"WHAT LIFE
CAN COMPARE WITH THIS?
SITTING ALONE AT THE WINDOW,
I WATCH THE FLOWERS BLOOM,
THE LEAVES FALL,
THE SEASONS COME AND GO."

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"WHAT LIFE CAN COMPARE WITH THIS?"

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A Thesis

Presented to

The Division of Philosophy, Psychology, and Education

Reed College

In Partial Fulfillment

Of the Requirements for the Degree

Bachelor of Arts

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by

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May 1968

ABSTRACT

Mind-blowing and its methods are discussed. Data suitable for statistical analysis are submitted therein.

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INTRODUCTION

The goal and focus of this thesis is the delineation of the problems and questions involved in exploring the phenomenon of consciousness. What I am presenting, then, is not so much validation or solution of a particular theory or problem as a description and demonstration of a potentially fruitful field of inquiry. One could call this field "psychophysiology of consciousness" or "transcendental technology," but one of the characteristics of this field is its eclecticism, so I will try to present an overview of the various technologies and disciplines applicable to the study of consciousness.

My approach to the problems of studying consciousness involves three complimentary and interlocking components: machines, people, and numbers. Since my work has been more concerned with defining problems than providing data towards the validation of some problem/hypothesis, the form of this thesis will deviate from the "standard" presentation of theory, apparatus and methodology, and results. The work I have done and the potential research I shall describe involves a technology, a combination of mechanical tools of observation and measurement; the subjective experience of a human being, the "content" of consciousness

which is strictly personal; and a method of using these tools to map, define, manipulate and control consciousness.

I feel that the problems of finding methods and tools with which to study consciousness has relevant implications and concerns problems crucial to psychology as a discipline and humanity as a whole. My data, the evidence of objective correlates of certain states of consciousness, will be prefaced by a discussion of the evolution of the technology involved and the importance of the human component in this field of research. I will be describing a way of using new tools for studying old problems as well as the problems arising between human beings and their tools. Within the context of biological evolution, psychology is becoming the focus of the problem of integrating human tools and human values. Human technology and human potentialities are vitally and dangerously fused in a manner which necessitates the redirection of scientific technology towards defining and actualizing human values and potentialities.

CHAPTER ONE

MACHINES

The premises underlying an attempt to study empirically (using human observation) the phenomenon of consciousness are not the most logically sound; Bertrand Russell, among a host of others, warns against the dangers of stating a proposition which is a member of the class it defines. How can it be possible to demonstrate objectively (which is to say publicly) the existence of a phenomenon which is both ultimately a private event and universally acknowledged to be the substrate of the act of observing? American psychologists of late have been in the habit of resolving the paradox by devising methods of ignoring it. Yet the nature of consciousness <u>has</u> been a popular problem for a few thousand years; in fact, it was as the "empirical investigation of consciousness" that psychology divorced itself from philosophy scarcely a century ago. The man responsible for revealing much about the nature of the neural bases of consciousness, Sir John Eccles, points out the obvious existential necessity of empirically dealing with the nature of consciousness:

> My approach to conscious experience is, in the first instance, based on my direct experience as a conscious self -- myself -- because I

> believe this to be the only valid approach to the problem of consciousness. This initial attitude of mine is not solipsistic because similarly I would maintain that each of you has to face up to the problem discussed in this lecture in relation to your own experience of self consciousness. My conscious experience is all that is given to me in my task of trying to understand myself; and, as I shall argue later, it is only because and through my experience that I come to know of a world of things and events and so embark on the attempt to understand it.[1]

One is faced with another problem in attempting to delineate the interdisciplinary and often divergent investigations which deal with the phenomenon of consciousness in a matrix of progressively more rigorous paradigms and functional relations. The manner in which one comes to understand the nature of consciousness is the best paradigm for relating the developments in biology, chemistry, physics, mathematics, and psychology which concern consciousness. Both the understanding of consciousness and the ordering of knowledge about consciousness require the recognition of the importance of patterning of dynamic processes and function as levels of complexity of relations.

Just as biological evolution becomes involuted when living organisms attain the consciousness necessary for controlling evolutionary mechanisms, the nature of discoveries concerning

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[1]Sir John Eccles, The Brain and the Unity of Conscious Experience (Cambridge: The University Press, 1965)

consciousness must necessarily change the methodology and level of research. One can see such a development in the biochemistry of brain metabolism, from research into chemical constituents of biological mechanisms to focus on enzymes with the discovery of the protein nature of enzymes to control of protein synthesis, to structure of chromosomes, to nucleic code, to genesis of nucleic acids, etc. Similarly one can see the progressively increasing complexity of neurophysiology and neuroanatomy. In the process of tracing the development of concepts relevant to consciousness in biology, chemistry, physics, mathematics, and psychology a very unusual, almost teleological, interdependence of discoveries reveals itself. Sir Julian Huxley described a similar process in his introduction to Teilhard de Chardin's Phenomenon of Man:

> This concept includes, as I understand it, the genesis of increasingly elaborate organization during cosmogenesis, as manifested in the passage from subatomic units to atoms, from atoms to inorganic and later to organic molecules, thence to the first subcellular living units or self-replicating molecules, and then to cells, to multicellular individuals, to cephalized metazoa with brains, to primitive men, and now to civilized societies.
>
> But it involves something more. He speaks of complexification as an all pervading tendency, involving the universe in all its parts in an enroulement organique sur soi-meme, or by an alternative metaphor, as a reploiement sur soi-meme. He thus invisages the world stuff as being "rolled up" or "folded in" upon itself, both locally and in its entirety, and adds that the process is accompanied by an increase...of individualized constructions of increased organizational complexity.

> For want of a better English word, I shall use convergent integration to define the operation of this process of self-complexification.
>
> Pere Teilhard also maintains that complexification by convergent integration leads to the intensification of mental subjective activity -- in other words, to the evolution of progressively more conscious minds. Thus he states that full consciousness (as seen in man) is to be defined as "the specific effect of organized complexity!"[2]

In the spirit of the interdisciplinary ecumenism I am trying to illustrate, I have borrowed the concept of "complexification" from a paleontologist and the orientation toward "meaning" in terms of patterns within and weaved by dynamic systems from a mathematician. Norbert Wiener devised "information theory" from certain aspects of the thermodynamic concept of entropy and post-Heisenberg probabilistic physics in order to deal with the mechanisms of feedback-control associated with "cybernetic" devices.[3] The construction of mechanisms incorporating someof the operations integral to consciousness generated a theory of information as the transfer of "meaningful" (non-random) messages, the nature and definition of message being "non-random spatial-temporal pattern." The concept of entropy reduction by transmission of patterns is applicable to the brain as an organ of consciousness as well as to the related

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[2]Sir Julian Huxley, Introduction to T.de Chardin, The Phenomenon of Man (New York: Harper, 1959)

[3]Norbert Wiener, The Human Use of Human Beings

disciplines concerned with concsiousness. The unity of cross-disciplinary research lies in the convergent integration of information -- meaningful patterns.

The convergent integration of information into meaningful patterns is a way of describing the manner by which knowledge about the universe is organized by the various research disciplines, but more importantly, it is a description of the process by which human technology is affecting human culture.

The phenomenon of life as an energy form runs counter to the stream of the universe. The simplest form of life earns its integrity as an organism only at the expense of an enormous collection and expenditure of energy from outside, from the environment. Each living cell requires the procurement and use of a proportionately huge amount of energy from its environment to maintain its boundaries (cell walls, skin, civilization) against forces which could destroy it. The way in which living things collect, store, and use energy from their environment in order to maintain and expand themselves runs directly counter to the current of entropy, the tendency of all the energy in the universe to stasis. The general tendency of energy over the entire system (the universe) is from complexity and pattern to simplicity and randomness. Life develops in the opposite direction; simple molecules in a random soup form more complex configurations until the pattern of the complexifying combinations

creates a code by which the organism can replicate and continue the process of gathering simple energy into configurations. The nucleic acids contain the information necessary for organizing replication (which insures the continuity of life as an energy process) and controlling metabolism (the means by which living things procure and produce the energy necessary to exist). The patterns of molecules in a DNA helix are meaningful; they possess potential energy absent from random molecular configurations because the meaningful pattern of DNA contains information, a manner of efficiently collecting and utilizing energy.

In terms of energy machines, human beings are unique in their amazing capability to extract large amounts of energy from their environment through technology, the use of tools. Tools are objects separate from the human organism which are used by humans to obtain energy for their own use. The lever provides a manner to obtain energy unobtainable by bare hands. The use of fire, some say, separates us from beasts, because it enables us to provide our own energy source. Humans are now attempting to control thermonuclear fusion, the only energy source for all life in this solar system. Technology exists in order to affect the environment. Technology also changes the humans who use it.

Man has long been conscious of the use of technology as a means of altering and feeding on the environment, but consciousness

of the effect of technology on humans is a recent event. McLuhan's Understanding Media is a discussion of the way in which technology changes the humans which use it. Media are the various artificial extensions of the human organism devised by the human collectivity; wheels are extensions of the foot, language the extension of consciousness, print the extension of speech, and cameras the extensions of the eye. With the adoption of Wiener's concept of information, such diverse phenomena as games, newspapers, money, roads, and airplanes can be considered media. Media are, in other words, the mechanisms and products of technology, the tool-using capacity which anthropologists claim distinguishes man among animals. McLuhan's thesis is a radical one, that man's technology transforms his environment and consciousness:

> After three thousand years of explosion, by means of fragmentary and mechanical technologies, the Western world is imploding. During the mechanical ages we had extended our bodies in space. Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. Rapidly, we approach the final phase of the extensions of man -- the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media.[4]

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[4]Marshall McLuhan, Understanding Media -- the Extensions of Man (New York: McGraw-Hill, 1964), p. 19.

Media are either "hot" or "cool" according to the amount of data presented, the degree of "definition", and the resultant degree of personal involvement demanded by the nature of the media. A "hot" medium extends a single sense in "high definition", presenting a great deal of data. A "cool" medium is of "low definition", presenting little data and thus demanding a large degree of personal involvement or "filling in" of the data. A photograph is "hot", a cartoon is "cool." "Hot" media are low in participation and hence involvement, while "cool" media, with their demand for completion of data, necessitate involvement "in depth" (using all the senses).

The "temperature" of the medium can have drastic effects on the consciousness of a population due to the degree of involvement demanded of the audience. One of McLuhan's most important distinctions, between the "mechanical age" of Gutenberg and Henry Ford and the "electric age" of TV and computers, rests on the observation that man's media are undergoing a process of "cooling down" which is having drastic effects on the ratios between human senses and degree of participation. "Mechanical man" was characterized by print and mass-production which had the effect on his consciousness of making it linear (in the way type is read) and fragmented (in the manner of specialization/ mass production assembly lines). "Electric man" is characterized by television and information processing, which are (and will be)

having the effect of emphasis on gestalt (rather than linear) perception and involvement "in depth" as opposed to fragmented, detached consciousness:

> Western man acquired from the technology of literacy the power to act without reacting. The advantages of fragmenting himself in this way are seen in the case of the surgeon, who would be quite helpless if he were to become humanly involved in his operation. We acquired the art of carrying out the most dangerous social operations with complete detachment. But our detachment was a posture of non-involvement. In the electric age, when our central nervous system is technologically extended to involve us in the whole of mankind, we necessarily participate, in depth, in the consequences of our every action. It is no longer possible to adopt the aloof and dissociate role of the literate Westerner...Electric speed in bringing all social and political functions together in a sudden implosion has heightened human awareness of of responsibility to an intense degree.[5]

In other words, man is approaching the point at which his extension of himself into the environment will enclose the environment within him. The processes of technological, electrical, information storage and retrieval are expanding the consciousness of the whole of mankind to the point of <u>containing</u> the environment: paradoxically, the crisis caused by rapid technological expansion is a crisis in human values. Through technology, civilization has become a huge machine with interchangeable human parts. It is here that the growth and direction of technology clashes with human values, for people are not

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[5] <u>Ibid</u>., p. 20.

parts of machines, machines should be used for human survival and ~~growth of humans~~ MAXIMIZATION OF HUMAN GROWTH POTENTIAL. Mankind needs a technology of value, a tool for determining what human values and potentials are and how to direct technology towards actualization of that potential. Psychology could and should be the study of humans, the exploration of human potential and the delineation of those characteristics which are peculiar to humans.

Behind this struggle against the mechanization of man is the insight that although the principle of mechanization has itself caused growth and change, further application excludes the possibility of growth or understanding of change. Mechanization is achieved by fragmentation of any process and arrangement of the fragmented parts in a series. David Hume pointed out in the eighteenth century that there is no necessary causality in a sequence. The effect of electricity was to end sequential, fragmented thinking by making information transfer instantaneous. The consequences of this for the human race are vital, for the concern with the population explosion lies not in mere increase in numbers but in the fact that everybody on the globe has to live in the utmost proximity created by electricity's instant involvement.

My concern with the study of human psychology as unified rather than fragmented parallels, and has been partially caused by, the recent revolutions in classical physics, economics, and

political science. Physics reversed the process of divisibility of phenomena by sheer overextension and Heisenberg gave way to unified field theory. The process of automation in industry has replaced the divisibility of process with the organic interlacing of all functions in the process.

McLuhan discusses technological changes with reference to their impact on society by altering the basic ratios between the senses. The danger to society is its ignorance of these shifts and inability to adjust to rapid changes in the nature of consciousness brought about by technology. In any structure or medium there is a "break boundary" at which the system suddenly changes into another or passes some point of no return in its dynamic processes. Psychology is deeply committed to <u>being</u> that break boundary:

> Each new impact shifts the ratios among all the senses. What we seek today is either a means of controlling these shifts in the sense-ratios of the psychic and social outlook, or a means of avoiding them altogether...to prevent undue wreckage in society, the artist tends now to move from the ivory tower to the control tower of society...The ability of the artist to sidestep the bully blow of new technology of any age, and to parry such violence with full awareness, is age-old. Equally age-old is the inevitability of the percussed victims, who cannot sidestep the new violence, to recognize the need of the artist. The artist if the man in any field, scientific or humanistic, who grasps the implications of his actions and of new knowledge in his own time. He is the man of integral awareness.[6]

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[6] <u>Ibid</u>., p. 70.

