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The Cartesian Bridge: On the Psychology of Consciousness and the Psychopathology of Addiction and Schizophrenia

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Abstract: This paper considers psychometry and the psychochemistry of the biogenic amines as instruments for exploring the psychology of consciousness and, thereby, rational treatment of disorders such as addiction. A hypothesis on the nature of schizophrenia follows as a corollary.

Key words: Psychology of consciousness, psychochemistry, EEG, biogenic amines, nature&nurture, addiction.

Dedication: To the memory of James Lee (1873-1951), pioneer psychonaut [1].

1. Introduction

Probably the most salient, familiar and universal experience of our lives occurs at about the age of five with the dawning of the Cartesian dualism, *viz.* "Me" and "The World". This recognition of "The Self" lasts a lifetime and is our constant experience throughout, whether alone or in a crowd. Only the unconsciousness of sleep gives respite, both from "The Self" and "The World".

Just as we have explored "The World" through geography, chemistry, astronomy, physics, etc., we have attempted the same for "The Self" through history, literature, music, art and of course biology. As medicine progressed using applied biology, the brain eventually became recognized as the source of mental function and psychology particularly as the study of "The Self".

Geography has now identified every small island in the world and chemistry every one of the hundred natural elements of the universe. Psychology has not fared so well but has developed a framework called "personality psychology" which attempts to quantify "Me" in a similar way to our successful quantification of "The World". This particular approach, called psychometry, has converged [2-6] upon a psychometry called the "Big Five" because it comprises five independent dimensions usually called by acronyms such as "CANEO", "OCEAN" or "CANOE" after the initials of the five psychological dimensions used: conscientiousness, agreeableness, neuroticism, extraversion and openness. These names have varied, with "sensitivity" instead of "neuroticism", "psychoticism" instead of "openness", etc., but the acronyms such as CANEO have stuck. This "CANEO psychometry" is well established and it has been statistically demonstrated to be both reliable and valid. Unfortunately, progress beyond this has been laborious and difficult. Psychometry is statistically complex and time-consuming to conduct and, despite its reliability and validity, questions of subjectivity remain.

In 2014, Marks & Schutte [7] demonstrated a simple, economic, objective method of approach to CANEO psychometry that was more independent of subject and experimenter. Essentially this used computerized analysis of the electrenkephalogram using a

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3-electrode electrenkephalograph, with the justification found by Marks in 2018 [8]. In this preliminary investigation, weak correlations between CANEO and electrenkephalographic parameters were found. It is likely that further analysis will substantiate this more accurately.

2. The Electrenkephalograph and Electrenkephalogram

From passport authorities to bank tellers, handwritten signatures are recognized and accepted as an almost infallible proof of identity. Yet no two signatures from the same hand are identical [9]. Similarly, any impromptu by Schubert is easily distinguishable from one by Chopin. In many ways, the personality manifests itself in bewildering variety over time, yet we have no difficulty recognizing particular personalities. It is not the aim of this paper to capture the detail and resonance of a character as a few paragraphs from a Dostoyevsky or a Dickens might, but can this ability be described objectively and succinctly?

Hans Berger invented the electrenkephalograph and first used it to record human brain waves in the form of the electrenkephalogram [10]. Both are abbreviated "EEG". The EEG is a series of recordings of waves of electrical potential and can be Fourier-analysed into sine waves, but the EEG appears to be fractal in time [11]. Berger called its most salient feature the alpha-rhythm, 10 Hz, which vanishes with conscious activity.

It would appear that the brain's basic physiology is achieved by cyclical oscillations of its neurons [11] and that this mechanism has evolved from muscles and the consequences of development of movement [12]. It appears to be disinhibited in conditions such as Parkinsonism and it is not surprising that almost all motor activity, from speech to piano-playing, from a hand-written signature to the alpha-rhythm, is governed by a similar 10 Hz oscillation. Gait is another idiosyncratic activity which readily identifies a person and which, when disrupted by Parkinsonism, reveals the "default" 10 Hz resting tremor.

