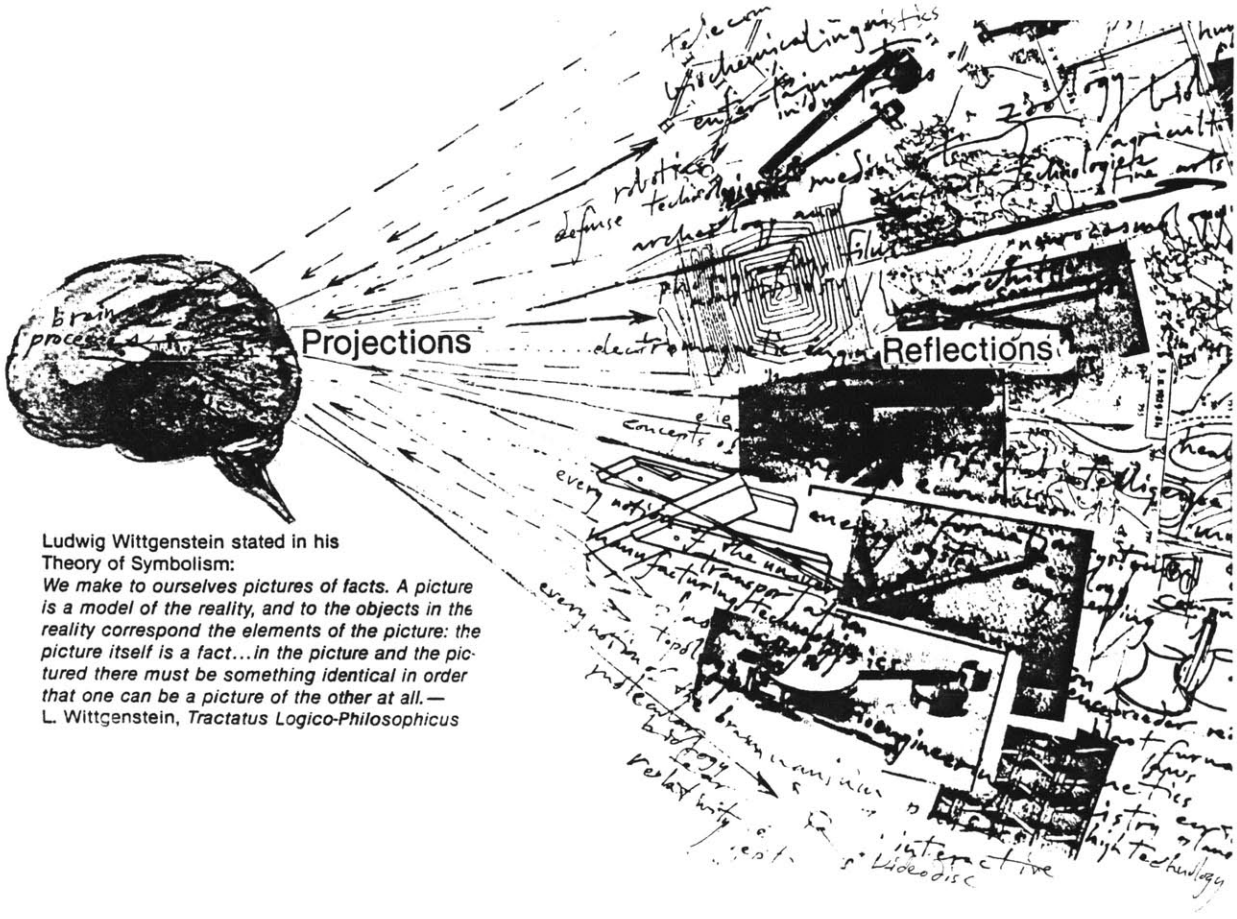
16. See footnote 8, (Chapter 2), regarding Papez's (1937) notion a 'stream of thought and feeling.'