The paradox of studying consciousness is that one must utilize the technology of consciousness to study it. The trial and error process of research is a function of consciousness as a tool, it is a means by which the human organism obtains information (and hence energy) from the environment. Consciousness, however, is a personal event which is not readily observable to anyone other than he who experiences it. There has been the need, then, for a tool with which to measure consciousness, a manner of making a "private" event "public" and therefore subject to empirical study.

Consciousness and what is now considered the subject matter of psychology were the domain of metaphysics and philosophy until relatively recently. In order to understand the differential development of multi-disciplinary concepts of consciousness one must look at the relative positions of the disciplines as psychology was becoming differentiated from philosophy.

The state of confusion in modern psychology regarding consciousness seems paradoxical in light of the advanced state of biochemical and neurophysiological knowledge. This appears to be due not only to psychology's late development but to ignorance of the significance of discoveries in other fields.

While mathematics is the oldest of the sciences, its applications to consciousness have developed rather deviously, via thermodynamics and statistical physics. The utilization of

feedback-control derived from living organisms and applied to mechanical devices gave birth to information theory which is only recently being applied to the neural mechanisms underlying conscious phenomena.

Physics is the next most established discipline, and is often cited as the paradigm for the younger natural sciences, but its first contributions to consciousness research were a comedy of errors. The initial incident in the chain of misconceptions occurred when Luigi Galvani observed the legs of a dead frog to kick when it was suspended between different metals. He deduced correctly that he had observed the effects of "animal electricity". The meaning of his discovery became confused when a contemporary, Alessandro Volta, refuted his theory by inducing a current with similar apparatus but no frog. The intellectual descendants of Volta advanced electrical engineering for over a century before electrophysiologists reopened the study of "animal electricity", a development fortuitous for electrophysiologists, whose basic tools could not be built until the development of the thermionic tube.

Chemists were involved in debating the paradigm of "phlogiston" when psychology was still the property of philosophers. The development of biochemistry from organic chemistry was one of the most important steps in the development of empirical analysis of consciousness because of the discovery of enzymes as

the catalysts of cellular metabolism; of the nucleic acids as the molecular engram of the directing code of organismic development and reproduction, species continuity, and control of metabolism -- the classical mediators of consciousness, as well as synthesis of the psychoactive chemicals. Although in the long run the functional/structural relationship between the nucleic acid molecules and brain metabolism will be the most important problem regarding consciousness, it was the discovery of psychochemicals that provided the important stimulus for reconsideration of traditional concepts of consciousness.

One can consider the synthesis of LSD, the most powerful of the psychoactive chemicals, in light of Chardin's concept of complexification by convergent integration. The important thing to note is that the probability that an organic molecule of the complexity of LSD would evolve cosmogenetically are very low. Viewing consciousness as a level of complexification, it is obvious that the appearance of LSD must be mediated by a consciousness capable of directing its synthesis. This leads to the possibility of conjecture that the discovery and experimental control of the process of consciousness is just as probably the result of Darwinian evolution as the evolution of consciousness.

The initial result of experimentation with LSD on humans was the American psychologists' noting the effects of the chemical on projective tests of personality, and leaping to make the

connection between the transitory effects of the chemical and the similar behavior of psychotics; hence their initial designation of the drug as "psychotomimetic". The importance of motivational as well as ability variables in test performance has been made since, but it was the discovery of chemical bases for phenylketonuria and galactosemia, diseases with profound mental effects, along with the discovery of the structural relation between LSD and serotonin (5-hydroxy-tryptamine), a brain metabolite, that seemed to furnish the link between LSD and psychosis. The causes of phenylketonuria and galactosemia have been verified as genetic abnormalities resulting in deficiencies in vital metabolites.[7] The competitive action of serotonin and LSD has been verified[8], but isomers of LSD that inhibit serotonin identically produce no mental effects, and thus far no metabolic imbalance has been causally related to psychosis. It is in the subjective, unverifiable reports of subjects, characteristic of consciousness phenomena , that is found the basis for the present methodological and legal controversy surrounding these agents.

There is certainly no need to go through the "LSD story", for it has been publicized most adequately. The evidence of

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[7]M.D.Armstrong and F.H.Tyler, "Studies in Phenylketonuria," J. Clin. Invest., 1955.

[8]J.H.Gadaum, "Antagonism between LSD and 5-hydroxytryptamine," J.Physiol., 1953, 121.

radical positive personality change, subjective reports of expanded or cosmic consciousness, discovery of psychochemical agents as components of primitive religions, the wide "illicit" use and official proscription and subsequent emergence of "psychedelic subculture" have certainly demonstrated that there is widespread and vital interest in understanding consciousness and that it may be possible to define consciousness, if one can change it with a chemical.

The development of biology as an empirical science and the eventual specialization of neuroanatomy, neurophysiology and biochemistry initiated several independent lines of research, branches of which have converged about the biochemical and physiological substrates of consciousness. There have been long periods of stagnation and frustration due to lack of communication between temporally parallel lines of research. While British physiologists were brilliantly describing the elementary physical elements of the nervous system, the lack of technological developments, particularly the thermionic tube, resulted in the delay of convergence of electrophysiology of the brain and classical conditioning even though work was being done simultaneously in each field.

In 1800 the physiological mechanisms which were necessary for the recognition of the reflex arc were elucidated by Bell[9]

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[9]L.G.Walter, The Living Brain (New York:Norton, 1963).

of England. He recognized the ventral and dorsal components of the spinal cord as discrete systems and correctly identified the dorsal component with sensory transmission and the ventral with motor transmission. At the same time, Flourens in France identified the cerebellum with motor and the cerebrum with integrative functions. The search for the physiological mechanisms of behavior slowed for a time, the next important step being Forel's concept of discrete nerve cells in 1886. Technological development in histology and microanatomy made possible the brilliant work of Santiago Ramon y Cajal. Cajal inferred the existence of synaptic transmission from the widely known histological observation that nerve axons generally terminate among dendritic ramifications. He further inferred from the anatomical arrangement of sensory, motor, and internuncial neurons that all neurons are dynamically polarized in such a way that excitation can be transmitted only from the axon of one neuron to dendrites or soma of the next.[10]

Around the turn of the century came the discoveries of the great British physiologists. The Cambridge school developed new techniques in investigation of electrical activity in muscles, nerves, and sense organs. At the same time Oxford under Sherrington was beginning to work on the problem of reflex action of the

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[10]T.H.Bullock, "Neuron Doctrine and Electrophysiology," Science 129, 997-1002.

spinal cord.

British research from that time to the present day, particularly by Eccles, Huxley, and Hodgkin, led to the formulation of modern neuron doctrine, the explanation of the mechanisms of neural transmission which is the fundamental functional unit of consciousness. The techniques developed by their studies have led to the science of electrophysiology, the next level of complexification investigation and the method by which objective criteria for states of consciousness were established.

The science of electroencephalography had its origins in the era of Sherrington, but it will be considered later, as a separate line of development. Preliminary to that, I would like to outline modern neuron doctrine and its possible relations to both the most basic elements of the electrochemistry of consciousness and what may turn out to be a macrocosmic function of giant masses of cortical cells. T.H. Bullock has presented four main revisions of neuron doctrine:

> (1). We now believe that the neuron is a functional unit somewhat in the same way that a person is in society in that it speaks with one voice at a time... but some neurons have two axons and can deliver two nonidentical pulse coded outputs at the same time in different directions.
> (2). We now believe that the responses of many or most parts of the neuron to impinging excitation do not spread to become impulses directly but help determine the firing of impulses at some critical region such as the base of the axon...these responses we will call prepotentials or subthreshold processes.
> (3). We now believe that many parts of the neuron

> cannot respond in an all-or-none fashion and therefore cannot propagate without decrement. Decremental conduction is probably characteristic of the great bulk of neuronal surface membrane -- that is to say, the cell membrane of the extensive ramifications and dendrites making up much of the gray matter of higher animals and the neuropiles of fiber decremental conduction requires that all such membranes be within shouting distance of the locue of spike initiation. Many dendrites are so short that we easily believe this condition is met, but some are so long and fine that it remains seriously open to question whether they can directly influence to any significant degree the initiation of spikes by the cell or whether their main role is quite another one. But it has been suggested that much of the activity of dendrites has its significance in an influence upon other neurons, even though the activity is local, graded, and small in amplitude. It seems likely that brain waves are the synchronized subthreshold dendritic potentials of many neurons summed and, further, are perhaps more than a mere by-product like the noise of a car, but are a significant causal agent..
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> (4). We now believe that the labile and integrative processes, insofar as they are localizable to the single unit level, are not confined to the synapse but occur as well at other places in the sequence of events preceding the initiation of the propagated spike. There may be as many as four or five different parts of circumscribed loci in various parts of the neuron, each of which is integrative in the same sense that it does not pass on whatever comes to it in a one-to-one relation but exercises some labile evaluative action.
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> We are getting closer to an explanation of one of the most basic features of the neuronal basis of behavior -- namely the mechanism of temporally patterned impulse sequences.[11]

The value of evaluating consciousness in terms of levels of complexity of relations is evident in neuron theory. There is no dispute that the neuron is the best candidate for the

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[11] Ibid.

fundamental anatomical element of consciousness. The complexity of the action of a single neuron is overwhelming in comparison with the basic on/off element of the computer, yet the concept of information in the form of communicated messages applies to the simplest reflex arc. As is well known, the order of magnitude of possible connections of units increases factorially so that the number of message configurations of one human brain is larger by many orders of magnitude than the number of electrons necessary to fill the universe. Certainly it is evident that the configurations of information-transfer would take on different patterns at different orders of complexity, and it is important to realize that the informational content of neural action depends upon temporally patterned impulse sequences. This applies to the action of single neurons as well as the sum of millions of dendritic subthreshold potentials. Perhaps the best metaphor for this conception of the brain-process as consciousness is Sherrington's: "...an enchanted loom where millions of flashing shuttles weave a dissolving pattern, always a meaningful pattern although never an abiding one...."[12]

The issue which finally determined the integrity of psychology as an empirical science independent of philosophy was

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[12]Walter, op.cit.

that of consciousness. The 16th century philosopher Descartes postulated a non-spatial mind influencing the body through the brain and suggested the pineal gland as the point of rendezvous. Hobbes in the 17th century rejected "cartesian dualism" and proposed a mechanistic model of thought based on bodies in motion.

It was in Germany in the late 19th century that psychology emerged as the empirical study of consciousness. In 1860, a year after the publication of Darwin's Origin of the Species, Fechner published his work on psychophysics which he envisioned as the foundation for formulating equations describing functional relationships between psychical and physical elements. From this was derived the Weber-Fechner equation relating stimulus and response.

In 1875, acting independently, James at Harvard and Wundt at Leipzig offered graduate biology courses in "physiological psychology." The first school of psychology was founded by Wundt in 1879 as a research/teaching facility. Wundt's school, later to be labelled "structuralism", had as its avowed purpose the introspective analysis of the human mind. Wundt considered the experimental problems to be three-fold: (1) analysis of conscious processes into elements; (2) discovery of connections between elements; and (3) determine laws of connection.[13]

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[13]M. Marx and W. Hillix, Systems and Theories in Psychology (New York: McGraw, 1963).

Wundt's line of research was continued by his American student, Titchener, whose plan of research was: (1) analysis of concrete (actual) mental experience into its components; (2) discovery of how these elements combine and the laws that govern their combination; and (3) to bring them into connection with their physiological conditions.

In light of current knowledge in biology and chemistry of the brain, structuralism appears to offer a valid plan of research on consciousness, except that the actual development has been from gross mechanisms, to elements, and then study of consciousness as a pattern of ascending orders of complexity of combination of elements. Considering the state of physiology and biochemistry at the time, it could even have been a viable theory. It was use of introspection as method that doomed structuralism in the context of American pragmatism. Wundt and his associates no doubt thought that the only logical place to start would be with the experience of consciousness itself; the ultimate unverifiability of introspective observation probably didn't enter their considerations. Boring's Physical Dimensions of Consciousness was thepeak and end of structuralism and the problem of consciousness in America was left for the psychoanalysts and behaviorists of subsequent decades.

Important research into consciousness was being done in the early part of the 20th century out of the mainstream of

physiological psychology. Several independent lines of research were occurring almost simultaneously, but their convergence was delayed considerably. Freud in 1900-20, Pavlov in 1904-27 and Berger in 1928 made independent discoveries which were not to converge into the electrophysiological correlates of consciousness for half a century. Freud's Interpretation of Dreams in 1900 introduced the crucial notions of levels of consciousness in the psyche, the importance of dream-consciousness, and the tools of free-association and hypnotism as agents for the manipulation of consciousness. The concept crucial to contemporary consciousness research is that of interpenetrating levels of consciousness, or the possibility of transfer of content from one level to another. Pavlov's 1904 publication of his discoveries concerning conditioned reflexes and bodily function presented the classic paradigm for studying the relationship between physical mechanisms and consciousness.

