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COMMENTS

TRANSLATION

Translator's Note:

"Qigong" is a Chinese system of breath control. The terms "Rujing", "Baihuichuqi", "Chutu", "Faqi", "Fazi", "Shouxiadantian", "Bihuan" and "Anjingbiyaw" apparently refer to specific exercises within the Qigong system, each of which has a corresponding mental state. The only one of these I could find anything about is Shouxiadantian, which involves breathing deeply from the abdomen. Translated literally, "Rujing" means "entering quiet", "Baihuichuqi" may mean "a hundred assemble and exhale", "Chutu" may mean "exhale patterns", "Faqi" may mean "generate breath", "Fazi" may means "generate words", "Shouxiadantian" is literally "guard the public domain", "Bihuan" means "close the ring", and "Anjingbiyan" is literally "peace with eyes shut".

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The human brain is regarded as a great system, having many kinds of functional states. The Qigong functional state may be a distinctive state among these. The use of various technical procedures to analyze the functional states of the human brain, and especially of the Qigong functional state, is of great significance for understanding the physiological mechanism of Qigong and for developing uniform research of the physiology of the human brain.

In recent years, more and more interest has been developed in physiological research of Qigong: in particular, it was the discovery of a series of extraordinary abilities of the human body which led to investigation of this area of science. There are also people abroad who pay attention to and research some of the special states of the brain, for example, the state of hypnosis, twilight sleep, reverie, fringe of consciousness, preconscious state, off-conscious state, transliminal exponence, etc. There has also been much attention paid in recent years to research into biofeedback which is related to this. What is still lacking, however, is thorough study of neurophysiology.

We shall try to use brain function measuring technology to conduct brainwave analysis of the Qigong functional state and study the place and function of the human brain in the extraordinary abilities of the human body.

Method

We made brainwave recordings for six test subjects (No. 1-6) who had the Qigong function. See Table 1 for the Qigong training and testing conditions of the six subjects.

TABLE 1.

Test subject	Year in which Qigong training began	Test items participated in
1	1980	Rujing, Baihuichuqi, Chutu
2	1979	Rujing, Faqi, Baihuichuqi, Fazi
3	1978	Rujing, Baihuichuqi, Shouxiadantian, Fazi
4	1977	Rujing, Baihuichuqi, Shouxiadantian, Bihuan, Fazi
5	"Many years ago"	Rujing, Baihuichuqi, Shouxiadantian, Fazi
6	"Long time ago"	Rujing 1, 2, 3, 4

In order to reduce interference with the test subjects' Qigong state, the number of electrodes was reduced as much as possible, and based on the experience of this laboratory, we recorded the frontal zone (Fz) and occipital zone (Oz) single-electrode brain waves. The time constant of the system enlarged by bioelectricity is 0.3 sec, and the high frequency wave filters are 30 Hz (No. 1, 2, 3, 4) and 60 Hz (No. 5, 6). The results, which are

stored on a magnetic tape, go through a modular transformation system, and power spectrum analysis is performed on a general-purpose digital computer. There are 256 sampling points for each second. There are two procedures. In one procedure, the time of the sample is 2 sec, the average power spectrum of 8 samples (16 sec) is taken, and the frequency resolution is 0.5 Hz/sec. In the other procedure, the sample time is 1 sec, and consecutive calculations continue for 16 sec, forming a power spectrum series chart. The frequency resolution is 1 Hz/sec. The total calculated power spectrum is 1113.

The test is divided into two groups: in the first group, subjects Nos. 1, 2, 3 and 4 are tested, with one repetition. In the second group, test subjects Nos. 5 and 6 are tested.

Results

1. In the Qigong functional state, we find in the frontal zone of the cerebrum the alpha dominance peak where energy is concentrated. Here the frontal zone-occipital zone relationship is reversed.

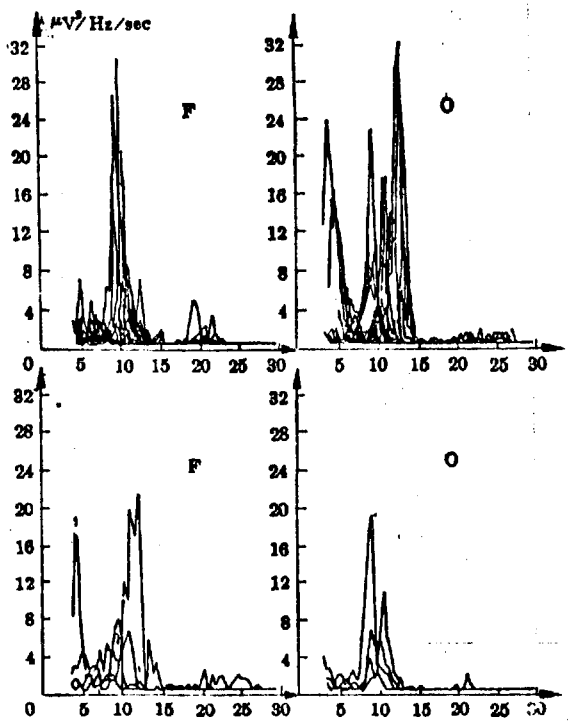

Figure 1. Comprehensive Comparison of Brain Wave Power Spectra (Test Subjects Nos. 1, 2, 3, 4). Top: Qigong state; Bottom: Rujing, Anjingbiyan. F = Frontal zone; O = Occipital zone; y-axis: Brain electrical power (μV^2/Hz/SEC); x-axis: Frequency.