17. Cf. James Ackerman's notion of interpretation and response response as applied to our understanding of the 'meaning and functions of works of art' (in Interpretation and Response; Suggestions for a theory of criticism, 1982). Ackerman writes:

"The synchronic system [of interpretation], developed to reveal the interactions of the object and its milieu, is confounded by the relationship between the object and the interpreter. We need a structure capable of accomodating both the object-milieu axis and the object-observer axis - to join interpretation and response in a single critical method" (p.7, of first draft)..."Interpretation could be represented as the analytic-intellectual component and response as the synthetic-sensual component of criticism. But the mind and body interact. Methods of interpretation, guided by principle, give us a particular insight into certain works of art and predispose us to respond to them. Conversely, works of art may affect us that do not conform to those methods, and may draw us into an effort to reconcile our interpretative position with actual experience. This accomodation is necessary to the vitality of criticism" (p.11, of first draft).

My method of interpreting the imagery of "Thought Assemblies" translates Ackerman's description of **the 'object-milieu' relation** as the function of **the** Y-axis (Figure 27a) and **the 'object-observer' relation** as the function of **the X-axis** (Figure 27a) in my symbolic model.

18. The photo-collage presented here is my picture-statement of the relation between the inventor and the invented.



Ludwig Wittgenstein stated in his Theory of Symbolism:
We make to ourselves pictures of facts. A picture is a model of the reality, and to the objects in the reality correspond the elements of the picture: the picture itself is a fact...in the picture and the pictured there must be something identical in order that one can be a picture of the other at all.—
L. Wittgenstein, *Tractatus Logico-Philosophicus*

19. From article by Redon entitled "Suggestive Art," in A soi-meme: Journal [1867-1915], (Paris: Corti, 1961).

20. From Wittgenstein's preface to Tractatus Logico-Philosophicus (London: Routledge & Kegan Paul, 1961), p.3.
In describing the goal of his book, Wittgenstein writes that he wishes "to draw a limit to thought, or rather...the expression of thoughts: for in order to be able to draw a limit to thought, we should have to find both sides of the limit thinkable (i.e. we should have to able to think what cannot be thought)...It will therefore only be in language that the limit can be drawn, and what lies on the other side of the limit will simply be nonsense" (p.3).

21. Cf. Kant's notion of the "categorical imperative" (Critique of Pure Reason, 1788)

22. I wish to underscore that the images of "Thought Assemblies" are for the most part suggestive (in spite of the explicit, science-oriented information presented on the Y-axis, $s^{1 \to 4}$). According to Redon, "suggestive art forms (of which I include "Thought Assemblies") are transposed and transformed without any relation to the contingencies at hand, but which nevertheless possess a logic all their own..."(From A soi-meme: Journal [1867-1915], 1961).

23. "Duende" is a Spanish term used by the poet, Federico Garcia Lorca, to refer to the beautiful "force" and natural power or spirit of an "enlightened" person. In Lorca's view, a person who has "duende" has invested in him or her the full lifeforce of the universe - affecting nearly every thought and self-expression. When I speak of the "duende of intuition," I mean extraordinary intuitions, yielded by unusual minds.
In Poet in New York (New York: Grove, Press, 1955 [Translated by Ben Belitt]; Appendices: "The Duende: Theory and Divertissement," pp.154-166), Lorca informs us that the **duende** is found in "everything that springs out of energetic instinct." He relates that:

> Goethe...defined the **duende** when he said, speaking of Paganini: "A mysterious power that all may feel and no philosophy can explain."
> This 'mysterious power'...is, in sum, the earth-force, the same **duende** that fired the heart of Nietzsche...or in the music of Bizet...
> The **duende**, then, is a power and not a construct."

Images 42 and 43 (p.103) and **Image** $135a^2$ (p.109) in "Thought Assemblies" are my visualizations of the **duende**.

24. Henri Matisse once remarked that "Rules have no existence outside of individuals." (From "Notes d'un peintre," in La Grande Revue [Paris], December 25, 1908.) Expressed another way: Rules are for those who are willing to follow rules. In my realization of the "Thought Assemblies" artwork, I went through phases of creating and breaking my own rules - regarding the organization of the imagery and composition of each section.

