Application of Photic Feedback System to Psychosomatic Medicine

Masaru Chijiiwa, Mitsuo Yasushi, Satoshi Saito,
Kawagoe R&D Lab., Pioneer Electronic Corp.
Sueharu Tsutsui, Kouji Tsuboi and Mariko Makino
Department of Psychosomatic Medicine, Toho University

1. Introduction

Even when external conditions such as room temperature vary, internal conditions of the living body such as body temperature and blood density remain constant. The autonomic nervous system and endocrine system support and assure this constancy unified by the brain. This function is called homeostasis. Both the autonomic nervous system and endocrine system are controlled and adjusted by the hypothalamus region of the diencephalon. Moreover, the hypothalamus is governed and regulated by the limbic system. The autonomic nervous system consists of sympathetic and parasympathetic nervous systems, and all internal organs are controlled in parallel by both systems.

Stress is a kind of strain generated in a living body when such stressers as physical, chemical or psychological stimulus act upon it. Stress is originally a reaction of the body to adapt to the stressers. However, stress is stored in the body and becomes harmful when the stresser is too strong or continues for too long a duration. Modern people sometimes suffer from too many psychological or social stressers and generate excess emotion. The limbic system is also the seat of emotion. Here, the body and the mind are related to each other. The signal generated by an emotion is conducted to the hypothalamus and mental stress causes an irregular condition of the autonomic nervous system. This is autonomic imbalance of psychosomatic type.

"The EEG feedback system by photic driving" (hereafter photic feedback system or PFB) which the authors previously developed is equipment which activates brain waves by photic driving principles using the subject's own electroencephalograph (hereafter EEG) as the photic stimulus. A band pass filter is utilized in signal processing with an automatic gain control circuit regulating photic driving. The system consists of two elements, the photic driving equipment and the brain wave biofeedback system. The former makes the brain wave of the subject synchronize to the photic stimulation and the latter makes the subject learn to enhance alpha wave by means of mental efforts by monitoring how much alpha wave is generated. Using the PFB, the subject can activate the alpha wave with individually inherent rhythm without any mental effort.

Moreover, he can control the frequency of the alpha wave to a certain extent by setting the center frequency of the band pass filter adequately. The subject should be relaxed by lowering the alpha wave frequency with PFB. We did some clinical experiments to verify the effect of the relaxation. We used patients from the psychosomatic division as subjects, as they were considered hard to relax.

2. Method

At the Psychosomatic clinic of Musashino Central Hospital, we did experiments to verify the effect of PFB.
2. 1 Subjects

The subjects were 25 patients of neurosis, depressive disorder and psychosomatic eating disorder as shown in Table 1. Some also have physical illnesses such as cardiovascular or digestive problem. We sorted them by mental disease because relaxation effect of PFB is supposed to act on psychic side directly. All had evident cause of their illness, such as a change of occupation or home. They had other medical and psychological treatments, such as psychiatric care or music together with PFB.

<table>
<thead>
<tr>
<th>Neurosis</th>
<th>10 (7/3)</th>
<th>28.6 (20~48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Depression</td>
<td>3 (2/1)</td>
<td>37 (24~60)</td>
</tr>
<tr>
<td>Dysthymia</td>
<td>7 (1/6)</td>
<td>37.7 (21~61)</td>
</tr>
<tr>
<td>Bulimia Nervosa</td>
<td>4 (0/4)</td>
<td>26 (18~25)</td>
</tr>
<tr>
<td>Anorexia Nervosa</td>
<td>1 (0/1)</td>
<td>26</td>
</tr>
</tbody>
</table>

2. 2 Procedure

The subjects sat in an easy chair with eyes closed. Each session took 17 minutes (Fig. 1). After the first 2 minutes rest, the center frequency of the band pass filter of PFB was swept from 12 to 8 Hz to learn the inherent background frequency range of alpha wave. Then the center frequency was fixed so as to evoke the alpha of about the low end among the frequency range detected above.

Fig. 2 shows an example of the brain wave spectrum through a session. Fig. 3 shows the frequency of background alpha and the set up frequency of all subjects at the first session. Each subject had a session once a week, and repeated the sessions from 2 to 8 times in total.

To examine the effect of 1 session of PFB, data of same subjects were taken as a control group in the same figure for the same duration without PFB. This experiment was carried out just before the third session of PFB for each subject.