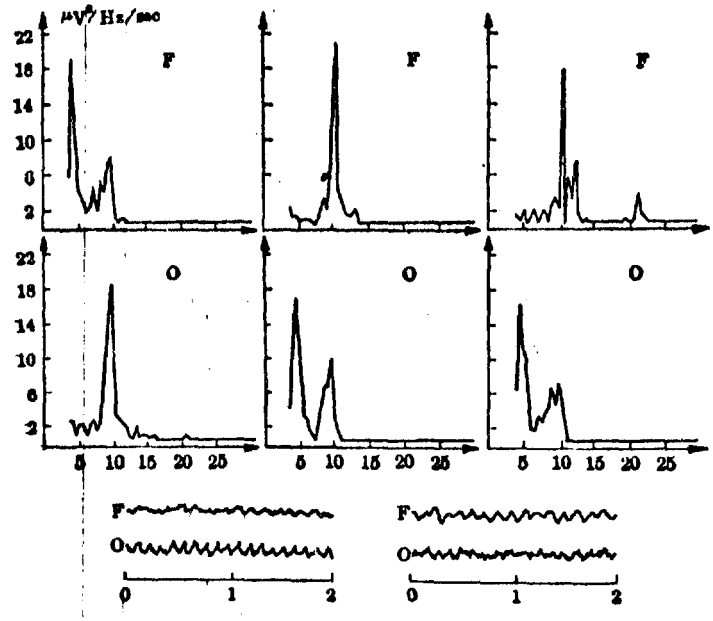

Figure 2. Frontal-Occipital Brain Wave Reversal (No. 4 Test Subject). Top: Power Spectrum. Left: Anjingbiyan; Center, Right: Qigong state. Bottom: Original brain electricity graph. Left: Anjingbiyan; Right: Qigong state.

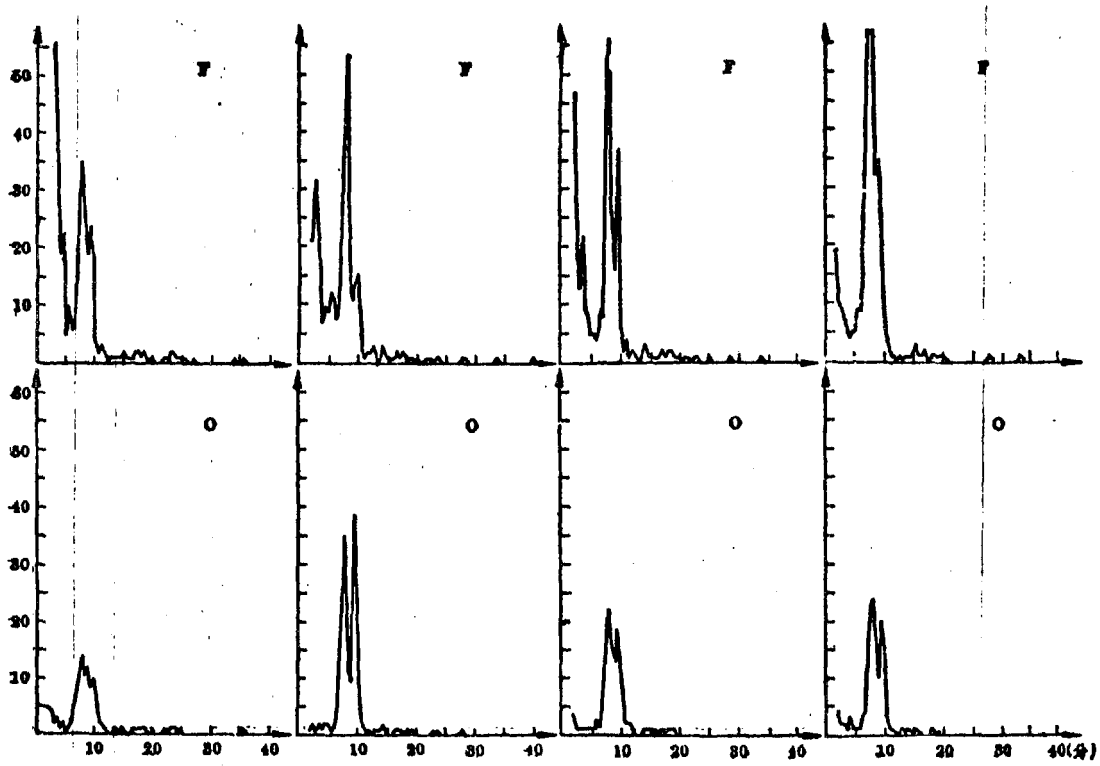

Figure 3. Rujing Process Comparison (Test Subject No. 6).