25. Here I envision the "order" of thoughts to parallel the 'order' of subatomic particles that may be described scientifically by the boostrap theory (and philosophy). The gist of the theory is that there exists an order (based on the interconnectedness of subatomic processes) which stresses **self-consistency**, i.e. "every particle consists of all other particles" (Capra, 1982, p.94).
    In the context of this reference, each insight-perception in "Thought Assemblies" contains all the other insights in this artwork.

26. This book analogy was inspired by a similar analogy proposed by physicist Heinz R. Pagels (1982): "...in our universe there are only a rather few fundamental building blocks: quarks, leptons, and gluons. These are the letters in the alphabet of nature. With this rather small alphabet, words are made - these are atoms. The words strung together, with their own special grammar - the laws of quantum theory - to form sentences, which are molecules. Soon we have books, entire libraries, made out of molecular "sentences." The universe is like a library in which the words are atoms... Our own bodies are books in that library, specified by the organization of molecules. The universe as a literature is, of course, a metaphor - both the universe and literature are organizations of identical, interchangeable objects; they are information systems."
    "Thought Assemblies" interprets the universe as a work of art (a work of mind); and the dynamics of this artwork reflect the dynamics of the thing it wishes to describe abstractly - namely the universe (of the brain). As Pagels uses the words "book" and "library," my symbolic model is indeed a book (with images on the nature of mind) and a library of sorts.

27. Review footnote 8, Chapter 2.

28. See Figure 12, Chapter 2 and Figure 29b, Chapter 3.

29. Note the implication of the terms "cerebral **fusion and fission**," footnotes 3 - 5, Chapter 2.

30. See **Image 78** (p.105) in addition to Figure 37, entitled "A View Inward And Outward Simultaneously: A view of the brain viewing the brain."

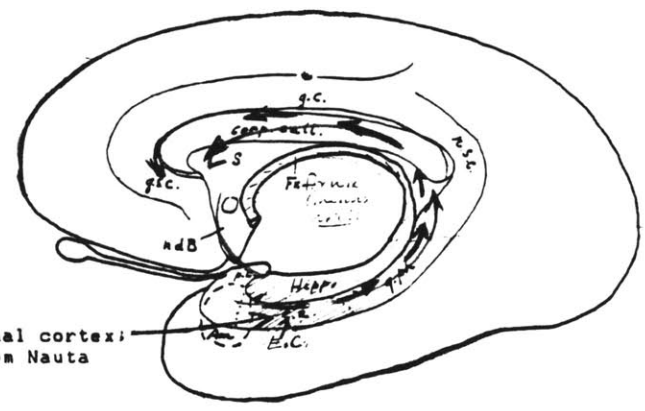
31. Review footnote 18, Chapter 3 (and footnote 30, above).

32. Many scientists and philosophers readily admit: "Explained vision is still vision, explained imagination is still imagination, and explained consciousness is still consciousness" (Bunge, 1980, pp.8, 9). And yet, we continue to devise new theories and explanatory models to describe the nature of mind. This [**will to know and need to explain**] is, perhaps, the greatest human mystery (alongside [as Kant had said] man's place in the universe and moral law).