2. 3 Evaluation methods

The effect was evaluated by the measurement of the physiological indexes of the autonomic nervous system, the psychiatric report and the total diagnosis of the illness. Among the physiological indexes, the brain wave of the forehead
and the back, electromyogram, skin conductance level, heart rate and systolic blood pressure (hereafter EMG, SCL, HR and SBP) were measured. The brain wave was not used as a factor in our evaluation because it was directly manipulated by the experiment. The degree of mental relaxation was measured by psychiatric questionnaire at pre and post session. The items questioned are shown in Fig. 4.

The comparison with the control group was based on these measurements and the effect of PFB through the recovery process was judged totally taking account of these results, the subjective symptoms and the outlook of the patients, the history of the illness and the effect of prior treatments.

3. Result

Fig. 5 shows an example of raw data of EMG and SCL. The value for the evaluation was read at the ending point of the first rest and the feedback period. As for HR and SBP, the value of the digital blood pressure meter was used.

3.1 Comparison with control group

Table 2 shows the result of measurement of physiological indexes and psychiatric report.

(1) Measurement of physiological indexes of the autonomic nervous system

In some items, a significant difference is found. Main items are as follows.

For total subjects,

a) EMG decreased for both groups. Comparing
both. PFB group showed a tendency to decrease more.

b) SCL showed a tendency to decrease for PFB group.

c) HR showed a tendency to increase for PFB group and to decrease for control group. There was the same tendency in the comparison of both groups.

d) SBP decreased for control group. In the comparison of both groups, there was a tendency that SBP decreased more for the control group.

For each disease,

e) EMG decreased much more for PFB group with neurosis than control.

f) SCL decreased for both groups with neurosis and PFB group with dysthymia. In comparison of both groups, PFB group with dysthymia decreased much more.

g) SBP decreased for the control group of neurosis patients. HR showed a tendency to decrease for the control group of the neurosis patients. There was a significant difference for HR in the comparison of both groups with neurosis.

(2) Psychiatric report

Fig. 4 shows the change of the psychiatric report between pre and post session as the average of all subjects. The score was more increased in PFB than in non FB session.

3.2 Progress of illness and recovery

Fig. 6 shows an example of the change of EMG, SCL and the psychiatric report through 8 sessions including control session. The value is not an the absolute one but the difference between pre and post session. Though some change is recognizable in this case, the statistics for all subjects showed the following.

Table 2 The results of measurement of physiological indexes and psychiatric report

The numerals in the table are Ave.±S.D.

Ave.=(Σ 100 (POSTi - PREi) / PREi) / N

With regard to psychiatric report,

Ave.=(Σ (POSTi - PREi)) / N

P: level of significance for the difference between PFB and Non FB session

○: p<0.01 level of significance for the difference between the score of

△: p<0.05 PRE and POST session

×: p<0.1
(a) KN, 35 years old, male

Chief complaint: reverse of night and day

History of present illness:
He joined a computer software company after he graduated a college. He worked overtime generally without holidays. He suffered from the depressive disorder and retired when he was 29 years old. He moved back to his family's restaurant. For 6 years after diagnosed depressive disorder, he took two kinds of antidepressant, a hypnotic and a Chinese medicine. He did not notice even when he mistook night and day sometimes. However, since September of 1990, the reverse perception of night and day was fixed and he became lethargic and lost his appetite. It was diagnosed that his depressive disorder had changed for the worse. The antidepressant was adjusted in vain and he at last visited a psychosomatic clinic and entered the hospital in January of 1991.

Past history: depressive disorder

Family history: no problem

Diagnosis: depressive disorder

Target of treatment: correction of reverse perception of night and day

Strategy of treatment:
#1 PFB (twice a day, morning and afternoon)
#2 Discontinuance of medical treatment (discussing with the patient, we decided to take PFB without any medical treatment for a while, and to revert to medical treatment if necessary)
#3 Passive music therapy with bodysonic (together with PFB)

Psychotherapy to provide mental support toward social adaptation

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Fig. 6 An example of change of indexes over a long term

(1) Measurement of physiological indexes of the autonomic nervous system

There was no remarkable change for long term.

(2) Psychiatric report

There was no remarkable change for long term.