At the time of such Qigong activities as Rujing, Shouxiadantian, Faqi, Baihuichuqi, etc., the brain wave forms are fairly similar, all displaying predominant wave peaks of relatively concentrated energy in the alpha segment of the frontal zone brain power spectrum. The upper left part of Figure 1 is a composite of the four types of frontal brain wave power spectra for the Qigong state, for the four test subjects of the first group. There is an obvious prominence of a sharp peak in the alpha segment, while the other frequency segments do not have any marked wave peaks. In contrast, in the composite of the occipital power spectra shown in the upper right portion of Figure 1, the wave peaks are obviously dispersed.

The brain wave observations described above are clearly the opposite of the brain waves of the normal person. For the sake of comparison, we calculated the brain wave power spectra of these test subjects for the Anjingbiyan state, as shown in the bottom of Figure 1. Although when the Qigong master closes his eyes, he can easily enter the Rujing state. From the figure we can still see the distinction between the two: namely, at the time of Anjingbiyan, in the occipital zone there is a concentration of energy in the alpha segment, while in the frontal zone it is relatively dispersed; thus, it has an inverse relationship with the brain waves in the Qigong state. In the individual person's brain wave power spectrum, too, we can see a typical example of this kind of frontal zone-occipital zone brain wave inverse relationship. As in the top of Figure 2, in test subject No. 4's Anjingbiyan (left) and Qigong states (center, right), the frontal-occipital brain wave relationships are completely reversed. At the bottom of Figure 2 is said test subject's original brain graph. At the time of Anjingbiyan, the occipital alpha waves are dominant; at the time of Rujing, the frontal alpha waves are dominant. The inverse relationship between frontal and occipital can be seen very clearly with the naked eye.

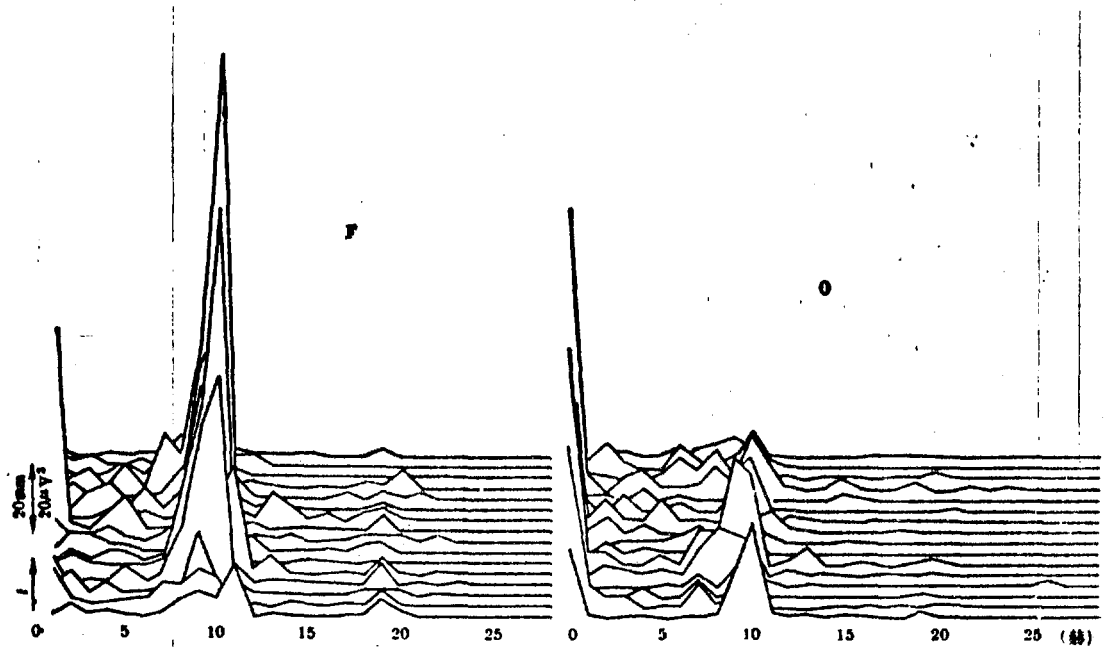

Figure 4. Rujing Brain Wave Power Spectrum Series Chart (Test Subject No. 4). (From bottom to top: 0-16 sec power spectrum).