Hans Berger was one of those unsung heroes for a long time, probably because he knew little about the electrical nature of the phenomena he was studying. He invented electroencephalography when he adapted the electrocardiographic technique by which electrical impulses generated by the heart are recorded. At first he inserted silver wires under the subject's scalp; later he used silver foil bound to the head with a rubber bandage, one electrode over the forehead, the other over the back of the

head; the leads taken from these to a string galvanometer and recorded the 1/10,000 volt fluctuations as a function of time by the use of photographs. He discovered the regular low amplitude rhythm at 10 cps, which he named alpha, and observed blocking of the rhythm when the subject opened his eyes or performed mental arithmetic. All this was back in 1928 and Berger was pretty widely ignored until Adrian and Matthews[14] confirmed Berger's research in 1935.

The British researchers were the first electroencephalographers who had some knowledge of the electrical phenomena they were studying and methods of recording them. They used a tube-amplifier and ink oscillograph which enabled them to localize alpha in the occipital visual association area of the cortex. The lack of electronic methods of wave analysis made study of the normal EEG unpopular at the time, and the device was soon turned to the study of nervous disease. Electropathology progressed much more rapidly than electroencephalography in the early years and the use of the tool in localizing tumors and brain injury was quickly discovered. Eventually the EEG was turned to the study of epilepsy and mental disorders.

It was through the unexpected route of pathology that electroencephalography was again applied to conscious phenomena.

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[14]E.D. Adrian, The Physical Background of Perception (Oxford: The University Press, 1947).

Of particular interest are certain psychical manifestations of epilepsy. For some patients the forerunner of a seizure is a strong emotional sensation often described as ecstasy or exaltation. Frequently there is an overwhelming feeling of deja vu. The alpha pattern of epileptics is abnormal, typically disturbed by irregular bursts and fluctuations. If an EEG is recorded at the onset of a seizure the small regular alpha waves are replaced by huge, slow, rolling waves that break into a train of high amplitude spikes at the actual onset of the attack.

A phenomenon which hints at the nature of alpha and its relation to epilepsy was discovered by J.S. Barlow in 1960[15] when he measured the EEG of subjects while exposing them to short, intense flashes of light. It was found that each flash set off an entire train of waves with the frequency of alpha and that flickering light at alpha frequency appears to "drive" the brain waves in phase with the flicker. Walter[16] observed brilliant visions with near-alpha flicker. By the use of the electroretinogram he was able to determine that the visions were not produced in the perceptual organs, but by some central process. Significantly, it was discovered that near-alpha flicker could set off a seizure in epileptics.

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[15]J.S. Barlow, "Rhythmic Activity Induced by Photic Stimulation in Relation to Intrinsice alpha Activity in the Brain of Man," EEG and Clin. Neurophys., 12 (1960), 317-26.

[16]Walter, op. cit.

Dean Woolridge[17] proposes an electronic model of the brain in which the synchronous character of alpha, the postulated waxing and waning of cortical dendritic waves of sensitization, and the necessity of relaxation for appearance of alpha suggest that alpha may function in a manner similar to a scanning mechanism monitoring all incoming sensory data for "out of tolerance" conditions; these, when found, may trigger an automatic alert system that reorganizes the internal connections of the brain into an arrangement more suitable for consciously dealing with the problem at hand. Of particular interest is the corresponding comparison of a system which performs a feedback function but goes into oscillation when stimuli are fed into it at its circuit resonance frequency. The observation that epilepsy can be focussed in one small area of the brain and cause no aberration for a long period and then suddenly spread wild electrical discharges over the brain. One explanation for the onset of seizure is that some electrochemical vibration associated with epilepsy may spread over large areas if it catches alpha in phase (during greatest sensitivity of a wide area of cortex.

Three developments of utmost importance in the delineation of the nature and mechanisms of consciousness have occurred in the last decade. EEG research has yielded a wealth of information on dreaming, and has furnished the first "objective"

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[17]Dean Woolridge, The Machinery of the Brain (New York: McGraw, 1963).

criteria for distinguishing states of consciousness. Research concerning the functions of the reticular formation has indicated it as the anatomical center mediating and necessary for consciousness. Most important, the convergence of the long-separated paths of Berger and Pavlov has occurred. Studies of the EEG correlates of learning and the conditioning of discrimination of type of brain wave activity consciously are now under way.[18] The convergence of Pavlov's discovery that any bodily function can be made the basis of a conditioned reflex and that one conditioned reflex can be built on another and Berger's discovery of the electrical rhythms of the brain was crucial for brain physiology in that it brought together a mechanism of unknown function and a mental activity as yet unaccounted for, both the mechanism and the activity unique attributes of the brain.

The application of the EEG to dream research and sleep provided the first real "breakthrough" in the technology of consciousness study. Studies made in the 1950s of EEG correlates of sleep provided the first objective tool for measuring states of consciousness. Brain wave-forms are radically different in sleep and waking. Coupled with correlation of other physiological measures such as heart rate and respiration, these

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[18] Ibid.

studies have provided reliable objective correlates of the states of waking and sleeping.

Dream research has been the occasion for one of these serendipities. During a study of infantile sleep cycles, a graduate student noticed that the infant's eyes continued to move even after onset of sleep.[19] The researcher correlated ERG monitoring of eye movements with EEG and respiration measurements, and found that REM came in clusters of 50 minutes average duration and appeared cyclically. The EEG correlation of REM changes from the typical deep sleep pattern to one indicating lighter sleep, even though other correlates such as body motion were unchanged. By arousing and awakening the sleepers after REMS it was conclusively shown that REM was associated with dreaming.

Further experimentation with REM sleep[20] indicated that direction and patterning of movements were some kind of scanning mechanism, that the individual dream cycle occurs throughout the night in a regular cycle, and that prevention of dreaming one night would result in more dreaming the next night, that repeated prevention of dreaming would result in shorter cycles

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19N. Kleitman, "Patterns of Dreaming," Scientific American, Nov. 1960.

20D. Foulkes, "Theories of Dream Formation and Recent Studies of Sleep Consciousness," Psychological Bulletin, 1964, 62.

of repetitive "attempts to dream" and eventually in behavioral disturbances such as anxiety and irritability.

Magoun and Moruzzi, working with implanted electrodes in cats, discovered that stimulation of the ascending reticular formation was sufficient to awake a sleeping cat[21] and confirmed the results with EEG activation correlates.[22] The formation was renamed the reticular activating system. The RAS receives inputs from every great sensory nerve trunk, so that a portion of every mode of sensory data reaches the RAS before the cortex. Evidently the RAS acts as a general filtering mechanism and alarm in that it responds in the same way to any sensory stimulus, by spraying the cortex with non-specific "arousal" impulses.

The work which stimulated my research and which opened the possibility of using the EEG as a method of mapping and controlling states of consciousness was an outgrowth of sleep research. Joseph Kamiya, now at Langley Porter Neuropsychiatric Hospital, made the first attempt to manipulate states of consciousness using the EEG:

> While conducting experiments on sleep in 1958 at the University of Chicago, I compared EEGs made during the sleeping and waking states. I became fascinated by the alpha rhythms which came and

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[21]H. Magoun, The Waking Brain (Springfield: Thomas, 1963).

[22]G. Moruzzi and H. Magoun, "Brain Stem Reticular Formation and Activation of EEG," EEG. Clin. Neurophys., 1941 1:455-73.

> went in the waking EEGs and wondered if, through laboratory experiments with this easily traced rhythm, the subject could be taught awareness of an internal state.[23]

Kamiya's first experiments started simply, with a single subject, an EEG, and a bell. The subject was placed in a dark room and instructed to close his eyes. The first was to produce a verifiable discrimination of brain wave modes. The subject was told that the bell would ring occasionally, and that it would occur when he was in either of two brain wave states (alpha and non-alpha). After each ring, the subject was to guess which of the two states he was in, and was told after each trial whether he was right or wrong. The initial results were phenomenal; the percentage of correct guesses went from 50% to 100% in four days. Kamiya and his associates then investigated the possibility of a connection between the physiological state of the brain waves and the threshold of hearing by repeating the experiment without the bell. Again the subject discriminated.

The next step was to look for other possible physiological changes or cues which might be connected with the discrimination. Initial investigation of eye position and alpha discrimination showed that the subject could produce alpha by moving his eyes toward the top of his head and that moving the eyes to a straight-

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[23]J. Kamiya, "Conscious Control of Brain Waves," Psychology Today, April 1968.

ahead position resulted in an immediate drop in ability to discriminate. The subject learned to discriminate at his former degree of accuracy within 40 trials, however. Further experimentation, the complete results of which have yet to be published, has produced evidence that most subjects can and do learn quite rapidly to discriminate brain wave modes and even to produce them at will.

What immediately interested me in this research were Kamiya's reports of the subjective states associated with the alpha state and the correlation between alpha and the subjective experiences of Zen masters and Yogis. Pragmatically, however, the technology of EEG conditioning precedes the yoga of mind control. My immediate problems in exploring this area of research were technological; building a working model. In trying to decide what equipment needed to be built or procured it occurred to me that what I wanted to build was an extension of the brain, an extra feedback loop. A feedback loop in any electronic system consists essentially of components serving either of two functions; monitoring components which would monitor the information output of the system and a signalling device which would feed information about the monitored process in the brain back to the brain. The EEG would be the monitor and visual or auditory stimuli the signalling device.

Actually it wasn't as simple as all that. A detailed

description of the apparatus and proposed changes can be found in the machine appendix. Besides monitoring and signalling, the feedback loop required two other functions. What was needed was a regulation/discrimination device which would determine the criteria for feeding back information, a filter which could discriminate alpha from non-alpha. The other required function was a trigger mechanism which would feed the information from the EEG filter back to the brain through the signalling device (in this case, a tone generator). The triggering device has been my major problem as well as being one of the elements of the system which could stimulate further research. Possibilities of refinements, and extensions of the mechanical system are discussed in the machine appendix.

So, with the generous electronic assistance of Richard Crandall, the machine was built. Whether it worked, what I did, and the evidence thereof are presented in numbers, the last chapter.

CHAPTER TWO

PEOPLE

The most important thing I wish to communicate concerning my work has to do with what I feel to be the basis of my commitment to both humanity and psychology. This basis is a subjective experience which I have come to seek and recognize. In describing this experience, terms such as non-verbal, unitary, ego-transcending, self-validating, beautiful, perfect, complete, alive, spiritual, and awe-inspiring come to mind. I wish to avoid the difficulties involved in translating a non-verbal experience in symbolic terms, so I will use Abraham Maslow's term peak-experience in the course of this chapter. What I mean to say in describing my commitment and direction as being based on these experiences is that my commitment and direction are primarily visceral and intuitive rather than intellectual and conceptually guided.

The particular importance of peak-experiences to me as a psychologist lies in those peak-experiences which revolve about human encounter. I feel that there is a special experience that can only arise between man and man, the experience of encounter, of dialogue. This experience may occur between lovers, gurus and devotees, therapists and patients, between eyes passing on a crowded street. It is a communication-transcending experience,

for at that moment there are not two people but one eternal moment which reconciles the distance between humans in a clear, blissful unity. Buber's concept of the I-Thou, the biblical idea of covenant, and love concern this experience.

The experience of dialogue, of encounter, is at the core of my commitment to life and to psychology. It is from within the context of this experience that I obtain my belief in man as a unique phenomenon, the product and goal of biological evolution, the phenomenon which gives meaning to the universe and which creates being out of nothingness. It is from dialogue that man encounters God within himself, that he realizes that man is the fulfillment of this planet's destiny just as a rose fulfills the destiny of a rose bush. The evolution and history of life on this planet, from cosmogenesis through increasingly complex configurations of organic molecules to life and man, the entire entropy-fighting process of information transfer culminating in DNA is fulfilled in the moment of consciousness when two humans meet in true dialogue.

As a result of my commitment to these peak-experiences and my consciousness of myself as a product of human technology and my consciousness of my consciousness as the fulfillment of biological evolution, I must also be committed to the idea of a radical turning point in evolution marked by human consciousness of the very process of evolution. I can feel and see a

new age marked by evolution becoming conscious of itself in man and the organic growth of human technology into a global nervous system growing towards consciousness. This new age in the evolution and history of this planet is differentiated from previous milieus and other utopian visions because its basis lies no longer in the physical extension of evolution and external growth of technology but in the exploration of human potentialities and consciousness.

The first and most important result of this vision of a new age is that my awareness of human potential and the methods of exploring it is unified, one-pointed, and open-ended rather than specialized, fragmented, and technological.

I feel that psychology's place as a discipline in relation to humanity, history, and science must be a humanizing one in a twofold sense. Primarily, psychology must direct and guide the global consciousness developing rapidly from human technology purely as a matter of survival. It is vitally and immediately necessary to direct the force of technology towards actualization of human potentialities rather than towards self-annihilation. Once self-preservation is secured, the exploration of human potentialities and the nature of consciousness is valuable both as an end in itself, as the ultimate goal of humanity, and as a universal basis for meaning and value of humanity as a whole and men as individuals. Humanity as a collectivity is rapidly

approaching a critical point where human-based values must direct mankind. Individual man is already estranged, alienated, depersonalized, and generally in bad need of some meaning in life.

The growth of my consciousness of humanity approaching a value/meaning crisis and the relation of myself in that milieu has always been guided and evaluated through peak-experiences as crucial points in my process of growth. I have come to view these experiences as both karmic cusps at which I must choose my one unique direction in the universe from the void of potentialities and possibilities and as quantum jumps of consciousness by which my psyche will either recoil and atrophy or accept and grow.

The peak-experience as confrontation between what I see to be my own being and my expected role within society, the academic community, and psychology as a discipline and profession has always been a disquieting event, a source of conflict. The most important conflict concerns my reluctance to abandon a unified and eclectic view of humanity and the human mind in favor of the technician-proliferating, data-collecting role of the modern pragmatic "behavioral engineer". This conflict is most clearly illustrated by the choices available to the undergraduate psychology student in this country today: become a "clinician" if you want to deal with (deviant) persons instead of albino rats,

or become an "experimentalist" and "do research" in some institutional setting if you want to explore the nature of the mind and nervous system.

