Eeg Alpha Frequency Correlate of Emotional Stability in Normal Adult Subjects

正常人腦波頻率與其情緒穩定性之關係

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EEG ALPHA FREQUENCY CORRELATE OF EMOTIONAL STABILITY IN NORMAL ADULT SUBJECTS[1,2]

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An individual's behavior is undoubtedly related to his brain functioning; this relationship should be more intimate in higher mental processes. Pshcologists as well as physiologists have attempted to study the brain in order to correlate its functioning with behavioral phenomena. The approaches for investigating this relationship can be placed into two categories: the indirect approaches and direct approaches. The traditional indirect approach for studying behavioral correlates of brain functioning is to deduce the function from the behavioral data. The experimental situation, for example, is structured in such a way as to reflect, in terms of the theoretical orientation of the individual, the processes of the brain. The fuction of the brain is deduced indirectly through the experimental variables. This method has been used extensively by gestalt psychologists and learning theorists, especially in the field of conditioning. It does not allow a direct correlation between the psychological and neurological proesses, but it does allow one to deduce the latter from the former.

The oldest direct approach for investigating the brain functioniog is the incursive technique in which some direct manipulation of the brain is necessary. One illustration of this method is to extricate parts of the brain and then to study the effects upon the behavior of the organism. A more recent method is to implant electrodes in the brain in order either to stimulate electrically a given area or to record electrical potentials from it.

The difficulties encountered in studying brain functioning are compounded when human subjects are used. In any incursive method a part of the brain must be exposed, and with human beings this is done only if there is a good reason for it.

In 1929 Hans Berger, a German neuropsychiatrist, demonstrated a new technique which he called electroencephalography (EEG), to recorded the electrical activity in the brain by using electrodes applied to the scalp. subsequently, this technique has come into extensive use as clinical diagnostic aid in neurological and psychiatric work and as an experimental tool in psychological and physiological investigations. Literally hundreds of published articles attest to its widespread interest and use. Some of the more extensive studies and expositions of the technique are those by Jasper (1935, 1937, 1941), Walter (1938), Lindsley (1936, 1939, 1944), Travis (1937, 1938), and Gastaut (1958, 1961).

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The human electroencephalogram (which is also called brain waves) shows a dominant pattern when an individual is at rest with his eyes closed but not asleep. This is the alpha rhythm, consisting of a regular series of rather smooth waves of about 8 to 13 cycles per second (cps) frequency (Glaser, 1963).

Alpha rhythms are recorded primarily from the occipital cortex but may also come from the parietal and temporal areas. In psychological laboratories the alpha rhythm has been more extensively investigated by experimenters.

Psychologists are especially interested in the alpha rhythm because: 1) it shows individual difference in terms of frequency and amplitude; 2) it varies in responding to physical stimuli such as light and psychological functions such as mental activity, emotional state, and anxiety. There have been a number of attempts to relate personality and general behavior to the alpha rhythm in the EEG, but for the most part these studies have not generally been too successful. Short and Walter (1954) attempted to correlate apha activity with verbal and visual imagery. They found that individuals who have minmal alpha activity was associated with marked visual imagery. In the past, passive-dependent individuals have been found to quite alpha-dominant with little reactivity, whereas aggressive personalities correlated with minimal alpha (Saul, Davis, and Davis, 1949). Glaser (1963) has observed that tension, apprehension, and anxiety resulted in a decrease in alpha activity.

Some investigators have also studied the EEG alpha rhythm in connection with intelligence test scors. However, most of them found no correlation between these two variables (Shagass, 1946). Expceptions have been noted for feebleminded adults (Kreezer, 1940), and for eight-year old boys (Knott, Friedman, and Bardsley, 1942) where positive correlations were found.

Poor alpha organization and a predominance of fast activity are commonly found in anxious subjects. Ulett (1953) compared the EEG records of 40 high anxiety subjects with 150 normal subjects. Both groups were given to psychiatric interiews and a series of psychological tests to detect anxiety-proneness. Analysis of the EEG records showed the greatest amount of alpha activity in the nonanxiety-prone group, and the least in the patients with anxiety neurosis.

