Psychosynthesis Research Foundation

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January 1, 1969

Dear Colleague:

The fourth meeting of the 1968/69 series of Psychosynthesis Seminars (held on the third Friday of each month) will take place on Friday, January 17th at 7:30 P.M.

Our speaker will be Dr. Leonide Goldstein of the New Jersey Bureau of Research in Neurology and Psychiatry; the subject: "The Relationship of the Electroencephalogram to Spontaneous and Induced Changes in States of Consciousness." Following his talk will be the usual group discussion.

We trust it will be possible for you to be with us at the forthcoming meeting.

Cordially,

JACK COOPER, M.D.

Date & Time of Meeting:	Friday, January 17, 1969 - 7:30 P.M. prompt.
Place:	"Directors Room," mezzanine floor, Park Sheraton Hotel, 7th Ave. & 55th St., N.Y.C. (There is a public car park across the street from the hotel.)
Speaker:	Leonide Goldstein, D. Sc.
Subject:	The Relationship of the Electroencephalogram to Spontaneous and Induced Changes in States of Consciousness.

PSYCHOSYNTHESIS SEMINARS

1968/69 SERIES

Fourth Meeting: January 17, 1969

Speaker: Dr. Leonide Goldstein
Box 1000
Princeton, N.J. 08540

Subject: The Relationship of the Electroencephalogram to Spontaneous and Induced Changes in States of Consciousness.

Participants:

A.J. Brodbeck, Ph.D.
Jack Cooper, M.D.
Leonide Goldstein, D. Sc.
Virginia Glenn
Frank Haronian, Ph.D.
Frank Hilton
Hilda Hilton
Newton Lichtblau
John Parks, M.D.
Paul G. Smith, M.D.
William Swartley, Ph.D.
Shirley Winston, M.A.
William Wolf, M.D.

Psychosynthesis Research Foundation
Room 314
527 Lexington Avenue
New York, N.Y. 10017

Introduction by Dr. Frank Haronian

I am very pleased that Dr. Leo Goldstein was willing to speak to us tonight. He has been doing some very interesting work with the electroencephalogram for six years or more, starting with a paper that was published in 1963 on the relationship between variability of electrogenesis and personality. At that time we tried to get an O N R grant for a follow-up and normative study, but it did not go through. More recently, we have been studying how psychosynthetic exercises modify the electroencephalogram, and in which direction. We are curious about the possible effects of psychosynthetic techniques on the conscious state of mind of a person. We are only just beginning our studies on that, but we will say something about it at the end of Leo's talk.

Leo comes to us from France. He got his B.A. degree at Amherst, then he went back to France for his Doctorate of Sciences in Psiology.His main love is biometry; he likes to lecture and does a very nice job of it. He came back to this country after working in France quite a while at the University of Paris and studying there. Since 1961 he has been at the Bureau of Research into Neurology and Psychiatry in New Jersey.

Dr. Goldstein:

What I would like to present tonight is some of the data which we have accumulated for the past ten years (it takes many, many years for these things to come through in any intelligible form) in which we have attempted to characterize states of consciousness by means of quantitative electroencephalography.

We are all interested in what states of consciousness are and in how one changes from one state to another. In spite of the fact of that Herophilus pointed out 2,200 years ago that the brain is the seat of consciousness, we still do not have the slightest knowledge of how the brain works and what type of change occurs in the brain when we move from one state in consciousness to another. We know from a large background of analytical studies of biological systems that the study of changes is much more meaningful, and will permit one to understand what mechanism we are dealing with, than any one constant state.

There is a great theoretical interest in the study of the changes in the states of consciousness. It is also obviously of practical interest because if we had a good knowledge of what is the normal state of the system, and by what mechanism the system changes, then we could use it as a diagnosis for abnormal states of consciousness, abnormal changes in the states of consciousness; and we could also appraise in an objective way the relative efficacy of the different types of therapy. This is the goal; but what are the difficulties? They are well known. Up until now, three approaches have been advocated:

One, is the psychological approach, in which one could say that what one does essentially is a reaction type study whereby you put something into the system and the system reacts. From the reaction of the system you can then infer by extrapolation what was the original state of the system. I don't need to tell you that enormously valuable information has been acquired by such methods, but one difficulty, however, which I am sure you are well aware of, exists, which is similar to what happens in physics where, as Schroedinger pointed out, when you focus your attention on an electron - on the position of the electron - you

change that position. In the same way one can wonder if by putting something into the system, that is the brain, one does not modify the brain, with the result that one cannot determine what was the real, original, state of the system. It is lost the minute that one interacts with it. When one puts something into the system one immediately modifies the system.

The second approach is the bio-chemical approach. You know that the tissues and cells, etc., of the brain are made up of chemical constituents so that it would only be logical to think that whenever the state of consciousness changes the biochemical setup of the cells also changes. This has been, and still is, the major field of interest in a great many laboratories. Something like 70% of public funds now invested in studying the brain are given in the biochemical field. It is a very fine field except on one essential point and that is that all the biochemistry of the brain that we have today is the biochemistry of the dead brain. We have no way in which we can say that amino acid has increased or changed, etc., in the living cell of the brain. The only recourse is to measure changes in blood, urine, etc.

But one can argue that the biochemical approach is at best indirect. People can observe changes in the blood, in the urine, etc., but they cannot obviously open the skull, take a piece of tissue for analysis and then do the same thing the following week.

The third approach to which I will devote my talk is the electrophysiological approach. In 1870 Richard Caton was the first to notice that the brain produces all the time electrical signals, which one can detect, amplify, and record. That activity changes abruptly when the animal changes state and/or conditions. Caton was operating on animals. He anesthesized them and found that their electrical activity was very different in wakefulness and sleep. Later on, in 1929, Hans Burger in Germany demonstrated that in man one could get that electrical activity through the skull and that it would also change in relation to the man's changes and states of consciousness, such as wakefulness and sleep.

Brain waves being essentially electrical signals, analysis might appear simple and straightforward. Unfortunately, this is not so. To understand why, a glance at samples of brain waves recorded in normal subjects in different states of consciousness, and in pathological cases, may be revealing (see Figure 1). (Charts follow p. 7. Ed.)

It is easy to see that although each state corresponds to a distinct general pattern, what may be predominant in a particular case often exists as an exception in another case. Apparently, in any type of analysis to be attempted, quantitation is needed. But what to measure and how?

In Figure 2, another example is presented. This is the same subject recorded while awake and during behavioral drowsiness. As can be seen, a definite change has taken place. This consists most prominently of a "flattening" of the waves. However, a trained biometrician would be quick to point out that another phenomenon is also present, although not as grossly visible; that is, a difference in the time-course variability. Whereas during wakefulness the waves follow each other with a fair degree of likeness, during drowsiness this regularity is lost. This is an extreme-type change; as we go along numerous other examples will be presented in which the same phenomenon of increase or decrease in the regularity of brain wave occurrence will be seen.

In face of such facts, it occurred to Dr. Zenon Drohocki in 1948, and to myself later on, that perhaps what should be measured was the variability itself. To achieve this, one needs to perform series of successive measurements and from their spread (or distribution, to use statistical terminology) compute how alike or different they are. For example, as seen in Figure 3, variability can be high, or low, or absent altogether, depending on how the different waves relate to each other. The measurements which appeared most informative, and easiest to handle, were those related to brain waves amplitudes. We are fortunate in that Dr. Drohocki, endowed with creative talents in electroencephalography, electronics and biometry (a rare combination indeed) was able to design a relatively simple electronic device performing automatically, and continuously, on-line, the type of measurements required for the analysis of variability.

I will not expound on the technical aspects except to point out that the device in question, called an EEG Integrator, operates according to a well known mathematical principle relating electrical power and time (Figure 4).

The distinctive and unique feature of Drohocki's Integrator is that condenser discharges are recorded with the brain waves concurrently and directly opposite each other. The electrical activity is translated into pulses, the number of which is, for any period of time (whether 1/50th of a second, or 1 second, or 1 minute, or 1 hour) directly proportional to cumulated amplitudes.

An important point here is that in this type of analysis frequencies are not taken into consideration. The number of pulses delivered by the Integrator for a given input is the same regardless of the number of individual waves comprising the input. The coefficient of proportionality between input and output (i.e. the slope of the curve) can be varied by changing the values of the condensers. Attention should be called to the absence of latency and carry-over in the operations of the Integrator. (Figure 5)

Let us see now how this is applied to the problem previously mentioned, namely the measurement of variability. Figure 6 contains ten successive strips, each corresponding to 20 seconds of recording obtained from the left occipital area of a subject lying down, eyes closed. One can see the direct tracings and their integrated counterparts. Computation is performed by numeration of the pulses for each strip and by calculation, from these successive numerations, of an overall mean and a standard deviation. In this case, a 20-second period is used as a basic time-unit of measurement. However, one can perform measurements on shorter time intervals, such as 1 or 5 or 10 seconds, from the same data. From the standpoint of variability, one can define the entire 200 seconds as corresponding to a situation where the standard deviation represents 9.2% of the mean.

In collaboration with Dr. Pfeiffer, Dr. Murphree and Dr. Sugerman, we performed an extensive study on a large number of so-called "Normals" (Laboratory staff members, attendants, etc.) in which measurements such as these were performed repeatedly. The subjects were under no drug treatment of any kind. In order to find out whether measurements of variability had any meaning, we compared these measurements to an almost equal number obtained from the most abnormal patients we could find, namely, chronic schizophrenics. These also were off drug treatment for at least 2 months, matched as closely as possible for age, recording conditions, etc.

From more than 8,000 measurements, the data presented in Figure 7 were obtained. As can be seen, while overall amplitude levels were indistinguishable between normals and patients, the variability levels appeared to be quite different, as a matter of fact, 50% lower in patients. Even within the patient group, a differentiation could be made in that the catatonics were at the extreme of hypovariability.

Postponing for the time being its interpretation, this surprising finding appeared interesting in that a number of studies based on visual inspection of EEG records had failed to reveal any difference between normals and patients. But this might be due to the fact that since the overall amplitude levels are not different, changes in height, which the eye can normally detect, do not occur. The change which is present is not of a nature that the eye can grasp.

In these studies, the time basis for measurement was always set at 20 seconds. One could argue that the difference between normals and schizophrenics would not appear if different basic time-intervals were used. To check on this point the same type of analysis was performed using, 1, 2, 5, 10, 20 and 60 seconds as time-bases for measurement. The results appear in Figure 8.