With regard to this primary conflict, my own life-experience, my Reed education, and my experience in clinical and experimental settings has convinced me that my refusal to abandon my peak-experience oriented commitment in favor of the institutions, ideology, and methodology of clinical or experimental psychology as curative or data-collecting disciplines has not been a negative rebellion but a positive determinant of the direction taken by my life and work. I have recently begun to think in terms of the need for a new type of consciousness necessary for the survival and growth of psychology as an empirical study of man's mind.

At the risk of oversimplification, psychology today is a duality with two distinct poles: the technician-data collector and the clinician/therapist as medicine man. Collectors of data have become technicians, and the overwhelming flood of data from many fragmented, highly specialized disciplines (therapy, behavioral experimentation, neurophysiology, biochemistry, palenntology, information theory) creates the necessity of a consciousness which can be eclectic, unifying, and based in <u>human</u> values. What is needed in the mechanical gathering, sorting, and transmission of information is the uniquely human

ability to perceive the human relevance in the cold facts of myriad unrelated disciplines. What psychology needs is people who could think like Mendeleev, who could see the natural order of the periodic table behind the separate experiments of hundreds of chemists over thousands of years.

The other pole of modern psychology is that of the clinician/therapist as medicine man. I think it of prime importance that humanity and psychology recognize that a good psychotherapist _is_ a medicine man, a _brujo_, an alchemist, a guru, and that many of the people he deals with are not sick and out of touch with reality but actually may be desperately trying to cure the sickness of human alienation and may, in the process, contact realities far more "real" or "sane" than that of "normal" men. There is the need for a realization that a psychotic breakdown may be far more than the sum of certain biochemical imbalances and ruptured social relations, that it may entail a consciousness which is spiritual in nature and possibly not the destruction of reality but liberation from the bondage of ego-illusion. I see the process of reconciliation of the deviant and the society which declares him deviant as the model of the spiritual revolution which mankind must experience as the only alternative to alienation and annihilation. Every culture has had its alchemists, gurus, and medicine men. The niche into which western civilization and the culture of this country has put this vital person,

organized religion, has failed miserably. The various clergy have always been ecumenical in their denial of the core-experience of religion as the goal of religion and in their role as defenders of the existent social order. People who see God these days end up with a therapist instead of a clergyman. Our culture and the whole of humanity has a desperate need for guides through the inner world which we now call insanity but which is the result and cure of the death-fear, fragmentation, alienation and rapidly accelerating self-destruction of "sane" twentieth century earthlings.

My confrontation with psychology as a technology, a "behavioral science" and my rejection of it as a personal commitment has also left me with a certain respect for the potential usefulness of the rapidly evolving specialized technologies. I, as a product of this culture, cannot reject technology but must transcend it. My goals for psychology as a science concern those areas which the behaviorist relegates to the non-empirical limbo of "subjectivity", but as a psychologist and member of this culture I recognize the necessity of empirical methodology as the most useful tool for transforming chaotic phenomena into relevant data.

Although the technological aspect of brain-wave control struck me as an important tool for the task of mapping the objective correlates of consciousness, it was the subjective

experience associated with alpha that most interested me in this work. At the core of my research is the experience of controlling my own brain waves in Kamiya's laboratory and the consciousness associated with alpha. I like alpha. I think further refinement of equipment and techniques could lead to a peak experience of sorts, a harmonizing of consciousness and physiological rhythms analogous to tuning a musical instrument.

Kamiya's research was also concerned with the subjective state associated with alpha. He reported a majority of his patients describing the alpha state as a pleasant one, one of tranquillity and alertness, a state of mental non-distraction and awareness of bodily processes of respiration and circulation. Some subjects asked for more tests because they simply liked the way their minds felt in alpha. Kamiya saw similarities between the subjects' reports of alpha and the states described by the mental disciplines of Zen and Yoga.

Kamiya's research with seven experienced Zen meditators produced evidence that they could learn control of alpha more rapidly than average subjects. Kamiya cites work done by Tomio Hirai and Akira Kasmatsu of Tokyo University who

> ...found a high correlation between EEG patterns and the number of years of Zen practice and the proficiency rating of Zen masters. These two researchers described progressive changes in the EEG of Zen masters during meditation: prominent alpha activity (with eyes open); increased alpha amplitude, particularly in the central as opposed to the posterior cortical regions; the slowing of alpha frequency;

> and -- in mystics with 20 years or more of zen practice -- the appearance of trains of theta activity. (The theta wave is even slower than the alpha wave and has a rhythm of five to seven cycles per second.) In another study, B.K.Anand, G.S.Chhina and Balden Singh of the All-India Institute of Medical Science at New Delhi, found that beginning Yoga students with pronounced alpha activity in their EEG patterns while they were at rest had an unusual aptitude for the practice of Yoga.[1]

If this thesis has at times seemed a little apocalyptic for a psychological study, it is because I feel that mankind as the vanguard of biological evolution is approaching a crisis which can only be resolved through the mobilization of research technologies in a true science of human beings. The recent discoveries stemming from research into sleep and dreaming, psychoactive chemicals, sensory deprivation, and EEG conditioning all support the thesis that oriental "ways of liberation" have espoused for millenia -- that man has awareness and control of a pitiably small fraction of his psychophysiological processes. If man truly is as cosmically unique as he claims, it is because of the fantastic efficiency of the nervous system as an energy processing device. The manner in which human nervous systems gather and process information/energy is still a mystery to most of the human race.

Twentieth century American researchers are beginning to acknowledge the gross inefficiency of the manner in which

humans utilize their potential capabilities. This concept isn't quite that new, but is probably older than civilization. Plato's allegory of the cave, the old testament story of Nebuchadnessar leaving his palace to dwell with the beasts, King Lear, and the story of the Prodigal Son, are all mythic statements of what mystics, sages, and madmen have been saying for a long time. The importance of the "Myth of the Mad King" to present-day psychology has recently been stated quite well by Robert S. De Ropp:

> This old myth, in its essence, compares man to a king with a sumptuous palace at his command. But the king went mad and insisted on living in the cellar surrounded by rags and bones and other worthless objects which he called his possessions. If any of his ministers reproached him for this behavior and tried to remind him of the palace and its splendors, he indignantly replied that he had never left that place. Such was the nature of his illusions that he saw the wretched cellar as a palace and the rags and bones he had collected as precious jewels.
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> Today we can rephrase this old myth in terms more precise and in more accord with our new knowledge of human nature. We can say that man is a being with great powers at his disposal, which are his by virtue of his large brain and, more specifically, his huge cerebral cortex, an organ he has not yet learned how to use. Because he does not know how to use this powerful machine it tends to operate in ways not beneficial to its possessor, to generate a host of illusions among which he wanders like a babe in the enchanted wood, frightened and confused, a prey to terrors that he himself has created.
>
> In psychological language the myth of the mad king means this: Man's ordinary state of consciousness is not the highest level of consciousness of which he is capable. In fact, it is so defective that the condition has been defined as little better than somnambulism.

> Man does not really know what he is doing or where he is going. He lives in dreams. He inhabits a world of delusions, makes dangers for himself and others. If this is accepted, then we ask the next questions: What can be done about it? Can man really awaken? What other states of consciousness are possible for him and what must he do to attain these states?[2]

The focal problem of this thesis is that of delineating the tools and methods by which one can determine the range of consciousness of which man is capable and the methods of achieving that potential. I don't believe that this problem has only recently been uncovered by the advances of western science. The exploration and expansion of awareness is at the core of the oldest known scriptures and in many cases also forms the nucleus of ancient orally transmitted doctrines. I consider much of western alchemical and hermetic literature, Taoist and Buddhist meditation manuals, and Indian Yoga doctrine to concern not primarily mystical or metaphysical concerns but the psychophysiological methodology of exploring and expanding man's potential consciousness.

The philosophical and religious traditions as well as individual cultures of India and China are the necessary context for the oriental ways of liberation, but I cannot deal with

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[2]Robert S. De Ropp, The Master Game (New York: Delacorte Press, 1968).

them in any depth here. Nor can I, as a product and member of my culture, adopt disciplines which can only be properly applied within their particular context. Nervous systems, ignorance, and enlightenment transcend cultural boundaries, so there is an underlying assumption in this thesis that there must be neurophysiological correlates of whatever consciousness can be attained and that the states described in ancient doctrines can be produced (and verified) by an electric technology.

I would like to consider the disciplines of Taoist, Indian, and Buddhist "sciences of consciousness" in the context of western research into consciousness (neurophysiology, biochemistry, biophysics, and psychotherapy). Particular attention will be paid to states of consciousness and mental disciplines which have neurophysiological correlates or which can be duplicated by electric technology. I will try to synthesize ancient and modern doctrines and methods in a rough "map" of the possible levels of human consciousness and outline a possible technology of transcendence.

Yoga is the oldest of the eastern traditions, and the one which is most concerned with bodily energy processes. Yoga shares a common goal with other ways of liberation, the attainment of a certain state of consciousness and liberation from the illusions of man's ordinary consciousness. These doctrines

also share the concept that the "higher" states are not innate, are in fact suppressed by some bodily mechanism, and can only be attained by great effort. Yoga is translated "union" and its ultimate goal is the union of organism and environment, body and mind, individual ego with supreme self. Yoga is the method, and Samadhi is the goal.

Samadhi is hard to explain, being a state of consciousness beyond name, form, or symbol:

> The whole of this world and all the schemes of the mind are but the creations of thought. Discarding these thoughts and taking leave of all conjectures, obtain peace. As camphor disappears in fire, and rock salt in water, so the mind united with the atma loses its identity. All that appears is the knowable, the mind is called knowledge. When the knowable and the knowledge are both destroyed equally, then duality is destroyed.[3]

Perhaps the most important aspect of samadhi, for the purpose of this thesis, is the elimination (or realization of the unreality) of a certain duality. The notions of duality and polarity are important aspects of many oriental philosophies, but it is the duality of consciousness and its elimination that is dealt with by the various Yogas.

It is not my purpose to interpret or shape oriental philosophy into the form of empirical psychology, but to discuss

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[3]Swami Vivekenanda, The Yogas and other Works (New York: Ramakrishna-Vivekenanda Center, 1953).

the points at which they intersect. I consider the goal of my work to be the unification of consciousness and the energy processes of the organism, a goal no different essentially from the yogic goal of psychic unity (non-duality). Hatha Yoga is the body of teachings which concern the specific methods by which full utilization of human potential may be realized. This body of teachings incorporates a doctrine of energy-flow and evolution, an empirical methodology of exploration and expansion of consciousness, and a "map" of awareness and conscious states. Raja Yoga, a more advanced empirical structure based on the principles and assumptions of Hatha Yoga, is a method which has important parallels with the type of EEG conditioning with which I am working.

Before attempting an outline of the methodology of Yoga, it is important to stress that yoga is essentially an <u>empirical</u> method based on an empirical conception of the physical universe. The two stages and eight steps are nothing other than an outline of a guide to research. Yoga makes the important distinction between "outer" or extended (in McLuhan's sense) technology and "inner directed"(based on the experience of consciousness) methods:

> Basically, all physical and mental knowledge is, of necessity, an experience. A conception uncorroborated by experience remains a speculation and we can never be certain of its reality. The extent of our knowledge

> is therefore limited by the greater or lesser extension of our perceptions. If in any way we extend the field of our perceptions, new horizons immediately open up before our powers of knowing. In the field of sensory perceptions, the microscope, the telescope, the instruments sensitive to all kinds of vibrations have extended according to their power the horizons of scientific knowledge.
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> The means of investigation at the disposal of experimental science are, however, mostly limited to the extension of the senses outwards, to the pushing of their limits further afield. But, however powerful the instruments at our disposal, there will always be a limit to the extension that can give to the senses, and never will they be able to grasp that which, by its very nature, is not within the field of sensory perception.
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> Hindu philosophers have asserted that all knowledge is built upon experience. But they maintain that an outward perception only is not real knowing, and that the only way for us to know a thing completely, outwardly and inwardly, is to identify ourselves with it; only when we are one with it, can we know it in itself and not merely as it appears to be from an external point of view.
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> This is the meaning of the word yoga, which means 'identification'; identification with Divinity being 'realization.'[4]

The body of knowledge from which the various yogas are drawn are chiefly portions of ancient religious scriptures such as the Upanishads which have been collated and systematized by a historical/mythical person named Patanjali.

As I have stated, the yogic systems rest upon theories concerning both the physical body and the processes of consciousness, treating the apparent (to the normal person) duality of

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[4]Alain Danielou, Yoga: The Method of Reintegration (New York: University Books, 1949), p. 4.

mind/body as an illusion which can be therapeutically erased. The yogic conception of cosmic and bodily energy processes, their relation and atonement, is the basis for the first step in the process of "psychic reintegration." The theories and methodology comprising the first steps are known as Hatha Yoga.

The relation between the reintegration method and energy theories upon which it is based is evident in the name Hatha. The syllable Ha, in Sanskrit, is "sun"; the syllable Tha is "moon". Hatha, then, the connection of sun and moon (which are considered as cosmic principles of energy flow which apply on both the level of the living organism and the solar system), represents the conjunction of these principles. These principles, which I will discuss later in the context of other oriental physical theories, are manifested in humans in the form of two entity/energy processes; the doctrine of gross and subtle bodies stems from this theory. (See appendix for diagrams.)