Emotional stability is generally regarded as one trait of personality, and the EEG alpha rhythm has been used as a valuable index of individual differences in emotional responsiveness. However, the previous studies have been mostly concentrating the clinical aspects of the brain functioning. The main purpose of this study concerned to investigate the relationship between the tested emotional stability and the EEG alpha frequency in a group of normal adult subjects.

METHOD

Subjects:

Twenty four college students, 11 males and 13 females, enrolled in an introductory psychology course at Taiwan Normal University participated in this study. Their ages ranged from 19 to 24 years. These subjects were selected from 120 students on the basis of two criteria: 1) They were free from pathological conditions of the brain, or any auditory or visual difficulties; 2) In terms of emotional stability tested, they were the top one-tenth or the bottom one-tenth of the 120 studeuts enrolled in the course.

Apparatus:

An Offner Type T amplifier and an eight-pen ink-writing oscillographic electro-encephalograph were employed for recording the EEG alpha rhythms.

Tests:

The Thurstone Temperament Schedule and the Bell Adjustment Inventory were used to measure the subjects' emotional stability. These tests have been translated into Chinese and reliability and validity studies have been completed on them.

Procedures:

The Thurstone Temperament Schedule was first administered to a sample of 120 college students. The Factor E of the schedule which is designed to measure emotional stability was used as the independent variable. The scores of the 120 students were ranked according to this factor. The top 10 percent were selected as the emotionally stable group (ESG) and the bottom 10 percent as the emotionally unstable group (EUSG). Each group consisted of 12 subjects.

After two weeks the Bell Adjustment Inventory was then administered to the same 120 students. This procedure, giving the test to the total rather than the selected group, was done to avoid the possible effects of having been selected out of the original group. Test scores of the subjects who had been selected in the two extreme groups were then matched with each subject's scores on the Thurstone Temperament schedule.

Before EEG recording began, the experimental procedure was explained in general terms to the subjects to avoid possible apprehension regarding the study. Scalp electrodes were applied by meams of microhm jelly to the occipital and temporal areas. Bipolar recording technique was employed. Approximately a 30 minuts record was obtained on each subjects. During the recording period, the subject was seated comfortably with eyes closed. When the alpha rhythm appeared, the subject was instructed to open his eyes frequently to test the effect of visual stimulation upon alpha activity.

In general, when the occipital EEG frequency varies between 8 to 13 cycles per second if is considered a normal alpha frequency (Glaser, 1963). The measure of the individual's alpha frequency in this experiment was based on an average obtained from a subject's recoreds. Ten three-second segments were randomly selected and the average of the frequencies obtained represented each subject's alpha frequency.

RESULTS

According to the design of this study, each subject should have three measures available for analysis. two test scores and an EEG alpha frequency. These data are shown in Table 1 and Table 2.

Table 1. Emotionally Stable Group

Subject	Thurstone	Bell	EEG Freq.
1	18	5	9.75
2	16	8	10.25
3	14	3	7.25
4	14	1	11.50
5	14	10	10.50
6	12	9	10.00
7	12	6	10.00
8	12	6	6.50
9	12	7	11.50
10	12	5	12.00
11	11	12	10.00
12	11	6	11.50
	M=13.08	M=6.50	M=10.05

Table 2. Emotionally Unstable Group

Subject	Thurstone	Bell	EEG Freq.
1	4	7	10.25
2	4	29	10.50
3	4	27	10.00
4	4	27	7.25
5	4	26	12.00
6	3	28	11.00
7	2	24	9.00
8	2	28	10.50
9	2	21	11.50
10	2	21	12.00
11	1	13	11.50
12	1	25	15.00
	M=2.75	M=23.00	M=10.92

The following figures show the phenomena of individual differences in terms of frequency and amplitude in EEG alpha rhythms.

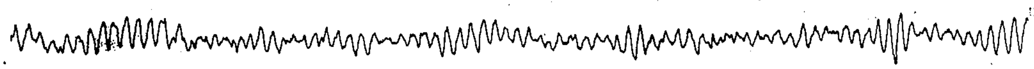

Fig. I. EEG alpha record for subject Ca. 4-F-19-4/69 shows a slow frequency (6-7 caps) and middle amplitude.