It is clear, in the first place, that whatever the time-interval used, the statistical distribution of values follows a "normal" or "Gaussian" curve (a fact to be discussed later). It is also clear that, whatever the time-basis, the records of normals and patients matched by similarity in means, reveal the same differentiation in variability.

Interestingly enough, as shown in Figure 9, the relationships between coefficient of variation and time-basis for measurement are parallel. Since the curves become asymptotic from 20 seconds on, we have used repeatedly this time basis in all our studies.

It occurred to us that, if this finding is valid, improvement of behavioral status in patients should correspond to an increase in the variability of their EEGs. A study was designed on a group of 16 schizophrenics. This was strictly a double-blind study which lasted one year and involved a number of antipsychotic drugs administered chronically for a month at a time, and interspersed twice with placebo. Besides EEG measurements, the patients were scored monthly by psychiatrists (unaware of which drug or placebo was administered) on the basis of rating scales, especially the Inpatient Multidimensional Psychiatric Rating (IMPS). The results obtained on the whole group appear in Figure 10. Each time behavior improved, as evidenced by a disorganization, the variability of the EEG increased, almost in a mirror-image-like fashion. As a matter of fact, the coefficient of correlation was -0.79, a very highly significant inverse relation. Notice that both times placebo was substituted for the active medication, following a lag due to the well known slow elimination of phenothiazines, there occurred a worsening of behavior and a downward trend in the C.V.

This relationship between worsening of behavior and decrease in EEG variability was further confirmed in a small scale study involving MAO inhibitors. When administered to patients, these drugs produced a definite worsening of their schizophrenic symptomatology. This went along with a decrease in EEG variability; the final levels were below the already low pre-drug levels.

The next obvious question is: what happens in normal subjects when psychotic-like states are induced. The immediate approach is to use LSD. The

studies I will report on were carried back in 1962, also in collaboration with Dr. Pfeiffer, Dr. Murphree and Dr. Sugerman.

First let us examine, in one of the LSD experiments, what Dr. Drohocki calls an "electrochronogram". This is a plot of the successive values of the integrated EEG versus time, during the pre-drug control period and at different times following drug administration (Figure 11). Two changes are quite apparent: a decrease in the mean level of amplitudes and a decrease in the variations above and below the mean level. On a quantitative basis, on groups involving 6 to 13 subjects, the data presented in Figure 12 were obtained. With the threshold dose of 0.3 micrograms per kilogram the changes in amplitude were minimal. However, there was a decrease in variability, especially prominent 90 minutes following drug administration. Behaviorally, the subjects were nervous, somewhat distressed but their reports did not include hallucinations. With the higher dose of 1 microgram per kilogram most volunteers did experience visual hallucinations. This became maximal 90 minutes after drug administration, at a time, as can be seen, when the EEG variability was lowest, as a matter of fact, well within the range found to prevail in schizophrenics.

Another type of "psychotic-like" change is sometimes obtained following prolonged sleep deprivation. We ran such experiments on a young lady (Figure 13). The records obtained each day in the morning and the evening were identified only by code numbers so that EEG analyzers never knew which record corresponded to which particular period of sleep deprivation. Two independently performed psychological studies were also run. It so happens that after 50 hours of continuous wakefulness this subject experienced a full blown psychotic episode. At that time the C.V. was at its lowest level, again around 8%, again within the range of psychoses.

Working with an Integrator similar to ours, Dr. Marjerisson and collaborators of Saskatchewan Hospital in Canada have recently communicated to us data obtained in chronic schizophrenics and in acute schizophrenics, i.e., on patients experiencing sporadically hallucinatory states (Figure 14). As can be seen, the difference in EEG variability between normals and schizophrenics exists in Canada as well as in New Jersey. What impressed us most is the finding that in the same patients the C.V. was significantly lower during hallucinatory episodes in comparison to its level in the absence of such activity.

So we have the two extremes, so to speak, with normals at one end and psychotics at the other end. What about intermediate states? Do they exist and, if so, what types of subjects could be so characterized?

A partial answer has been obtained in a study performed, in collaboration with Mr. Burdick and Dr. Sugerman, in which different groups of subjects were recorded. A plot was made of the regression of the standard deviations on the amplitudes (for each record, a relationship was established between amplitudes and corresponding levels of variability). (Figure 15). As can be seen, normal males and schizophrenics occupy the extreme slopes, whereas the catatonics are the lowest on the scale. In between, we find students (these were male Princeton University Students, recorded at a time when they were preparing for mid-term examinations); next, female subjects; and finally, chronic alcoholics, recorded while undergoing psychiatric treatment. One could easily match these slopes with slopes of increasing anxiety.

Before discussing these experimental findings and their possible relevance to consciousness and creativity, I would like to dwell on fairly recent data which throws an interesting light on all I have said so far.

The measurements I have presented were all obtained from one specific location, namely, the left occipital area. For a number of reasons, we were previously not able to obtain measurements simultaneously from other areas or from the other hemisphere. However, a few months ago, this did become possible and we have now a certain number of recordings of simultaneous measurements from the left and right hemispheres. Instead of one Integrator, we use two such devices, operating independently but calibrated to perform as identically as possible.

Figure 16 shows the relationships obtained from a subject treated with marijuana. There, an interesting phenomenon is apparent, namely, a separation of the values characteristic for each hemisphere. Notice that the downward trend is still present, i.e., the subject retains the tendency to becomes drowsy. However, he has become euphoric, relaxed, happy as if inebriated.

Next, the reverse (Figure 17). Now we deal with a heavy smoker. Following the pre-drug run during which the subject was quite relaxed, he had the surprise to learn that from that moment on, and for the next 6 hours, he would not be permitted to smoke. This produced a state of anxiety, manifested by the large scale decrease in EEG variability. It produced also something unsuspected, namely, a decrease in the difference between EEG amplitudes of the left and right hemispheres.

Lastly, very recent recordings of 2 persons (who shall remain anonymous) prominent in the fields of literature and painting respectively. These persons were recorded initially with instruction to relax as much as possible, preferably with no thought of work or worries; then with instruction to concentrate as deeply as possible on their creative occupations. The data obtained appears in Figure 18. As can be seen, concentration corresponds to two changes: a decrease in EEG variability and a decrease in lateralization.

These studies suggest the possibility that the time-course variability of the EEG is related to at least some states of consciousness. The lowest level of variability is found in the most extreme deviation from behavioral normalcy, namely, schizophrenic catatonia (Figure 19). The level is slightly higher in other types of chronic schizophrenia as well as in psychotic states induced in normal subjects. Variability is still higher, although below the "dull-normal range," in creative persons actively engaged in their endeavors. In cases where euphoria and extreme relaxation prevail, variability is above that found in normal subjects under usual daily-life conditions.

A parallel could be drawn between such relationships and what is sometimes called "strength of arousal". There are numerous indications, from psychiatric as well as psychological considerations, that catatonics are in a constant state of hyper-arousal (or extreme excitation). Ascending the scale of variability, we find anxiety states to be associated with abnormally increased involvement with the environment, manifested by a tendency to attach undue importance (and often fearful potential threat) to the most unimportant events. Creativity requires concentration, i.e., sustained attention, therefore, from our standpoint, sustained arousal. Euphoria, or extreme relaxation, lie in the opposite direction since they are concomitant with drowsiness, thus, decreased

arousal. During sleep, in absence of arousal, variability levels are generally high, except during stage 1-REM where they are equal to or below those prevailing during wakefulness.

It should be pointed out that although only preliminary data has been acquired, laterality relationships are also indicative of states of consciousness. The electrical activity is very similar in both hemispheres in anxiety states and during creative thinking, while, on the contrary, it is different during euphoria and stage 1-REM sleep.

If one considers brain function as being homeostatic (a concept which is indicated by the existence of a Gaussian distribution of the measurements of brain activity), one can envision a heuristic model of the relationships just presented. This model would have at its starting point Ross Ashby's "Law of Requisite Variety." This law states than in order to perform efficiently a homeostat must be endowed with a range of operational mechanisms sufficiently varied to encompass the total range of environmental changes. Hypovariability (or hyper-regulation) would then correspond to incomplete cerebral function since a part of the input would not be processed. In the case. of hyper-variability, the input would tend to lose most of its relevance since it would be integrated before coming really to consciousness.

The interesting point, for this particular audience, is creativity. From the extremely limited data avaiable, it would appear that it carries with it cancellation of parts of the environmental input to the brain. Could it be that this would permit the replacement of the outside world by the inside world of the creative person? It is worthy of note that during dreaming periods, when a similar shift is believed to occur, the levels of EEG variability are quite comparable to those found during cerebral activity corresponding to creative thinking.

A number of problems must be solved before such a model can be developed. For example, laterality relationships are quite different in creative thinking and dreaming. But, in the experiment reported, dream content has not been established, and it is possible that it was creating anxiety; furthermore, in the creative subjects described, induced anxiety may be a factor. LSD produces profound stimulation of the brain; yet it is now generally agreed that it is not conducive to creative activity. More extensive and detailed studies are required before more conclusive distinctions can be made.

I would like to say, in conclusion, that until now psychic research has largely concentrated on "normalcy" and on "pathology". It is time to start an analysis of the processes involved in the most important of all aspects of brain activity, that of creativity. Let us hope that the approach I have outlined will be of help in such an endeavor.