It is in the doctrine of the subtle body that yoga can be investigated through psychophysiological technology. The doctrine is essentially a theory of the relation between neural functioning and conscious processes:

> The cosmic Principles which, in relation to the earth, manifest themselves in the planetary world as the sun and moon are found in every aspect of existence. In man, they appear mainly under two forms, one in the

> subtle body, the other in the gross body. In the subtle body they appear as two channels along which our perceptions travel between the subtle center at the base of the spinal chord and the center at the summit of the head. These two channels are called Ida and Pingala. Ida situated on the left side, corresponds to the cold aspect or the moon, and Pingala on the right side, to the warm aspect or the sun.
>
> In the gross body, the lunar and solar principles correspond to the respiratory, cool and the digestive, warm energies, and are called Prana and Apana. It is by coordinating these two most powerful vital impulses that the yogi achieves his aim.[5]

It is clear from the exposition and commentary of many Indian Yogis that the principles of "sun and moon" and "Ida and Pingala" refer to energy processes on the cosmic and neural levels.

The concept of Prana is an important one for the purposes of this thesis, for it links the theories and practices of yoga with physical theories which are not only testable, but also quite compatible with western science. The control of Prana is the step which separates the "inner" and "outer" stages of yoga and is derived from a remarkably "modern" cosmology. According to the scriptures upon which yoga is based, the universe is seen as a huge energy system governed by two principles, Akasa and Prana. The primordial "stuff" of the universe from which men and stars have evolved is Akasa. Akasa is regarded more as an unmanifested store of energy than some kind of

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[5]Ibid., p. 19.

fundamental particle. Matter and life evolve from Akasa through Prana, the formgiving and manifesting principle. Akasa is a "subtle" principle, for it cannot be sensed until manifested through Prana.

The philosophy of Akasa and Prana favors the theories of modern cosmologists who espouse the theory of an expanding and contracting universe:

> By what power is this Akasa manufactured into this universe? By the power of Prana. Just as Akasa is the infinite, omnipresent material of this universe, so is Prana the infinite, omnipresent manifesting power of this universe. At the beginning and at the end of a cycle everything becomes Akasa, and all the forces that are in the universe resolve back into the Prana; in the next cycle, out of this Prana is evolved everything that we call energy, everything that we call force. It is the Prana that is manifesting as motion; it is the Prana that is manifesting as gravitation, as magnetism. It is the Prana that is manifesting as the actions of the body, as the nerve currents, as thought force. From thought down to the lowest force, everything is but the manifestations of Prana. The sum total of all forces in the universe, mental or physical, when resolved back to their original state, is called Prana. 'When there was neither aught nor naught, when darkness was covering darkness, what existed then? That Akasa existed without motion.' The physical motion of the Prana was stopped, but it existed all the same. At the end of a cycle the energies now displayed in the universe quiet down and become potential. At the beginning of the next cycle they start up, strike upon the Akasa, and out of the Akasa evolve these various forms, and as the Akasa changes, the Prana changes also into all the manifestations of energy. The knowledge and control of this Prana is really what is meant by Pranayama.[6]

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[6]Swami Vivekenanda, Hatha Yoga (New York: Ramakrishna Society, 1946), p. 33.

Compare this passage with the theories of physical energy, biological evolution, and consciousness discussed in the first chapter. The Akasa closely resembles the steady state limit of the entropy of the universal energy system. Prana parallels the "complexification through convergent integration" through which simple molecules evolve into life and consciousness. Akasa is chaos, randomness, formlessness, unmanifested seed. Prana is meaningful pattern, information, evolution.

The fundamental method through which Yoga effects the process of reintegration is Pranayama, the control of the "vital energies" of Prana. Actually, Pranayama is the fourth step of the process, preceded by Yama (mercy, honesty, continence), Niyama (cleanliness, austerity, surrender, study), and Asana (physical posture). Together, these four steps constitute the "inner stage" through which the energies of the organism and the universe are attuned in preparation for turning them inward.

The doctrine of the subtle body is intimately connected with the process of awareness and control of the pranic rhythms. The "subtle body: is, in fact, a map of the centers (chakras) of energy-flow through which the "gross" body can be attuned with cosmic pranic rhythm. The conception of the body in Hatha Yoga is consistent with, and based upon, the concept of the

universe as energy-flow. Through the action of Prana upon Akasa, the universe exists as an infinite ocean of energy manifested in a spectrum of vibrations. Matter and life are considered to be "gross" vibrations in that they are within and part of the infinite store of vibrations, only existing as distinct entities through the illusion of duality. Consciousness, as the ultimate complexification of living matter, is the most subtle human vibration, that part of the human organism which can contact the subtle vibrations of which the universe is composed.

Yoga considers the entire process of biological evolution to be a progression through more and more subtle vibrations towards the ultimate unity of energy. Through Pranayama and creation of the subtle body the entire process of evolution can be shortcut in one human life-span. The Yogic concept of cosmic vibrations is the synthesis of the two essential characteristics of prana; motion and rhythm. A vibration is simply patterned movement. Cosmic Prana is primarily manifested in the human organism through ten "subtle rhythms" of the physical body, primarily breathing. These rhythms are identical with those discovered by western biology: respiration, circulation, metabolism, sleep-waking cycles, brain waves, and reproductive cycles.

A better translation for physical prana would be <u>respiration</u> in the sense of <u>expenditure of the energy provided by metabolism</u>.

Living is breathing; if a living organism stops breathing its brain and heart soon stop. Breathing collects fuel for metabolism and eliminates metabolic waste.

It is through control of breathing that the mind gains control of the gross body. Yogis agree with biologists that breathing is connected with other vital rhythms, and in a sense, controls them. By directing awareness toward harmonizing bodily rhythms, the energy processes of the body (which are continuous with the mind and the unity, Atma) can be understood and controlled. When the rhythms of the gross body are understood, and organismic energy-flow is harmonized and controlled, the "outer stages" of Hatha Yoga are completed.

Hatha Yoga is considered to be a preparation and purification for the "inner stages" of Raja Yoga, the "royal way" to Samadhi. When the body is harmonious and controlled, the attainment of full human potential is possible through the inner direction of awareness:

> Having first to conquer the sub-mental energies and then dissolve the united sub-mental and mental Conscious into the supra-mental, the yogi must at every stage follow a course distinct from that of the sensory perceptions and mental activities which are the normal field of human investigation. Leaving outward observation and silencing his mind, he turns his attention inwardly, and it is within himself that he experiences all the stages of re-integration from multiplicity towards unity. To each of these stages corresponds a subtle center which the introspecting mind experiences as having a form resembling that

> of a lotus or a wheel (chakra). These centres appear as diagrams of geometrical forms, associated with numbers, forms, sounds, and colors. They are the maps, so to speak, of the stages of this inner journey. Each of the centres of the subtle body thus corresponds to a stage of realization. The mind of the yogi concentrates one after other on each of these centres; using their diagram as a mental guide, it follows their outline, stops on this or that detail, to the left or to the right, in an angle or in the centre, etc., just as if it were visiting the quarters of an unknown city. But in each of these quarters it enters a different order of things, finds itself in a new world, discovers new aspects of reality and gains new powers.[7]

The symbolic diagrams in the appendix are the maps of this process of reintegration. The process begins when Pranayama awakens the coiled Kundalini (serpent) energy in the Muladhara chakra which corresponds with the sacral plexus of western physiology. The Kundalini exists in a dormant state in all human beings, according to the yogis, until it is awakened by Pranayama along with the "inner stages" of Pratyahara, Dharana, Dhyana and Samadhi. When the Kundalini is aroused, it can be raised up through the chakras in the navel, solar plexus, heart, and midbrain to the Sahasrara or "thousand petalled lotus" in the roof brain, at which point Samadhi is obtained. The "subtle channel through which the Kundalini rises is Sushumna, which lies between Ida and Pingala. At this point empiricists might as well

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[7]Danielou, op. cit., p. 10.

dismiss notions such as those regarding "subtle channels" in the spinal cord. According to yoga doctrine, the Sushumna is more of a harmonization of neural conduction (brought about by Pranayama) than an actual anatomical organ. The Asanas and Pranayamas serve the purpose of creating both a physical alignment of the nervous system in a harmonious manner and a controlled equilibrium of efferent/afferent and sensory/motor conduction. By harmoniously directing the energy flow of physical processes, the infinite ocean of energy is tapped through Kundalini, the serpent which rises from the ocean to the heavens.

If one is in doubt about the verifiability of some of the yogic concepts which have as of now no "scientific" explanation, the possibility of their eventual verification is certainly suggested by this passage, written by Swami Vivekenanda in the last century:

> Everything that we see, or imagine, or dream, we have to perceive in space. This is the ordinary space, called the Mahakasa, or elemental space. When a Yogi reads the thoughts of other men, or perceives supersensuous objects, he sees them in another sort of space called the Chittakasa, the mental space. When perception has become objectless, and the soul shines in its own nature, it is called the Chidakasa, or knowledge space. When the Kundalini is aroused, and enters the canal of the Sushumna all the perceptions are in the mental space. When it has reached that end of the canal which opens out into the brain, the objectless perception is in the knowledge space. Taking the analogy of electricity we find that man

> can send a current only along a wire, but nature requires no wires to send her tremendous currents. This proves that the wire is not really necessary, but that only our inability to dispense with it compels us to use it.[8]

Remembering that Vivekenanda died before the discovery of wireless telegraphy, I wonder whether Marconi ever read Indian philosophy?

Pranayama is a prerequisite for the "inner stages" of Pratyahara, Dharana, Dhyana and Samadhi. When the senses and energies of the gross body are brought under control, the Kundalini is awakened. The further ascent of the Kundalini towards higher consciousness is accomplished by an involution of the yoga process, beginning with withdrawal of the senses from external objects (Pratyahara), and progressing through stages of concentrating the consciousness on the specific centers (Dharana) until it is fixed (Dhyana) on the point-limit (Bindu) where the unmanifest becomes manifest. Once the vital energies are controlled, the senses withdrawn from external objects, and the consciousness progressively concentrated within itself to its core, the entire technology of yoga (i.e., the use of consciousness as a tool) is discarded and the consciousness is merged (Samadhi) with the subjective experience resulting from

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[8]Vivekenanda, Hatha Yoga, p. 53.

perception of the core of the neural energy process.

In a simplified form, the inner stages can be used as a guide for the use (and limits) of any technology for the purpose of exploring and expanding the potential of the human nervous system. That is, if the mind can first concentrate upon an object, and then is able to continue in that concentration for a length of time, and then, by continued concentration to dwell only on the internal part of the perception of which the object was the effect, everything comes under the mind's control. The methods by which this is done in Yoga, in conjunction with some methods derived from Taoist and Buddhist doctrines, will be considered in relation to Western psychophysiological technology at the conclusion of this chapter.

The disrepute with which Oriental psychology has been associated by Western psychologists can be blamed largely on the misinterpretation of "consciousness manuals" which have been passed on in an exoteric form. The work of Richard Wilhelm and C.G. Jung in the first part of this century provided the first important opportunity for empirical investigation of the psychological theories imbedded in the exoterically "supernatural" texts of Taoism. Jung's analytical psychology has provided the classic paradigm for psychological investigation of human potential. Jung's lifework with alchemical texts

convinced him that the intricate esoteric procedures of alchemy were the protective camouflage which early investigators of consciousness used to disguise their work from the persecution which such work has suffered throughout history.

Jung considered the alchemical creation of a homunculus to be the "secret doctrine" camouflaged by the exoteric goal of making gold. The concept of the homunculus, like that of the subtle body, Jung recognized as a metaphor for the creation of a "new man" through efficient utilization of human "psychic energies". Jung drew from ancient Oriental doctrines as well as from his alchemical and psychoanalytical studies to synthesize his concept of the "integration process". One of the most "esoteric" and misinterpreted Taoist "magical" texts, stripped of its archaic context, was revealed as a guide to the secrets of growth latent in the psyche through Richard Wilhelm's translation and Jung's commentary on The Secret of the Golden Flower.

The Secret shares the basic premise of all other "ways of liberation": that vast reserves of potential within the human nervous system can be tapped through the understanding and control of basic principles of energy-flow. Although the parallels of such widely separated disciplines as alchemy, yoga, and Taoist meditation provide ample evidence for the universality of the principles and experience with which they deal, it is in its difference from other ways that The Secret is most

valuable for my discussion.

The individuality of Taoist meditation theory lies in the particular foundation of the philosophy upon which it rests. The Secret derives its method from the premise that the cosmos and man, in the final analysis, obey the same law; that there are no "real" barriers separating the human microcosm from the macrocosm. Both micro- and macrocosms are ruled by the same law, operate through the same principles, and a way leads from one to the other. The psyche and cosmos are aspects of the same One; hence man participates by his very nature in all cosmic events, and is inwardly as well as outwardly interwoven with them.

The one principle which governs "heaven and earth" (invisible and visible nature) is the Tao, the Way:

> The character for Tao in its original form consists of a head, which probably must be interpreted as 'beginning', and then the character for 'going' in its dual form in which it also means 'track', and underneath, the character for 'standing still', which is omitted in the later way of writing. The original meaning, then, is that of a 'track which, though fixed itself, leads from a beginning directly to the goal.' The fundamental idea is that the Tao, though itself motionless, is the means of all movement and gives it law. Heavenly paths are those along which the constellations move; the path of man is the way along which he must travel. Lao-Tse has used this word, though in the metaphysical sense, as the final world principle, which antedates realization and is not yet divided by the drawing apart of the opposites on which emergence into reality

depends.[9]

The Tao of life, like evolution, is seen as a reflection of the patterns of energy-flow as phenomena arise from the primal unmanifest.

One might say that the special domain of Taoism is its understanding of the principles of the transformations of energy which constitute the phenomenal world. Out of the Tao develop the polar principles of reality, yin and yang. These are the poles of the fundamental duality (light/dark, active/passive, positive/negative, male/female, creative/receptive) which distinguishes the phenomenal world (energy in transformation) from the primal unity (energy as pure potential). As in the doctrine of Akasa and Prana, the universal energy-flow (Tao) is manifested as the "ten-thousand things" of the phenomenal world through the rhythm of the alternating principles of yin and yang.