33. Recall my comments on p.9 and 10; also, footnote 17, Chapter 1.

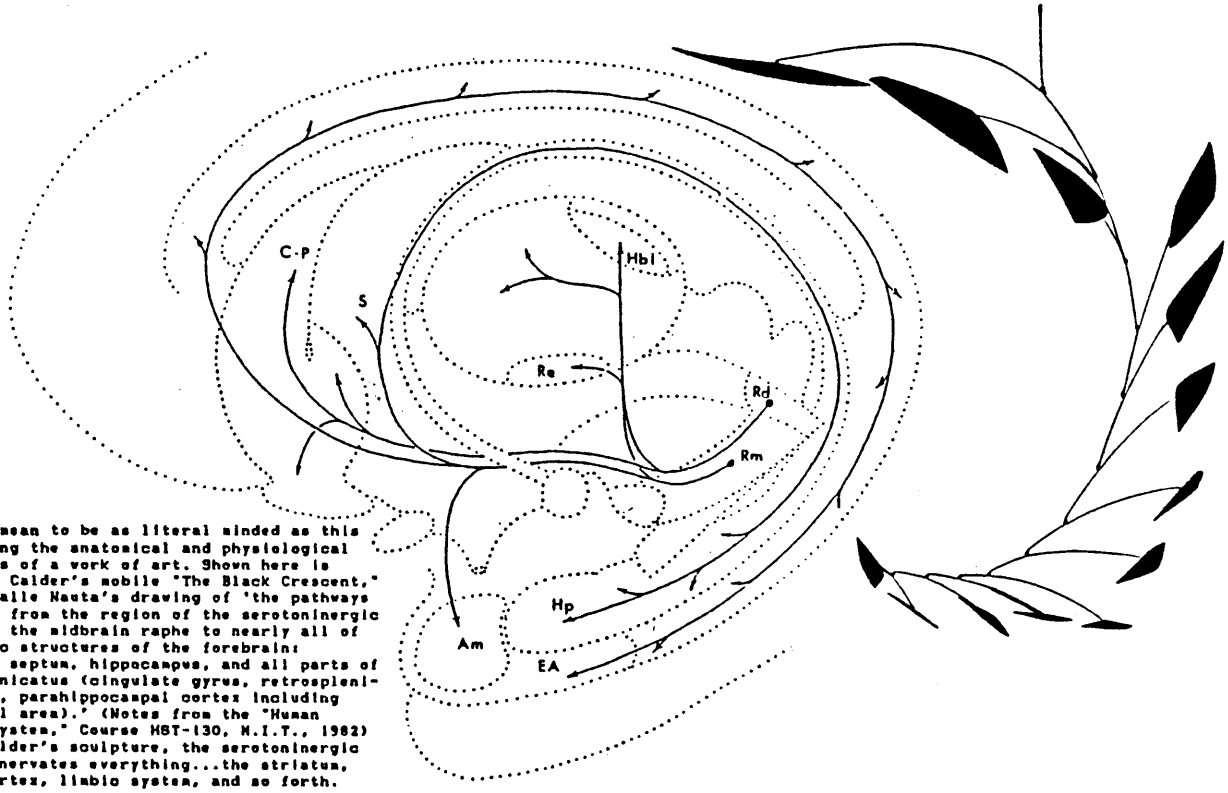
34. As one views the imagery of my symbolic model, ask oneself: Can the composition of, for example, **Image 101s**[1] (p.122) - with its random looking graphite marks and dashes - be related to the functions of specific cortical and subcortical neurons involving various neurochemical systems? I contend that one can learn as much about the expression of emotion and intellect, the phases of analytical and emotional or affective reasoning (i.e. reasoning about [one's] emotions, feelings, and sensory impressions) by looking crtically at this symbolic image as one can carrying out psychophysiological studies of human emotion. I would like to believe that Ernst Cassirer (had he been interested in brain science and experimental psychology) would have arrived at a similar conclusion when analyzing an artwork's 'analogical and symbolic expression' (1953, p.186-197), 'intuitive expression' (p.198), and the 'sphere of inner intuition' (p.249).

35. The idea of relating or "mapping" what appears to be the painted states of mind (in works of art) to the uncharted states of brain and functional anatomy is quite strange. I mean the thought of pointing to the Papez circuit in the Limbic system and exclaiming - There! That's where the idea for **Image 87** originated from - is both exhilarating and terrifying in that something is gained and lost. Suddenly our appreciation for the spiritual side of the work of art wanes.



e.a. - entorhinal cortex; Hipp. - Hippocampus. From Nauta (1983) (modified)

One implication of this passage is that an appendage to the history of art needs to be written which is equally sensitive to the neuropsychology of works of art and of science.



I do not mean to be as literal minded as this in relating the anatomical and physiological correlates of a work of art. Shown here is Alexander Calder's mobile "The Black Crescent," and Dr. Walle Nauta's drawing of 'the pathways ascending from the region of the serotoninergic nuclei of the midbrain raphe to nearly all of the limbic structures of the forebrain: amygdala, septum, hippocampus, and all parts of gyrus fornicatus (cingulate gyrus, retrosplenial cortex, parahippocampal cortex including entorhinal area).' (Notes from the "Human Nervous System," Course HST-130, M.I.T., 1982)
Like Calder's sculpture, the serotoninergic system innervates everything...the striatum, the neocortex, limbic system, and so forth.

