"Vision For Neurosciences in the Next Millenium"

First of all, I would like to make it clear that I am not a biologist, psychologist or a medical doctor or Neurosurgeon or biochemist or a biophysicist. I am just an experimental physicist who has spent almost 50 years in hunting elementary particles and their interactions and in the search for sources of very high energy particles and Radiations. Of course in this endeavour, I had to develop a large number of Radiation detectors, the associated electronic circuits, Computer Controlled Monitoring and Recording Systems, Computer based analysis etc.

For the past 5 years, for a variety of Reasons I have been making efforts to understand 'human Consciousness' in Scientific terms - especially in terms of fundamental concepts in physics which is at the basis of all Scientific explanations - a kind of hierarchy that has stepped in the "reductionistic Method" that is characteristic of all modern Scientific explanations.

The General assumption that is made by most Scientists is

Consciousness = Mind = Function of Brain = Function of Neuronal assembly. = Emergent property of a system of matter

"Vision For Neurosciences in the next millenium"

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- The 20th. Century : Major advances in physical Sciences and Science based technologies.

  1. Fundamental Particles and Forces.
  2. Uncovering the Universe through the various astronomical windows: radio, optical, IR, UV, X-ray, γ-ray.
  3. Nuclear, Space, material technologies.
  4. Electronics, Computers, Communications.
  5. Instrumentation - Detectors, accelerators, telescopes, tomographs

- The 21st. Century :
  - The expectation is major breakthroughs in life sciences both in basic and applied areas.
  - Basic understanding of Life, Consciousness.
  - Conquest of diseases.

- The last decade has been called the "decade of the brain" - the new instruments functional NMR, PET, .. have started playing a major role in analyzing different mental States - Conscious, Unconscious, ... (Transparencies).

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Anomalous Features	Physical phenomena.	Mental Phenomena
Duality	Particle / Wave.	Dr. Jekyl / Mr. Hyde
Non-local	EPR Paradox.	Binding Problem. ESP / Paranormal. / Synchronicity.
Super-position.	QM States begin Collapse. Energy States of atom.	Mental States - Free-will.
Mechanism not "Picturisable"	Radioactive decay Energy Jumps.	Oneness of Consciousness.
Uncertainity Relation	$\Delta P \cdot \Delta X \sim \hbar$ $\Delta E \cdot \Delta t \sim \hbar$	Focus on one thought defocusses others. You cannot remember more than 7 items at a given time.
Q.M. Coherence.	Laser. Super Conductor. Bose-Einstein Condensates	Correlated neuronal firings, oscillations. Bio-radiations from neurons.

* None of the above explainable within the classical physics framework.
* role of Consciousness in collapse of the wave function.
* Current ideas on what matter is in the ultimate analysis - fluctuating Q.M. vacuum.
* non-linear dynamical, non-equilibrium processes.

Information Carried by

Modulation of Action Potentials.
frequency, firing in bursts
Number of related neuronal firings
Generation of High Frequency waves modulating 40-50 Hz background oscillations
emission of coherent optical bursts

Information distributed in

Various Cortices of the brain.

Binding Problem

Who integrates and how?

Who accesses memory and interprets?

Necessary Conditions but not Sufficient Since the problem is not Solved.

In analogy with explanation of physical phenomena the Sufficient Condition is perhaps in investigating the role of the Substratum - the Empty Space - in generating new physical processes secondary to all the dynamical processes, Chemical processes in the brain. The binding and memory problems become simpler. Quantum processes will hold the key. The Special features of QM like Superposition, non-locality Heisenberg's principle of uncertainity may help features like free-will, Transpersonal phenomena, higher mental States

(Curious example : radio reception through a gold capped tooth

Nasadiya Sukta

① Whatever was there cannot be called as existing (सत) or as non-existing At the time of creation (रजस)

In Science, the objective of Unification leading to the idea of ONENESS is essentially Academic.
However, these attempts have led to applications

- Unification of Electricity and Magnetism by Maxwell
  - Em waves - all the applications
- Unification of Mass and Energy by Einstein
  - Nuclear Energy
- Unification of space-time. } Quantitative
- Unification of Electro-weak forces } Cosmology.
  - ↓ possibilities of Unification of all forces (not achieved yet) String Theory
  - ↓ Resolution of Mind-Body problems ?

-

In Oriental philosophies - Vedantha, Buddhism, Confusianism etc - the Unification leading to Brahman, Sunyata, Tao .. are both Academic and also for <u>personal benefit</u>
- Brahma-Sakshatkara, Mukti, Nirvana, Satori...

→ (Self-Realization)

EMERITUS.

Abner Shimony (Professor of philosophy and professor of physics, Boston University)

1. Mentality can be treated scientifically.
2. Ideas of Quantum Mechanics are relevant to mind-body problem
3. Quantum mechanical problem of the actualization of potentialities is a genuine physical problem that cannot be solved without modifying quantum formalism.

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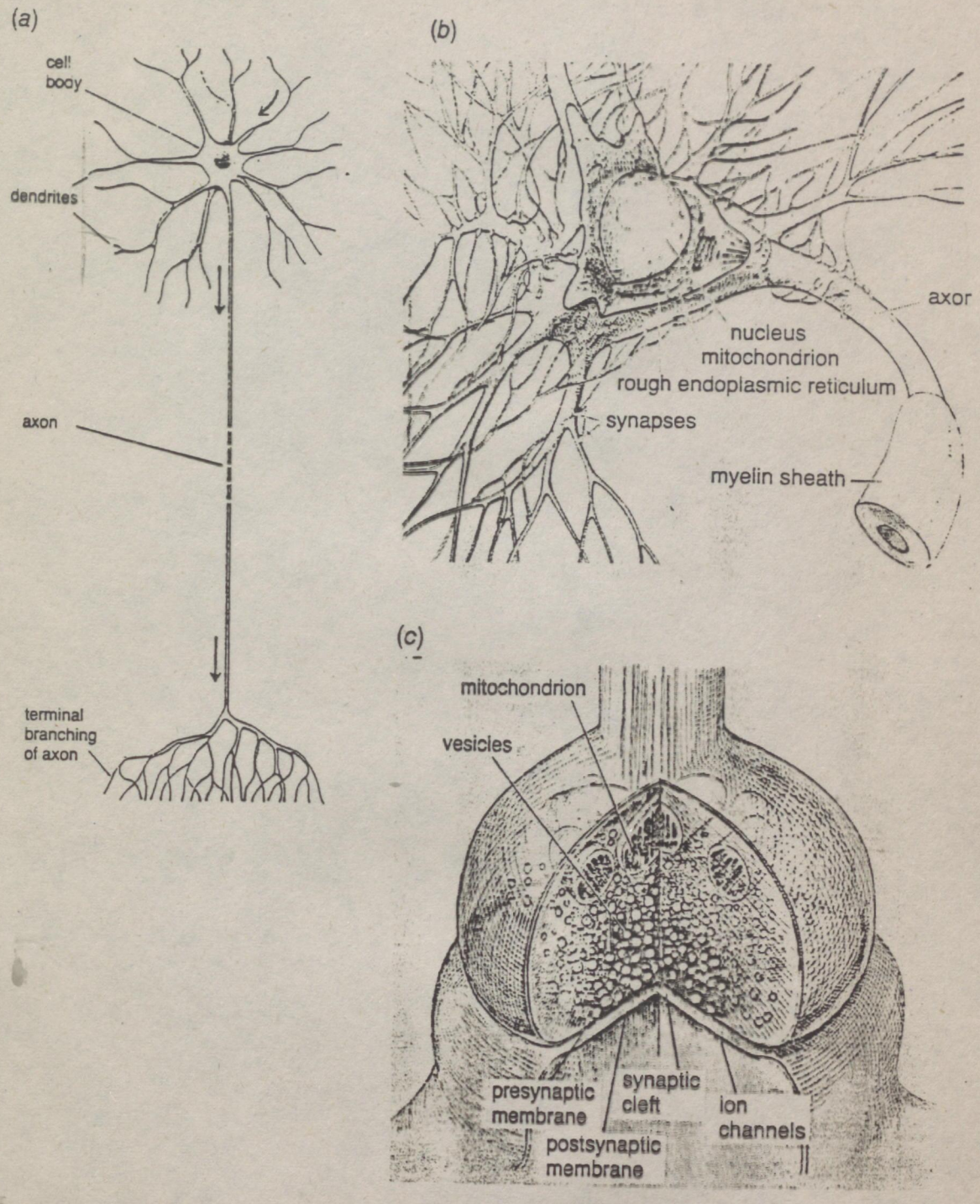
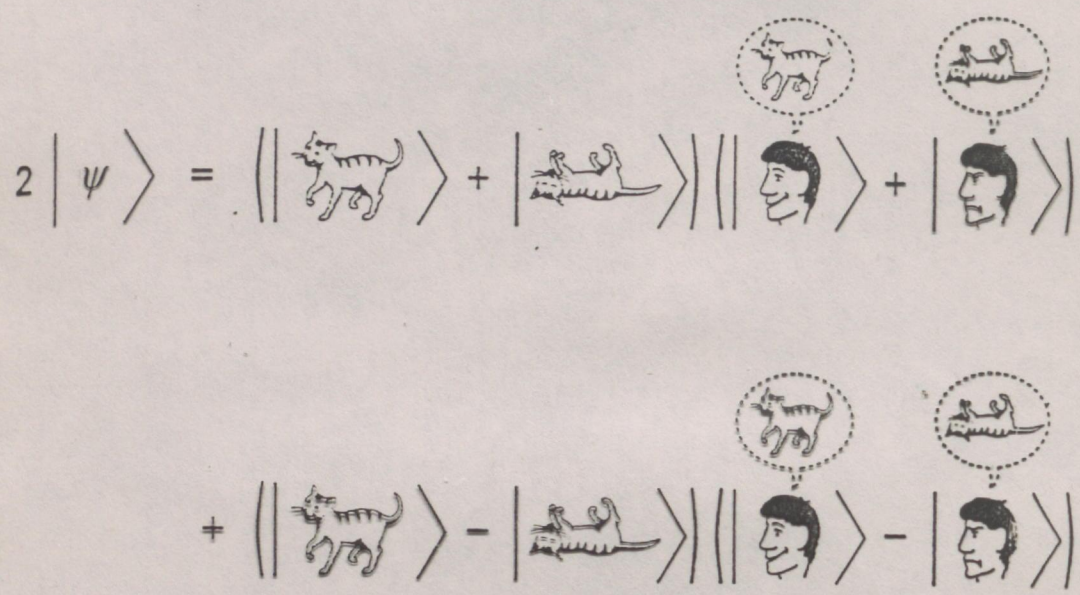
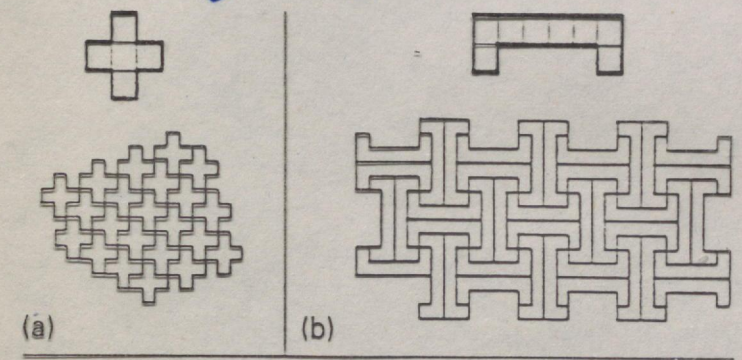