Just as yogic doctrine focuses on the Prana as the universal principle through which man is connected to the fundamental unity, the Taoists consider human nature (Hsin) to be the phenomenal form of the Tao. In the phenomenal world man develops into a multiplicity of individuals in each of whom the central monad is enclosed as the life-principle; but which, at the moment of conception, separates into the bi-polar phenomena of human life and nature:

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[9]C.G. Jung, Commentary on The Secret of the Golden Flower, trans. Richard Wilhelm (London: Routledge & Kegan Paul, 1931), p.10.

> The word for human nature (hsing) is made up of those for heart or mind (hsin), and origin, being born (sheng). The heart (hsin), according to the Chinese idea, is the seat of emotional consciousness, which is awakened by the five senses through unreflecting reactions to impressions received from the external world. That which remains as a substratum when no feelings are being expressed, but which lingers, so to speak, in a transcendental, supraconscious condition, is human nature (hsing).[10]

The fundamental difference between the philosoohical premises underlying Chinese and Indian psychological thought can now be stated. While both recognize the fundamental unity of life-energy and cosmic energy through the phenomenon of consciousness and the human potential for discovering that unity, and even share similar doctrines concerning this unity, they are opposed in one vital aspect of their methodologies. The goal of Yoga is the integration of the individual consciousness with the fundamental unity through the action of the will (or ego) which accomplishes the actions of Pranic control, withdrawal of senses, internalization of perception, concentration and identification. The way of Taoism recognizes the same unity and even employs the same theories of neurophysiological energy centers and similar techniques, but its goal is to allow the Tao to spontaneously manifest itself by silencing all the "noise" of perceptual/conceptual processes.

The yogi endeavors to tap the infinite energy of the cosmos

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[10] Ibid., p. 13.

through refinement and control of the senses as tools which can penetrate and perceive the point at which human and cosmic energies merge. The Taoist also seeks this point of continuity, but seeks to contact it by silencing the noise of his consciousness and allowing the Tao which lies at the core of human nature to manifest itself. In other words, yoga seems non-divided energy-flow through the active use of the individual consciousness as a refined tool. To the yogi, human potential depends upon the skillful application and redirection of the nervous system. To the Taoist, human potential depends upon the silencing and harmonization of the nervous system.

The difference in the doctrines manifests itself on other levels. The yogi controls his vital energies and then directs them inward to their origin; the Taoist harmonizes his senses and redirects his energy flow around the "still center" through which the Tao spontaneously manifests itself. Aspects of both methods may well prove useful in directing neurophysiological investigation of consciousness.'

Following the paradigm of the methods just discussed, a psychology of human potential suitable to electric technology must begin investigation of the energy-processes of the human organism with an eye to the "vital rhythms" through which these processes could be consciously controlled. Human energies are

gathered and utilized by the processes of metabolism and respiration. A majority of the energy stores are located in the muscles or stored as glycogen in the liver and released through muscular activity. The "instinctive" operations which maintain respiration or metabolism (digestion, circulation, breathing) also use a large part of the total energy. The processes of thought, emotion, and sex consume a regular quota of energy. The energy which is left over manifests itself in the level of total awareness.

The major neurophysiological evidence for the existence of vital rhythms controlling these energy processes comes from investigations of the glandular and reticular systems.. Energy for all processes of the body is chemically bound, specifically in the ATP molecules stored in discrete packets throughout the organism. The availability of locked-in energy is controlled by the glands; gonads, adrenals, liver, pancreas, thyroid, and pituitary. The pituitary can control the action of the other glands through its tropic hormones, and it itself linked to the hypothalamus in the RAS which is in turn connected directly to the cerebral cortex. The hypothalamus and RAS, which anatomically corresponds with the Indian and Chinese wake/sleep centers, functions as a master coordinator and regulator of glandular activity and, in turn, of availability of energy for processing.

The RAS, as discussed in the first chapter, apparently serves in the capacity of an on-off switch for consciousness. Here then we have a physiological chakra which controls the vital rhythms which direct physical energy processes. There is evidence of a definite relation between the RAS and brain waves, since brain waves seem to indicate the rhythms of sensitivity to excitation over perhaps the entire brain. If brain waves can be shown to be controllable, and if the relation of brain waves to the RAS is elucidated, then the conscious control of brain waves would be the neurophysiological counterpart of the yogic pranayama and taoist "circulation of the light".

CHAPTER THREE

NUMBERS

I approached my experimental work, then, with a dual purpose:

1. Establishing objective evidence for the hypothesis that neural energy processes can be manipulated and controlled simply by making the subject aware of them.
2. Determining correlations between the methods (and effects) of EEG conditioning and previously discussed techniques of expanding human potential.

The first purpose can serve as a condensation of the experimental hypothesis underlying my work. The experimental technique consisted simply in making the subject aware of the state of his brain waves by sounding a tone while he was in a particular state. Since the purpose of the investigation was to explore awareness rather than to established a fixed tone as the conditioned stimulus, the frequency and intensity of the tone were varied from session to session and tone was alternated with silence as the signalling stimulus. Here we have an elementary technological translation of the yogic paradigm of energy-

consciousness integration (Pranayama) through the use of awareness; the subject is made aware (through the auditory stimulus of tone) of one of the subject's basic neural energy processes -- "brain waves". The percentage of total time in alpha (see appendix) during the first session was taken as a baseline for each subject. Criteria for "control of energy processes" were then associated with change in that base ratio over the course of the experiment.

The experimental sessions lasted 10 minutes for each subject. The sessions were divided into two five-minute trials; one in which a tone was sounded in the presence of alpha activity, and one in which the modalities were reversed (tone sounded in the presence of non-alpha). Three subjects were used: one who was experienced in meditation techniques, one who was "naive" with respect to such techniques, and yours truly. The meditator (designated "M" in the data) was given four sessions, each separated by a two day interval, followed by a fifth "re-test" two weeks after the fourth session. The naive subject, (designated by "N") was given five sessions at two-day intervals. Yours truly submitted to five consecutive sessions in one evening.

The data is submitted in graphic form, and my conclusions of positive evidence of change are based on visual inspection,

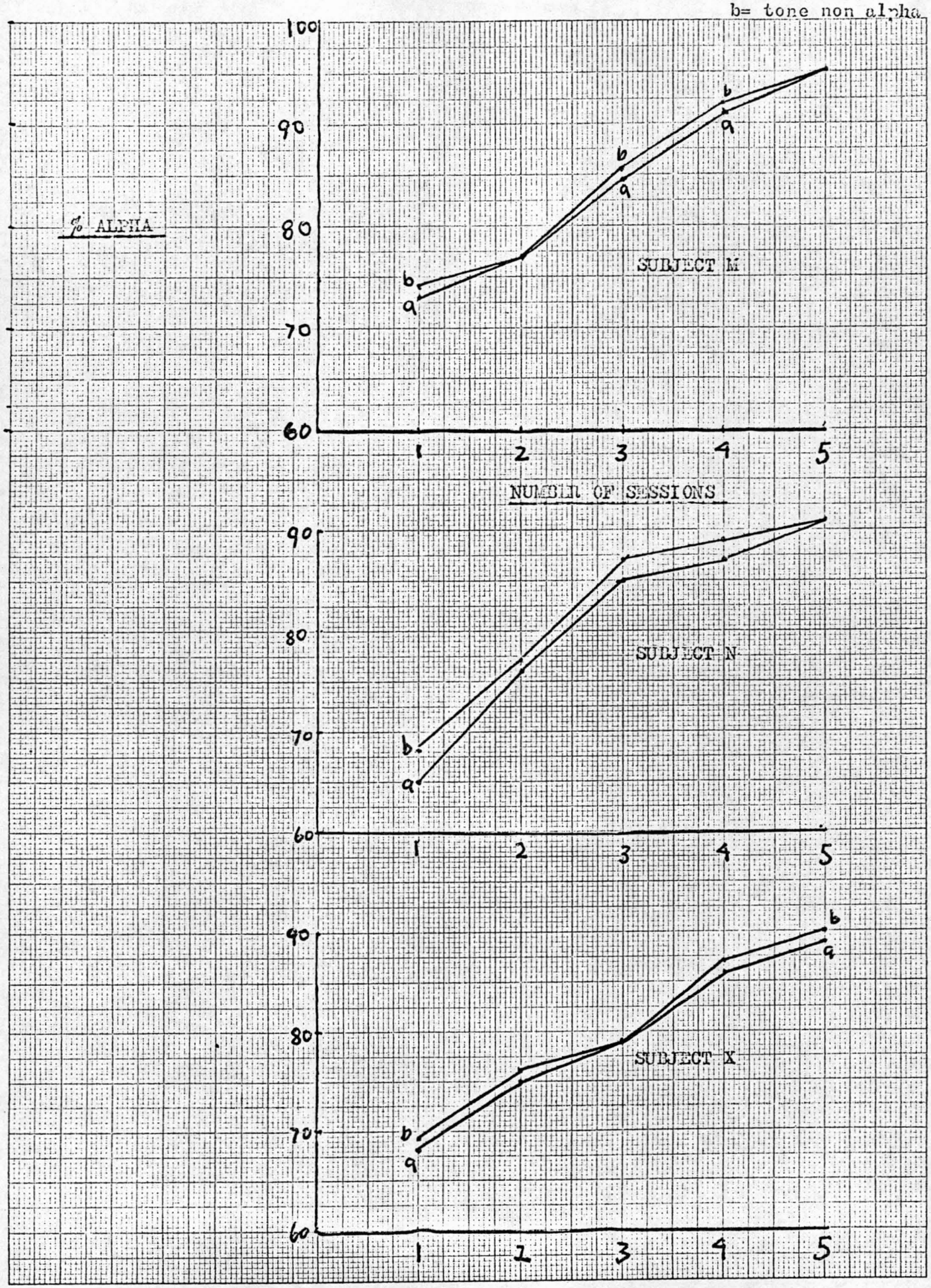
although the data will obviously demonstrate a high level of significance if submitted to t-test, trend analysis, or any other statistical test of significance. The graph of the data simply looks exactly like a learning curve. The total amount of change (in alpha-percentage), from first to final session, was 22% for M, 37% for N, 27% for yours truly (designated "x").

The subjective reports of the subjects (including my own experience) combined with my own observations of the components of EEG conditioning, were the "data" from which my conclusions concerning the second purpose of the experiment were drawn. The concepts of "levels of consciousness" espoused by oriental methods and experimenters in the field of psychoactive chemicals can be combined with neurophysiological correlative techniques to yield a "map" of potential human consciousness:

(State 1.) Dreamless sleep can be distinguished from other sleep states by regularity of respiration and circulation as well as a distinctive "delta" pattern of brain wave. Deprived of dreamless sleep, humans become physically and mentally deteriorated. Evidently this state is necessary for the body to perform repair and refueling of physical energy processes.

CHANGE IN ALPHA LEVEL DURING CONDITIONING

code: a= tone alpha
b= tone non alpha



(State 2.) REM or Dream-sleep also has a distinctive EEG pattern coupled with rapid eye movements which have been shown to be correlated with the subjective experience of dreaming. This state is also necessary for physical and mental well-being.

(State 3.) Waking consciousness, the state which, for the Mad King, constitutes the entire range of potential consciousness. EEG and breathis patterns are "noisy" and irregular.

(State 4.) Peak or transcendental experience can be attained as a momentary peak through the use of chemicals, yoga, or other methods of "working on one's self." Alpha, as will be explained later, lies at the gateway to this consciousness which probably entails momentary disruption of the biochemical mechanisms of normal consciousness.

(State 5.) Samadhi, Satori, or Cosmic consciousness is distinguished from "peak" or other transitory "higher states by the fact that it is permanent.

How is the Alpha state connected to these states and how can EEG technology be used to move from one state to another? The key to the process lies in conservation of awareness. Awareness, as a "vital balance" of human energy forces, is the tool with

which we are working. Without training of awareness of energy processes, the neural and muscular energies are undirected, noisy, as typified by the random activation pattern of the EEG.

The method of controlling awareness through EEG technology is analogous to yogic Pranayama and Taoist "quieting of the mind-noise" in that induction of alpha reduces the primary level of consciousness to a relatively quiet state. Reports of my subjects indicate that the noisy activation pattern interrupts alpha when conceptual processes interrupt silent awareness of bodily rhythms such as heartbeat and breathing. When in alpha one is aware of these states, but alpha disappears when the subject begins "thinking about how alpha feels". The first step in the process, then, is the reduction of noise, entrance into the silence remaining when the chatter of normal consciousness is reduced.

The way in which noise reduction is accomplished involves direction of attention in a manner similar to yogic sense-withdrawal (Pratyahara). This means essentially the focussing of awareness away from sensory impressions and towards bodily rhythms. Sensory deprivation experiments have shown the radical effect upon the general level of consciousness of withdrawing all sense impressions. By sounding the tone when the subject is in alpha, attention is directed towards the physiological and subjective concomitants of that state. Direction of attention

requires energy which is not available when the noise of undirected consciousness continues. The very state of alpha suggests subjective experience of tranquillity and harmony, a "quiet mind".

There are other analogies to Eastern methods, chiefly in the area of channeling destructive (e.g., noisy, disruptive) energy into specific controllable channels. Mantras and mandalas are two oriental tools which are applicable to our technique. Mantras are repeated sounds or syllables which are repeated during meditation to quiet the mind and provide a "base vibration". Compare this to the experience reported by my subjects of a "tone inside the head" which appears during the final sessions, when brain wave output is over 80% alpha. The tone used in this experiment accomplishes the same end (of focussing the attention) in our process.