(3) Medical diagnosis

Except two patients who complained of a headache, 23 patients among 25 felt better. That is, they got evidently better than before PFB treatment and lost the illness they had when they entered the hospital. Especially for patients of depression, the depressed mood and irregular mood and tensions in the morning improved. For the patients of the eating disorder (especially for bulimia nervosa), the treatment suppressed the impulse to eat too much and reduced the depressed mood after eating too much. Many subjects were conscious of more relaxation a few days after the treatment than when under going it.

Some case studies follow.
Progress: For the first week, PFB was carried out for 10 minutes each in the morning and afternoon. As the patient had no painful feeling, duration was lengthened by 10 minutes every week up to 40 minutes each. From about the 14th day, he became able to awake without nurse’s morning call, and to fall asleep at about 0~1 o’clock and sleep soundly. From about the 20th day, he began to feel active in the morning. He felt so in the evening only before entering the hospital. At the same time, he recovered enough vigor to join the active music therapy session with other patients. He enjoyed hospital life with daily PFB (together with bodysonic) and playing music (active music therapy: he played a flute). He gradually got better in the reverse perception of night and day.

Consequently, he left the hospital in the beginning of April. He is now working at a pasture for rehabilitation.

(b) MM, 28 years old, male, outpatient
Chief Complaint: He blushed and trembled when he spoke in public.

For example, he often dropped a glass due to his hand trembling when someone poured beer at a party.

History of present illness: When he was in the 2nd grade of college (20 years old), a teacher suddenly asked him a question in a class and he became extremely tense almost to fall down blushing with hands and legs trembling. After this he tended to be tense, blushing and trembling especially when he had some presentation in public or when he traveled to a strange place. At the same time, he experienced an unspeakable anxiety.

This condition was sometimes so bad that others recognized it.

After he got a job, he avoided speaking in public. Because he could not avoid his own wedding 3 months later, he visited psychosomatic doctor in August of 1990 without the knowledge of his family and fiancee.

Past history. Family history: no problem
Diagnosis: anxiety neurosis
Target of treatment: to master relaxation
Strategy of treatment:
#1 PFB (together with passive music therapy by bodysonic)
#2 Support by medical treatment (Bromazepam (antianxiety) 2mg after every meal) and psychotherapy

Progress:
As he was an outpatient and the wedding would be held only 3 months later, we treated him on as many days as possible. We gave the patient an instruction that PFB is a system to make his body and mind learn relaxation by themselves without any effort from him. We strengthened the motive to heal at every treatment.

During the PFB, the patient imagined a scene where wine was fully poured to his wine glass. At the beginning of October, he said he thought he would be able to relax now. In November he attended his wedding confirming again that his body and mind must have mastered relaxation. When he held the champagne glass to toast his marriage at the beginning of the wedding, he found he neither trembled nor blushed. He got confidence from this fact, and he completed the wedding without any problem even though he felt a little tense. After that, he visited the clinic about every two months as an outpatient.

(c) AK, 30 years old, female
She suffered from major depression for 7 years and had been in hospital for a month when we began PFB treatment. After that, the duration of
the depressive phase reduced and she successfully left the hospital 5 months later.

(d) MY, 27 years old, male

He suffered from bipolar disorder depressed type for 2 years and had been in the hospital for a month when we began PFB treatment. He recovered the normal rhythm of night and day.

(e) FI, 59 years old, female

She suffered from dysthymia for 2 years and had been in the hospital for two month when we began PFB treatment. She lost the feeling of tension and got a feeling of relaxation.

(f) JF, 22 years old, female

She suffered from bulimia nervosa for 4 years and had been in hospital for two month when we began PFB treatment. Her depressed mood lessened and the frequency of the impulse to eat too much was decreased.

(g) KI, 27 years old, male

He suffered from major depression for 4 years and just entered the hospital when we began PFB on his uncomfortable and lethargic condition in the morning. He recovered the vigor gradually.

Thus all subjects except the two who complained of headaches, recovered from the illness and left the hospital a few months later. One of the two headache cases felt that the headache changed for the worse as PFB was performed.

The other case is still under investigation. We have to use PFB carefully under such conditions.

We have to add that PFB was popular among patients as a comfortable treatment and we could get a lot of voluntary cooperation for the experiment.

4 Discussion

The results above show that PFB is effective in comparison with the control group for the patients of neurosis to promote relaxation in the nervous physiological indexes, EMG and SCL.

However, even for these patients, we did not see a long term change of these physiological indexes. We think that EMG and SCL could not indicate the long term change of the autonomic nervous function stably because of the circadian rhythm and the stability of measurement.