36. I realize how abrasive and awkward this thought is. It is hard to image how anyone could trace the origins and evolution of a single thought or group of related thoughts by studying the functional anatomy of the central nervous system. (It is difficult enough to try to trace or reconstruct one's own thoughts, nevermind the thoughts of someone else.) The idea of following the course of one's 'preperceptions, discriminations and comparisons' (James) over a certain period of time seems impossible. And yet, I feel that this exercise is important and productive in that it can potentially broaden mans views on the nature and interactions of thought and matter.
See Figure 28c, on the whole-part relation of "Thought Assemblies."

37. Gauguin expressed this thought in Vers et Prose: "Notes Synthetiques" (Paris), XXII (July - September, 1910).

38. In syncretism, one tries to reconcile or combine different beliefs or notions in order to achieve some sort of unity. Cf. synthetic thinking (and synergy).

39. See footnote 7, Chapter 2; note especially the center of the diagram - the "Zero" point (or union).

40. For some reason critics and art historians continue to play down the analytical side of the arts and in doing so, they inadvertently separate the experience of art from that of science (and from that of life or living; one is constantly using various forms of reasoning in making life-dependent decisions). Along with this separation comes the conceptual division regarding the constitution of artistic and scientific thought. Naturally our perceptions of this separation persist in influencing (I think, negatively) the very languages and means we use to express our perceptions. Here it becomes clear why the physical sciences (i.e. the body) is considered as something separate from the arts and humanities (i.e. the mind and spirit). It is as if we dualisticly divide reality into two or more worlds which we then imagine to exist independently of one another.

41. I mean that the functional anatomy may not be clearly defined.

42. "Thought Assemblies" is one visualization of my theory of thought which combines both artistic and scientific methods of inquiry in exploring the dynamics of thinking-feeling-acting (creating). Through visual and literary metaphors and similes it presents my views on:

- the brain (Mirror) mind relation: Images 37, 43, 69, 121
- descriptions of brain processes: Images 25, 42, 43, 118
- " " mental processes Images $40a^{1\to3}$, $40s^{1\to3}$, 112
- " " thinking: Images $53a^{1\to4}$, $53s^{1\to4}$, $73a^{1\to4}$, $73s^{1\to4}$
- " " feeling: Images $84a^{1\to3}$, $84s^{1\to3}$, $87a^{1\to3}$, $87s^{1\to3}$
- " " creating: Images 1 - 6, 150, 153, 164 - 175
- the neuropsychology of intuition: Images 78, $145s^{1\to4}$
- " " " of analytical reasoning: Image $67s^{1\to3}$
- " " " of affective reasoning: Images $85a^{1\to4}$, 94
- " " " of expression: Images 131, $131s^{1}$, 138
- "artistic thought": Images $\underline{a}^{1\to4}$
- "scientific thought": Images $\underline{s}^{1\to4}$
- metaphor and simile: Images 9, 15, 18, 58, 63, 78, 87, 175
- qualification and quantification: Images $114a^{1\to3}$, $114s^{1\to3}$
- relating different artistic and scientific representations of "mind" to one another: Images $119a^{1\to3}$, $119s^{1\to3}$, $122a^{1\to2}$, $122s^{1\to2}$

- relating the dynamics of human inventions (e.g., symbolic languages, forms, and inventions of advanced technology) to the dynamics of the inventor: **Images 15, 57, 64, 78, 175**
- the creation of a common language and system of communication between the arts and sciences: **Images 63, 63a$^{1\rightarrow2}$, 63s$^{1\rightarrow2}$, 66, 66a$^{1\rightarrow2}$, 66s$^{1\rightarrow2}$**
- the convergence of different sources and forms of information (in creating this new language): **Images 51, 51a$^{1\rightarrow2}$, 51s$^{1\rightarrow2}$, 55**
- the forms of expression this common language will take: **Images 1 - 175 (and collateral Images $\underline{a}^{1\rightarrow4}$, $\underline{s}^{1\rightarrow4}$)**
- the attainment, application, and study of knowledge (towards the realization of "Gnothic seauton" ["know thyself"]): **Images 128 - 143 (and collateral Images $\underline{a}^{1\rightarrow4}$, $\underline{s}^{1\rightarrow4}$).**

The list labels some of the elements of my imagination represented in the eleven sections of this symbolic model (see schematic, pp.90 - 100).