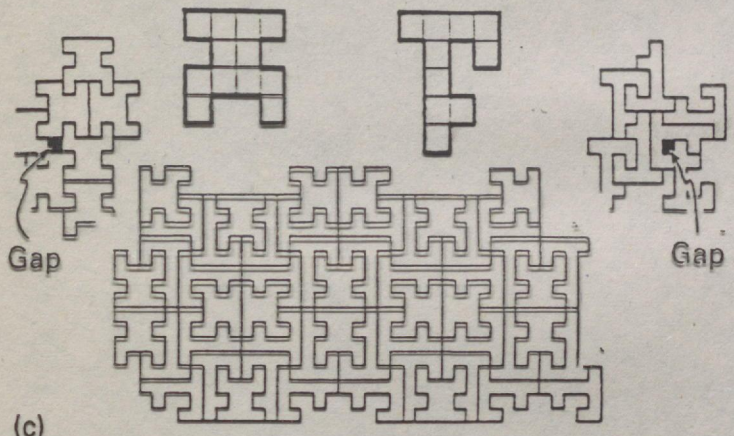
Figure 3.6 (a) A formalised 'standard neuron'; (b) a closer look at cell body region; (c) a synapse.

Part (a) from Alberts *et al.* (1989); (b, c) from Stevens, *The Neuron*. Copyright © (1979) by Scientific American, Inc. All rights reserved.

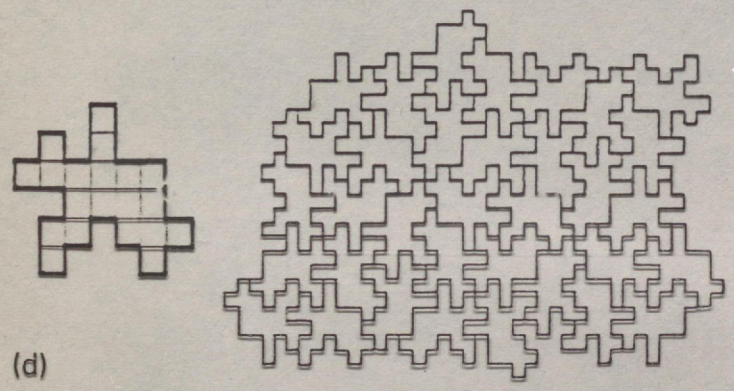


Can tile a Complete plane





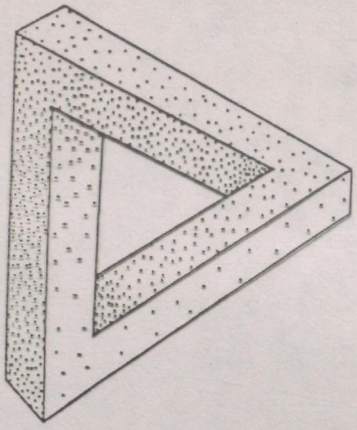
These cannot tile a plane by themselves. Gaps arise Taken together the gaps can be filled.



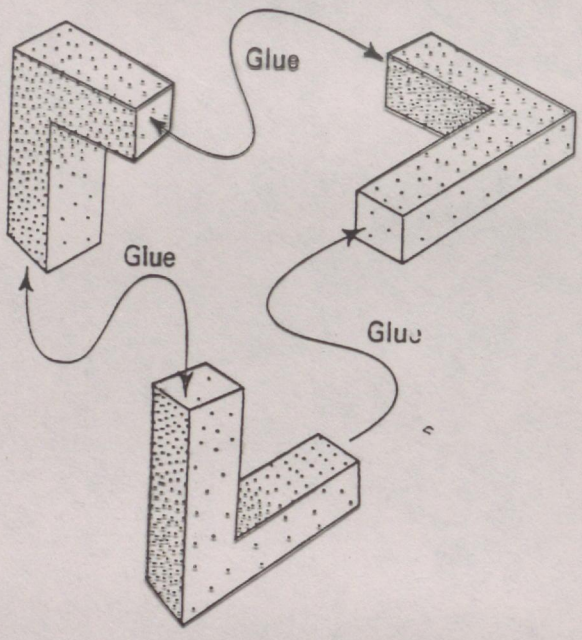
Complicated Way of tiling the plane.

Various sets of polyominoes that will tile the infinite Euclidean plane (reflected tiles being allowed). Neither of the polyominoes in set (c), if taken by itself, will tile the plane, however.

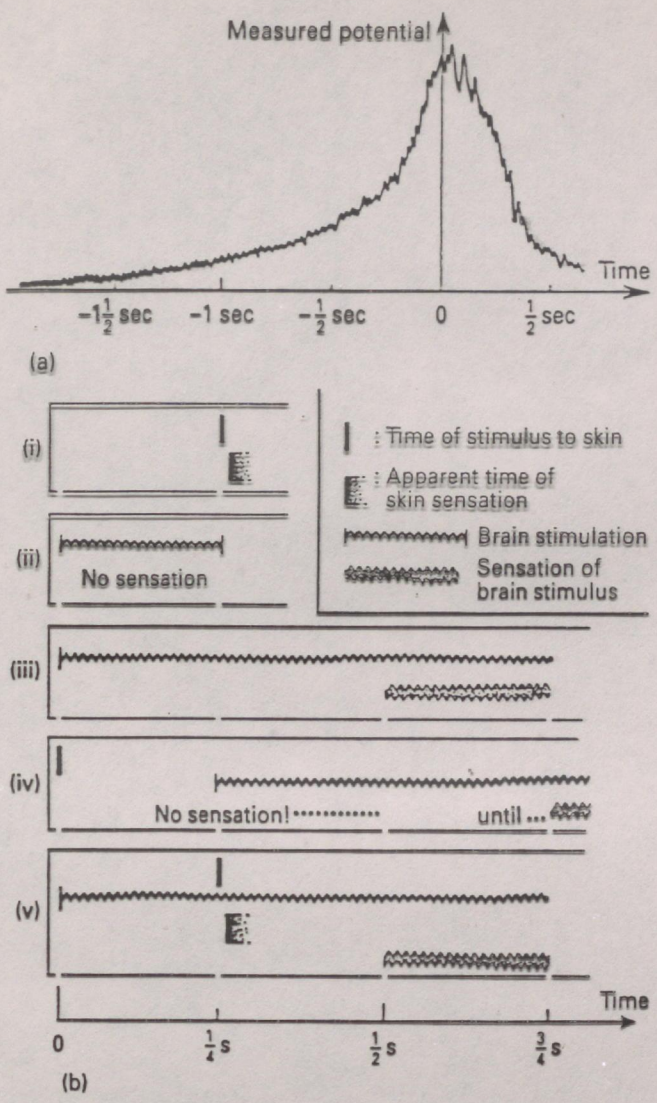
From Penrose.



Where is the impossibility?

