

EEG Alpha Power and Laterality during Dreaming in N-REM and REM sleep

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ABSTRACT

In the present study, electroencephalic (EEG) alpha power, alpha frequency and their individual laterality were studied. The dream data used in this study were collected during N-REM and REM sleeps for 3 or 4 nights. In N-REM sleep, the alpha power spectrum tend to show higher value in dreaming than in non dreaming. On the other hand, the decrement of the alpha power in REM sleep was rather apparent during dreaming. The correlation between the alpha power and the mean alpha frequency was significantly positive, while a significantly negative correlation was seen in N-REM sleep. Finally, we discussed the relation between the cortical activation and the alpha activities in dreaming on the basis of the results we obtained.

Key Words : Dreaming, alpha activity, Laterality, N-REM and REM sleep

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INTRODUCTION

It is well known that alpha activity is present in stage 1 of N-REM sleep and REM sleep. Sadato et. al.(1998) reported that a strong positive correlation between cerebral blood flow (rCBF) and the alpha power was found in the brain stem and the limbic system, which includes hypothalamus and amygdala and extends to the basal prefrontal cortex, while negative correlations were found in the occipital cortex and in the dorsomedial prefrontal cortex. Several studies have suggested that the neural system which governs our visual perception and language use during waking is also applied in dreaming(Ehrlichman and Wiener, 1980, Fenwick et. al, 1984). A decrement in EEG alpha activity may be an index of cortical activation in sleep, as in wakefulness(Hong et. al., 1996) .

To explore whether cortex is activated in dreaming during N-REM and REM sleep, we studied the correlation of dreams with its EEG alpha power, as well as with its alpha-frequency in the alpha frequency range from 8 to 12 Hz.

METHODS

Two male and four female healthy students, with no complaints of insomnia, aged 20 to 23, participated in the present study. We recorded a 6-channel EEG (C3, C4, P3, P4, T3, T4, according to the international 10-20 system with earlobe electrode used as a reference, and a low-path filter at 50 Hz), EOG, EMG and electrocardiogram (ECG) for 3 subjects for three consecutive nights. In addition, we conducted the same recording session twice for the other 3 subjects for two consecutive nights with a week interval.

To collect dream reports, subjects were awakened and questioned about their dream content during N-REM sleep (at about 4 mins. after the appearance of slow eye movement) and/or during REM sleep (at about 9 mins. after the onset of second and subsequent REM episodes). These interview data were tape-recorded and transcribed. After finishing the data transcription, we started the actual analysis on the basis of the following 3 categories: 'Thinking-like Dream,' in which language serves a major role in dreaming, 'Dreaming-like Dream,' in which visual imagery frequently appears in it, and 'Others.'

Analog data were digitalized and analyzed with the Fast Fourier Transform (FFT) routine, using Spike 2 (Cambridge Electric design Ltd.) for power spectral analysis within the range of alpha activity (8 ~ 12 Hz). In addition, laterality coefficient [$\{LC = \{(L-R)/(L+R)\} \times 100$] was calculated.

RESULT

Fig. 1 shows the mean value of the alpha power (the EEG power in the frequency range 8 to 12 Hz) during the dreams in N-REM and REM sleep, respectively. In N-REM sleep, the alpha power spectrum tends to show higher value during dreaming than during non dreaming. On the other hand, in REM sleep, the alpha power is clearly reduced during dreaming, compared with the mean value appeared during non dreaming.

As seen in Fig.2, the correlation between the alpha power and the mean alpha frequency is significantly positive in N-REM sleep, while the significantly negative correlation appears in REM sleep in all subjects.

The mean frequency within the alpha band is higher during the dreaming in REM sleep. The significant positive correlation between the alpha power and the number of the rapid eye movements per 30 secs. was found in all of the collected REM episodes.

As for the laterality coefficient (LC) obtained by the mean alpha frequency, we found a sufficient relationship with the content of the subjects' dream reports in both of the N-REM and REM sleeps. The negative values of LC, which indicate the left hemisphere plays the dominant role in dreaming, were found in 'Thinking-like Dreaming,' while the positive values were found in dreaming with visual imagery, namely in 'Dreaming-like Dreaming.' (Fig. 3)