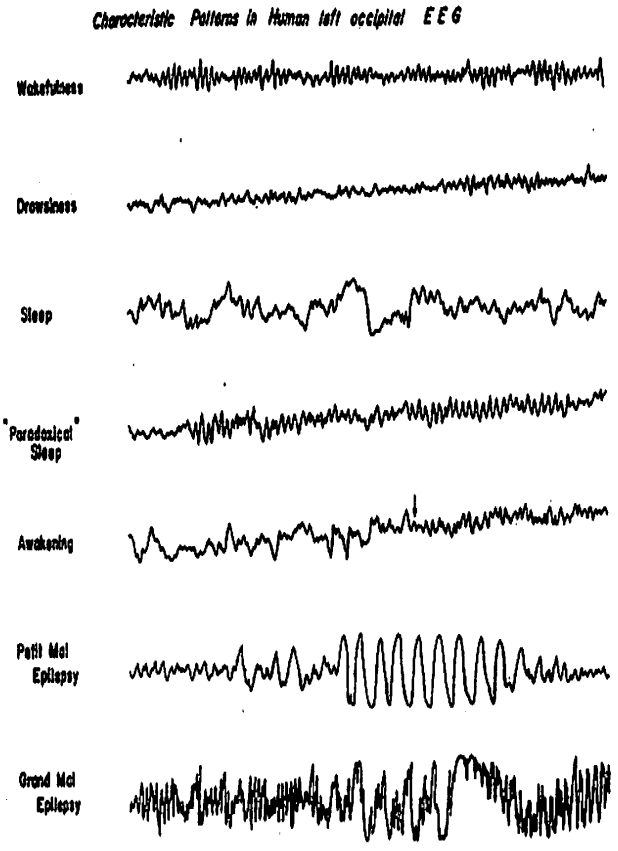


Fig. 1

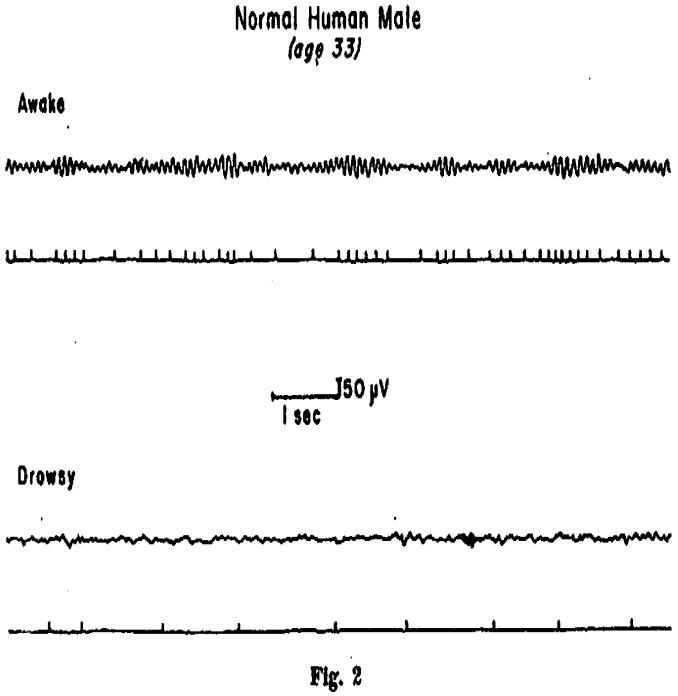


Fig. 2

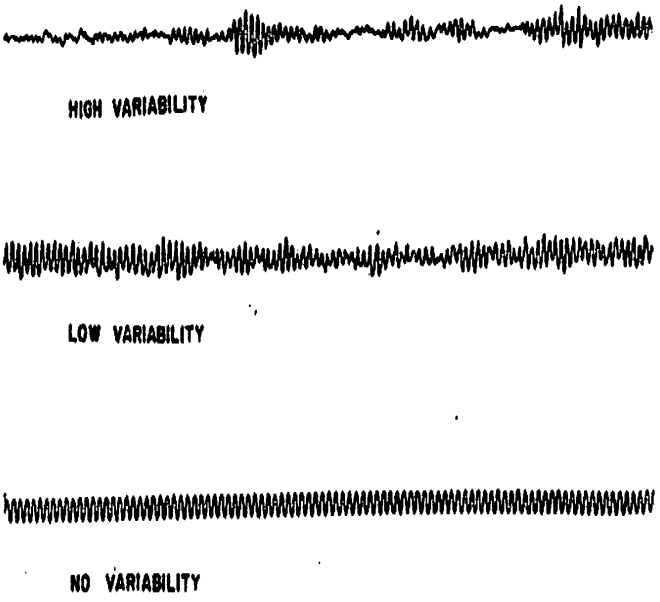
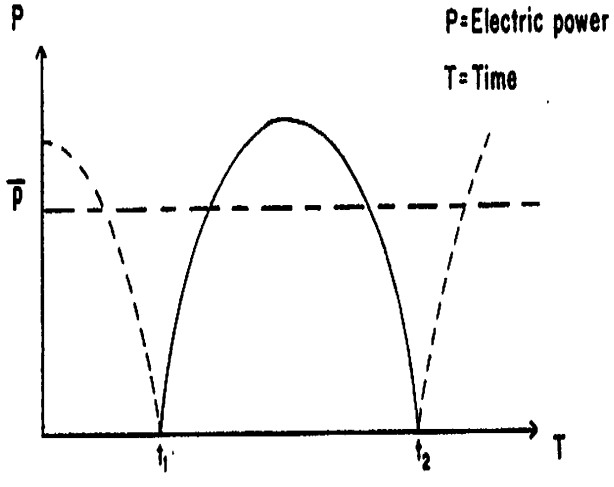


Fig. 3



$$\bar{p} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} p\,dt = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} f(t)\,dt \quad \therefore$$

$$\int_{t_1}^{t_2} f(t)\,dt = \bar{p}\,(t_2 - t_1)$$

Fig. 4

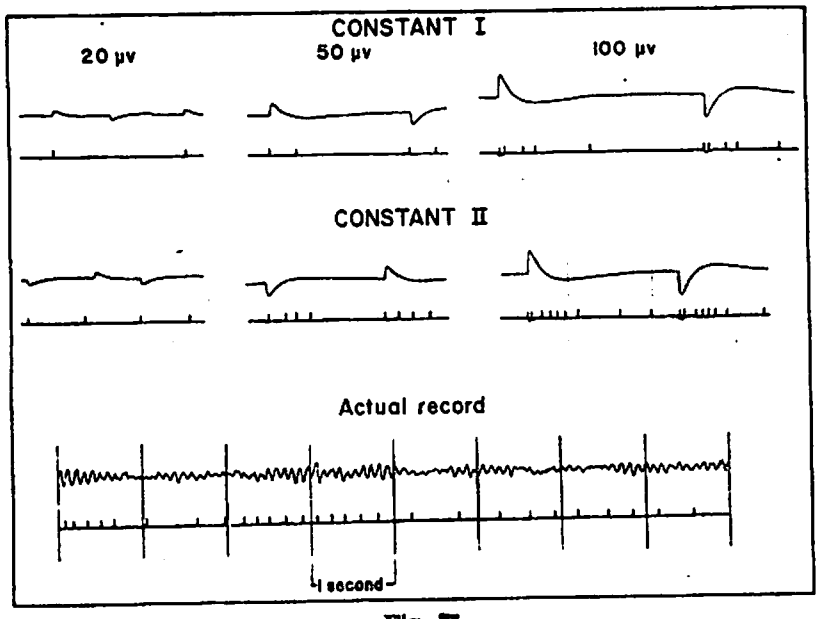

CONSTANT I
20 µv
50 µv
100 µv
CONSTANT II
Actual record
1 second

Fig. 5

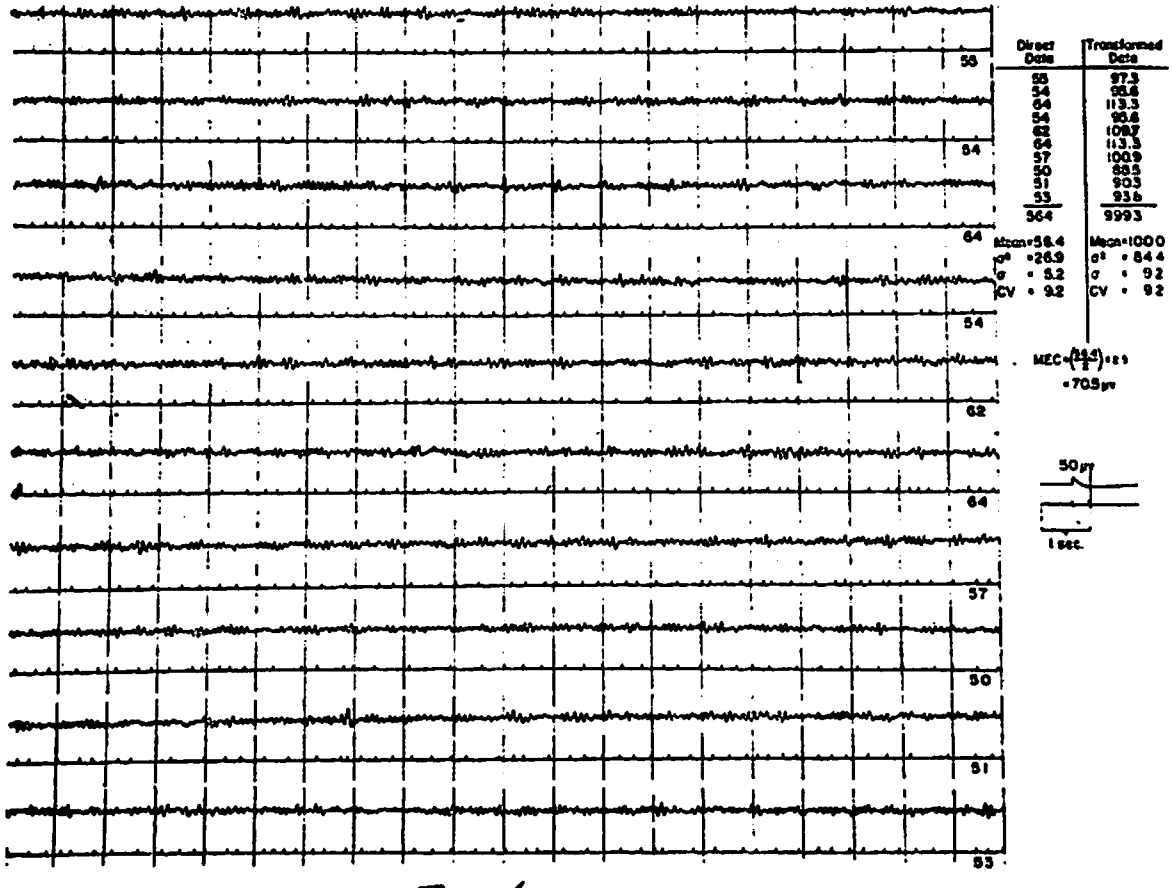

55
54
64
54
62
64
57
50
51
53
Direct Data
Transformed Data
55 97.3
54 95.6
64 113.3
54 95.6
62 109.7
64 113.3
57 100.9
50 88.5
51 90.3
53 93.6
564 9993
Mean=56.4
σ² =26.9
σ = 5.2
CV = 9.2
Mean=1000
σ² = 84.4
σ = 9.2
CV = 9.2
50µv
1 sec.