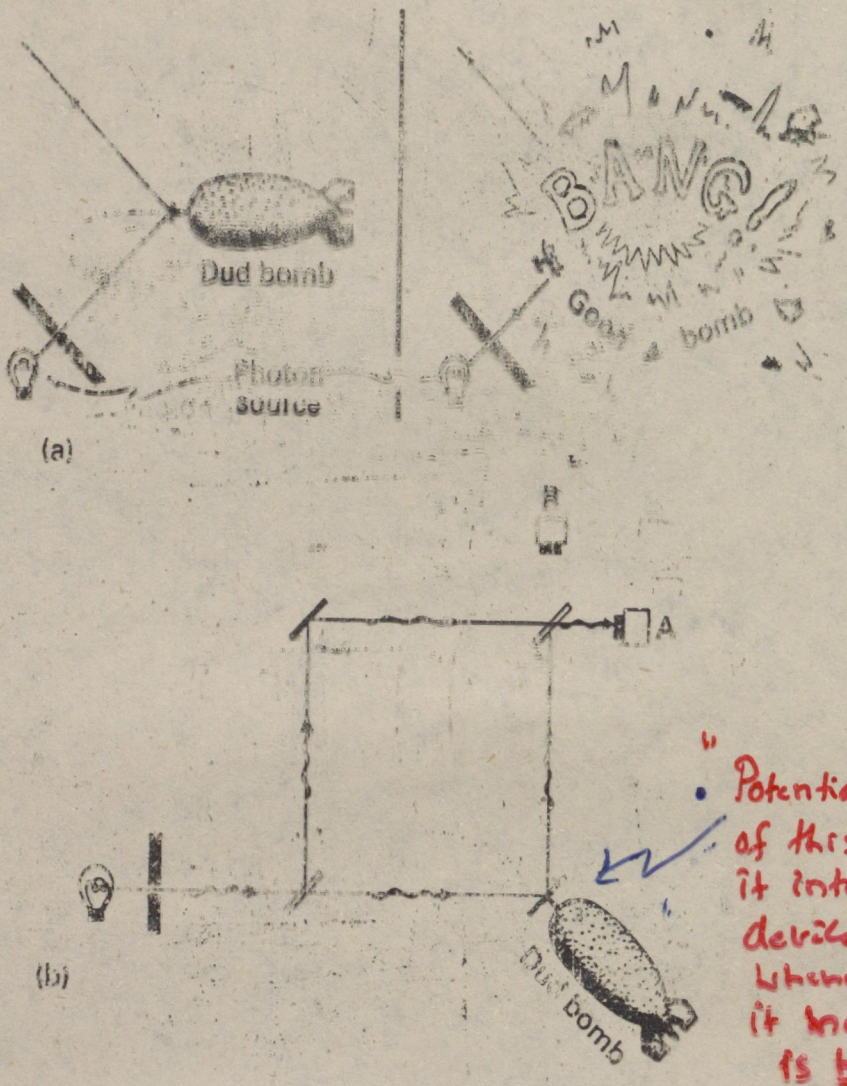


An impossible triangle. The 'impossibility' cannot be localised; yet it can be defined in precise mathematical terms as an abstraction from the 'glueing rules' underlying its construction.



. (a) Kornhuber's experiment, later repeated and refined by Libet and his colleagues. The decision to flex the finger appears to be made at time 0, yet the precursor signal (averaged over many trials) suggest a 'foreknowledge' of the intention to flex. (b) Libet's experiment. (i) The stimulus to the skin 'seems' to be perceived at about the actual time of the stimulus. (ii) A cortical stimulus of less than half a second is not perceived. (iii) A cortical stimulus of over half a second is perceived from half a second onwards. (iv) Such a cortical stimulus can 'backwards mask' an earlier skin stimulus, indicating that awareness of the skin stimulus had actually *not yet taken place* by the time of the cortical stimulus. (v) If a skin stimulus is applied shortly *after* such a cortical stimulus, then the skin awareness is 'referred back' but the cortical awareness is not.

Quantum Mechanics Enables you to TEST WHETHER SOMETHING MIGHT Have Happened, but didn't happen.



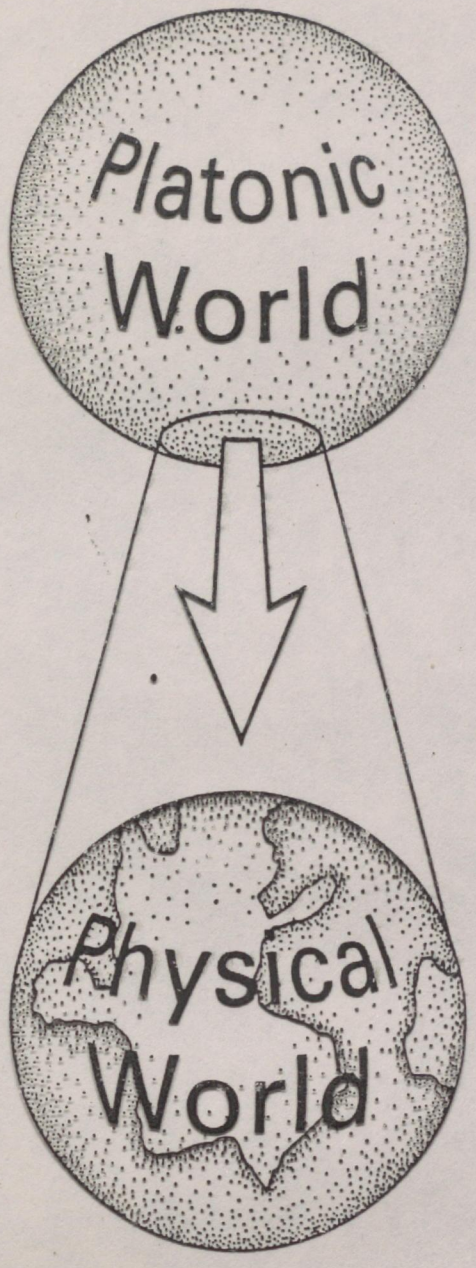
(a) The Elitzur-Vaidman bomb-testing problem. The bomb's ultra sensitive detonator will respond to the impulse of a single visible-light photon – assuming that the bomb is not a dud because its detonator is jammed. The problem is to find a guaranteed good bomb, given a large supply of questionable ones. (b) The arrangement for finding good bombs in the presence of duds. For a good bomb, the lower right-hand mirror acts as a measuring device. When it measures that a photon has gone the other way, this allows the detector at B to receive the photon – which cannot happen for a dud.

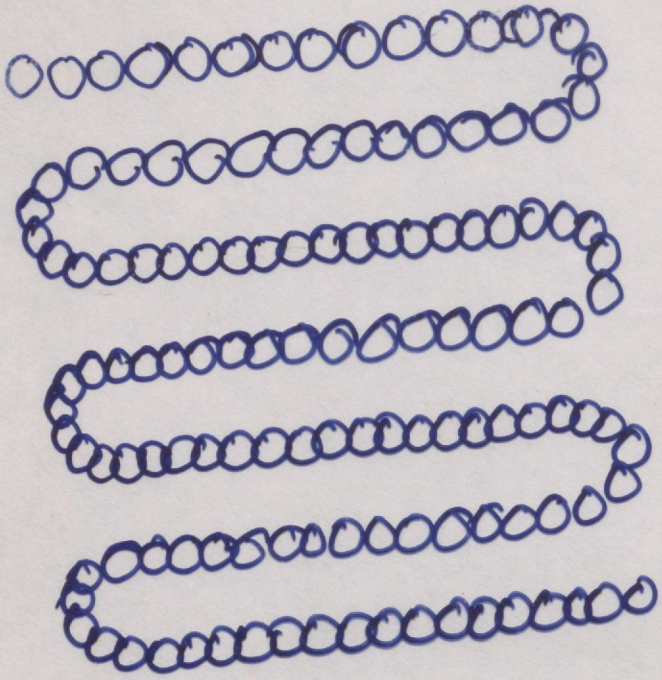
• "Potentiality" of wiggling of this mirror turns it into a measuring device. Whenever 'B' goes off it means that it is not a Dud Bomb.

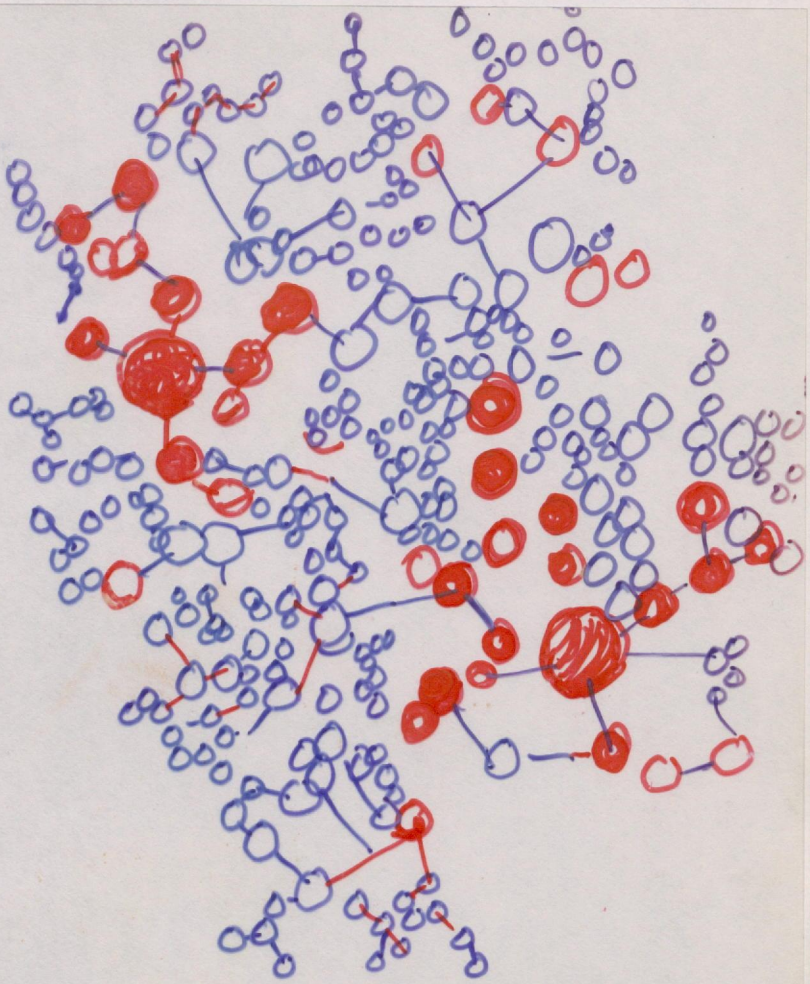
• 'A' goes off when mirror 'B' is struck. or when the photon went the other way (- 50-1.) of the time)

• Neither A nor B go off when the Bomb explodes.