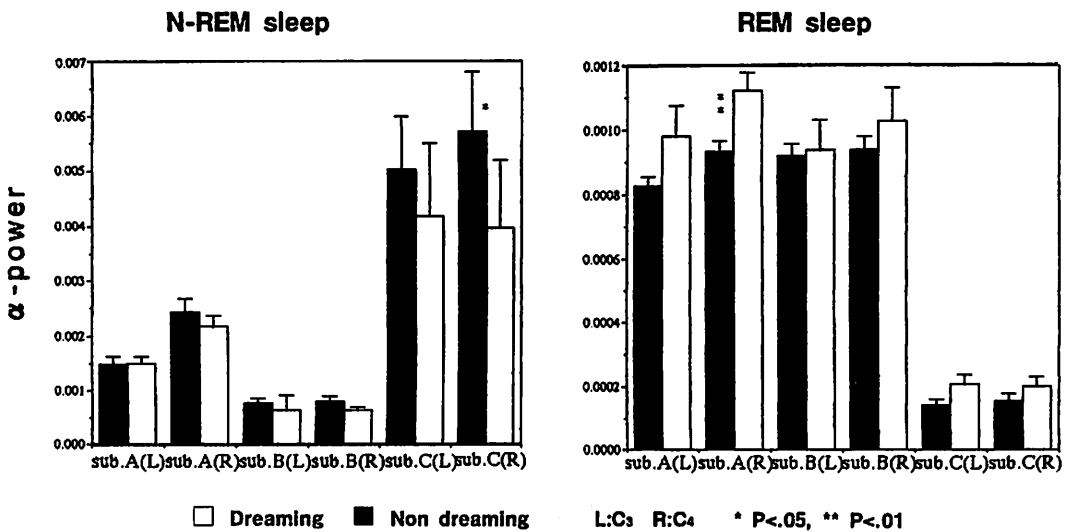


Figure 1. The mean±SEM of the alpha power in the EEG frequency range(8-12 Hz) during dreaming and non dreaming in N-REM sleep and REM sleep.

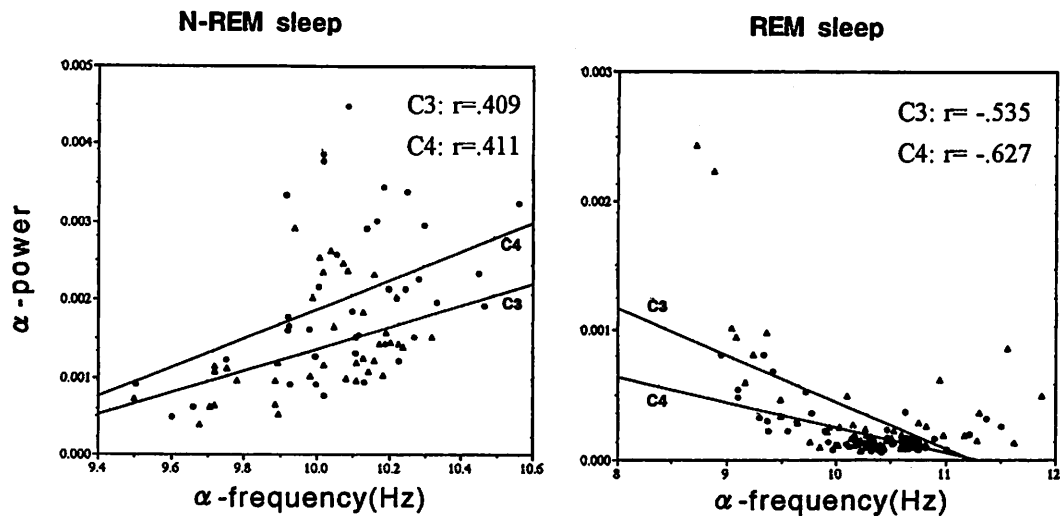


Figure 2. Correlation between the alpha power and the mean alpha frequency in the EEG frequency range(8-12 Hz) in N-REM sleep and REM sleep.

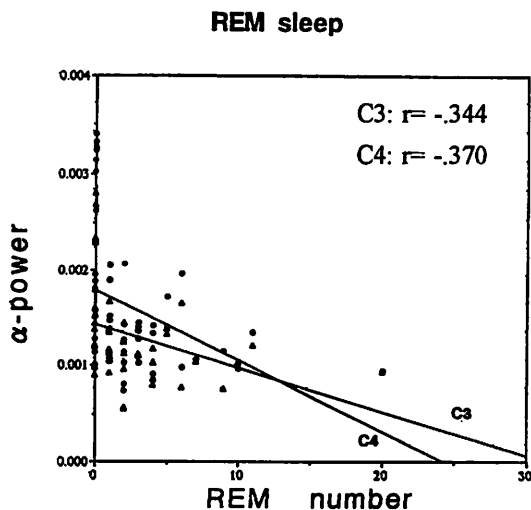


Figure 3. Correlation between the alpha power and the number of eye movement per 30 secs. in REM sleep

DISCUSSION

In the present study, we observed the decrement of the alpha power, the increase of the alpha frequency, as well as a significant negative correlation between the alpha power and the amount of rapid eye movement in REM sleep. In addition,

it was also obtained as the result that the activities of the left and right hemispheres respectively played the dominant role in the dreams with verbal activities and with visual imagery in REM sleep. These findings may confirm the assumption that the neural system used during waking also works during dreaming in REM sleep(Hong et. al., 1966).

In the dreams in N-REM sleep, the value of alpha power as well as the mean frequency of alpha activity was higher compared with the data obtained in non dreaming. This maybe partly because the EEG components with relatively high frequency was superimposed on the low amplitude slow wave during non dreaming and consequently they affected on the value of the alpha power. On the other hand, the alpha wave itself can also appear in the dreams in N-REM sleep. If so, the result may suggest the possibility that the appearance of dream during N-REM sleep associates with the alpha activity of the cortex. However, further research should be conducted more in detail to confirm the findings of this study by considering the effects of other EEG components, such as spindle wave.

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