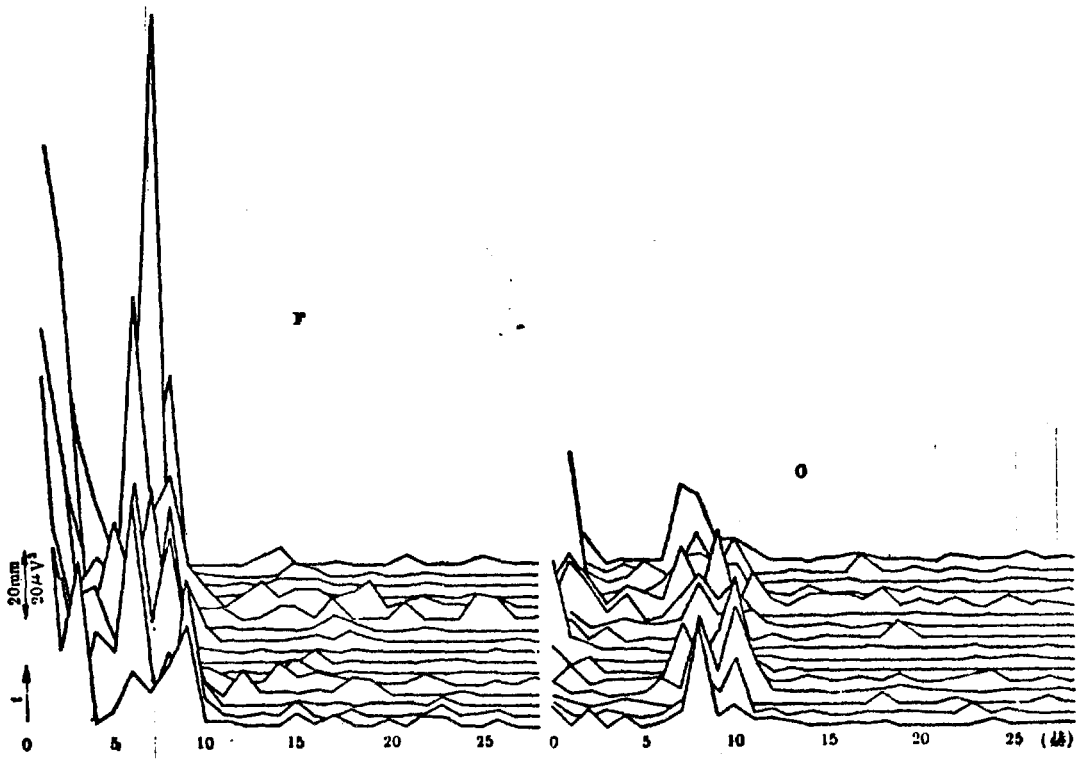

Figure 5. Rujing Brain Wave Power Spectrum Series Chart (Test Subject No. 6). (From bottom to top: 0-16 sec power spectrum).

In the same test subject, the frontal zone alpha dominance may be prolonged or increased along with the Rujing time. Figure 6 shows 5, 10, 15 and 20 min brain wave power spectrum graphs for test subject No. 6 in the Rujing process. It is clear that the frontal zone alpha peak increases and steadily rises along with the Rujing time, while the occipital zone alpha peak fluctuates at the lower level. Thus, the difference between the frontal and occipital zones becomes greater and greater, i.e., the frontal-occipital inverse relationship becomes more and more evident.

In the 16 sec power spectrum series charts (Figures 4-7), too, we can see this kind of clear relation among the different test subjects. The alpha dominant wave peaks all appear in the frontal zone, while in the occipital zone they are smaller or scattered. Moreover, the longer the training time, the greater the skill, and the greater the frontal zone alpha peak power. When the frontal zone alpha wave power is small (Nos. 1 and 2, Figures 6 and 7), in the occipital zone no unified wave peaks can be found. Only when the frontal zone's alpha wave power reaches a relatively high level (Nos. 4 and 6, Figures 4 and 5), do the occipital zone's alpha waves start to develop and to show unified peaks.

These facts prove that the normal person's occipital zone alpha wave peaks, when in the Qigong state, shift to the frontal zone. In 29 cases of testing of the Qigong state (except for Fazi), the frontal zone displayed alpha wave peaks in 24 cases, or in 83% of the cases.

2. Frequency Characteristics of the Frontal Zone's Alpha Peaks

We can see from the top of Figure 1 that the frontal zone alpha peaks in the Qigong state have a tendency to shift to less than 10 Hz, while most of the energy of the occipital zone brain wave alpha segment is above 10 Hz. By comparing this with the bottom of Figure 1, too, we can see that most of the alpha waves in the Anjingbiyan state, too, are above 10 Hz. This proves that frontal zone alpha peak frequency in the Qigong state involves the phenomenon of a downward frequency shift (left shift). The frontal zone alpha peak frequency of an old Qigong master can shift leftward to 7.5 Hz. The top of Figure 8 is a comparison of the frontal zone alpha peak values for different test subjects in the Rujing state; it can be seen that with the increase of power there is a general tendency for the frequency to shift to the left.

We can also see from Figure 3 that the frontal alpha peak of test subject No. 6 includes two peaks, distinguished as 7.5 and 8.5 Hz. In the Rujing process, the 7.5 Hz peak rises, and the 8.5 Hz peak drops, i.e., a frequency shift to the left is produced, causing the 7.5 Hz wave peak to emerge. Although the occipital zone also has this tendency, it is not nearly as evident as in the frontal zone. In the 16 sec power spectrum series chart, too, we see the phenomenon, in the case of test subject No. 6, of competition between the wave peaks (Figure 5).

In analysis of 0-64 Hz power spectrums, we can also see that the frontal zone has relatively strong resonance peaks at intervals of about 6 Hz, which can extend all the way to over 60 Hz, and the resonance can repeat more than 10 times (bottom of Figure 8).