• A fraction of the good bombs can be retrieved. This is shown by 'B' going off. When 'A' goes off the bomb may be dud or good. When it was good, the bomb did not explode because the mirror was struck or the photon went the other way.


Platonic
World
Physical
World





Protein Folding Problem:

The Proteins of the living organism are formed as sequences of a large number of amino acids. - Strung out like beads on a neck lace.

- Once the beads are put in the right sequence the Protein folds up rapidly into a highly specific three dimensional structure that determines its function.
- On a Super Computer, using plausible rules for folding it takes 10^{127} years to simulate a sequence of 100 amino acids.

How does Nature do it all the time in living organisms?

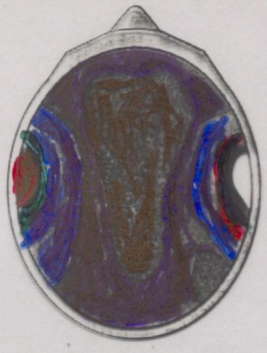
EEG BRAIN MAPPING OF THE HEMI-SYNC PROCES

The Hemi-Sync process is a patented auditory guidance technology based on the natural functioning of the brain. Originally developed by Robert A. Monroe and continuously being improved through research at the Monroe Institute, Hemi-Sync employs a blended and sequenced series of binaural sound pulses to induce a Frequency-Following Response in the human brain. Hemi-Sync alters EEG brain-wave patterns and generates expanded states of consciousness, what researchers call "dissociative" and "transcendent" states. When experiencing a dissociative state, an individual perceives nonphysical phenomena as constituting his or her whole field of awareness, like a dream.

Additionally, during a dissociative-state experience, there is no impression of being "normally" in the physical body, because the physical body itself is either asleep or fully entranced. In electroencephalographic brain mapping, the shift from normal waking consciousness into a dissociative state is evidenced by a change in amplitude, frequency, and locale of predominant brain waves.

The waking state is characterized by alpha and beta (8–30 hertz) brain waves. Alpha brain-wave activity confined to the cortex behind the Sylvian sulcus (the back of the head) is known as "resting-state alpha." The dissociative state is characterized by elevated amplitude, synchronous slow-wave delta and theta (0–8 hertz), and the suppression of the alpha and beta activity established in the waking state. As one moves toward a dissociative-state experience, resting-state alpha activity is suppressed and replaced by synchronous slow-wave activity in the median of the central cortex (top of the head).

Beyond dissociation, there is transcendence. An experience in a transcendent state can be defined as being outside the normal limits of one's ego and the personal unconscious mind, into a universal awareness. Experiences in this state are many times ineffable and cannot be explained or described in mere words. In terms of EEG brain mapping, the shift from a dissociative state into transcendence is evidenced by further changes in amplitude, frequency, and locale of predominant brain waves. The transcendent state is c acterized by "resting-state alpha" and atively high-amplitude, synchronous s wave activity in the median of the ce cortex accompanied by regional (comm ly temporal) gamma (30-hertz-plus) b wave activity.



Transcendent state: "Seeing" beyond the limits of normal perception into universal awareness—ineffable, profound.

Dissociative state: When consciousness shuts down, the body is asleep or in a meditative state—like in a dream.

Resting-state alpha: Sylvian sulcus shows and tells all—from the way we process reality to our temperaments.

The characteristic EEG parameter resting-state alpha reveal an individ temperament, the customary wa which an individual processes and i acts with the world he or she perce The suppression of this alpha ac frees one to perceive nonphysical ene outside the confines of physical-law b systems. The ability to modify res state alpha directly affects one's ex ence of his or her environment. Chan or suppressing ones' resting-state alph fectively transforms the person's per tual venue, or concept of reality.

Hemi-Sync generates an audioenc alographic interferometric effect which be used to transform or suppress in resting-state alpha and stimulate alte tive brain-wave patterns necessary for sociative- and transcendent-state ex ences. Some "Focus Level" Hemi-Sync quencies used do not interfere with res state alpha and allow the listener to grate and relate to "tape experience his or her everyday, familiar life. O Hemi-Sync frequencies modify or supp resting-state alpha to provide liste with hi-fidelity, rich Focus Level disso tive states and transcendent experien

With the advent of modern comp ized EEG brain mapping, objective EEG idence of the effect of the Hemi-Sync p ess has been established. The lower ditory centers of the brain provide neural pathways for the propagation of aural beats. It is there, in each he sphere's olivary nucleus, deep inside brain, that beat-frequency oscillations be measured directly. At the cortex, site of EEG brain-mapping electroc these original binaural frequencies can ly be observed as having been integra with prevailing electroneural activity. the brain-wave entrainment which occ during this integration process that counts for the effectiveness of the He Sync sound patterns.—F. Holmes Atw

α-β (8-30 hertz)
θ (0-8 hertz)

What is Soul ?

- A famous advice of Socrates was "take care of the Soul"
- Socrates identified the Soul with Consciousness - The Self, posessed of the Capacity of Rational activity - Speculative and practical.
- The Soul (Psyche) according to Plato, is the principle of life and motion. Wherever these are present there is Soul.
- Besides human and infra-human Souls there are in Plato's Universe, the Soul of God, the World Soul, the Divine Souls that move the Stars
- Plato believed the Soul to be immortal.
- Human, like all other Souls, existed before incarnation in the body and will survive body's death.
- The body is the prison-house, the tomb of Soul & and death its liberation.
- Philosophy according to Plato leads to Conversion of Soul from darkness of Sense-World to Light of World of Forms and as Life long preparation for the unfettered exercise of reason in the World beyond the grave.

For Hebrews: (Pre-Christian) The Soul was the life principle that quits the body at death and passes to the under-world where it exists as an inanimate ghost in a State of unConsciousness.

Modern Science.

The Upanishadic method of acquiring knowledge is very different from that of modern Science which is based on experimentation (observation), mathematical formulation of theory, prediction, further experimentation, verification etc.

For a long time, till the beginning of this century, the method was 'reductionistic' - explaining the whole in terms of parts - by identifying the constituents and their interactions This required the extension and use of concepts from daily experience - Space, Time, Causality, matter, energy. Conservation laws, laws of motion, determining the values of constants of nature etc.

The method was highly successful in many fields of science and led to development of many technologies which in turn helped advancement of Science in many fundamental and applied areas.

In the last hundred years, however, this reductionistic method itself has led at the most fundamental level to the recognition of "Wholeness" and "Unity"

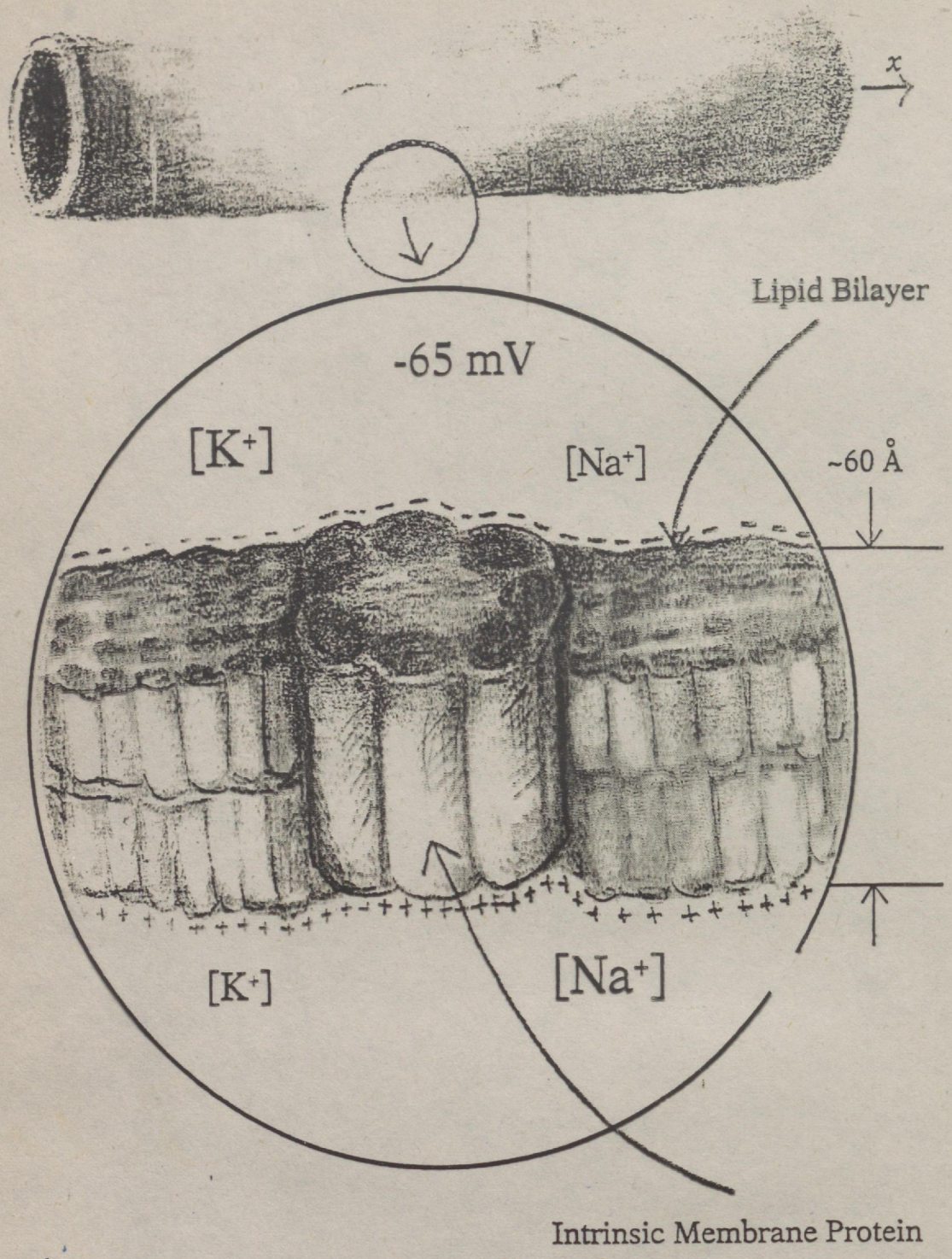


Figure 11. A short section of nerve axon at rest. The inset shows a protein that is imbedded in the nerve membrane. [K^+] *indicates the concentration of potassium ions, and* [Na^+] *indicates the concentration of sodium ions.*