Mandalas express in symbolic form the interplay between microcosm and macrocosm, inner and outer, between man and the world around him. The mandala is essentially a symbolic diagram illustrating the different levels of energy locked in the human organism, the forces needed to release those (the four circles), the ways of approach (the four gates), and the energies themselves (the four triangles). The Mandala is used to aid meditation by providing a fixed point for the noisy mind ("the

center in the midst of conditions" of Taoism). The effort of holding it gradually drains the destructive noise of certain mental processes and attaches it to a creative process, re-establishing harmony with the Tao of consciousness, establishing the psychophysiological equipoise prerequisite for control. I can think of two specific procedures by which this tool can be immediately adapted to EEG research. Primarily, use of the oscilloscope in conjunction with the EEG provides an actual "picture" of the state of consciousness which can be seen by the subject. By adjusting the sweep so that the horizontal sweep is 10 cycles (alpha), then a "pure" state of alpha would appear on the screen as a circle. Oblation or distortion of the circle would provide a visually verifiable ("mandalic"?) correlate of the degree of "noise" in terms of impurity of alpha. Another method which comes to mind is the use of stroboscopes and color translators.

As discussed in the first chapter, the stroboscope can be used to drive the brain wave if synchronized with the alpha frequency. Instead of a tone-no tone set of modalities, darkness would correspond with alpha and alpha-synchronized stroboscopic stimulation could be triggered by the appearance of non-alpha activity. Hypothetically, this would "lock-in" the awareness of the subject upon alpha.

The color translator has been adapted from an entertainment device used by light shows to produce visual correlations of music. It essentially is nothing but a sophisticated trigger mechanism which would enable one to adjust different colors to different sound-frequencies; red for bass, blue for treble, shades for ranges within and between those frequencies, for example. The intensity as well as trigger-threshold for each color can be pre-set. It would not be at all difficult to alter such a device to respond to different ranges of the brain-wave spectrum. Such a device, called the Toposcope, has been used strictly for observation purposes and without use of color.[1] One could recreate a mandala in many small bulbs arranged in such a way that the pattern would not become discernible until a criterion such as a certain ratio of wave-modes was reached.

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[1] Walter, op. cit.

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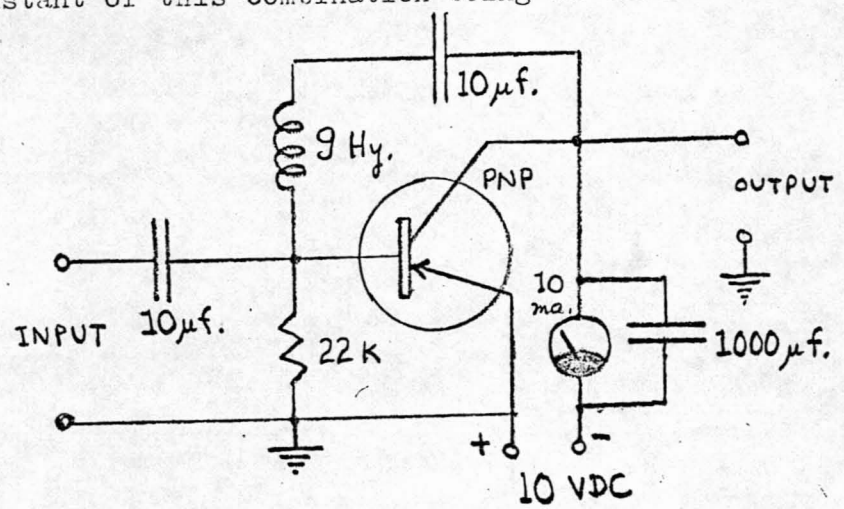
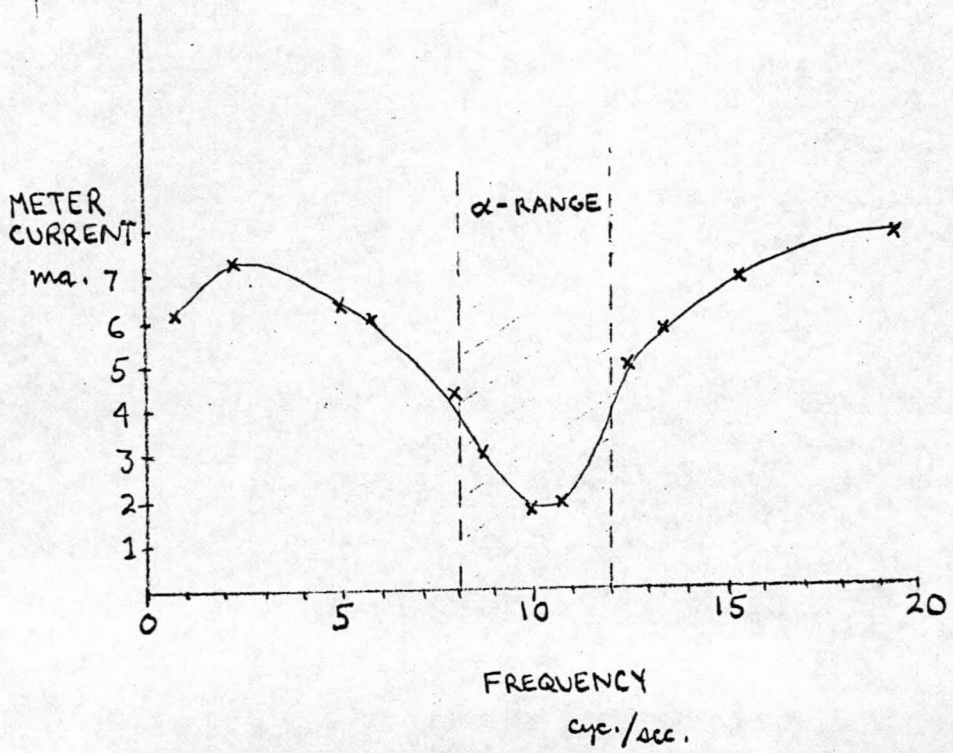
FOREWORD TO TECHNICAL NOTES

In this experiment it was desired to monitor the brain waves of a relaxed patient in order to detect so-called "alpha waves" (emanations of between 8 and 12 cycles/second) in his brain output. Further, it was desired to allow the patient to be conscious of those times when he was, indeed, producing them. Finally, it was desired to determine whether such procedure would result in any change in the average alpha-production from session to session. Toward this latter end, the "alpha-ratio"-- a measure of the purity of a subject's brain output with respect to alpha content--was defined and measured. For the conditioning phase of the experiment, a device called the "alpha-conditioner" was used in conjunction with an electro-encephalograph in order to generate an audible signal in the presence of a significant amount of alpha rhythm. A clock was connected with the tone generator in order to determine the relative amount of time which the subject spent producing mainly alpha-waves. The conditioning apparatus was designed so that the clock reading would afford a value used to calculate the alpha-ratio at the same time that the patient was being conditioned. There are operational fluctuations and manipulative difficulties with the present apparatus, not to mention the tedious calculations involved using the available data. Accordingly, I have included proposed improvements in the alpha-conditioner at the end of these notes.

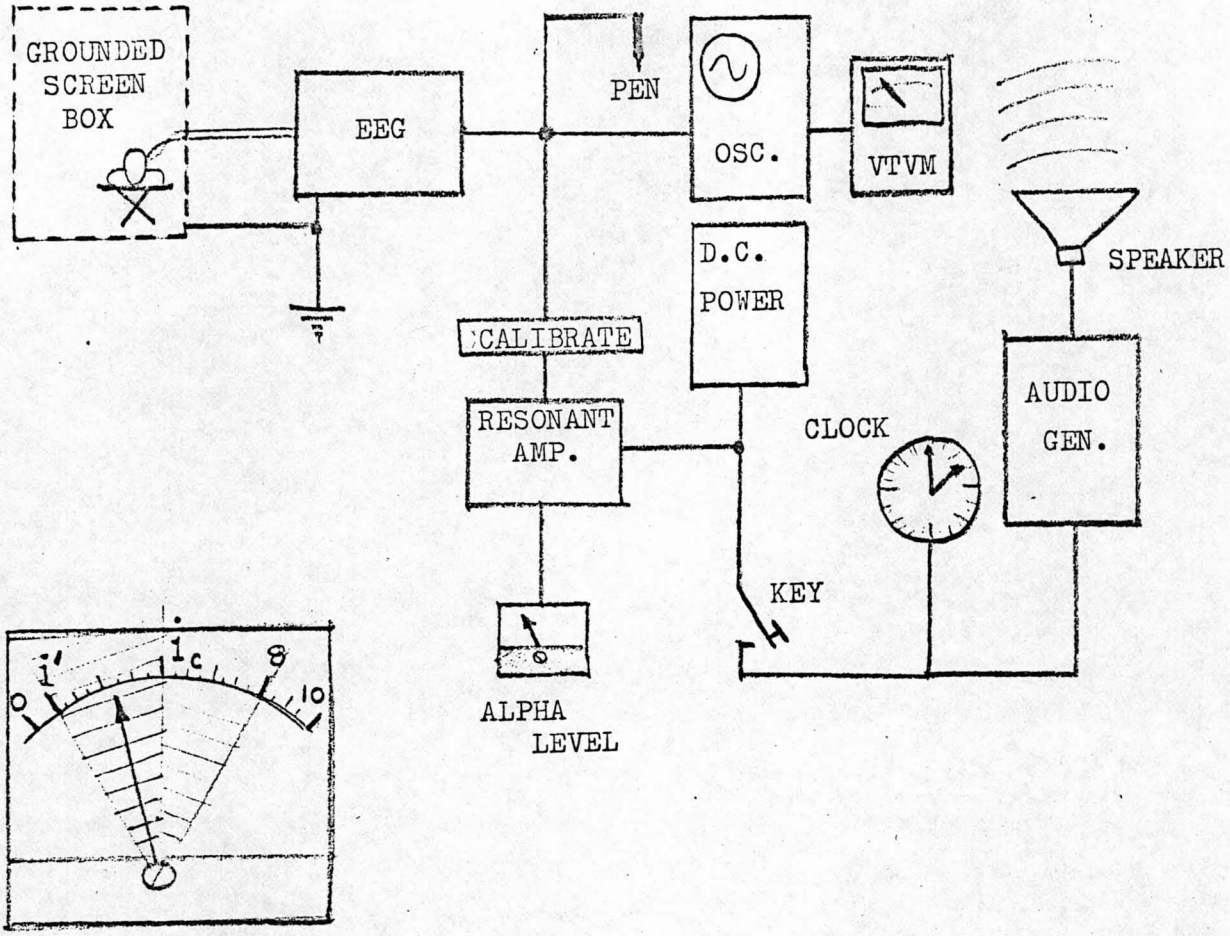
The Alpha-Conditioner

The key to the alpha-conditioner is a simple low-frequency amplifier whose gain drops sharply when the input signal lies in the 8-12 cycle alpha range. The collector-to-base feedback loop in the schematic diagram below is resonant at about 10 cyc/sec. Below the schematic is the frequency response curve measured with an audio generator and a 10 ma. current meter. Due to rapid fluctuations of the meter reading, a large 1000 μf. capacitor was placed across the meter terminals, the time constant of this combination being on the order of 1 second.





To provide input for the resonant amplifier, an EEG was tapped across the recording-pen coil. The patient(s) were placed in a screened-in compartment with the screen grounded in an effort to minimize noise. A variable resistance was placed across the EEG output so that the resonant amplifier would respond to an alpha-free signal with a meter reading of i_m = 8.0 ma. In addition, a tone generator set at 2 kc. was connected with a clock to a telegraph key with which the operator was enabled to sound the tone when the meter read less than a pre-chosen current value i_c, usually 5.0 ma. A block diagram of the apparatus appears on the next page.



= TONE ON, ALPHA DOMINANT

= TONE OFF, ALPHA ABSENT

ALPHA*-CONDITIONER

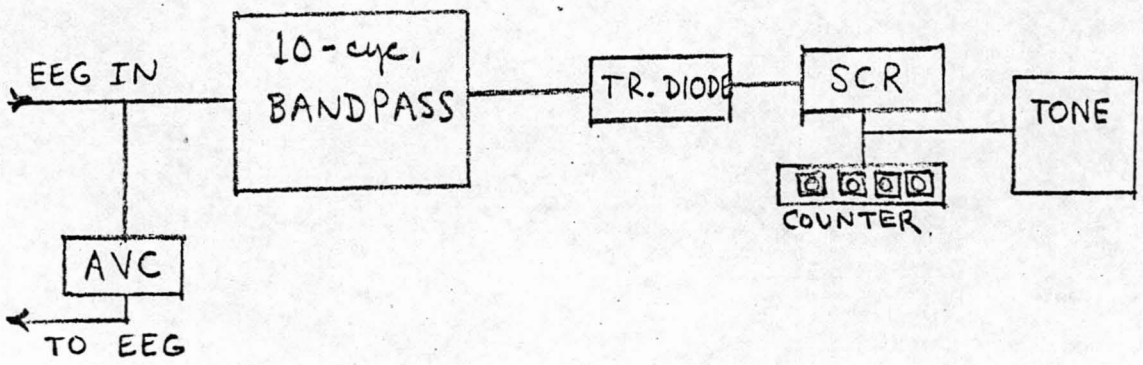
BLOCK DIAGRAM

Proposed Technical Improvements

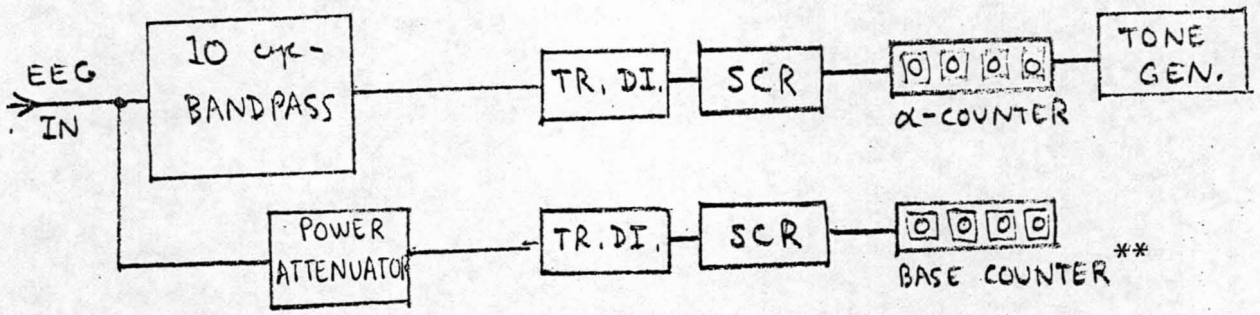
The problems and difficulties that arise from the present apparatus can be enumerated as follows:

1) Noise in the EEG output
2) Spikes in the EEG output, partially due to the high inductance of the pen coil
3) Sudden lapses in brain output, which read like pure alpha-rhythm
4) Error in manual control of the tone, as well as the abruptness of sudden and transitory tones
5) Difficulty in obtaining R_{α} in terms of total tone-time

Problem (1) can be alleviated by replacing the EEG now used with a high-gain DC amplifier, or a differential amplifier with a 60-cycle trap, either of which would eliminate problem (2) as well. Difficulties (3) and (5) are related, and could be alleviated by the addition of a modification of the AVC circuit in an ordinary radio, i.e., a circuit which would keep the total power of the EEG output roughly constant. I suggest that problem (4) be eliminated by making the tone control automatic in such a way that the intensity of the tone varies with changing R_{α}, but never goes completely off. This can be accomplished by replacing the resonant amplifier now in use with a 10-cycle bandpass filter leading in to a trigger-diode, silicon-controlled rectifier combination. The output of this, then, can be connected to a varying-drive counter:



Since the AVC circuit may be difficult to engineer for such low frequencies, an alternative proposal involves another counter to register elapsed power:



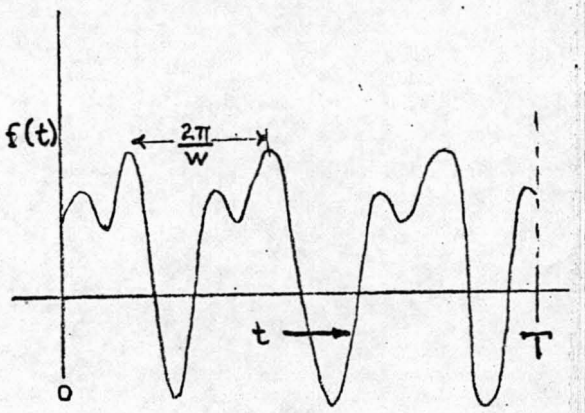
In any event, it appears that continuous tone-control is most desirable.

** Here, R_α would be an easily-computed function of the ratio of the two counter readings...

NUMBER APPENDIX

Definition of the Alpha-Ratio

Inspection of various brain waves leads one to notice that the major frequency components lie at multiples of a base frequency on the order of five cycles per second. What is more, the brain output is usually periodic over time periods of a few seconds. Thus, we may use Fourier analysis to arrive at a measure of how closely a given brain output approximates a pure alpha wave. Assuming a base frequency w corresponding to the theta-frequency, we can approximate the brain wave over a time period T by a Fourier sum:



$$1) \qquad f(t) = \sum_{n=1}^{\infty} \hat{f}(n) e^{inwt}$$

Now a reasonable measure of the power due to the k^{th} frequency component is

$$2) \qquad P_k = \left|\hat{f}(k)\right|^2$$

Whereas the total power averaged over T is given by

$$3) \qquad \langle P \rangle = T^{-1} \int_0^T f(t)^2 dt = T^{-1} \int_0^T f(t) f^*(t) dt. \quad \text{But, from (1),}$$

$$= \sum_{n=1}^{\infty} T^{-1} \int_0^T \left|\hat{f}(n)\right|^2 dt = \sum_{n=1}^{\infty} \left|\hat{f}(n)\right|^2 = \sum_{n=1}^{\infty} P_n ,$$

as it should.

Thus, we take for our measure of the purity of the brain output with respect to alpha content what shall be called the "alpha-ratio", or just R_α. This is just the power ratio

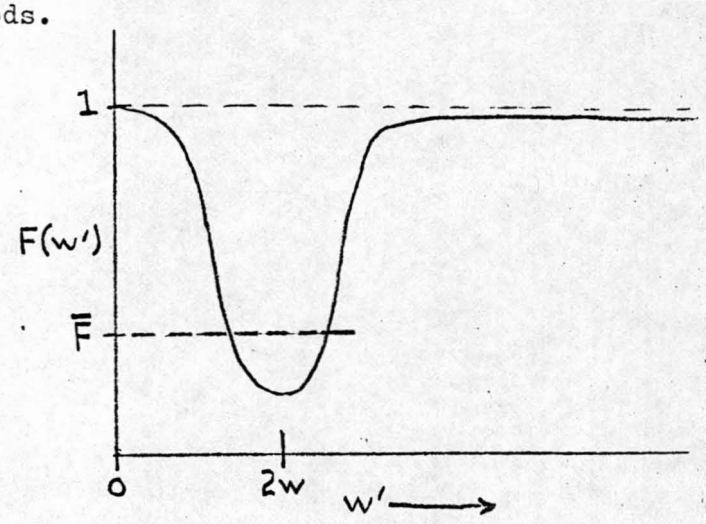
$$4) \qquad R_\alpha = \frac{\left|\hat{f}(2)\right|^2}{\langle P \rangle}$$

and is simply the fraction of the total power that appears at the frequency 2w = 10 cyc./sec. Notice this is defined only over a particular interval T for which f(t) is periodic.

Measurement of the Alpha-Ratio

The device used to condition the output of alpha waves can also be used to obtain a rough measure of the quantity R_α over short time periods, and, though with dubious accuracy, the average value of R_α over long periods.

The frequency response curve of the conditioning circuit is shown at the right. Here F(w') is the normalized voltage across the output resistance. Assuming a power attenuation K due to circuit characteristics, the voltage response V(t) to the brain signal f(t) is given by



$$5) \qquad V(t) = K^{\frac{1}{2}} \sum_{n=1}^{\infty} F(nw)\hat{f}(n)e^{inwt}$$

so that the average power out during the time period T is

$$6) \qquad \langle P' \rangle_T = T^{-1} \int_0^T V(t)^2 dt = T^{-1} \int_0^T V(t)V^*(t)dt. \quad \text{But by (5),}$$

$$= \sum_{n=1}^{\infty} T^{-1} \int_0^T KF^2(nw) \left|\hat{f}(n)\right|^2 dt = K \sum_{n=1}^{\infty} F^2(nw) \left|\hat{f}(n)\right|^2$$

Thus, if we set $\overline{F}$ = value of F at the half-power points, and make the simplification

$$\begin{cases} F(2w) = \overline{F} \\ F(nw) = 1 \quad \text{for } n \neq 2 \end{cases}$$

we get, from (6),

$$7) \qquad \langle P' \rangle_T = K(\overline{F}^2 \left|\hat{f}(2)\right|^2 + \langle P \rangle - \left|\hat{f}(2)\right|^2)$$

Solving for $\left|\hat{f}(2)\right|^2$ and using (4) we obtain R_α in terms of the power output of the conditioning circuit:

$$8) \qquad R_\alpha = (1 - \overline{F}^2)^{-1}(1 - \frac{1}{K}\frac{\langle P' \rangle}{\langle P \rangle})$$

The value of P' over a period T will be $L\langle i^2 \rangle$ where i is the meter reading minus the threshold reading, and L is some constant. If we assume that $i = i_m$ when there is no alpha-component, and $i = i_o$ when there is no signal, (8) gives

$$9) \qquad K\langle P \rangle = L \left\langle i_m^2 - i_o^2 \right\rangle$$

which renders R_α over short time periods to be

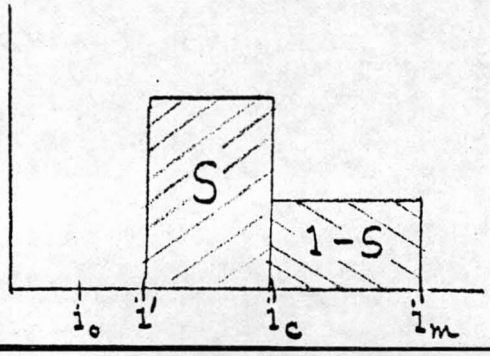
$$10) \qquad R_\alpha = (1 - \overline{F}^2)\left(\frac{i_m^2 - i^2}{i_m^2 - i_o^2}\right)$$

where i^2 is taken now to be its T-average. We note that since R_α must be less than or equal to unity, there is a minimum operating current, say i', given by

$$11) \qquad i' = (1 + \overline{F}^2) i_o^2 + \overline{F}^2 i_m^2$$

It should be noted that (10) can be extended to long time periods only if i_m does not vary appreciably. As the brain output is not always of constant intensity, we must either determine R_α separately for many small periods, or obtain the average of i_m^2 over the total period, both methods yielding the average of R_α over a succession of many small periods. In this experiment the latter alternative was taken, with i_m^2 determined as an average by inspecting the conditioner's response without the inverse feedback loop. Thus, the problem of measuring the average of R_α for a long session was reduced to that of determining the value of i^2 over that session. To this end, we wish to express $\langle i^2 \rangle$ as a function of i_c, the cut-off current, and S, the fraction of time for which i is less than i_c, for then (10) will yield the total average of R_α for a given session in terms of S, which is easily measured to a good accuracy.

Assuming a distribution of meter readings close to that at right, where the vertical axis represents the relative number of small time periods T for which the current assumes a particular value, we obtain the mean



value of i^2:

12) $$\langle i^2 \rangle = \frac{S(i_c^3 - i'^3)}{3(i_c - i')} + \frac{1 - S}{3} \frac{(i_m^3 - i_c^3)}{(i_m - i_c)}$$

Now if we set

$$A = \frac{1}{3} \frac{(i_m^2 + i_m i_c - i'^2 - i' i_c)}{(1 - \bar{F}^2)(i_m^2 - i_o^2)}$$

$$B = \frac{1}{3} \frac{(2i_m^2 - i_m i_c - i_c^2)}{(1 - \bar{F}^2)(i_m^2 - i_o^2)}$$

we obtain an expression for R_α of great experimental value:

13) $$R_\alpha = AS + B$$

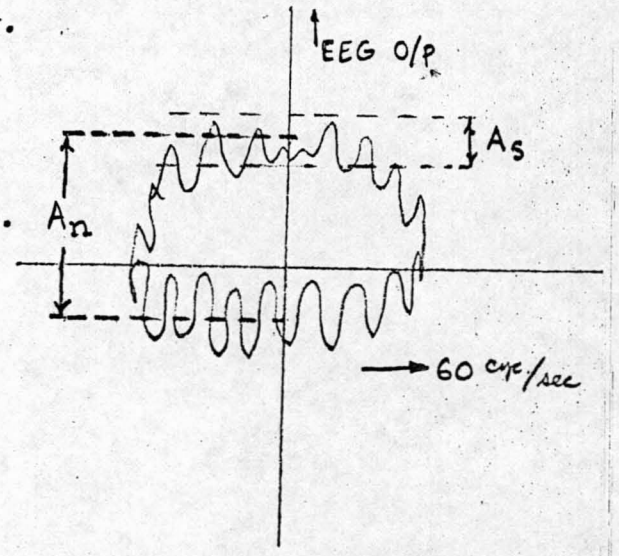
For the apparatus at present, $\bar{F} = .30$ and $i_o = 0.5$ ma. For all sessions, the conditioner was calibrated so as to make $i_m = 8.0$ ma. The following table gives the values of A and B to be used for any of five choices of i_c:

i_c (ma.)	i' (ma.)	A	B
3.0	2.07	.432	.531
4.0	2.07	.466	.447
5.0	2.07	.498	.352
6.0	2.07	.538	.246
7.0	2.07	.565	.128

The ensuing graph relates the average of R_α for a given session to the length of time for which the current is less than i_c. Thus, if the tone generator sounds when $i < i_c$, the alpha-ratio is found directly from the graph, where S is now the fraction of time the sound is heard.

Error and Noise Considerations

While not the most accurate method at hand, the previously outlined statistical approach to measuring the alpha-ratio of a particular subject should indeed detect any significant changes in R_α from session to session. To determine just how well the apparatus supports the theory, some idea of the amount of error in R_α due to electrical noise is necessary. In the figure at the right is a typical oscilloscope trace of the brain output after amplification by the EEG. Here, the horizontal sweep is set at 60 cyc./sec. Thus, any oblate bulge in the pattern indicates a 60-cycle component in the EEG output. If this bulge is stationary, it is probably due to noise. From the diagram we obtain the signal-to-noise ratio



$$14) \qquad S/N = (A_s/A_n)^2$$

For the apparatus at present, A_s/A_n averaged around 4 or 5, so we estimate $S/N \approx 25$ as an upper bound. This gives an error in $\langle P \rangle$ of about 4%, and, since this is only a positive error, we take the error in R_α due to noise to be $\pm$ 2% . Finally, the statistical error in our value of $\langle i^2 \rangle$ for a long session depends on the complicated motion of the meter needle. However, said motion tends to cover the entire range of possible values and the aforementioned density function regarding its movement seems the best possible, so we estimate the statistical error to be on the order of $\pm$ 7% after cumbersome analysis. Thus, the total error in our values of R_α is on the order of $\pm$ 10%.

A SYMBOLIC REPRESENTATION OF THE KUNDALINI RISING THROUGH THE DIFFERENT CENTRES IN THE SUSHUMNA TO THE THOUSAND-PETALLED LOTUS IN THE BRAIN