Usually an EEG time-series is plotted on a Cartesian coordinate system with time along the abscissa and voltage (usually in μV) up the ordinate. If, instead, we use an Eulerian system of polar coordinates (r, θ) with the radius, r, in μV and θ tracing out the time along the azimuth in radians, a circular plot results, analogous to a "portrait" of the electrenkephalogram. A pure 10 Hz sine wave will, under such a plot, yield a circle. Since the EEG is fractal in time [11], any plot will yield a "Berger circle" with the fractal ξ-process (1/f white noise) [13] superimposed (Fig. 1):

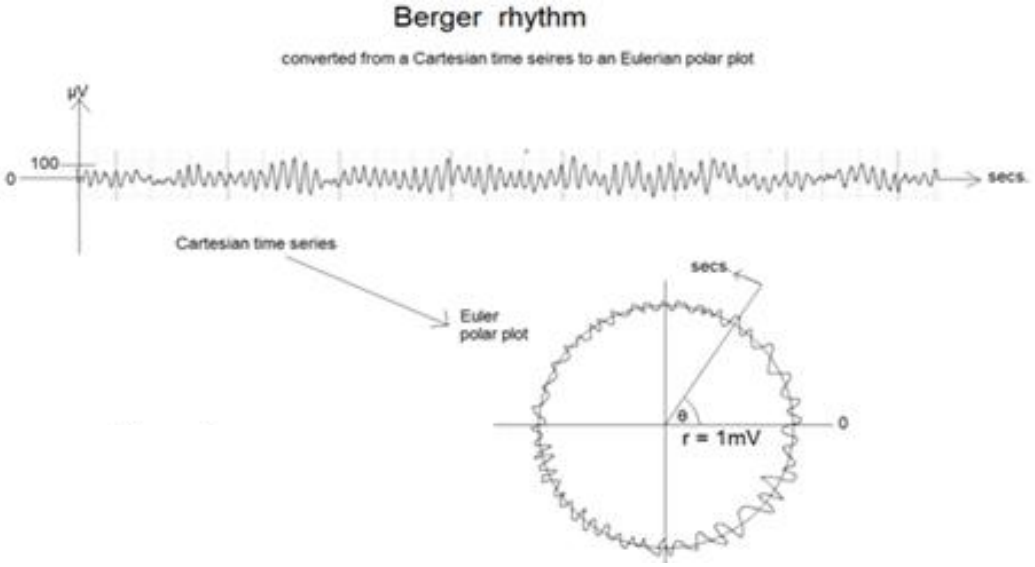

Fig. 1 Cartesian→Eulerian plot.

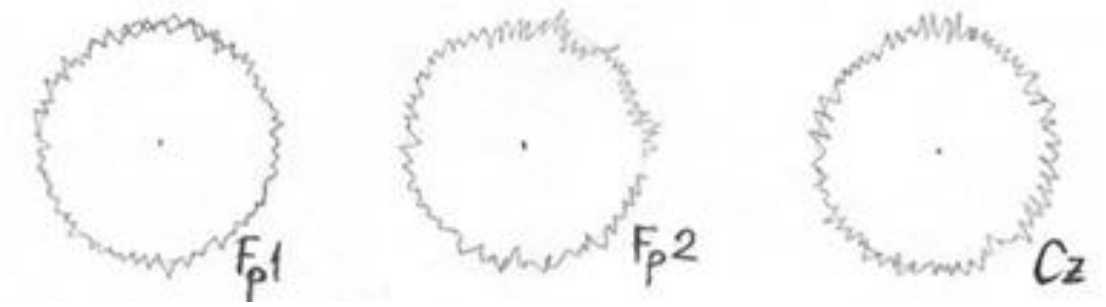

Fig. 2 Psychograms from the three recording electrodes.

This produces a succinct picture where the temporal evolution of the electrenkephalogram is contained in one frame. Since the hypothesis posited in Ref. [7] is that the personality is manifested as electrochemical activity over time, it may justly be called a "psychogram". Such psychograms are more easily compared than their lengthy Cartesian time series.

The personality is a gestalt [8] and all the electrenkephalogram provides is an electrical gestalt. Investigation of source location is difficult because of Hertz's inverse problem [8] and electrenkephalographers vainly attempt to mitigate this difficulty by deploying a vast array of recording electrodes. This is entirely unnecessary and just three electrodes, with leads colour-coded for convenience, suffice: Fp1 (red), Fp2 (green) and Cz (blue) of the 10-20 system [14]. The left earlobe, A1 (black), serves as ground and the right, A2 (white), as reference.