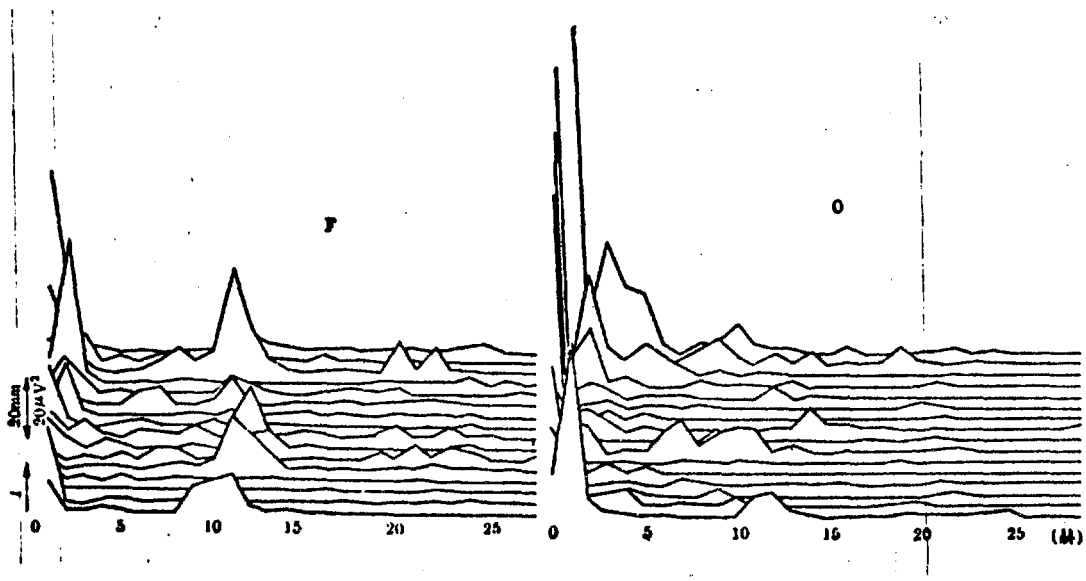

Figure 6. Rujing Brain Wave Power Spectrum Series Chart (Test Subject No. 2).

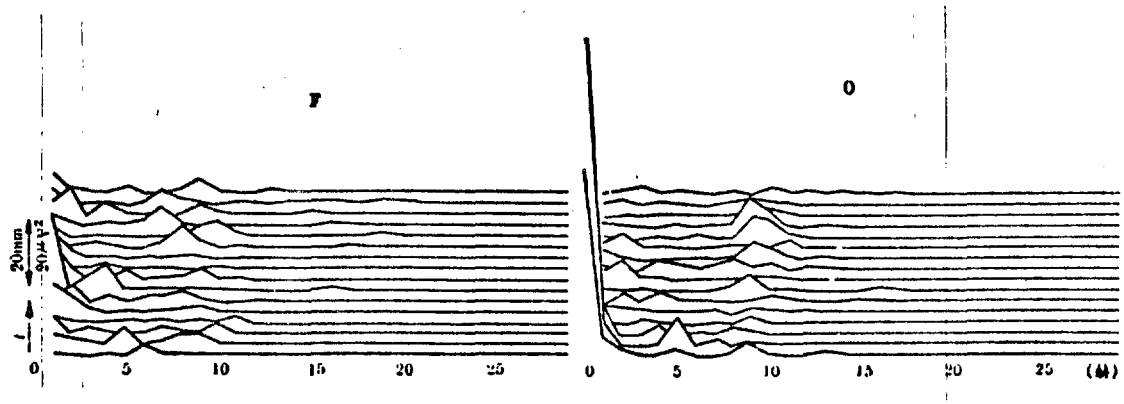

Figure 7. Rujing Brain Wave Power Spectrum Series Chart (Test Subject No. 1).

When the occipital zone's alpha waves have developed to a certain degree, mutual resonance peaks may appear between the frontal and occipital zones. Using the mutual power spectrum to calculate the degree of coherence of the frontal zone and occipital zone, when we first see that the coherence value is relatively large, the test subject subjectively feels the state to be very good for Qigong. For example, when test subject No. 6 had been in Rujing for 10 min, he stated that the Rujing was very good, and the coherence value reached 1015, higher than the values for the several other times Rujing was tested (200, 733, 761). For other persons such as test subject No. 5, the frontal-occipital power spectrum coherence value fluctuates between 10.6 and 103, far less than for the test subject No. 6.

3. The Brain Wave Power Spectrum in the Fazi State

The brain wave power spectrum in the Fazi state is clearly different from other Qigong states. The frontal zone alpha peak does not appear or is unstable (Figure 9), and desynchronized brain waves often appear.

Test subject No. 5, who himself stated that the Fazi function was very good, also displayed, to a large extent, desynchronized brain waves at the time of the Fazi, and moreover, from his power spectrum series chart we can see that the two kinds of functional states, cynchronous and desynchronized, appear alternately. In the series of graphs at the top of Figure 10, the frontal zone is in the desynchronized state (the opposite of the occipital state); the series of graphs in the center is in the synchronized state; while in the series of graphs at the bottom, in the first half of the time segment (1-10 sec), the frontal zone brain waves display desynchronization, and in the latter half (11-16 sec) they shift to synchronicity, clearly showing the phenomenon of brain wave transition (the occipital zone has the opposite tendency). The transition between different brain wave states and the inverse relationship between frontal and occipital is shown here fairly typically.