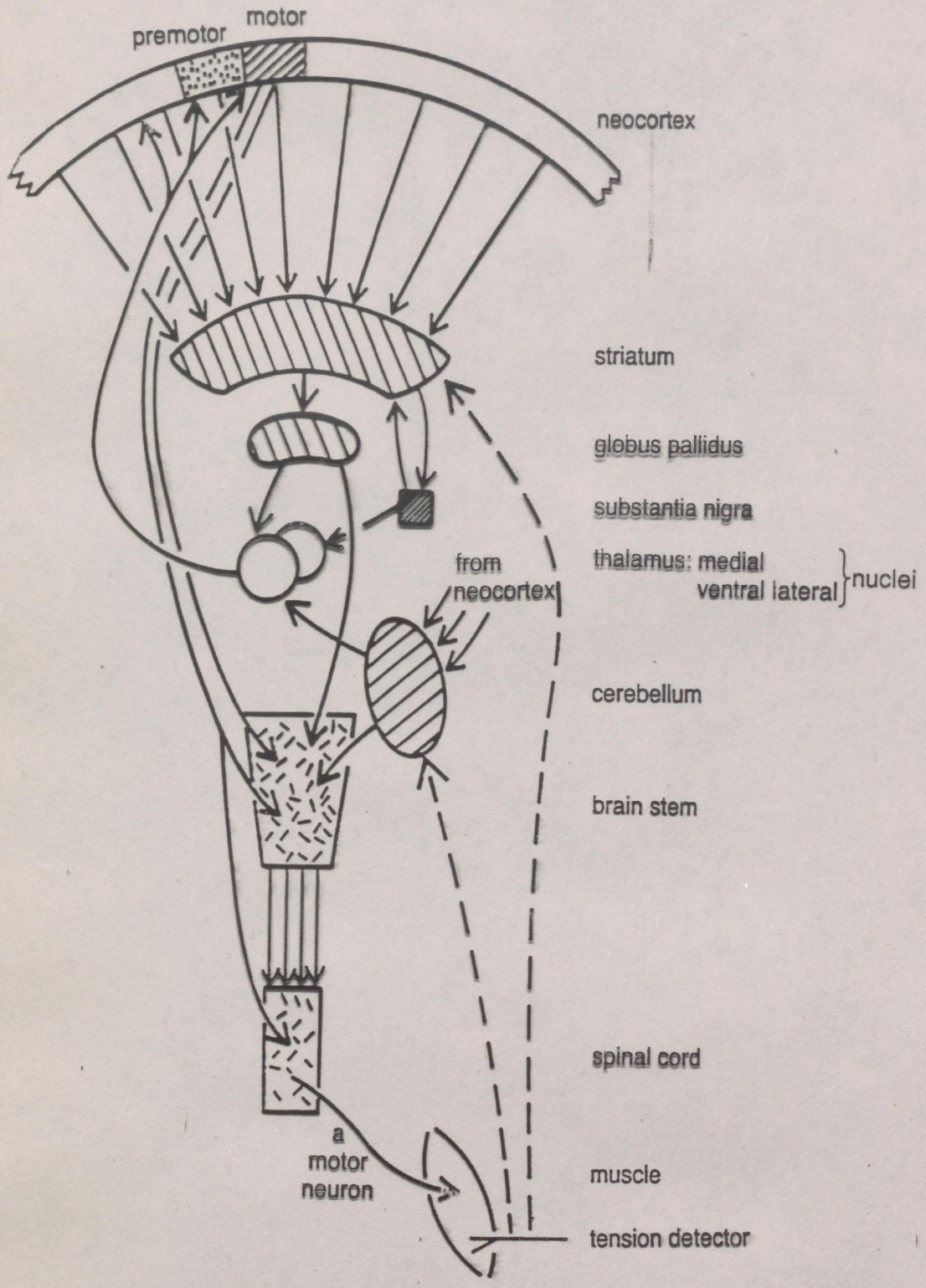


Figure 5.7. Some routes from thought to action (see text).

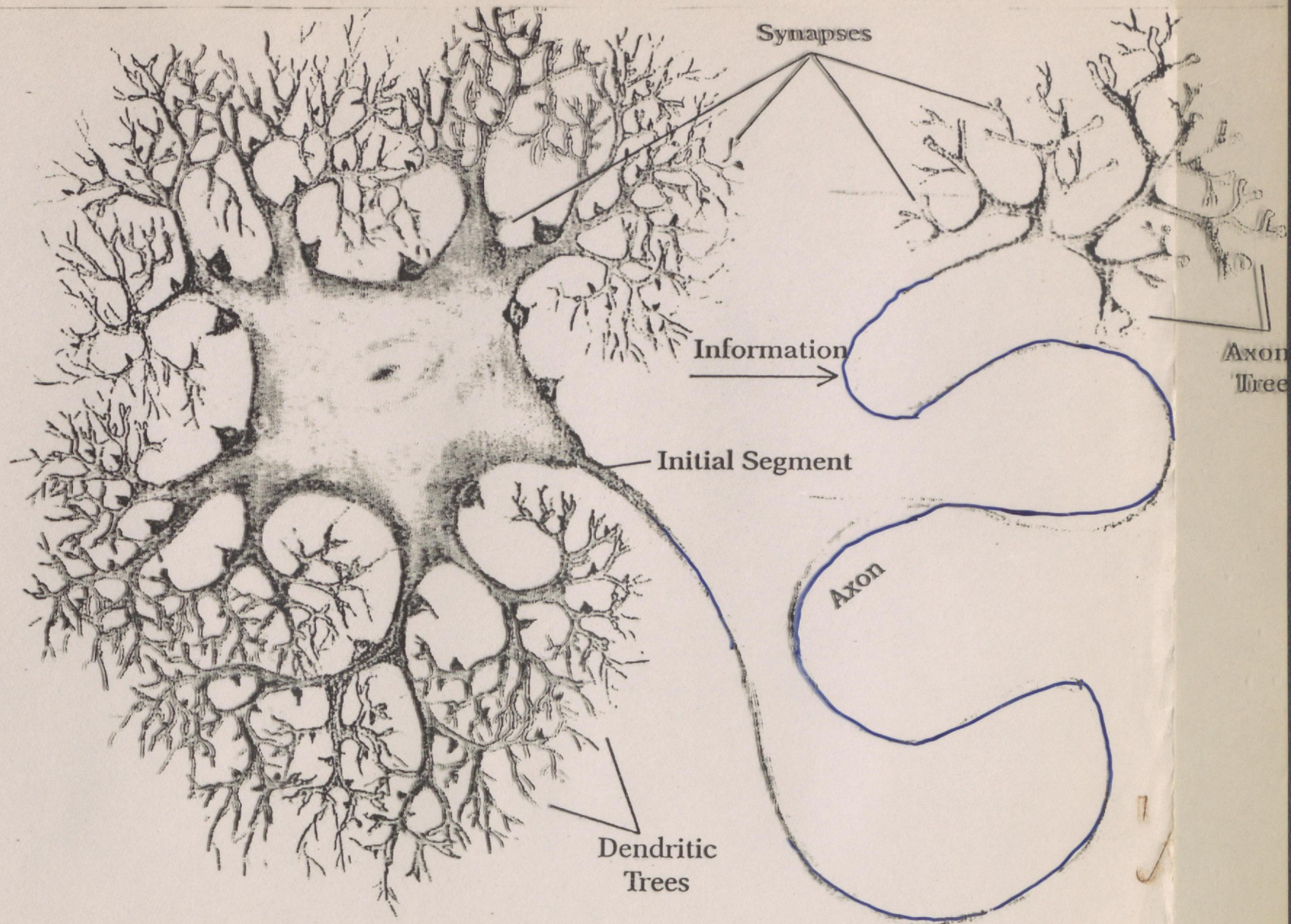


Figure 12. The structure of a typical neuron. Incoming information is gathered from synaptic contacts on the dendritic trees. After processing, this information is carried by nerve impulses to the tips of the axonal trees.