Fig. 6

Overall data on M.E.C.[1] and on C.V.[2] : 20 sec time basis

Type of subject	Number of subjects	Number of measurements	M.E.C.[1]	C.V.[2]
Non-schizophrenics				
Reformatory inmates	51	2330	36.24	18.62
Staff volunteers males	33	1550	35.85	17.52
Staff volunteers females	20	620	25.97*	17.42
Total	104	4500	32.68	18.52***
Schizophrenics				
Chronic undifferentiated	54	2148	35.05	9.18
Hebephrenic	15	548	37.30	10.02
Paranoid	20	769	32.77	9.98
Catatonic	12	455	36.00	7.39**
Total	101	3920	35.28	9.14***

* Difference statistically significant with values obtained on reformatory and staff volunteers (t-test) $p<0.05$.
** Difference statistically significant with any one or all other groups taken together (F-ratio) $p = 0.05$.
*** Difference statistically significant (F-ratio) $p<0.001$.
[1] Mean energy content.
[2] Coefficient of variation.

Fig. N 7

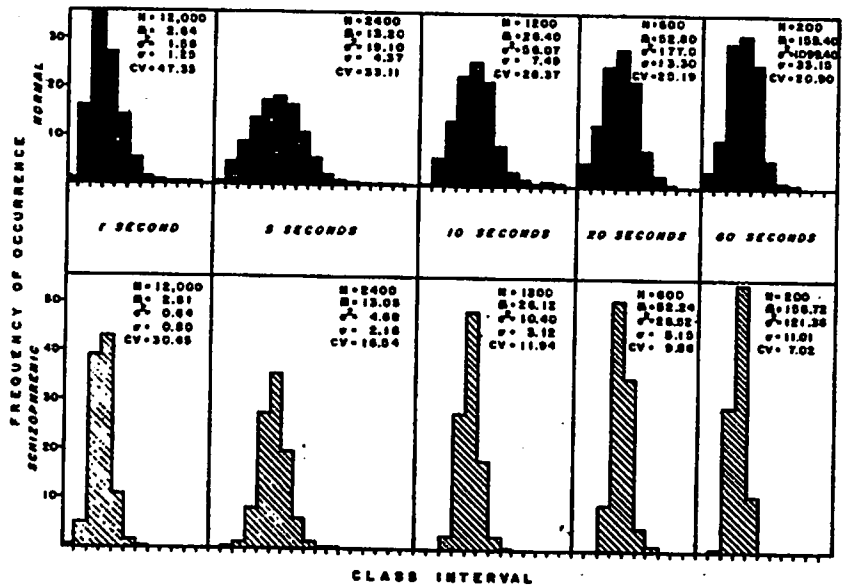


Fig. N 8

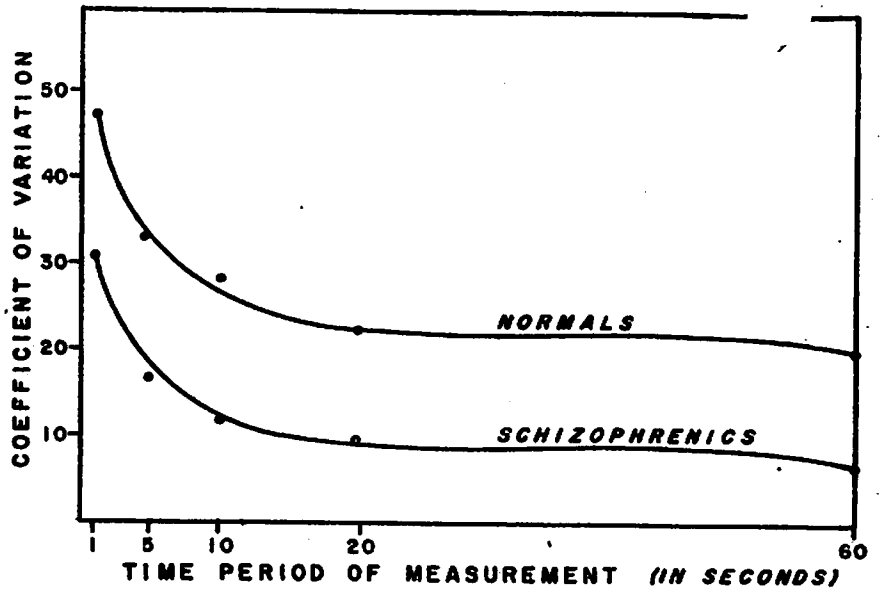


Fig. N 9

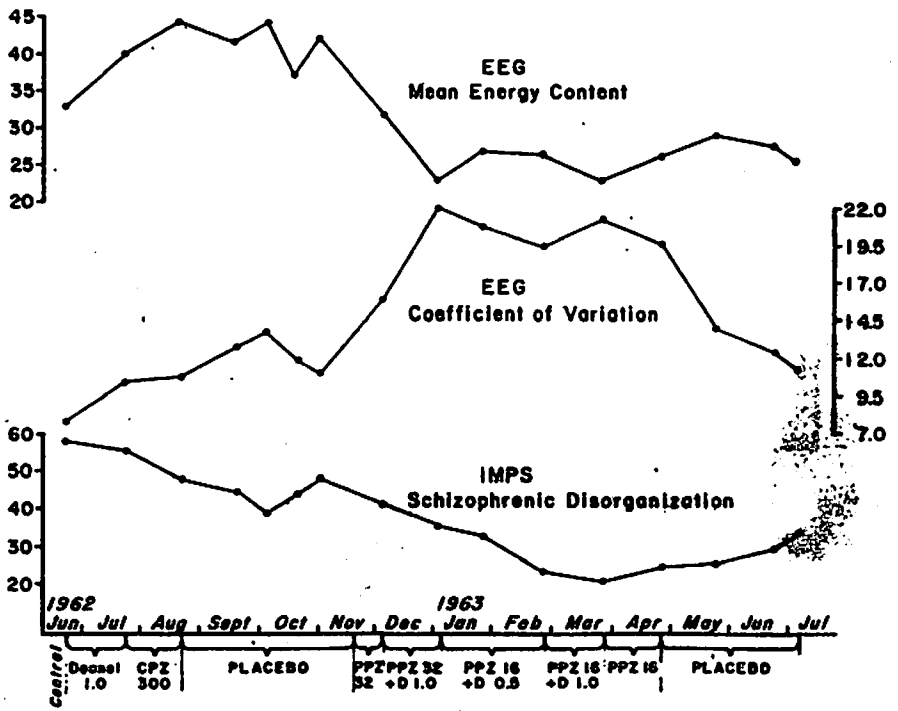


Fig. N 10

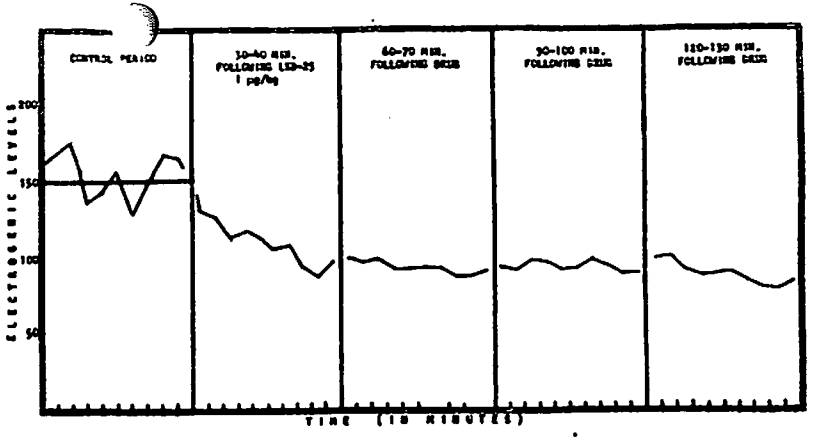


Fig. № 11

Dose of lysergic acid diethylamide (µg per Kg. orally)	*No. of subjects*	*Control period*	*Interval after drug administration*				
			30 min.	*60 min.*	*90 min.*	*120 min.*	*150 min.*
0.3	6	100 ± 17.6 (N = 171)	93.5 ± 16.8 (N = 179)	93.6 ± 14.3 (N = 179)	95.8 ± 11.7 (N = 179)	98.2 ± 12.8 (N = 180)	
1.0	13	100 ± 14.7 (N = 343)	93.8 ± 13.5 (N = 382)	85.3 ± 11.7 (N = 380)	77.3 ± 8.7 (N = 381)	78.0 ± 10.7 (N = 381)	74.1 ± 7.9 (N = 386)

Fig. № 12

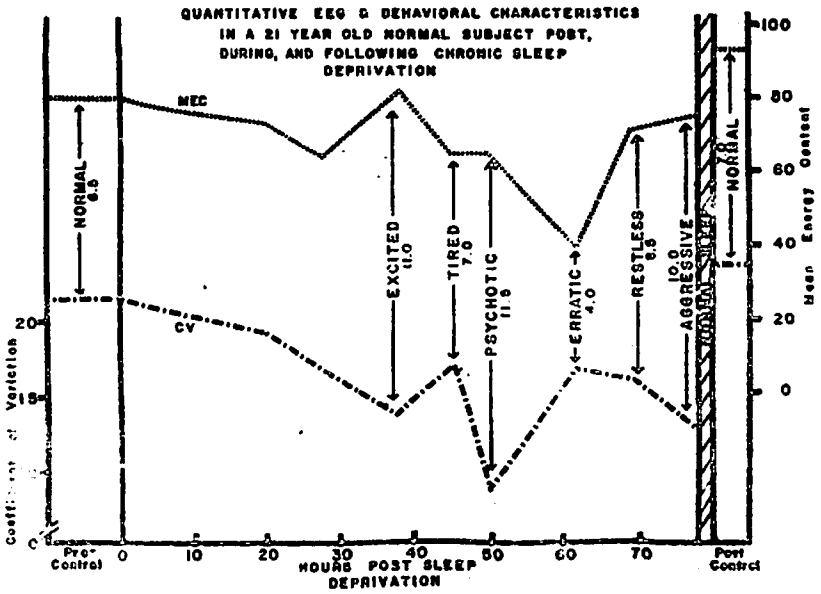


Fig. № 13

Time-course variability levels in integrated EEGs

Staff volunteers and mental patients

SUBJECTS	Number	Coefficient of Variation
Staff volunteers Males	12	14.04
Staff volunteers Females	12	15.43
Schisophrenics. Chronic. Males	14	11.84*
Schisophrenics. Chronic. Females	14	10.19*
Schisophrenics. Acute. Males	30	14.45
Schisophrenics. Acute. Females	30	12.43
Hallucinating during EEG	10	10.23*
Non-hallucinating	50	14.09