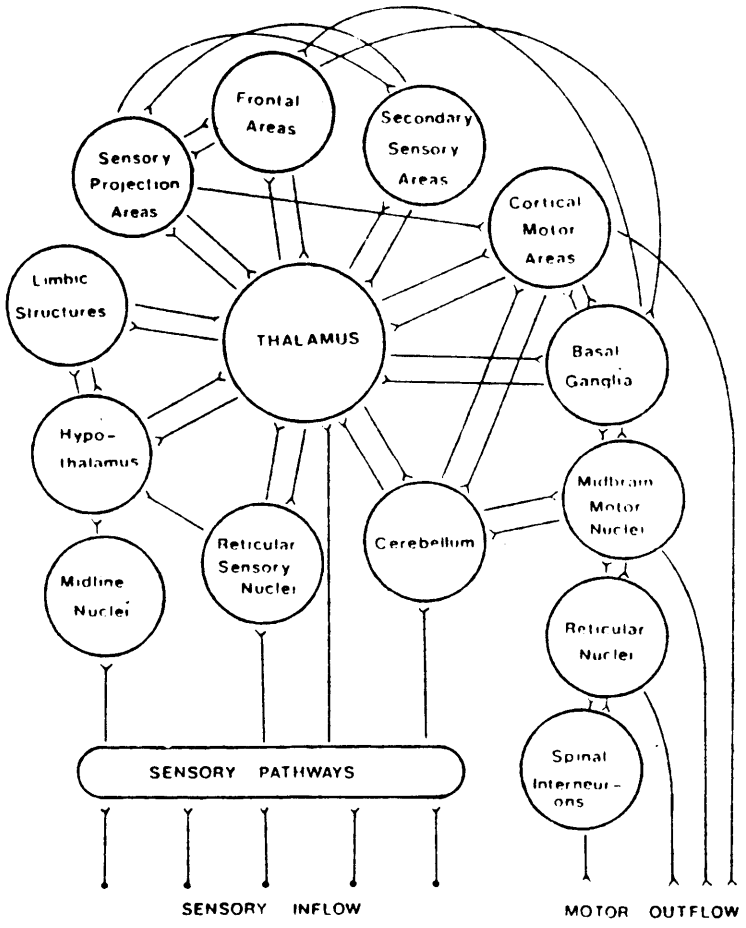
43. The likelihood is great that it will involve this kind of point-to-point matching of particulars because inductive inference (the basis of science) relies on "particulars" and "physical evidence." No matter how wide the criteria for scientific investigation becomes through the 'de-definition' of science (to borrow the art critic Harold Rosenberg's word [1972]), the necessity of inductive reasoning seems obvious.

See comments in footnote 40, above.

I am confident that this "new understanding" (under the influences of the neurosciences) will help illuminate the interrelatedness of artistic and scientific languages - in particular, the [neural] thought processes responsible for these symbolic languages and forms (of expression). However, to initiate this examination, one first needs to re-evaluate the current notions about the ways of artmaking (i.e. "artistic thought") and sciencemaking (i.e. "scientific thought") and 'worldmaking' (Goodman, 1978). Furthermore, one needs to scrutinize the various systems in the human brain which are supposedly responsible for generating specific **sensations** and **thoughts** associated with intuitions and reasonings. (Before carrying out this examination, recall the pitfalls of Lashley's research on the 'engram' and the localization of cerebral functions, in Brain Mechanisms and Intelligence [1929].)