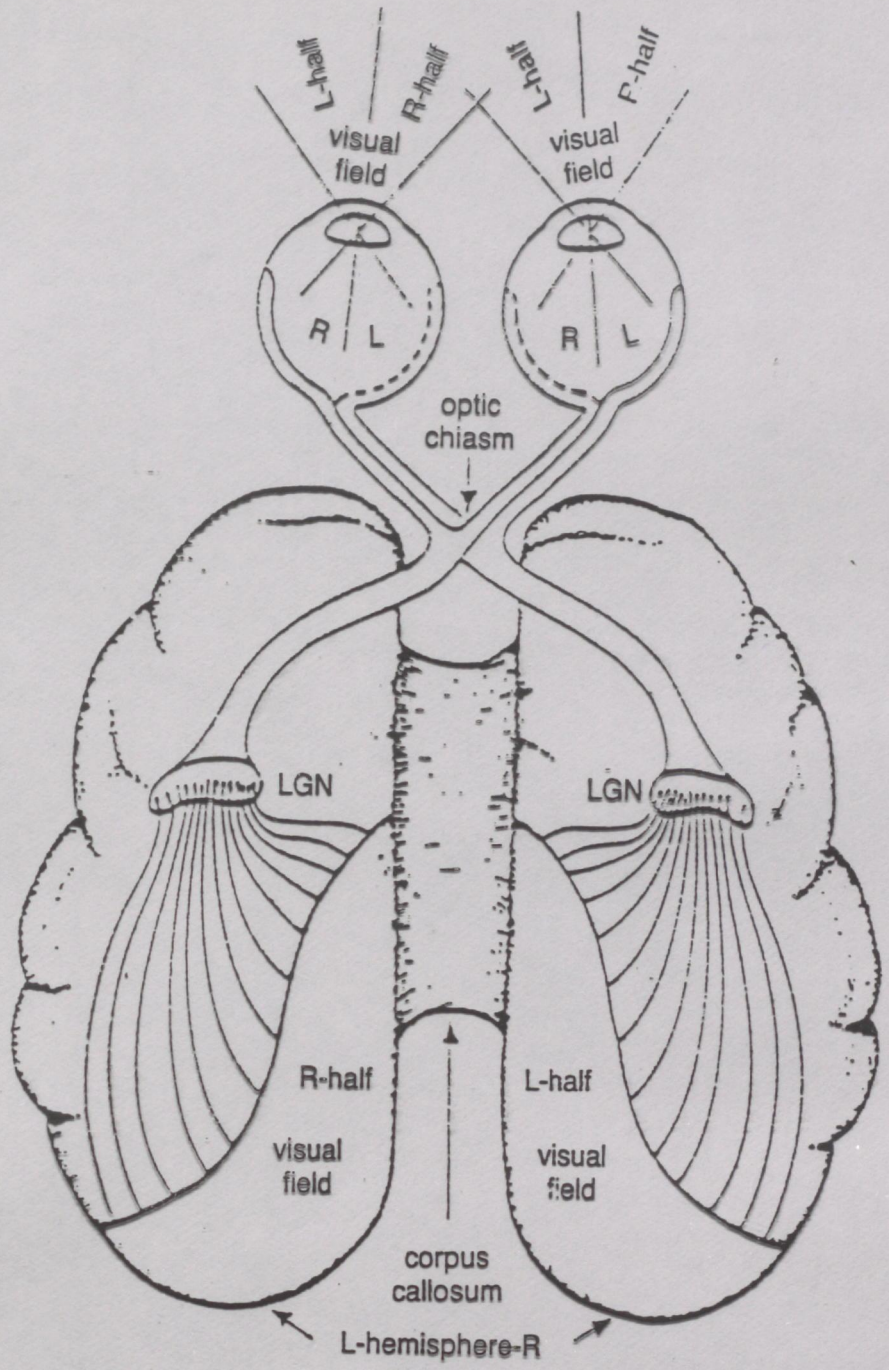


Figure 5.4. Diagram of visual pathways showing how signals from the left and right halves of the visual field go from each eye, via the lateral geniculate nuclei of the thalamus (LGN), to the right and left visual cortex, respectively.
From Popper & Eccles (1977).

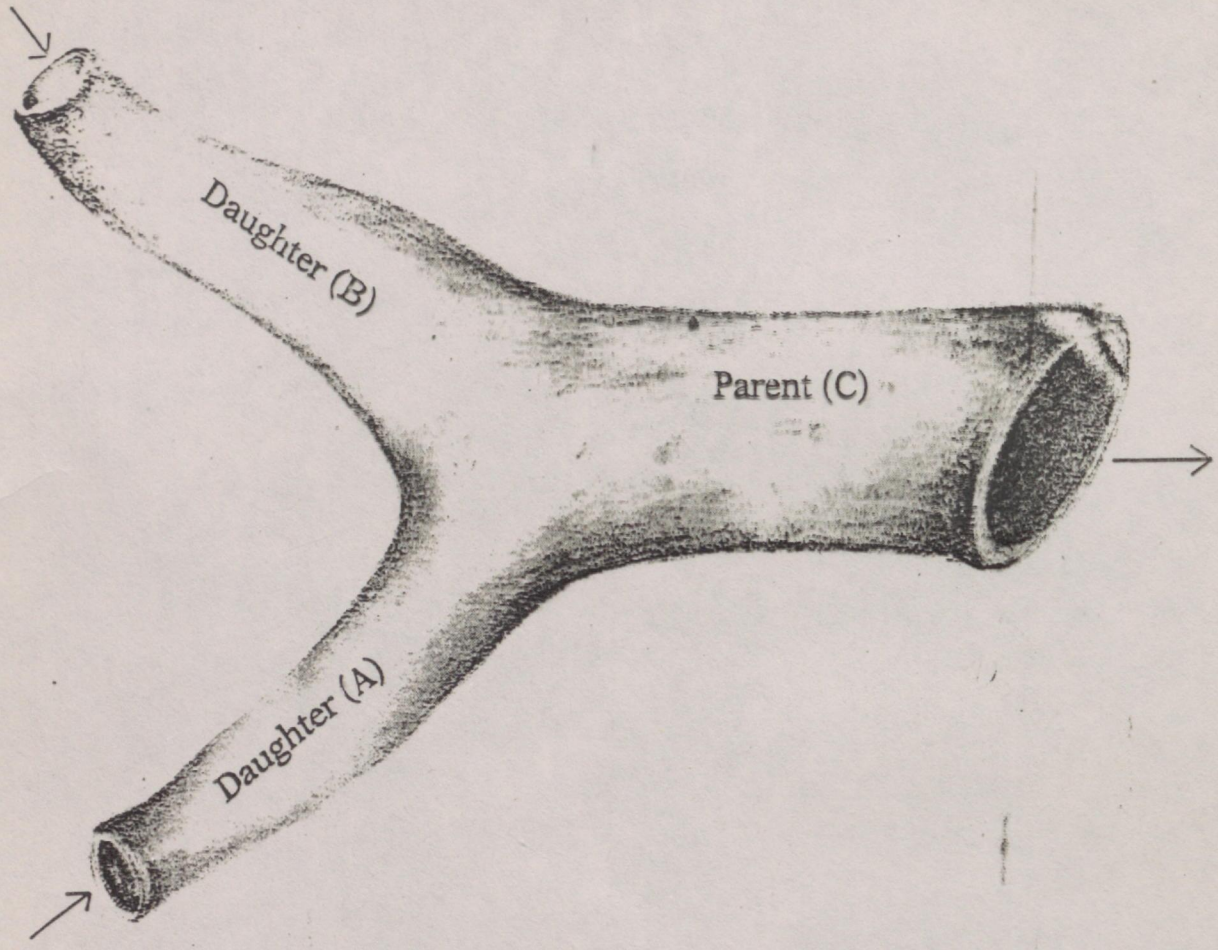


Figure 14. Geometry of a branching dendrite. Can incoming impulses on either or both of the daughter branches ignite an impulse on the parent?