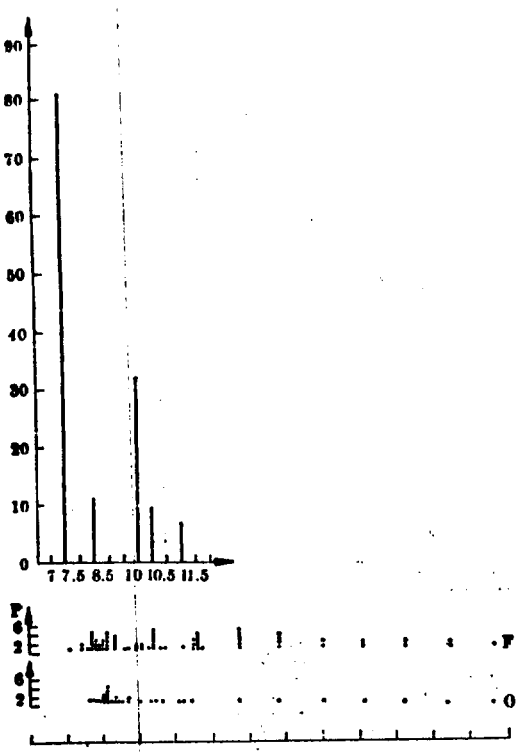

Figure 8. Brain Wave "Left Shift" and Resonance.
Top: Comparison of 5 test subjects (from left to right: Test subjects Nos. 6, 5, 4, 3, 2);
y-axis: Power (μV^2/Hz/sec); x-axis: Frequency.
Bottom: Test subject No. 5; y-axis: P-value;
x-axis: Frequency (1-60 Hz).

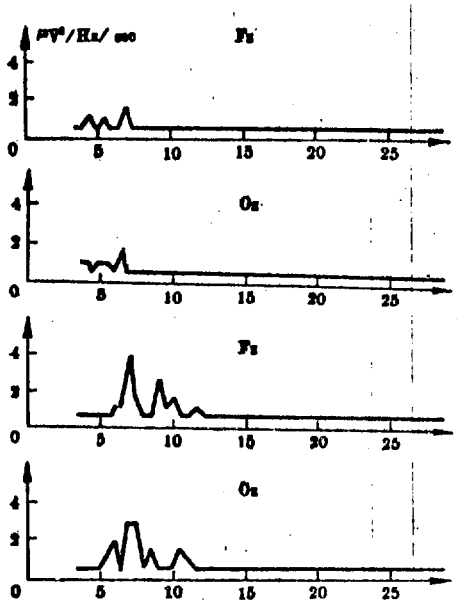

Figure 9. Fazi Brain Wave Power Spectrum.
Top: Test subject No. 3; Bottom: Test subject No. 4.