A bluetooth-linked Optima-4 (Neurobit) electrenkephalograph with a digital analyser (BioEra Pro) yields three time series from Fp1, Fp2 and Cz respectively. Each may be converted to a polar plot of ten cycles (*viz.* one second for an α-rhythm of 10 Hz, 1.1 s for an α-rhythm of 11 Hz, etc.) (Fig. 2).

Such an Eulerian polar plot of a simple (3-electrode) electrenkephalogram may serve to identify any individual. Digital analysis of such psychograms may sharpen this to rival the identification of hand-written signatures, even by the best graphologists.

3. Psychochemistry

We are unaware of many of the activities of cells in our bodies, e.g. the spleen or pancreas, until something goes wrong. We are similarly unaware of the activities of most of the neurons in our brain, which operate electrically and communicate with one another chemically. The study of this electrochemical activity is neurochemistry. However, we are aware of the collective result of the activity of a small minority of neurons in the manifestation of consciousness. The study of the chemistry of this subgroup is psychochemistry, a subset of neurochemistry. The psychochemicals concerned are known as the biogenic amines and comprise 5-hydroxytryptamine (5-HT), noradrenalin and dopamine.

In 1949, Moruzzi & Magoun [15] established the reticular activating system as the source of consciousness and subsequently narrowed it down to three specific areas. The areas of the brain responsible for producing these peculiar chemicals were localized many years ago. Vicq d'Azyr first identified the *locus cæruleus* in 1784 [16]. It is now known to be the source of noradrenalin. Bechterew, in 1899 [17], identified an area at the rostral end of the dorsal raphe *nuclei* now known to be the source of 5-HT and Tsai identified an area in the *ventral* tegmentum in 1925 [18], now identified with the production of dopamine. However, it was not until the later twentieth century that their psychochemical activities were discovered.

4. Consciousness

In any science, communication of the basic ideas to ordinary folk is ultimately essential. In navigation of the oceans, just as sailors in the days of classical exploration used ships, so there exist groups of investigators who call themselves "psychonauts"

(from Gk. *psyche* = mind, L. *nauta* = sailor) who use drugs for an analogous purpose. "Psychonautics" is the exploration of the subjective experiences of mind using a practical model based on anatomy, physiology and neurochemistry [19]. Although the instruments used are psychotropic drugs, much as the classical navigator used ships to explore the Earth, no charts nor instruments, no sextants nor compasses are available to guide such explorations. Even the great compendia already published (e.g. Rätsch [20], Shulgin [21]) offer detailed but qualitative descriptions such as "Here be visual hallucinations", "There be elevated mood", etc., like pre-scientific charts once labelled areas with "Here be dragons".

Tentatively, it is heuristic to identify the actions of these three psychochemicals with Eysenck's psychological dimensions of personality [5], *viz.* neuroticism, N, (5-HT); extraversion, E, (noradrenalin); and psychoticism, O, (dopamine). We then "test" the world, in the sense of Karl Popper [22], and the instrument for this testing is consciousness, determined by the "play" of N, E and O activity, modified by the experiences that have structured C and A [*vide infra*], two further dimensions contingent upon nurture.

To facilitate the analogy with geography, which the name "psychonautics" implies, the dimensions N, E and O may be likened to latitude, longitude and altitude respectively:

4.1 Latitude

We are most comfortable in our own latitude: a northern European may find the humidity and jungles of the East Indies or the Amazon oppressive or frightening, just as an Ethiopian might detest the climate or fear the isolation of Iceland. The dimension N (neuroticism) reflects this contrast we feel between extremes of personal comfort and security, i.e. whether we are within our "*psychic latitude*".

4.2 Longitude

While enjoying familiar climates or seasons from Istanbul to San Francisco, from Lisbon to Tokyo (all similar latitudes but wildly differing longitudes), there is little denying the boldness required to venture so far, especially in earlier times. This suggests an inclination to bold action, to extraversion, E, to travel and see the world. Hence "*psychic longitude*".

4.3 Altitude

Openness, O, is the essence of curiosity, to be open to new ideas and to integrate them, achieving a bird's-eye view, hence "*psychic altitude*".