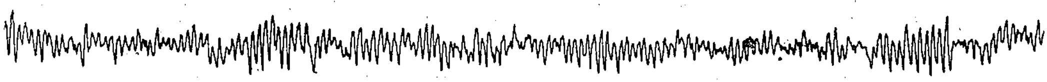

Fig. II. EEG alpha record for subject Ca. 10-F-21-4/69 shows a middle frequency (10-11 cps) and middle amplitude.

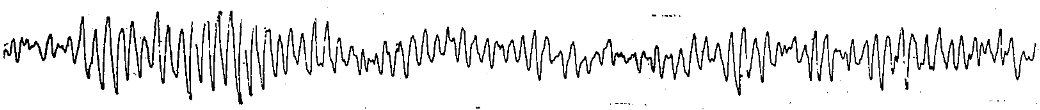

Fig. III. EEG alpha record for subject Ca. 3-M-21-3/69 shows a slow frequency (6-7 cps) and high amplitude.

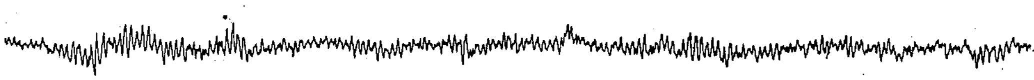

Fig. IV. EEG alpha record for subject Ca. 14-M-20-3/69 shows a fast frequency (12-13 cps) and low amplitude.

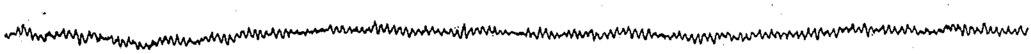

Fig. V. EEG alpha record for subject Ca. 7-F-21-3/69 shows a fast frequency (11-12 cps) and low amplitude.

Correlation Between the Two Test Scores

The two sets of scores obtained from the Thurstone Temperament Schedule and the Bell Adjustment Inventory were negatively correlated (r=0.48). According to the scoring method of the Thurstone Temperament Schedule, the higher the score of Factor E, the more emotionally stable the subject tends to be. On the Bell Adjustment Imventory, the higher the score of emotional adjustment, the poorer the sabject's adjustment teuds to be. The evidence of negative correlation indicates, therefore, that consistent results were obtained from the two tests.

Difference of Emotional Stability Between the Groups

On the basis of the primary independent variable, the emotionally stable group and the emotionally unstable group should be tested on the statistical significance of the means obtained from the groups. Since the variances of the two groups were unequal, the approximate method suggested by Cochran and Cox (1950) and by Welch (1938) should be employed. The differences between the mean (M=13.08) of the emotionally stable group representing the top ten percent of the sample and the mean (M=2.75) of the emotionally unstable group representing the bottom ten percent was significant at the one per cent level ($t=5.30$, $P < 0.01$). This result could happen by chance would be less than one time in a hundred.

Difference of EEG Alpha Frequency Between the Groups

From the data analysis of EEG alpha records (Table 1 and Table 2), the mean frequency of emotionally stable group (M=10.05) was not statistical significant from that of the emotionally unstable group (M=10.92). The little difference (0.87) could easily be the result of chance factors.

DISCUSSION

The main result of the present experiment indicated that the EEG alpha frequency did not correlated with tested emotional stability. These findings agreed with the previous studies concerning some other personality variables; intelligence test scores (Shagass, 1946), extroversion and rigidity (Werre and Barendregt, 1963), etc., which also proved to be insignificant.

The question then arises, "Does the EEG characteristic pattern correlate with psychological functions?" or put differently, "Are the fifferences in EEG alpha pattern pyschologically related functions or just a pure physiological funtions?" To answer these questions, we must first turn to current explanations of how the potential changes recorded in the EEG are produced. There seems to be agreement that these changes are the result of processes of polarization and depolarization of cortical neurons, but investigators disagree as to what causes these processes. Some theories hold that both processes are the results of metabolic changes in the neurons. Others think that polarization is the results of some metabolic change, but that depolarization occurs when volleys of incoming action potentials (derived from neural excitation) trigger off the stored electrical charge. It is also possible that depolariztion may occur spontaneously when the charge of neurons exceeds a crittical level so that any factor capable of generating potential differences will touch it off (Cohn 1949).