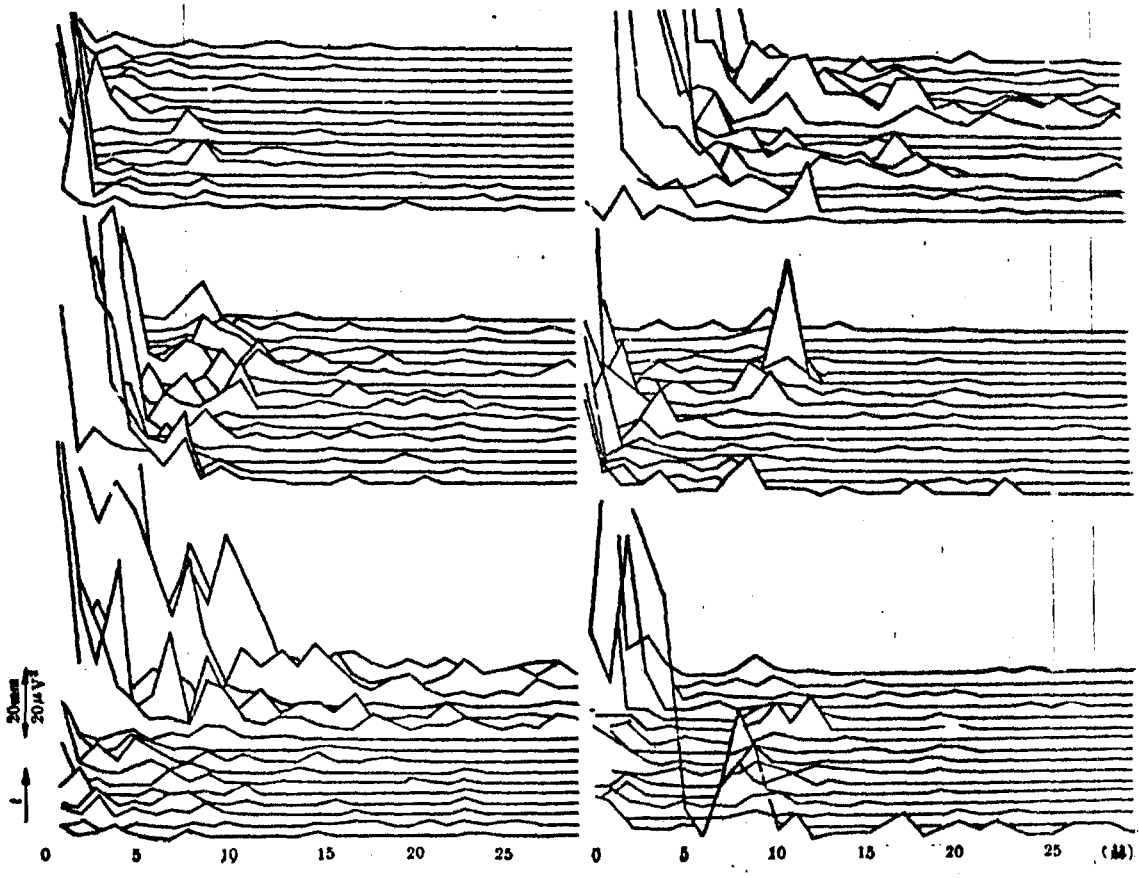

Figure 10. Fazi Process Analysis (Test Subject No. 5).

Discussion

1. The Extraordinary Nature of the Qigong Functional State

All of our results support this view: Qigong is an extraordinary functional state.

The phenomenon of brain alpha wave dominance shifting from the occipital zone to the frontal zone has not been seen reported in the ordinary states of ordinary people. In the brain electric power spectra of 50 pilot candidates recorded in W.R. Adey's "Collective Brain Wave Charts", the frontal zone is not seen to have any evident alpha peak [3]. However, the greatest power of the frontal zone alpha peak in the Qigong state reported in this paper can reach 150 μV^2. This is quite a large change. Only test subject No. 5's frontal zone alpha dominance is not evident. However, his frontal zone has a clear frequency "left shift" and resonance. We see from the results of many persons that the brain wave forms of the frontal and occipital zones are clearly inverse, proving that in the Qigong state the human brain functions, and especially the frontal zone functions, display some kind of qualitative change (sudden change, transition). Concerning the relation between the phenomenon of frontal-occipital inverseness (opposition) and qualitative and quantitative change, we have also pointed out its significance in brain function research. The qualitative change of the frontal brain functions may be the foundation for a series of unusual phenomena which appear in the Qigong state.

2. The Significance of the Qualitative Change of the Frontal Zone Functions

The frontal zone is the region of the brain which is most recently formed in the evolution of the cerebrum. In its occurrence in races, its growth in fetuses and in its cell structure, it is clearly different from other parts of the brain. Eccles regards the frontal zone as the place where sensory processes turn into conscious processes [6, 7]. Regarding the frontal zone as the important region for conscious activities of the human brain is based on many physiological facts. In research on color perception, hand coordination and memory, our laboratory repeatedly observed the special functions of the frontal zone. Therefore, the qualitative change of the frontal zone functions in the Qigong state certainly have special significance. It can bring about some kinds of qualitative change in conscious activity or in the level of consciousness. In extraordinary functional states, can subconscious activities enter into the realm of the conscious? Can consciousness be expanded? Can it produce in the brain some new kind of material category? These may all be questions which must be explored in research into the unusual functions of the human brain.

The facts concerning the relation between the front zone's activity in "get in touch with" the various sensory and motor regions and the outer world of the body are already known to physiology. However, the relationship between the frontal zone and the inner world of the body has been studied very little. Neuroanatomy proves that the vegetative nervous system-hypothalamus are connected to the frontal zone through the dorsal nucleus of the thalamus. The frontal zone can also exert an influence on peripheral systems and the hypothalamus. Signals of the related internal states of the body (hunger, thirst, joy, anger, fear, sex, etc.) may be conveyed from the hypothalamus and peripheral systems (Fascia Hippocampi, Nucleus Amygdalae) through the

dorsal nucleus of the thalamus to the frontal zone, and cause the consciousness to be affected by the emotional coloring conveyed. No other cortical region can have such a clear connection with the hypothalamus. Therefore, there is very good reason to suppose that the qualitative change of the frontal zone in the Qigong state "mediates" the connection between the frontal zone and the inner world of the body, causing the processes which originally belonged to the subconscious to enter the realm of the conscious, and thus the frontal zone receives signals of "coloration" from the internal organs. It also regulates the internal organs, exerting control over all aspects of the "great system of the human body".

Can signals other than those sensed by the human body's usual five senses be received through the frontal zone? Adey reports that the Fascia Hippocampi responds to electromagnetic oscillations outside the body of 7 Hz (6-8 Hz) and that electromagnetic rhythms modulated by microwaves can be used to provide feedback to the human brain in order to amplify the brain waves. He shows that the human brain has the ability to receive electromagnetic oscillations. Whether this ability is greatly strengthened in unusual functional states, and whether the human brain can receive or transmit energy other than electromagnetic waves, in the way that gravity influences other unknown elements of the universe, are questions in "ultra-large system" research which must be answered.