*Statistically different from staff volunteers ($p < 0.025$)

Data communicated by G. Marjerrison, A.R. Krause and R.P. Keogh. Saskatchewan Hospital. Canada

Fig. № 14

Slopes of Regression lines
(Mean Energy Content / Standard Deviation)
in Psychotic and Non-Psychotic Subjects

Line	Group	n	r	Slope
1	Male Staff	33	0.84	0.389
2	Students	81	0.56	0.132
3	Norm. Fem.	35	0.79	0.153
4	Alcoholics	40	0.51	0.122
5	Chr. Schiz.(2)	23	0.47	0.092
6	Chr Schiz.(1)	46	0.54	0.068
7	Catatonics	9	0.54	0.056

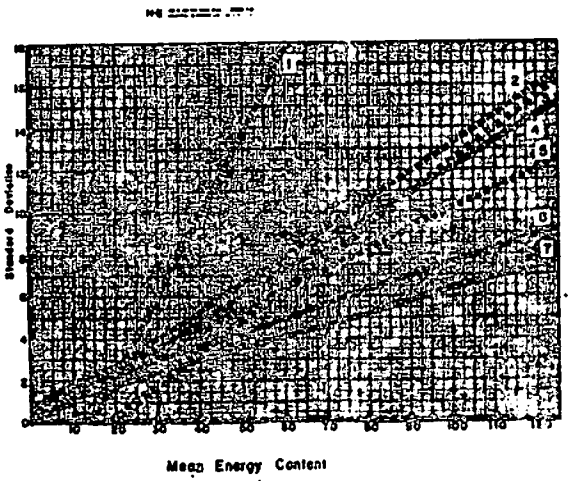


Fig. № 15

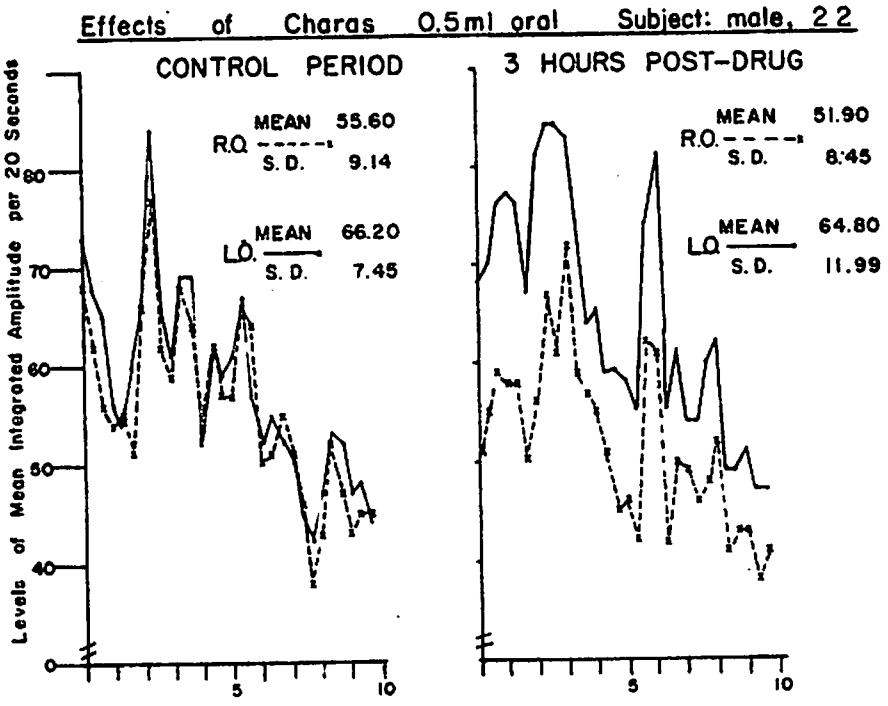


Fig. No. 16

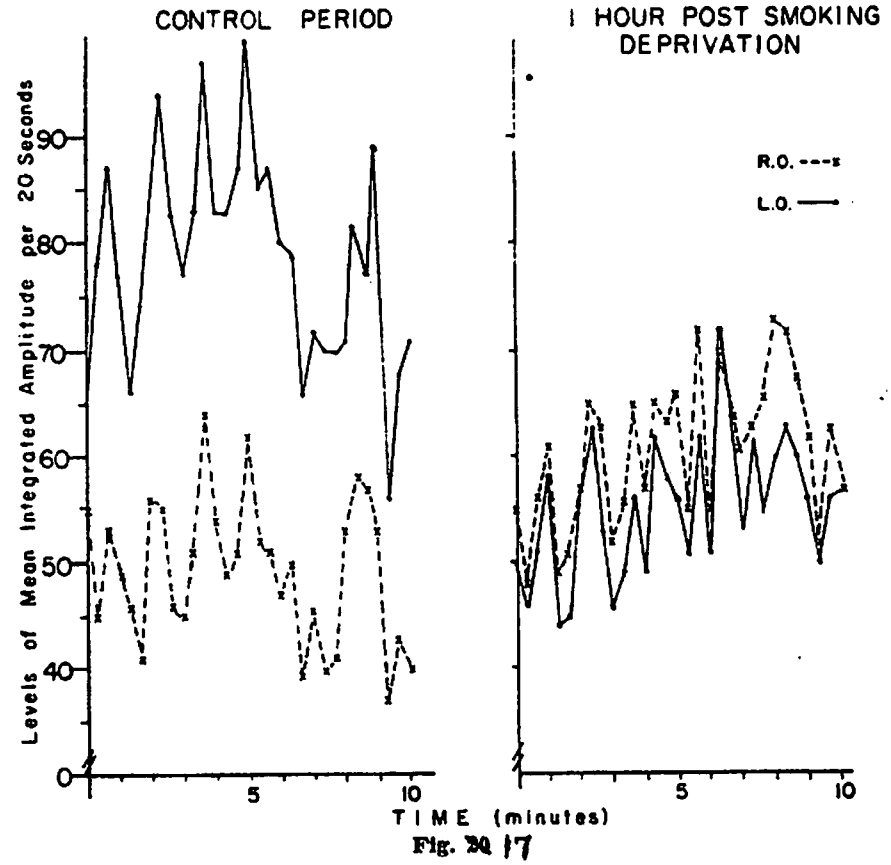


Fig. No. 17

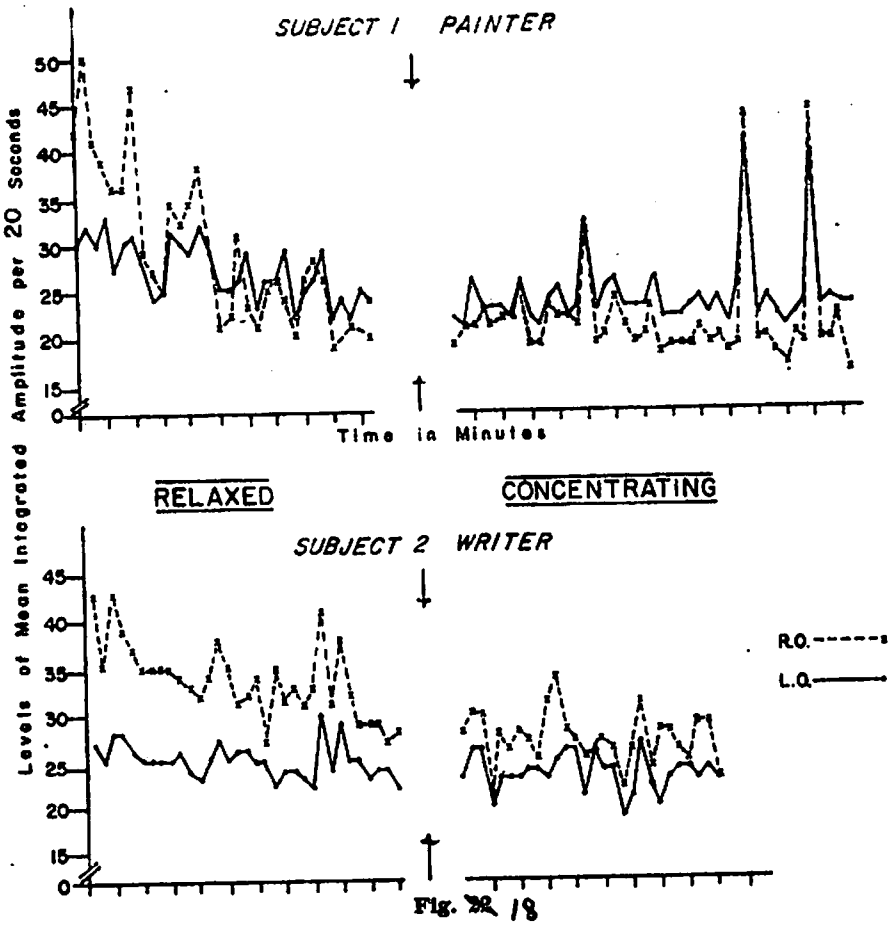


Fig. 18

States of Consciousness	Levels of arousal	Levels of EEG variability (expressed as C.V.)	Laterality relationships
Catatonia	Very high	7-8	?
Other types of schizophrenia	high	9-12	?
Hallucinations (either in patients or induced in normals)	high	10-12	?
Anxiety states	high	10-12	very close
Creativity	high	12-15	very close
Normalcy (daily routine)	Average	15-25	close
Euphoria	low	20-35	far apart
Drowsiness	very low	25-45	close
Stage-4 Sleep	---	20-25	close
Stage 1-REM Sleep	---	10-15	far apart

Fig. 19

Very lately, only last week, I have been doing some work with Dr. Haronian in which we have tried to apply the same method in order to induce changes in the states of consciousness and find out whether or not our method would permit us to detect them. Dr. Haronian will now pass around copies of a graph (see next page. Ed.), which I made very hurriedly - for we did not have time to have a slide made for this meeting.