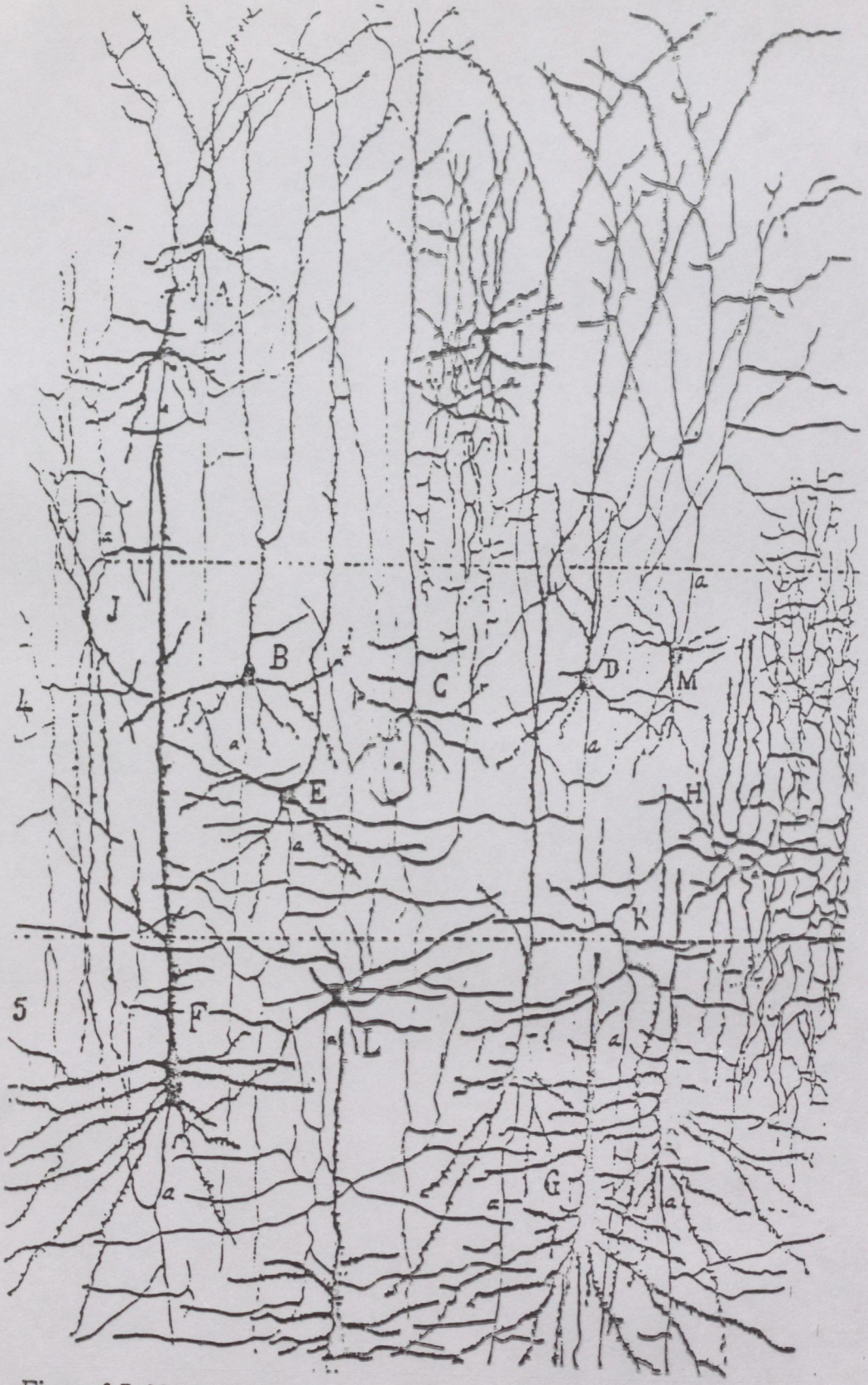


Figure 3.7. Neurons in the cortex of a kitten. Axons are smoother threads labelled 'a'; the others are dendrites. This drawing by Ramón y Cajal was of a section which had been stained by the Golgi method before being examined under the microscope. This technique has the effect of staining completely a very small proportion of the cells, so this picture greatly understates the true density of neurons in the brain.

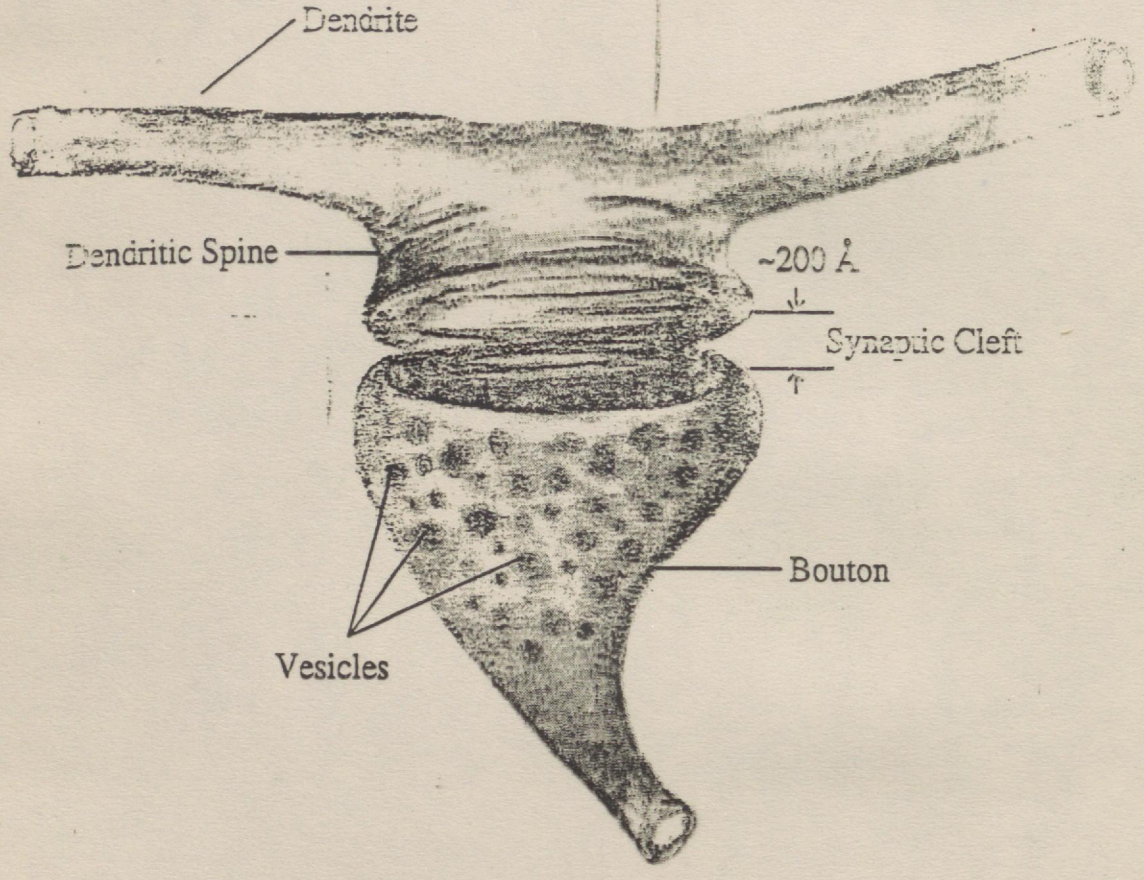


Figure 18. Schematic diagram of a synaptic contact between an axon and a dendritic spine. The vesicles are floating inside the bouton.

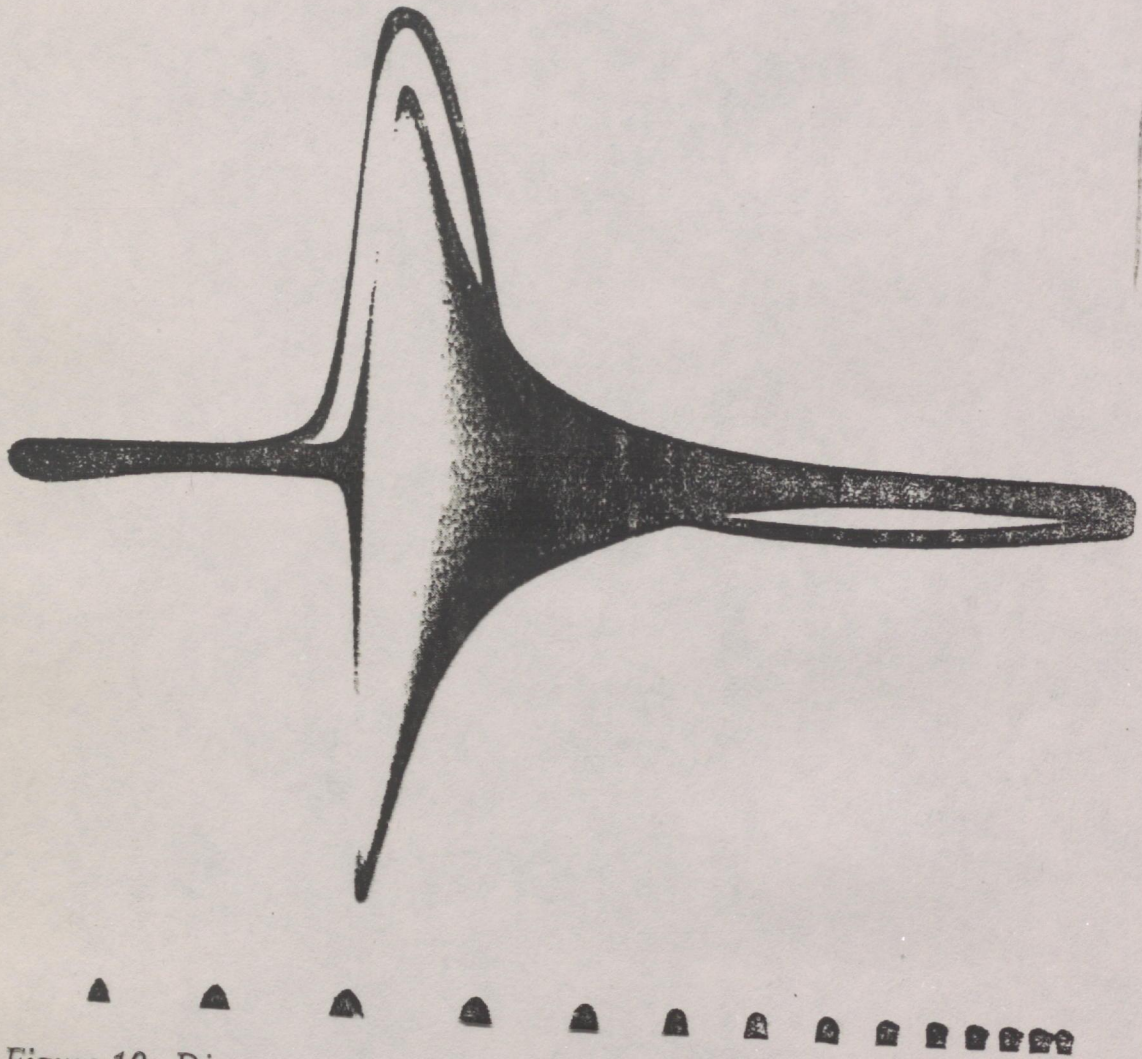


Figure 10. Direct measurements of the increase in membrane ionic permeability (band) and transmembrane voltage (line) on the giant axon of the squid. The time increases from left to right and th : marks indicate intervals of one millisecond. (Courtesy of Kenneth Cole.)