On the other hand, the medical diagnosis shows PFB is effective for the depressive disorders of major depression and dysthymia, as well as bulimia nervosa cases. The depressive disorder and the eating disorder are difficult to express by simple physiological indexes. It is said that these illnesses are deeply concerned with the irregularity of biorhythms such as the circadian rhythm. It is remarkable that PFB is effective for these illness which are difficult to medically treat. PFB may promote recovery by correcting troubled biorhythm. The mechanism of healing is very interesting. However, it is impossible to completely understand the mechanism because the construction and the function of the clock in a body is not as clear as those of a quartz clock. Furthermore, the relation between the biorhythm and the relaxation is also not clear.

Looking at the physiological data closely, we see that PFB causes more relaxation for nervous system indexes of EMG and SCL compared to the control group of relaxation by simple rest, and that it tends to cause nothing more than the usual or conversely activation of the cardiovascular system. We think the patients were led to a peculiar state other than relaxation by simple rest with eyes closed. There is a state of consciousness called “altered state of consciousness” (ASC). It is a different state of consciousness than the usual state caused by many conditions such as Zen, yoga, drugs and so on. In this state, the brain waves are sometimes slow alpha, theta or delta. In different ASCs caused by different conditions, the state of consciousness may be different. However, the difference of the consciousness and the function of the autonomic nervous system in those states can not be ex-
explained precisely. We suppose that the relaxed state by PFB is a kind of ASC. That the nervous system is relaxed and the cardiovascular system is activated is important for medical treatment. To explain these results, it is necessary to discuss the psychological state and physiological function collectively in these ASCs. Hereafter we want to collectively analyze the psychological factor, the functions of sympathetic and parasympathetic system by measuring respiraory sinus arrhythmia (RSA) and Mayer wave related sinus arrhythmia (MWSA), and that of the central and the peripheral nervous system by measuring such neurotransmitters as catecholamine, noradrenalin or serotonin. We expect that PFB will lead people to useful ASCs other than relaxation.

5. Conclusion

Though we cannot explain how the mechanism works, some indexes of the autonomic nervous system showed more relaxation with PFB. Moreover we found PFB is remarkably effective as a treatment for depressive and eating disorders in comparison with former treatments. We believe PFB will show improved efficiency and certainty in effect for more kinds of illness in the future when the usage of PFB will be optimized, and when research will make progress in other fields such as brain waves, the autonomic nervous system functions and biorhythm.

Summary

Application of photic feedback system to psychosomatic medicine.

We applied the photic feedback system, which we had previously developed, for the medical treatment of patients with neurosis, depressive disorders and psychosomatic disorders. We evaluated the system’s effects to verify it’s efficiency in promoting relaxation. The measurement of the physiological index of the autonomic nervous system for the patients with neurosis indicated greater relaxation according to the nervous index of electromyogram and skin conductance level than the control group using simple rest with eyes closed. The index of the cardiovascular system indicated conversely a tendency toward activation. In the psychological test, the photic feedback group’s mood became more relaxed than the control group.

We assume that photic feedback leads people to a kind of altered state of consciousness and psycho-physiological reaction which differs from ordinary rest with eyes closed, and therefore is efficient for relaxation. Moreover, according to medical diagnosis, the photic feedback treatment was significantly effective for patients with depressive disorders and eating disorders who are normally difficult to treat. It appears that photic feedback is efficient for rhythm disorders peculiar to these illness. However, we don’t know yet how the mechanism works.

要約

先に開発した光フィードバック装置のリラクセーション効果を調べるために神経症、うつ病、心身症の治療に応用し種々の方法で評価した。その結果、自律神経系生理指標の測定では対照群と比較の安静閉眼にしてもリラックスする状態と比べ、神経症の患者に対して、神経系の筋電位と皮膚電導水準に大きなリラクセーション効果が見られたが循環器系の指標では逆に活動が強まる傾向があった。心理評価では全症例の合計で対照群と比べ気分が大きく改善された。この事から、光フィードバックは単に安静閉眼にしてリラックスするのとは異なる意識変性状態に心身反応を導き、それがリラクセーション効果を上げたと考える。また医学的総合判断によると通常治療が困難なうつ病および摂食障害の患者に対して著しい効果があった。これはこれらの症例に寄与のリズム障害が光フィードバックにより改善されたと言えるが、そのメカニズムはまだ判らない。