What we have here in the graph: Column C represents the control state of this subject; then columns numbered 1 to 12 represent states which Dr. Haronian induced in the subjects. On the left is a scale of the mean number of pulses per second, calculated on one-second periods, and on the right is the scale for the variance of the distribution of these pulses. Remember, in most of what I showed you before, the time base for measurement was 20 seconds, but here we have 1 second. When we accumulated 100 such measurements we calculated the mean and the variance. The first column C corresponds to the pre-experimental control situation; the subject is lying down in a soundproof room; next to him sits Dr. Haronian. Now, Frank, will you take over and tell us what were 1, 2, 3, 4, etc.?

Haronian: Carl, our subject, is an 18 year old Princeton junior who is able intentionally to induce changes in the state of his consciousness. Carl has been trained to go into hypnosis on his own for the purposes of an altogether different experiment.

Condition #1 represents a three-minute period under which Carl was under self-hypnosis.

Goldstein: You will notice that in that period very little change occurred; the amplitude went up a little, the variance down a little - nothing remarkable. Therefore, self-hypnosis does not seem to produce great changes, as judged by this method.

Haronian: And we had a second subject who gave similar results - hypnosis by itself did not seem to produce any considerable changes in either the amount or the variability of electrical activity. That other subject is a 32-years old woman who goes into hypnosis instantaneously to a key word.

Column #2 shows the most dramatic single change and this happened when I said, "Carl, I want you to bring yourself back to your normal state of consciousness."

Goldstein: And this is remarkable, for what happened here was a very considerable increase in both quality and variability. And I was surprised; but then with our second subject, the woman, the opposite phenomenon occurred, namely, a kind of abrupt decrease in variability when the subject came out of hypnosis. In the case of Carl, we have an increase in the mean and the variability that suggests relaxation, but in the case of the woman, both the mean and the variability went down which suggested extreme anxiety. So, the change that occurs does not necessarily go in the same direction. Of course, we need to measure many more subjects than just those two before we can say anything definite.

Haronian: Regarding the woman, she always resists and resents leaving the hypnotic state and it is always with a little urging on my part that she comes back to a "normal" state. And what you found on her EEG, the lessening of variability, would correlate nicely with her conscious state as I have observed it. But with Carl the opposite occurred. He was considerably comforted as he was coming out.

We are interested in the effects of various kinds of mental imagery, so we tried a number of different things. Column #3 shows the results of the first attempt in that direction. The images that we used varied from abstract, unemotional kinds of material (such as a red circle) to material that was much more intensely emotional. In this instance, I showed the subject a card with a red circle drawn on it. I asked him to look at it and then to close his eyes and to visualize it as intensely as he could for a few minutes.

Goldstein: You can see that the variability went down dramatically. This is something that we have found under other similar circumstances - whenever a subject really focusses his attention very intensely on something, there is a dramatic drop in variability. Again we are back to that very bewildering phenomenon, and if we have time later, we might discuss it. There are various lines of approach to this problem. Here, we have a drop of variability from 3.8 to 0.8 which is a fantastic fall in variability. The two states follow each other very closely in time. Those changes did not occur over one hour, but over one minute - they were very dramatic and almost instantaneous. This was something that impressed me greatly.

Also, for those of you who are acquainted with clinical electroencephalography it should be pointed out that through all these states except state #7 we always had alpha waves present. If I had given that record to any classical clinical electroencephalographer he would have told me there was no change whatsoever - except at #7 where suddenly a lot of beta activity appeared. In all the other states there was no change detectable with the naked eye.

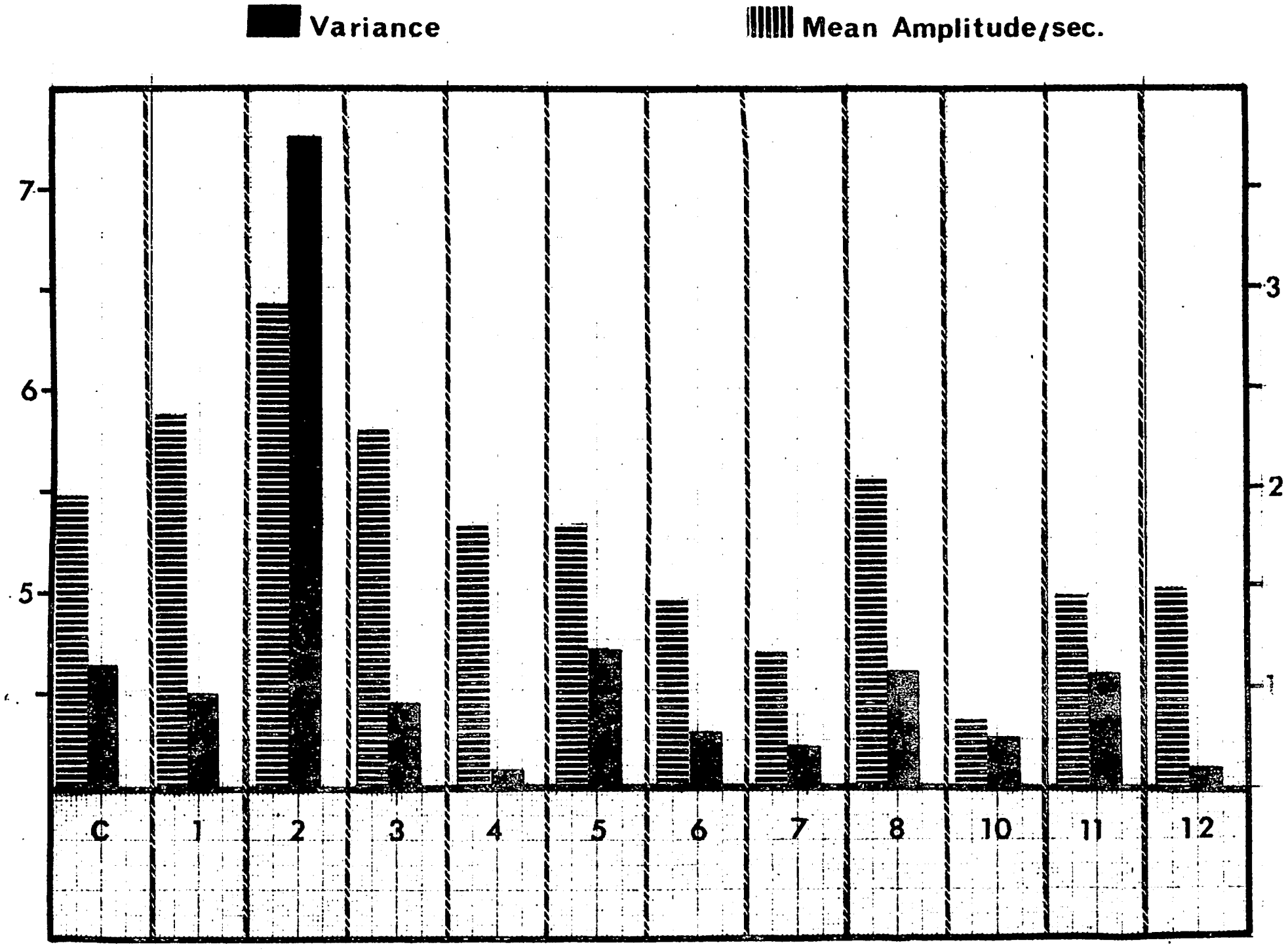
Haronian: #4 was a rest period; so we expected it to resemble the base line, C, although it certainly did not in variability, the output was pretty much the same. Would you like to comment on why, Leo?

Goldstein: I don't know. The only explanation I have is that it took much longer for Carl to bounce back to the control situation. The change that you induced in #3 was carried over, apparently, to #4. That is possible, but it is something that has to be studied. We will have to repeat that experiment. There might be a time element here; when we speak of instantaneous changes, I think they will occur when you induce a very dramatic change. But when you say to someone "Now try to regain your normal state," there is nothing dramatic about that, so he may or may not be able to erase from his brain what he was experiencing the minute before.

Haronian: Experiment #5 resembles very much the control state. I should explain that Carl can, or thinks he can, induce in himself a state which he calls "the experience of the self"; he can induce it by himself, simply by some kind of manipulation of his consciousness. He calls this "a self-induced self-experience," and as you will see, it resembles the control state very closely (as does #11).

It was a pleasant experience for Carl, but the EEG pattern certainly does not suggest that there is anything very dramatic about it one way or the other.

Column #6 shows a period of three minutes or so in which I was reading to him Roberto Assagioli's Dis-Identification and Self-Identification Exercise. And there you can see a substantial change in which variability drops below the control period. I want to compare that with #8, which was the Rose Exercise. I read to him the Exercise of the Rose which is given in Assagioli's book,


Variance
Mean Amplitude/sec.
7
6
5
3
2
1
C
1
2
3
4
5
6
7
8
10
11
12

Psychosynthesis. This was consciously felt by Carl to be quite pleasant, and if you notice the increase in variability over #7, it fits in - at least I think it fits in with the conscious experience of pleasantness. Now the Rose Exercise is one which requires a great deal of visualization whereas the Dis-Identification Exercise, although it is also a psychosynthetic exercise for evoking the self, has a lot more abstract conceptualization. So I offer this as a possible explanation of the difference in the EEG in these two instances. When one is dealing with more abstract content that requires more analytical thinking in order to concentrate on it, there is a tendency for "hyper-regulation" i.e., for the lower variance to appear. But when one allows himself simply to follow the imagery as in the rose experience in which the subject was listening to me describe the rose coming into full bloom, etc., when one does not have to think in abstract terms, then the variability increases, there is more relaxation, and there is a distinct sense of comfort.

The exercise - at least in this one trial - seemed to have opposite effects both in consciousness and in the EEG.

Now #7 was a very dramatic change, and in this I had the subject visualize a person who was emotionally important to him. I did not specify either positive or negative, but when Dr. Goldstein looked at the record, he was sure that Carl was having a negative experience. Subsequently when I went back and asked Carl, he told me that he had been thinking about something rather frightening at that time.

Going ahead to #10, this was again the recalling of an unpleasant experience which I promised Carl not to reveal. (Goldstein: This was the most dramatic change of all and he must have been very scared at that point, I would say.) In this instance, I had Carl tell me about this event in advance, and I had recorded his verbal account. During the EEG session I played back Carl's recording to him so that he could listen to his own voice talking about the experience. It was during this that #10 was recorded.