Lindsley (1951) suggested that fast rhythms in the EEG indicate the extent of neural excitation. Since emotion is accompanied by intense EEG activation, he suggested that emotion represents the extreme of neural excitation. EEG activation induced by stimulation of the brain stem reticular formation is permantly abolished by lesions in this area. Hence Lindsley postulated that it is this system which is responsible not only for EEG activation but also for emotional excitation.

Darrow (1947, 1950) maintained that the apha rhythm indicates autonomic (sympathetic) regulation of cortical activity. In cortical excitation, the stimulated cells discharge individually, potential differences are summated algebrically, and only small deffections remain, resulting in the low valtage fast activity seen in the EEG during waking mental activity. Darrow thinks that alpha activity creating large potential difference is an indication that sympathetic activity has cut short the cortical excitation.

For Darrow, fast electical activity in the brain represents inadequate regulation by the sympathetic nervous system and therefore persistent cortcal excitation. When this happens, cortical activity may become repetitive through a kind of feedback of effect and give rise to "cortical tension" or anxiety. In emotion, the opposite seems to happen; the overregulation by the sympathetic nervous system results in reduced cortical activity with increased alpha frequencies.

Darrow distinguishes between anxiety (cortical tension), which accompanied by fast activity in the EEG (deficient sympathetic regulation), and emotion, which is accompanied by a slower pattern (sympathetic over regulation). But, for Lindsley, anxiety is considered an emotional state and he concluded from the fact that fast EEG activity is associated with anxiety that all emotions must represent EEG activation. He thinks that the slow rhythm reported by some investigators may be based on artifacts in recording.

Although the individual's EEG alpha pattern is characteristic, the relationship between this and one's psychological functioning has not been well established. A really complete, well controlled, and reliable study on this subject is yet to be done.

REFERENCES

(1) COCHRAN, W. G. & COX, G. M.: Experimental designs, New York, John Wiley, 1950.

(2) COHN, R.: Clinical electroencephalography, New York, McGraw-Hill, 1949.

(3) DARROW, C. W.: Psychological and psychophysiological significance of electroencephalogram, Psychol. Rev. 1947, **54**: 157-168.

(4) DAVIS, P. & DAVIS, H.: Electrical activity of brain: It relation to psysiological states of impired consciousness, Res. Publ. Ass. Nern. Ment. Dis. 1939, 19-50.

(5) GASTAUT, H.: Some aspects of the neurophysiological basis of conditioned reflexes and behavior, in Wolstenholme, G. E. W. & O'Connor, C. M. (ed): Neurological basis of behavior, Little, Brown & Co., Boston, 1958.

(6) GASTAUT, H. & HERT, J.: Electroencephalographic detection of sleep induced by repetitive sensory stimuli, in Wolstenholme, G. E. W. & O'Connor, M. (ed) CIBA Foundation Symposium on the nature of sleep, Little, Brown & Co., Boston, 1961.

(7) GLASER, G. H.: The normal electroencephalogram and its reactivity, in Glaser, G. H. (ed): EEG and behavior, Basic Books, 1963.

(8) JASPER, H. H., CRUIKSHANK, R. M. & HOWARK, H.: Action currents from the occipital region of the brain in man as affected by variables of attention and external stimulation, Psychol. Bull., 1935, **32**: 565.

(9) JASPER, H. H. & CRUIKSHANANK, R. M.: Variations in blocking time of occipital alpha

potential in man as affected by the intensity and duration of light stimulation, Psychol. Bull., 1936, **33**: 770-771.

(10) JASPER, H. H. & CRUISHANK, R. M.: Electroencephalography II: Visual stimulation and affer-image as affecting the occipital alpha rhythm, J. gen. Psychol., 1937, **17**: 29-48.

(11) JASPER, H. H. & SHAGASS, C.: Conditioning the Occipital alpha rhythm in man, J. exp. Psychol. 1941, **28**: 373-388.

(12) KNOTT, J. R., FRIEDMAN, H. & BARDSLEY, R.: Some electroencephalographic correlates of intelligence in eight-year-and twelve year-old children, J. exp. Psychol., 1942, **30**: 380-381.