Like a nuclear physicist who explores the interactions of subatomic particles (see detail of **Image 101s** , p.122), I find it an invaluable exercise to examine specific passages in my own artworks and their "interactions" with other passages which I think reveal something of my neuropsychological processes. In time, I think it will be possible to know **(the most general sense)** which subsystem of the brain is active in the production of certain pictorial representations.

There may be hundreds of schematizations (like the one shown below) which specify the interactions of brain functions in productive thinking (and feeling). No neuropsychological model of thought has devised a truly workable paradigm, given the complexity of the neural processes. (Review my remarks on this matter on pp.9-11.) Although Bindra's interactional model does not reveal the specific details of the subsystems' operations in the production of emotions or thoughts, it does present an overview of the functional anatomy involved in these mental processes.



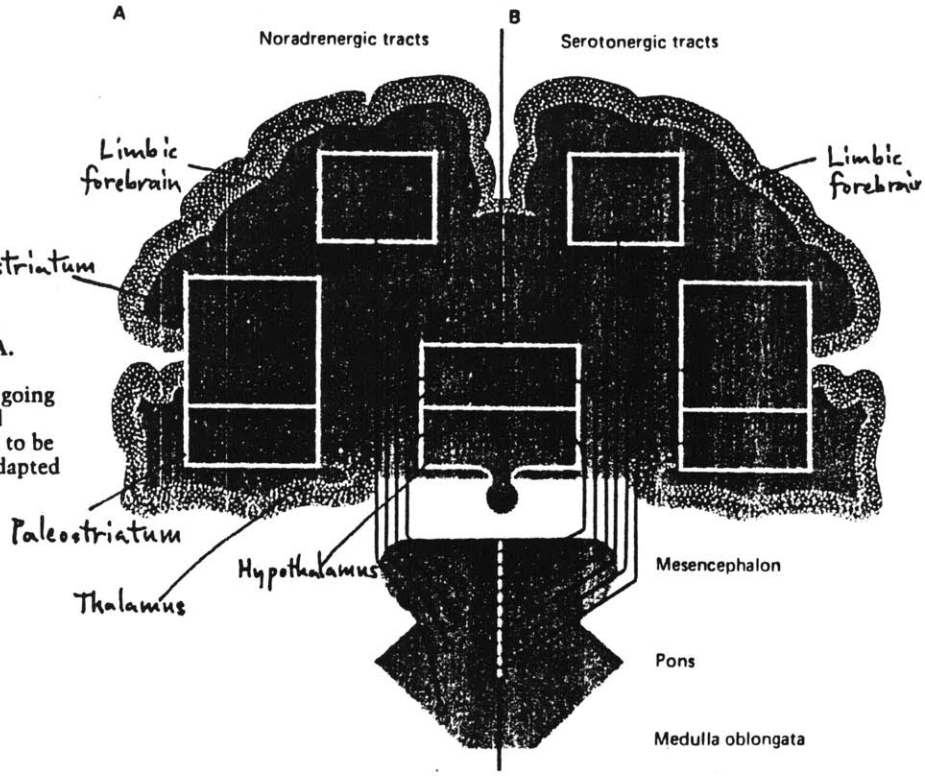
A schematic drawing of the interactional model of brain function, as it appears to be emerging. (From Bindra, 1976, p. 26.)

...A diagram of the functional anatomy of cerebral fusion?

44. See my comments on the concept of **pneuma** as discussed it in the context of intuition; p.39, footnote 17, Chapter 2.

45. The diagram below best illustrates the influence of neurochemical systems on states of mind - in this case, depression. Dr. Edward J. Sachar writes, "Currently, the most prevalent idea about the nature of depression is that it involves a functional deficiency in monoamines...According to this [biogenic amine] hypothesis (first proposed by G.M. Everett and J.E.P. Tolman), depression is caused by a functional deficiency of serotonin or norepinephrine or both, and the anti-depressants work by increasing the availability of either or both amines." (From E.R. Kandel and J.H. Schwartz, Principles of Neural Science [New York: Elsevier/North

Holland, 1981], p.615.) The diagram below was interpreted in the **Image 62s**[1], Section 5: "Stream of Thoughts"; its complementary **Image 62a**[1] expressed the idea that at the instant of intuition, the serotonergic tracts would be fully activated (see pp.123, 124).