Whether this is a useful analogy will depend upon the reader's intellectual taste as much as upon empirical experiment. To understand the construction and operation of the "ship", character is objectively a gestalt perceived in others and a typical manifestation of mind. Is there an objective way to perceive subjective selves, our "ships"? Psychologists have laboured mightily on this problem over the years and Galton's [2] & Allport's [3] lexical hypotheses, Cloninger's [4] and Eysenck's [5] theories of personality dimensions, and many others have all converged on a psychometry known as the "Big Five". "CANEO", "CANOE" or "OCEAN" are acronyms for the names of these five psychometric "dimensions", comprising five independent measures of personality, constituting "character".

5. Psychometry

As stated, psychometry is a time-consuming, labour-intensive, statistically complex method of classifying and quantifying different conscious mind-sets. The effects upon the conscious mind of psychotropic drugs are here attempted within the framework of psychometry using the method suggested in Ref. [7]. Starting from Eysenck's three heritable traits *viz.* neuroticism (N), extraversion (E) and psychoticism (O), Cloninger attributes these to activity in the aforementioned tryptaminergic, noradrenergic and dopaminergic systems, respectively, of the midbrain.

The extension from three dimensions to five, to include self-acceptance (C) and social acceptance (A), derives from the empirical Cartesian dualism we all experience as self-awareness develops along with the Berger rhythm, towards the end of infancy. The Berger rhythm, after its discoverer [10] is the most salient feature of the EEG—after the age of five. It is variously called the alpha (α-) rhythm over the occipital cortex (the brain's visual area), the tau (τ-) rhythm over the temporal cortex (auditory area), the mu (μ-) rhythm over the motor cortex, etc., depending upon the site of the recording electrode. C would appear to be correlated to histamine activity, measureable by skin conductance with an electrodermograph and A with cholinergic muscular activity, measureable by muscular tension with an electromyograph. However the development of the Berger rhythm appears to lock C & A together, reducing what would be five independent dimensions to four, where Ψ = C+A. This 4-D "NEOΨ" (pronounced "*neops*") psychometry would be more amenable to sophisticated mathematical analyses providing more heuristic concepts. The combined "C & A" dimension, appropriately labelled Ψ, would approximate Rotter's [23] "locus of control" dimension. Needless to say, this development is critically influenced by the quality of nurturing the infant receives, as noted by Alexander and Hadaway [24].

In summary, human psychometry may be represented efficiently by a 5-dimensional "space" (in the mathematical sense) where all dimensions are independent of one another (mathematically, "orthogonal"). They may be conveniently divided into those due to nature and those due to nurture. Three of them: N, E and O, seem determined by nature. These constitute our consciousness, though not its contents [8]: they determine our conscious attitude (e.g. mood, temper, humour) to whatever is currently in our consciousness. By contrast, C and A seem determined by nurture (Fig. 3).

The key idea is that the three biogenic amines (5-HT, noradrenalin and dopamine) secreted by discrete nests of cells in the midbrain are responsible for consciousness. At birth, the baby is aware of the world via this consciousness and nothing else. Between birth and about five years old, the brain has evolved to install an operating system called the "ego" [25] or the "reducing valve" [26]—generally known in western philosophy as "Cartesian dualism" [27]: "*Cogito ergo sum*". You can observe the endearing growth of this self-awareness in infants by the gradual appearance in the electrenkephalogram of the Berger rhythm (often called the α-rhythm over the occipital cortex, the μ-rhythm over the motor cortex, the τ-rhythm over the temporal cortex, etc.). The rhythm is established by an age Gaußianly distributed around 5 years (S.D. 1 year). It is lifelong stable, justifying the replacement of C and A with Ψ.

Table 1 The Big Five Inventory OCEAN has five basic personalities.

Drive	Purpose	Cloninger	Eysenck	Allport	
Nurture	Personal *survival*	histamine	internal focus	**c**onscientiousness self acceptance	**C**
Nurture	Environmental *survival*	acetylcholine	external focus	**a**greeableness social acceptance	**A**
Nature	Behavioural Inhibition Harm Avoidance *Safety*	5-hydroxytryptamine	**n**euroticism	sensitivity	**N**
Nature	Behavioural maintenance Reward dependence *Reward*	noradrenalin	**e**xtraversion	extraversion	**E**
Nature	Behavioural Activation Novelty seeking *Curiosity*	dopamine	psychoticism	**o**penness	**O**