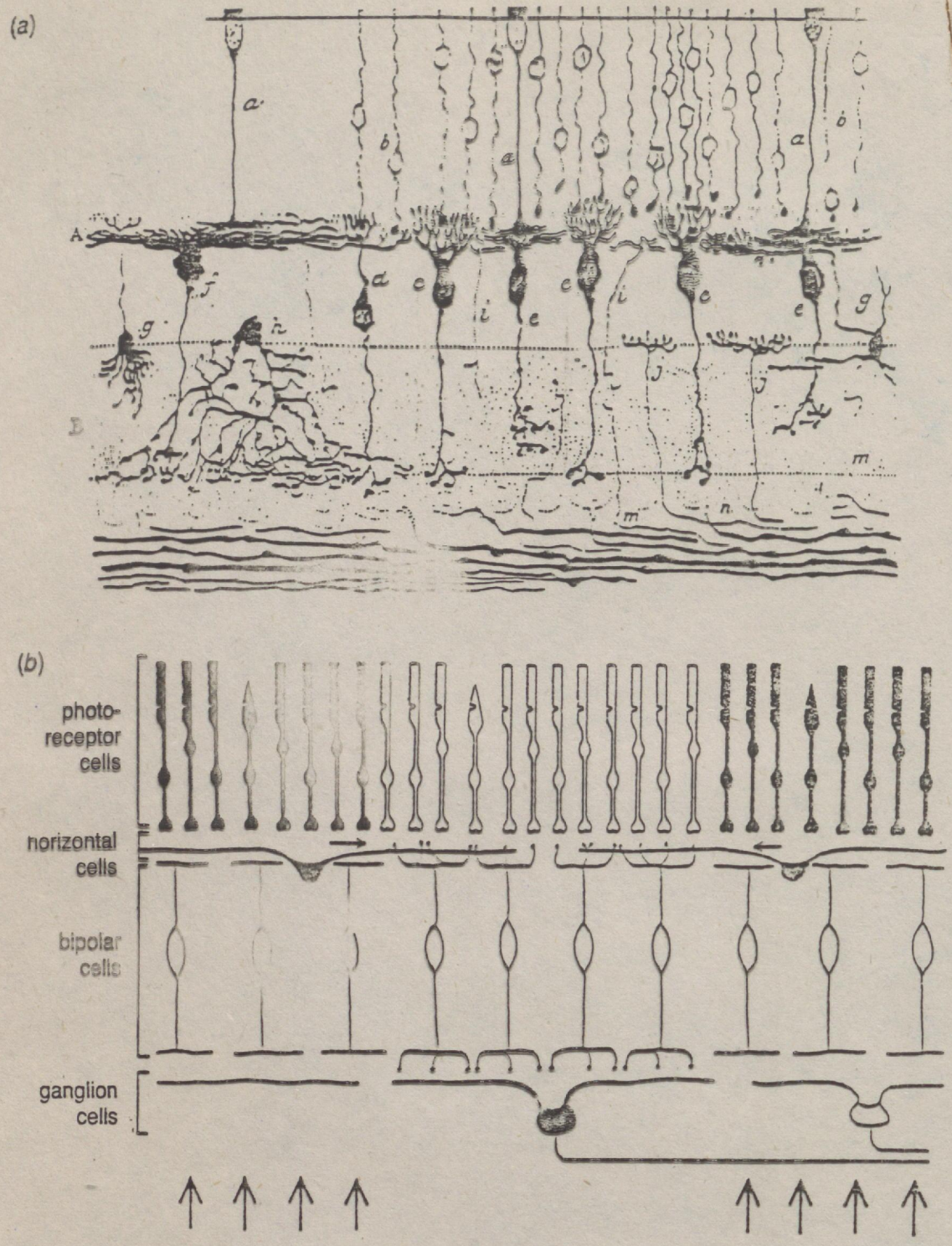
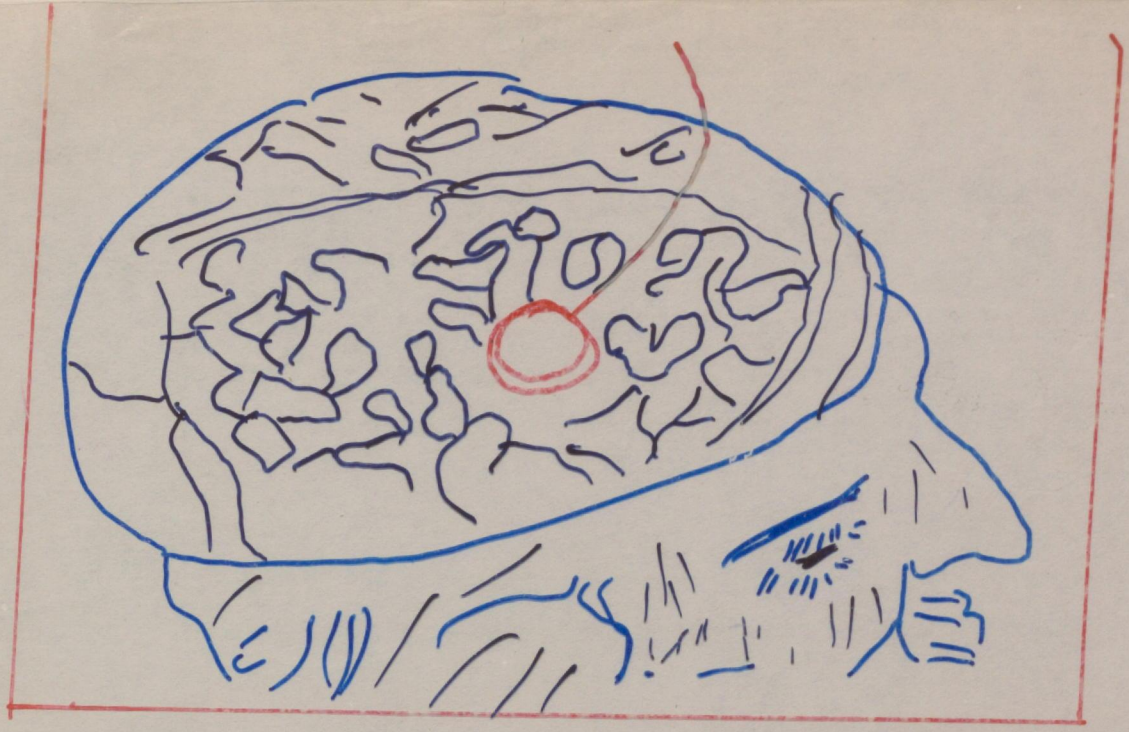


Figure 5.2. (a) Semi-schematic drawing by Ramón y Cajal of neurons in a mammalian retina based on microscope observations using the Golgi staining technique, which picks out and stains completely only a few cells (cf. figure 3.7). (b) A more formal diagram of this computer. The central network of cells are joined both vertically and horizontally. These, as well as the mass of fibres from the output or ganglion cells, all lie *in front* of the light-sensitive input cells, the rods and cones.

Part (a) from Ramón y Cajal (1909–11/1972); (b) from Masland. The functional architecture of the retina.



All Subjects (n = 28)

	Target hits	Misses	False hits
NO EEG	4212	312	111
Right EEG	4651	343	121
Left EEG	4557	286	110

THE SOUTHAMPTON UNIVERSITY EXPERIMENT.

(Collapse of a Quantum Field may affect Brain Function.
C. M. H. Nunn, C. J. S. Clarke, B. H. Blott
Journal of Consciousness Studies. 1, No. 1, (127-135) (1994)

- The Experiment.

The Subjects (Nuns from the University hospital) were asked to press a button with their right hand (only right handed Subjects) whenever they recognised target numbers (2, 5 or 8) among a series of target numbers (0 to 9) flashed ~~for~~ at intervals of one second. During this period EEG recordings were made randomly - neither the Subject nor the experimenter knew from which side of the brain the recording was being made at any particular time. This was known only at the time of analysis. The Experiment lasted 40 mins on each Subject.

- Result

The number of misses was less. when the EEG was recording the Left Side of the brain ~~Rather~~ Compared to the Right Side. In the Recognition task, it is the left hemisphere that is involved.

- Interpretation

Conventional ideas on Causality Cannot explain the result.
Does the act of recording collapse the wave function?
Is this evidence for ESM process?

Artificial Intelligence - (Robotics)

- The developments in Sophisticated Machines and Computers with parallel processing additionalities have led to the new discipline of A.I.
The optimists in this field have said:

"We already have machines that can literally think in the same sense as you and I do."

Herbert Simon, (Carnegie Mellon)

"The next generation computers will be so intelligent that we will be lucky if they keep us around the house as house pets"

Marvin Minsky (MIT)

"Since we now know that mental processes such as consciousness are purely formal processes there is an evolutionary advantage to having these formal processes (consciousness and so on) going on in silicon chips and wires, because that kind of stuff is better able to survive the universe that is cooling off organisms like us made up of messy biological machinery. So the next stage of evolution will be made out of wires and silicon"

Freeman Dyson (Cornell)

Those who are not convinced about AI say the following:

- There is no evidence that machines do non behavioural activities like imagination, conceptual thinking, activities like love, self pity, experiencing pleasure, pain etc.
- No computer has been constructed with organic molecules as hardware.
- You cannot get semantics (meaning) out of syntax.
- We do not know how the brain works. How can we construct a machine that can simulate it?

  There is no evidence that brain processes are just some sort of computations. It has to be a computer that is changing its inside connections all the time if it has to simulate the plasticity of the brain.
- The Turin Test

  The Test is whether or not an expert will be able to distinguish between the machine's performance from that of a human when both are hidden from him, by asking a set of allowed questions only.

SETi - Search For Extraterrestrial Intelligence

- No evidence yet
-

Crick's Dilemma

Well, at the end of 262 pages of the book "Astonishing Hypothesis" in which Crick has elaborated in a masterly way how his hypothesis is supported by neuro-sciences, he remarks

"the astonishing hypothesis may be proved correct. Alternately some views close to religious one may become more plausible. There is always a third possibility that the facts support a new way of looking at the mind-brain problem that is significantly different from the rather crude materialistic view that many neuroscientists hold to-day and also from the religious point of view. Only time and much more scientific work will enable us to decide"

[He did not attach importance to (i) Quantum phenomena (ii) Relied only on molecular levels]