Column #11 represents recalling a pleasant experience (Goldstein: Here we can see that Carl was able to counteract the very negative state which he was in in #10 - the readings came back nearly to the control levels.)

Column #12 was again self-hypnosis. Perhaps the most interesting thing here is, if you look at the relationship between C and #1, between the base line and the first self-hypnosis, and then again between #11 and #12, which were the pleasant experience and the second self-hypnosis, the movements in both cases were in the same direction. In both cases, there was a change to greater electrogenesis and lesser variance. We don't know just what that means at this point, except that certain consistencies developed in this first attempt at studying the effects of mental imagery and psychosynthetic techniques on the EEG with this one subject.

Goldstein: So now if I could summarize, I would say that although we do fully realize that like any other method this approach has limitations, I think that it also has a certain amount of promise to it in that by the study of the two parameters, namely, the amplitude and the variability, we can indeed predict changes in states of consciousness. And it seems to me, as was mentioned by Dr. Haronian, that we could even give some clues to the psychotherapist as to what kind of changes are desirable - be it the Rose Exercise or, on the contrary, some more abstract thinking. We could probably - although I am not convinced - make

a judgment from the initial state and the measurement of the two parameters as to the initial state of the subject; also,within the framework of a long range therapy, or as in a very brief therapy, whether or not it will induce changes. What I would like to say in closing is that one of the obvious advantages of that method is that all that it requires is an EEG machine - which unfortunately is expensive - a little black box that costs altogether $700. We deal here with a very elementary type of analysis, but it seems to me that to spend hundreds of thousands or a million dollars on the most extraordinarily complicated analytical tool to deal with brain waves about which we know nothing is at this point kind of ridiculous. Let us first learn more and more about what brain waves are, how brain waves change; and I think we have here one lead, however small of some key changes. The one that impresses me more than anything else is the change in variability, because for the biometrician this is the key to an understanding of the system we are dealing with.

* * * * * * * * *

DISCUSSION

Wolf: In the catatonic state, where you have the variability so much decreased, would you say that this is a chemical thing that happens?

Goldstein: This is the position that a number of people are taking; namely, that there is a built-in stimulating substance - some kind of endogenous LSD - and th' catatonic is the one who has most of it, or who least knows how to metabolize it But there is no evidence up to now which permits us to say "yes" or "no." As you have undoubtedly heard, there are people who believe in the edrenochrome theory, in the auto-immune theory, and in many different things, and some therapy has been developed purely on that basis. Dr. Hoffer claims that there are methyl groups scattered all around the brain; for instance, vitamin C will scavenge the nicotinic acid group and consequently the patient will be cured.

I think it is wonderful to go on with that and undoubtedly one may eventually end up with a major discovery; however, I do not know that there is any one indication that this is indeed the case.

Wolf: The fact that this remains stable for such a long time - this variability - in so many cases, would it not, in itself, suggest a sustained action biochemical stimulant?

Goldstein: Yes, however you will be in trouble to explain, for instance, the similarity with the effect of LSD in a normal subject. Would you then say that LSD produces the appearance of that which is present in schizophrenics, because don't forget that the low variability induced by LSD goes on for hours and hours? I showed you on the chart the readings after an hour and a half, but after nine hours it is still there and after 22 hours subjects under LSD are not back to the base line. So you would be in trouble to account for that unless you say it is another medianism that produces the same change; I don't know. The head of my department, Dr. Pfeiffer is a firm believer that all forms of mental disease are primarily organic diseases due to the accumulation of something or the metabolization of something; and now he is very much involved with histamine, spermine, spermidine and uric acid. If one were to count all the chemicals that have been involved you would end up with hundreds of them. At one

time people were claiming that it was thyroxine. Today I had lunch with a man who is a firm believer that it is adrenalcortical hormones which are involved. The trouble of such stories is that you can always find arguments in favor but you'll always end up with finding arguments against the theory. At one time there was a magnificent finding of a group of 12 schizophrenics; all 12 responded very abnormally to atropine. Now that was thought to be a great discovery; but unfortunately, the next 12 responded very normally.

There are differences; and one difference that impresses me most is the following: If you take normal subjects and give them chlorpromazine the EEG mean amplitude goes up and the coefficient and variation goes down. Now when you give chlorpromazine to schizophrenics the mean goes down and the variation goes up. How do you account for the difference? When you give it to schizophrenics it makes them essentially sleepy. Normal people don't like chlorpromazine; they are furious when you give it to them; they are not sleepy but they are simply incapable of operating - and in their case the means goes up and the coefficient variation goes down. There are other such differences between normals and schizophrenics. The fact that they are biochemical is, I think, unquestionable, but what is the chicken and what is the egg; are the biochemical changes by-products of the changes in consciousness or is it the other way around? I don't know.

Swartley: Do you have any evidence on the controversy as to whether the LSD experience is more or less schizophrenic-like? Bernie Aaronson has some evidence that it is the opposite of the schizophrenic.

Goldstein: That is a tough question. It is difficult because of what you mean by "more or less like schizophrenic" - what kind of definition will you give? I am not a psychiatrist, as you know, but what I would say is this: the type of psychosis that you get under LSD is not the same as the one you get in chronic schizophrenics. Under LSD you have visual hallucination, whereas in the chronic schizophrenic you get more auditory hallucinations. That is only one difference, and behaviorally there are others. What we did find under LSD which resembles very much the state of the schizophrenics is the great decrease in EEG variability. Another notable difference is that if you take normals and you give them LSD the mean goes down and the variability goes down; now with schizophrenics there is the same reduced variability but their mean is indistinguishable from the normals. So there is a difference here. The global amplitude in the schizophrenics are not different from normal subjects. Variability is different; our normal subjects under LSD will have the reduced variability of schizophrenics plus a reduction in the mean amplitude. Their amplitude will be lower than that in schizophrenics; so the state is not the same although it has a common factor which is the variability. That is as much that I could say at this point. Does that answer your question?

Swartley: Yes, that answers half of it; but there is a further one. Bernard Aaronson has had people in the so-called mystic state, and I wonder if you have any recording on such states.

Goldstein: No, I have no recordings. There are a number of experiments I would like to do - the mystic state, the out of body experience, depersonalization, so many fascinating ones I would like to study. I hope to be able to make recordings sometime. The symbol that stands in the way is $!

Swartley: Is your apparatus such that you can get quick readings?

Goldstein: Oh yes, you get it immediately. As soon as Dr. Haronian presses the button to tell me to start, at that very moment I start my counting and get the results immediately. All I have to do is count the pips, (which can even be done on-line). Under this type of analysis if you push the gain of your amplifier you can go down and measure electrical activity on successive intervals of 1/5 of a second. You could make a diagnosis as to the mean amplitude and the coefficient of variation in 10 to 15 seconds. That would be quite enough. In animals we do that routinely. The other day I had a visit from a neurologist from Ohio State; what he studies is a so-called Alpha-block. In such studies you have a subject having nice Alpha waves; a strong sound stimulation is produced and you get a disappearance or blockade of the Alpha waves. And in view of the work of Silverman and others the time between the stimulus and the disappearance of the Alpha - the so-called reaction time - should be smaller in schizophrenics, since they are more aroused and more reactive. In fact, nobody has found anything by looking and simply measuring with the ruler; but what we did was to use an integrator; we took as a standard of measurement 1/10 of a second. The successive measurements were cumulated, that is, we added the successive values, one to the next one. When the changes produced by the stimulation occurred the slope changed very abruptly. Now we are going to do some work with integrators where we will be able to go down to maybe 1/100th of a second; and under those conditions I expect that we might find a difference, as this is a very exact, very precise way to pinpoint the time of change.

Parks: I wondered about the influence of other variables; for instance, if you take one patient, or one normal, over a number of years what do you see?

Goldstein: That is an excellent question: In other words, how normal is normal? What happens in time? I am writing a paper which I will be submitting soon in which we have 16 normal females and about 20 normal males and about 20 Bordentown boys (reformatory inmates, prime offenders - not really bad, the first time they have been in trouble). And one of the most dramatic stories is that of my secretary - I always show it to everybody because it came out so beautifully. When she first came in to work in our laboratory and she discovered that she was going to deal with statistics she was scared, because she thought she could never do that type of work. The variability of her EEG remained quite low for the first three months; and then she discovered that, after all, there was nothing to the job, that it was just a question of patience and education, and then variability went up very nicely. Incidentally, she was recorded once a week. At that point she discovered that she would get better salary if she had a master's degree, so she went back to night school to learn statistics; that did not work out for she got into a very difficult class, way above her head, and there was a most dramatic decrease in her variability; and that lasted until she dropped school and she decided that she did not want to do it any more - and then it went back to a nice high level. Next - she is a married woman - her husband decided to buy a home, and the home was bought against her will; the variability of her EEG went down. When she realized that she could pay, it went up, but the last recording is the most interesting of all for during all this time she had been on contraceptive pills and then one day she and her husband decided they would have a baby, so we recorded her one last time (she would not take any drug because of possibly harming the baby), and the variability had gone way down. This was remarkable.

Incidentally, it was she who discovered this; she brought me the records and said that she could explain why it had gone up and why it had gone down - and this was long, long after she had stopped taking the pill. But it was not her interpretation of the data; the data was already there, and she simply told me she could recall events that would explain it. We have a boy working in our laboratory - an EEG technician, a normal man, married with two children; his wife works; an average couple shall we say - and you will find that in time there is quite large variability in his EEG. Now I don't like to ask personal questions so I don't ask when his EEG variability is very low whether he had an argument with his wife at that time, or anything like that; but the fact is, you will find that it varies most extensively. On the other hand, in our Bordentown boys it tends to be lower and to remain much more constant. They are operating in what I would call a subthreshold continuous anxiety state. But one thing surprised me: as they were nearing their time of release I thought EEG variability would go down, but it did not.

Parks: What about age? Is there a difference between the young person and the older?

Goldstein: Our experiments have been restricted to the age brackets 18 to 45. Dr. Pfeiffer is at present doing work on children, but children are notoriously difficult because their brain wave is so big and because it is difficult to get them to lie still with the eyes closed. One of the shortcomings of that method, although I did not mention it before except very casually, is the question of artefacts. Among schizophrenics, some of the most interesting could not be recorded at all because they swallowed all the time; they refused to close their eyes; they moved; they ground their teeth and did all kinds of nonsensical things.