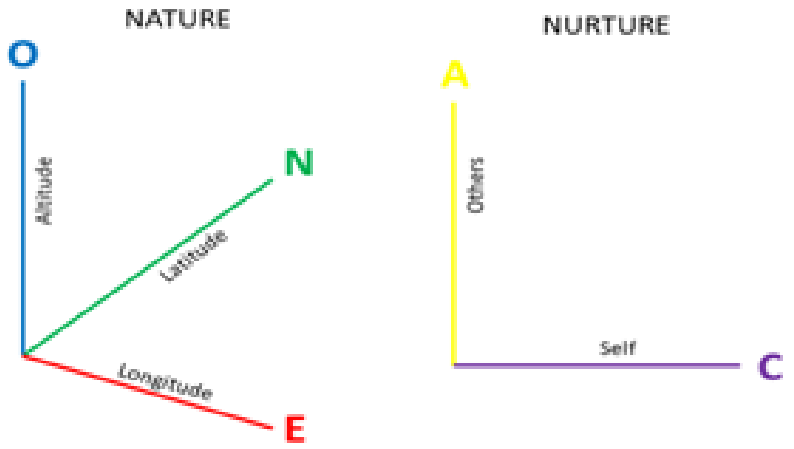

Fig. 3 This colour scheme is a mnemonic to assist identification and function of the dimensions. C: Violet: (*histaminergic*): Cloninger's "persistence". Called "personal" or "*internal orientation*". A: Yellow: (*cholinergic*): Cloninger's "cooperativeness". Called "social" or "*external orientation*". N: Green (*tryptaminergic*): Eysenck's "neuroticism", Cloninger's "harm avoidance" -> safety. Also called "*psychic latitude*". E: Red (*noradrenergic*): Eysenck's "extraversion", Cloninger's "reward dependence" -> action. Also called "*psychic longitude*". O: Blue (*dopaminergic*): Eysenck's "psychoticism", Cloninger's "novelty seeking" -> exploration. Also called "*psychic altitude*".

This key idea, from observations of functional neuroanatomy [19], is independently corroborated by the psychologists' five personality dimensions: "CANEO". The psychological dimensions accurately reflect the functional neuroanatomy and neurochemistry, with Ψ (C and A) due to nurture and N, E and O due to nature confirmed by genetic studies of heritability of personality. Two further amines, histamine and acetylcholine, are also widely distributed over the cerebrum and may correlate with C&A but these become fused into the combined dimension, Ψ, more determined by nurture.

A proposal that seeks to find a correlation between CANEO as measured by a psychologist and any parameter of the electrenkephalogram would present psychiatrists, GPs, psychologists, psychopharmacologists, etc., with an efficient method by which drugs or any other treatment may be tested.

6. Addiction

While a few may become addicted (< 5%) to drugs, for the vast majority their use is unproblematic [28]. There is no society anywhere, nor at any time in history, that does not appear to have used a drug for purposes of social communion or personal enjoyment. Even the notorious "Opium Wars" were really a "turf" battle between the Manchus and the British for control over the taxation of unproblematic but widespread opium use in China [29].

C (the violet, internal orientation) and A (the yellow, external orientation), which derive from nurture, reflect the development of self-consciousness at about the age of five as they lock together to form Ψ and this exactly mirrors the development of the Berger rhythm, likely the source of the Cartesian dualism we all experience. Severe trauma in early childhood may be expected to impair the normal development of the Berger rhythm and of Ψ (C and A) and, indeed, examination of the < 5% who become inveterate addicts finds overwhelming incidence of such trauma [30].

7. Psychopathology of Addiction

"Addiction" here refers to that use of drugs which leads users to have problems with their societies, their families or themselves. Of all drug or alcohol consumers who present clinically, more than half may respond to minimal advice such as "you're pickling your liver, cut down a bit" (e.g. for those who used to indulge in "liquid lunches" and were unaware of the

risks entailed). More than a third of all who present are self-remedying distress, such as relationship break-ups, bereavement or grief, economic hardship, and other life-events. These usually respond to psychotherapy that cures the drive and so removes the motive for such self-remedy. There remains, however, a small percentage (< 5%) of inveterate "addicts" (from L. *ad dictu* = at your beck and call) well known to the local casualty department, local GPs and even local police, from their frequent dangerous intoxication.