(13) KREEZER, G.: The relation of intelligence level and the electroencephalogram, Yearbk. Nat. Soc. Stud. Educ., 1940, **39**: 130-133.

(14) LINDSLEY, D. B.: Brain potential in children and adults, Science, 1936, **84**: 354.

(15) LINDSLEY, D. B.: A longitudinal study of the occipital alpha rhythm in normal children, Genet. Psychol. 1939, **55**: 197.

(16) LINDSLEY, D. B.: Electroencephalography, in Hunt, J. M. (ed): Personality and behavior disorder, New York, Ronald Press, 1944, pp. 1033-1103.

(17) LINDSLEY, D. B.: Emotion, in Stevens, S. S. (ed): Handbook of experimental psychology, John Wiley, 1951, pp. 473-516.

(18) SAUL, L. J., DAVIS, H., & DAVIS P. S.: Psychological correlations with the electroencephalogram, Psychosom. Med. 1949, **11**: 361.

(19) SHAGASS, C.: An attempt to correlate the occipital alpha frequency of electroencephalogram with the pesformance on mental ability test, J. exp. Psychol., 1946, **36**: 88-92.

(20) SHORT, P. L. & WALTER, W. G.: The relationship between psysiological variables and stereognosis, EEG Clin. Neurophysiol., 1954, **6**: 29.

(21) TRAVIS, L. E. & KNOTT, J. R.: Brain potential studies of perseveration: I. Perseveration time to light, J. Psychol., 1936, **3**: 97-100.

(22) TRAVIS L. E. & EGAN J. P.: Conditioning of the electrical response of the cortex, J. exp. Psychol., 1938, **25**: 524-531.

(23) ULETT, G. A., GLASER, G., WINKUR, G. & LAWER, A.: The EEG and reaction to photic stimulation as an index of anxiety proneness, EEG Clin. Neurophysiol., 1953, **5**: 23.

(24) WALTER, W. G.: The technique and application of EEG, J. Neurol. Psycholist. 1938, **1**: 359-358.

(25) WALTER, W. G.: Normal rhythms, their development, distribution and significance, in Hill, D. and Parr, G.: Electroencephalography: A symposium on its various aspects, London, Macmillan, 1963.

(26) WELCH, B. L.: The significance of the difference between two means when the population variance are unequal, Biometrika, 1938, **29**: 350-362.

(27) WERRE, P. F. & BARENDREGT J. T.: Correlation between some electroencephalographic and psychological variables, California Psychiatric, 1963, **6**: 181-190.

正常人腦波頻率與其情緒穩定性之關係

張　春　興

摘　要

本實驗研究之目的在使用 EEG (electroencephalography) 以探求正常成人 Alpha 型腦波的頻率與其情緒穩定性的關係。本實驗所用之主要器材爲美製 Offner Type T Elctroencephalograph 爲主。每一受試接受約半小時之腦波記錄。電極連接方式以雙極誘導法 (bipolar technique) 爲主。誘導區域以腦枕葉 (occipital lobe) 爲主。參加實驗之受試爲24人（男11人，女13人）。該等受試係由 120 人選出；選取標準係根據石爾斯頓性格量表 (Thurstone Temperament Schedule) 中因素E之分數選取上下兩極端各十分之一，並分別命名爲情緒穩定組與不穩定組。而後再參照受試者在貝爾適應量表 (Bell Adjustment Inventory) 上所得情緒適應方面的分數，做爲其情緒穩定性的根據。

由測驗結果看，在情緒反應上，兩種測驗的分數間成負相關的關係 ($r=-0.48$)；這顯示該二種測驗結果具有相當的一致性。

情緒穩定組（上 10%）與情緒不穩定組（下 10%）在測驗分數上所表現的差異程度達到極爲顯著的水準 ($t=5.30$ $P<0.01$)。

以隨機取樣的方式，選取各受試者 EEG 記錄中 Alpha 波出現時的十段（每段三秒鐘），並計算其頻率的平均值做爲其個人該型腦波頻率的代表，但就兩組頻率的平均值比較時，其差異程度未達到統計上的顯著水準。因此，就此次實驗研究結果看，常人 Alpha 型腦頻率似與其測得情緒穩定性沒有關係。