Central ascending aminergic tracts. A. Noradrenergic tracts. B. Serotonergic tracts. Those going to the limbic forebrain and hypothalamus are thought to be involved in depression. (Adapted from Andén et al., 1966.)

46. This idea of motion in stillness (and vice versa) refers back to the Stoics's notion of the continuum which, in turn, is founded on the ancient Greek concept of "tonike kinesis" (tensional motion). Read S. Sambursky's gloss of this concept in The Physical World of The Greeks (Translated from the Hebrew by M. Dagut.) (London: Routledge & Kegan Paul, 1963) p.139.

My interpretation of **cerebral fusion** (an instant of "stillness") and **cerebral fission** (moments of "motion") was inspired by the poem, "Burnt Norton" (Four Quartets, 1943). T.S. Eliot writes:

> At the still point of the turning world
> Neither flesh nor fleshless;
> Neither from nor towards; at the still point,
> there is the dance.
> But neither arrest nor movement.
> And do not call it fixity,
> Where past and future are gathered.
> Neither movement from nor towards.
> Neither ascent nor decline.
> Except for the point, the still point...

Consider Eliot's thoughts in connection with my two drawings entitled **Cerebral Fusion/Intuition** (Figure 7, p.26) and **Cerebral Fission/Reasoning** (Figure 8, p.27). Compare the differences in the forms of written text (note columns marked "Introspective Analysis").

Also, consider the implications of "points of intuition" and "lines of reasoning and expression" (Figure 12, p.32) in the context of this poem.

Note Weyl's "Light Cone" diagram of the past, present, future in footnote 11, Chapter 3.

47. Concerning the relationship (in terms of "dynamics") between "the inventor and the invented," see my notes on the origin of the biomirror concept (footnote 4, Chapter 2).

In my publication, The Biomirror (New York: Pilgrim Press, 1983), I ask: Are we, as in the Chinese adage, "riding on the back of the ox and looking for the ox at the same time?" Does the inventor, the brain, create objects and expressions in order to discover and understand its own dynamics? Is the formulation of the principles of fusion and fission reactors, for example, influenced by the physiological processes of the human organism? If so, then our understanding of these principles is constrained by our physiology, and this constraint imposes directions on technical developments.

See Figure 37, p.113.

48. Read footnote 4, Chapter 2; re: the origins of the 'magnetic mirror' plasma fusion reactor (from T. Siler, Cerebreactors [1981] and The Biomirror [1983]).

49. The problem of relating our experiences and their brain processes (note detail of **Image 123a**[1], p.130) remains problematical partly because of the way these subjects are studied independently of one another (or thought of as being separate but dependent on one another [Kohler, 1947]) and partly because of their complexity (see footnote 43, Chapter 3). Mapping brain functions and art - or, to use Berlyne's (1965) expression, "aesthetics and psychobiology" - will require more than just input from experimental psychology or clinical neurology. As I mentioned in the first chapter of my dissertation, it will require a major shift in scientific perspective (and methodology); see footnote 14, Chapter 1.

50. Review my notion of The Interconnectedness of Everything (T.I.E.); footnote 37, Chapter 2.

I think it is appropriate to end my description of the "Thought Assemblies" artwork with two extant fragments of Heraclitus. These two paragraphs encapsulate my point of view regarding the relation between parts and wholes in the architectonics of thought. (The fragments are quoted from

G.S. Kirk and J.E. Raven, The Presocratic Philosophers [Cambridge: Cambridge University Press, 1957] and M.C. Stokes, One And Many In Presocratic Philosophy [Cambridge, MA: Harvard University Press, 1971].)

> Things taken together are whole and not whole, something being brought together and apart, something which is in tune and out of tune; out of all things there comes a unity, and out of a unity all things. (Fragment 10)
>
> This order - the measuring out of all things and the holding of them in harmonious tension - is itself the great harmony: At each connecting point of the wood and the string in the instruments, there is a fitting-together that is at once a pulling-away: a dynamic equilibrium. (Fragment 89)

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