3. The Significance of the Ordering of Frontal Zone Alpha Waves

Concerning the occurrence of alpha waves, there have been the cortex-thalamus circuit theory [9, 16], the thalamus center line starting point theory [11], the thalamus function starting point theory, etc. Although the points that each theory emphasizes are different, all recognize the function of the thalamus in the generation of cortical alpha waves. There is a clear relationship between its nucleus lateralis thalami and the occurrence of alpha waves. And, as was pointed out in the above section, the dorsal nucleus of the thalamus is a decisive link between the frontal zone and the hypothalamus. This indicates that there is a close relation between the appearance of alpha dominance in the frontal zone and the link-up between the frontal zone and the hypothalamus. We can assume that in most cases the human brain is oriented toward the outer world of the body; therefore, the alpha waves of systems like the occipital zone, which are externally oriented, predominate. The human brain in the Qigong functional state is oriented toward the inner world of the body; the frontal zone thalamus and hypothalamus are linked together and the alpha waves are oriented toward the frontal zone.

Based on research on models of nervous system activity, "lumped models" can be divided, according to degree of complexity, into levels KO, Ki, KII, KIII, etc. [13]. Frontal zone alpha synchronicity in the Qigong state may represent fairly high-level KIII-level activity, while desynchronization may correspond to relatively low-level KO, KI-level activity. The process (Figure 11) which represents the ordering of neural activity, from desynchronicity to synchronicity to supersynchronicity, is interconnected with the nerve cell Amidine's process of depolarization, polarization and superpolarization. Haken compares the phenomenon of biological ordering to the phenomenon of lasers [14]. There is reason to believe that the transition from synchronicity to supersynchronicity is an energy-storing process, which causes the number of neurons in the supersynchronicity state to increase. The brain wave resonance mechanism, too, certainly plays an important role in this process [15]. The transition from supersynchronicity to desynchronicity is an energy-releasing process. The slow energy-releasing process is the one more often seen in

physiology; whether there may also be a faster "excited transition" in which a large amount of energy is discharged in a short period of time is an extremely interesting question. Are the "flashing light" phenomenon in the Qigong state and other forms of energy bursts related to this? We already know that biological systems have an observable amplification of power. The retina can in a few milliseconds amplify the energy of a light beam 1,000,000 times and cause the discharge of neuroelectricity [16]. Astronauts in space can observe flashing lights caused by heavy particles. Electrical stimulation in the brain of 0.1-0.01 μV/cm can cause neuroelectrical activity at a level of 1 kV/cm [17]. Aside from this, can the synchronizing activity of the large electrical potential after a sudden electrical shock also produce a similar response in a biological accelerator? From the standpoint of biological order and biological radiation, through study of the functional states of the human mind (primarily the frontal zone) on the macroscopic and microscopic levels is of great promise in the study of the unusual functions of the human body and will promote biological research to the vanguard of modern science.

Conclusion

By analyzing the brain wave power spectra for the six test subjects with Qigong fucntions, we obtained the following results:

1. In the Qigong functional state, the frontal zone of the human brain displays alpha wave peaks of concentrated energy; in the occipital zone, on the other hand, no alpha waves are evident. Compared with normal people, this frontal-occipital brain wave relation is clearly reversed. The longer the period of Qigong training, the greater the frontal zone alpha wave peak value. The largest peak value reaches more than 150 $\mu V^2/sec$.

2. In the Qigong functional state, the frontal zone alpha wave central frequency shifts to the left (i.e., shifts toward low frequency). Those test subjects with long Qigong training display an obvious leftward shift, reaching at the lowest 7.5 Hz. The frontal zone also displays repeated resonance waves at 6 Hz intervals, and resonance peaks may also appear between the frontal and occipital zones.

3. We tentatively observe that the Fazi process is different from other Qigong states: the brain waves display a desynchronized form and also the phenomenon of transition between synchronicity and desynchronicity.

We believe that Qigong is an extraordinary functional state. The reversal of the frontal-occipital brain wave relationship and the supersynchronization of frontal zone alpha waves are qualitative changes in human brain functions. We have discussed possible mechanisms of, and the significance of, the ordering of frontal zone brain waves.

This project was carried out at the suggestion of Professor Qian Zuesen; the participants were Bao Xiznwen, Zhang Wenjie, Hao Jinyao, Cao Jian, Wang Yonghuai and Li Yingbo; Comrade Luo Shuming helped perform the data processing, and in the course of the project we received Chen Xinfu's support and contributions to discussions. To these we express our appreciation.

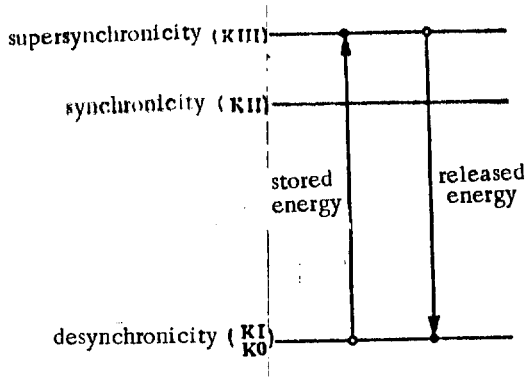

Figure 11. Brain Wave Transition Diagram.