The other day we ran into unexpected trouble: Frank Haronian was giving an hypnotic suggestion to a lady and threw her in such a turmoil that the electrodes went off and we had nothing but artefacts. It is a method that requires a number of precautions - I know that such procedures can bias analysis, but these are the rules of the game.

Parks: Suppose you take a chronic schizophrenic over a length of time?

Goldstein: You get a straight line - the most amazing straight line. However there are ways to change the patients, especially the catatonics; if you protect the periphery with a quaternary atropine, give them an inhibitor of cholinesterase they will wake up - and for 30 minutes they will move and will talk and at that point their brain wave variability shoots way up. That you can do; but if you don't do anything, you simply get the straight line. In the beginning we used to think it was because they were scared, scared to come and lie down; so we brought them over and over again with a reward system so that they were so comfortable that in time they would come in and lie down themselves, but that did not affect their brain wave variability at all.

Smith: I wonder if you have done any experiments on the effects of noise - I was thinking of the metropolitan conditions, of constant noise.

Goldstein: No, but that would be one of the subjects that would be most interesting. The negative aspect of all our work is that it is done under "abnormal" conditions; it is not normal for a person to be in a room with all the EEG machinery. And yet the problem is very easy to solve because now there are telemetry devices - I heard today that for $175 you can have an EEG telemetry

device that only weighs 20 grams and which will broadcast the brainwaves quite a long distance. So hopefully, if we can get some of these, we can have the subject lying in his bed or being in the street exposed to pneumatic drills and hammers. I hope that we will be able to do that, but up to now we do not have any evidence of it.

(Undecipherable question from Dr. Smith. Ed.)

Goldstein: No, I have been so wrong in my predictions. There was one prediction I made when we came to New Jersey when it became apparent that we could record schizophrenics and I remember a meeting with Dr. Sugerman and Dr. Pfeiffer and when we wondered what we were going to find I said "the variability in schizophrenics will be 60% higher than with the normal." And it turned out to be the exact opposite!

Dr. Drohocki used to say: "Think logically and then turn it around and that is what you will find in the brain!"; and this is really true, for in a great number of cases the brain seems to operate in exactly the reverse way to what you would expect in terms of logic.

Winston: Can you tell us why, even if it is only a guess, why the variability of brain wave should decrease with hyperalertness?

Goldstein: That is a good question. There is a group of people who call themselves cyberneticians and one of them is W. Ross Ashby, and he has been fooling around for many years with an electronic device which he built and called the homeostat. The homeostat is a device which operates best at a certain pre-set ratio of voltage input and output. Ashby has shown that there exists a certain critical relationship between the variety of states the homeostat can be put in and the variability of what is fed in. If you reduce either one or the other the machine will go beserk. And this is what you find in sensory deprivation, in sensory monotony, and what you find in schizophrenia apparently.

Winston: And in the situation where you knock out the input there is also a reduction in variability?

Goldstein: No! on the contrary there is an increase in variability. The pet subject of Dr. Margerisson is sensory deprivation. He found that in a very short time the variability of the EEG of the subject goes way up. You could expect that, because now you have too much "regulation" available for the amount of "input". In other words, if you think of the brain as an interdependent machine, if you reduce the input there will be too much variability for the amount of material to be processed. Up to the time that I read Ashby's book I was very unhappy about that hypo-variability, but now, reflecting back, I can see that that is what you should expect to find. If you decrease the regulating capacity of the system, the system will tend to become more and more unpredictable in behavior, and that is what you have in schizophrenics. Interestingly enough you have a combination of stereotyped behavior in that the patients will do the same thing over and over again and at the same time they will do stupid things, so that you would say that their behavior is unpredictable and they will take much longer to do something than normal people. So this agrees with Ashby's model I think.

Winston: How does this apply to the results with LSD?

Goldstein: I think LSD removes part of the regulating capacity of the brain.

As I tried to point out at the seminar where Dr. Houston spoke, it is not impossible that the brain is made up of a series of homeostats and they can cancel each other's effects in certain cases, or they inhibit each other; and if you knock down some of the channels of regulation, part of that inhibition will be lifted, with the result that some of the potential changes in the brain will occur which are usually not occurring when they are under control. It is very possible that the visual imagery you have (under LSD) would occur at all times if you did not have the regulating mechanism to prevent it. Now since LSD abolishes those regulators we do get into those hallucinatory states.

Cooper: From a forensic or legal standpoint could this be of any value to a court of law to determine the state of sanity?

Goldstein: I doubt it very much. Remember the controversy over Lee Oswald; Dr. Gibbs was claiming that Ruby was an epileptic; even epilepsy which is a well defined EEG change was not found acceptable in a court of law. With our approach, the question of insanity is one or even two steps removed; so I doubt very much that it could have any legal value. But what I would say is this: If you get from such a method an indication of hypo-variability then you could try other approaches - that is, you would be in a better position to push your idea that you are dealing with a schizophrenic. Sometimes, after looking at quantitative data, you see changes and then you go back to the original tracings and you can see them then, but you had not seen them before because you did not know what to look for. The EEG is an enormously complicated signal and as long as you do not know what to look for, you do not see it. And I feel that many people who say "there have been absolutely no EEG changes" would be extremely surprised if they looked at quantitative data and if they went back then to look at the tracings they would see changes.

Brodbeck: Suppose you were able to feed back to your subjects the EEG results they were producing, what do you think might happen in terms of the subject controlling his state of consciousness to produce a variability in the results?

Goldstein: Yes, this can be done. I have just read three papers by Barbara Brown. On the basis of frequency analysis you can distinguish in the human EEG at least three basic activities: one, the alpha activity, 8 to 12 cycles per second; then you have the Beta activity which is anything above 18 cycles per second; then you have the so-called theta activity which is say 3 - 6 cycles per second. Now, what Barbara Brown did, was to feed from the EEG to a battery of filters. Every time the filter 8 to 12 cps was acted upon a signal was produced and a blue light appeared. Each time the beta and theta were acted upon, a red light and a yellow light appeared, respectively. Then she said to the subject now try to light the red light or try to light the blue light, and it is amazing how very quickly they were able to do this at will. When we asked the subjects how they lighted this particular light they answered, "It is easy, all I did was to think about something that is very, very annoying." When she asked "How did you light this other light" the answer came "Well, I relaxed." The only one that did not work well was the theta-activated one; sometimes the subject could do it and sometimes could not, and I have no doubt that if you had a system of clues as to how successful their efforts were they would be able to do this also.

At Emory University I had one room for both human and animal work so my subjects would lie on the table and the machine was just at the back of them and they could hear the pulses produced by the integrator. Some of my subjects would say "Doctor, I am going to increase the number of your pips!" or "I am going to reduce the number of the pips," and they could do it.

Brodbeck: If you could add environmental stimuli which you know has some relationship to this, that might be interesting....(Goldstein: Very much so!)

Cooper: Regarding this work in which you drive the cps rhythm up by mental work, would sound increase the variability?

Goldstein: Yes; you can do that by changes of the frequencies and by auditory and visual stimuli. I am sure that you can change their ability, except schizophrenics; I don't think you will achieve that with schizophrenics.

Haronian: An idea that comes to mind here: could you telemeter electrical activity and have an immediate visual display that shows me, while I am working with my patient, what the direction of change is immediately after there is an interchange between us of some sort or another, so that I could then know how the patient seems to be reacting electrically, and if this jibes with the expression on his face, so that I could have a constant comparison between the two?

Goldstein: Yes, it could be done. I would not be a very big problem. (Haronian: I think this would be a very useful thing.) Oh yes. As a matter of fact, my director, Dr. Pfeiffer, is treating large numbers of acute cases with drugs and relies very much on the EEG to find out the effectiveness of his therapy. He will shift them from one drug to another according to whether or not their EEG coefficient of variation is increasing or not. It is very highly significant that whenever brain wave variability is increased their condition improves.

Haronian: One other thing I would like to ask you about: has there been a normative study of the coefficient of variation on normal subjects as to show what the normal range is?

Goldstein: Well, as we mentioned, this is something that you cannot say. The normal individual is essentially a time variable animal, and it depends entirely on, say, the day of the week. You know that Arthur Sugerman found definite changes in female subjects before ovulation and before menstruation. So I don't know that you can describe a fixed value or say that anyone who is not 50% is abnormal, etc., for this is not true. What you can say, however, is that whenever you get five successive recordings - or even three - and they are amazingly constant at a certain level, then I would begin to be a little suspicious that the individual is not normal. The normal individual should be going up and down. Another thing is to record them for one hour; a normal person cannot remain awake for one hour with his eyes closed, whereas a schizophrenic can remain awake for hours with his eyes closed and lying down. But to answer your question, we must be approaching now 3,000 recordings of normal people; so we have piles of data of what is "normalcy" but I don't know that there is a unique value - the most changeable thing, the most predictable thing, is the amplitude of brain wave where for some absolutely mysterious reason people will have alpha waves, which are big or small, and constantly so. When no alpha waves are visible you have to filter the frequency to find out it is there, because by looking at the record you do not see anything, you don't see any trace of alpha. I am one of these; you won't find any alpha waves in my brain - maybe that is because I do not have any brain at all! (laughter). But what that means, I don't know. I don't think it has anything to do with brain function. Don't forget that you record through the bone, through the diploiea, through the skull; you go through a large number

of tissues. What has always bewildered me is that you get different activity in different parts of the scalp; because I should think there should be a complete short circuit of all the activities, but apparently not.

Winston: Have you worked with any part other than the occipital?

Goldstein: Yes, the parietal for sleep studies. It is very important to use the parietal for that is where you have the maximum change - but only for sleep. Otherwise, we have restricted ourselves to the occipital. It is where you have the maximum alpha, and the alpha waves are the most variable and prominent of the brain activity.

Brodbeck: Have there been any attempts to measure the forms of EEG activity between wide differences of culture.

Goldstein: No, but it should be done; but it is awfully difficult to get people to use an approach like that. Either they will tell you "It is much too simple" or they will become completely opposed to any quantification. A lot of people don't want numbers - numbers scare people to death! Medical people are trained mostly outside quantitative methods and they are scared by numbers - but, of course, there are exceptions.

End of discussion

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