It is worth noting that this cohort has disproportionately frequent histories of early childhood trauma [30] and the hypothesis here put forward is that these histories adversely affect the healthy development of C (violet, self-esteem) and A (yellow, social relationships). The knitting together of C & A to produce a stable Ψ is thus conducted under constant stress, resulting in a distorted Ψ. The strain thus caused is assuaged by a psychic homœostasis involving a chronic alteration in the N (green), E (red) and O (blue) activity in the midbrain reticular formation and, therefore, in consciousness, so that such individuals experience a chronic strain [8]. The advent of adolescence and adulthood bring the stresses of "coming of age" and accidy [31] with which we are all familiar and which aggravate the strain already felt by folk with such a history of trauma. The discovery of drugs or alcohol and the finding that one or other of them powerfully relieves their hitherto life-long strain understandably leads to their chronic use and, often, to addiction [32]. Such psychopathology may underlie many other so-called "personality disorders", of which the addiction syndrome is simply a fairly common manifestation and would include compulsive gambling and other obsessions.

Vaillant [33] has noted the impervious nature of addiction to conventional therapies but, if the model of psychopathology being considered here is true, this is hardly surprising: pathology established before awareness or memory (i.e. in infancy) is inaccessible to the conscious mind and, so, intractable.

8. Treatment

This psychopathology explains the resistance of addiction to conventional treatment. Nor is it surprising that, if patients could access their infant mental states, psychotherapy might have a chance of being effective. That is exactly what Osmond et al. [34] found in their treatment of alcoholics: psychotherapy under the influence of a psychedelic drug (from Gk. *psykhe* = soul, mind; *eidolos* = idol, homunculus, representation or manifestation). Osmond's remarkable success, particularly with refractory alcoholics, was noted but not taken further because the treatment involved the use of drugs then deemed to have no medical indication. This psychedelic property was successfully pursued by Grof [35] as psycholytic (from Gk. *lysein* = loosen, dissolve) psychotherapy.

To understand what is happening, it is useful to consider another analogy: the brain and a computer. In fact, most physiologists see the brain as radically differently organized from a computer. That would appear to be so, but the fabrication of the "ego", of "I", "me", etc. (i.e. the locking of C and A to form Ψ) has all the appearances of an operating system which creates the Cartesian duality found so convenient for navigating "The Self" and "The World". Since psychopathology occurring in infancy was present before the "operating system" was installed, these "bugs" will go undetected by the full-fledged "I". The rationale of Osmond's use of psychedelics or Grof's psycholysis thus becomes apparent: they temporarily de-install the operating system, so the "bugs" can be detected and psychotherapy used to repair them.

9. Schizophrenia

The hypothesis, that the Berger rhythm is a physiological manifestation of the union of C and A to form Ψ, suggests an explanation of one of the most salient symptoms of the schizophrenia syndrome. The

symptom concerned is an almost pathognomonic alienation from, or confusion of, the Cartesian "I" and "The World". Its most common sign is disorganized speech, especially of grammar, and psychiatrists attribute this to disordered thinking. This phenomenon seems a likely cause of the apathy such patients suffer, manifesting itself as what psychiatrists call "negative" symptoms. The fact that dopamine activity appears critical in theories of the causes of schizophrenia and even more so in its current treatment, indicates a significant role for activity of at least one of the biogenic amines, *viz.* dopamine (O). Any putative pathology of Ψ is thus likely to be more complex and profound than the stress surmised to produce the strain in Ψ, the relief of which by drugs or alcohol may be responsible for addiction.

It seems that all the other functional (i.e. without anatomical or chemical signs) psychoses of psychiatry may also be similar disorders of consciousness, i.e. of the reticular activating system and its psychochemical activity, and form a better basis of classification [36] from putative aetiology.

After the confirmation of Berger's findings by Adrian in 1934, research was primarily directed into its applications in neurology, particularly epilepsy. However, from early on, the activity of the EEG and particularly of the Berger rhythm was also studied by psychiatrists such as Lemere [37] but the lack of electrenkephalographs and the inability to analyse electrenkephalograms, except by cursory "eye-balling", severely limited progress. It is only now, with cheap, portable electrenkephalographs and powerful, computerized analytical algorithms that the EEG can be more effectively investigated.

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