Delta Oscillations During Positive Emotional Recall: Exploring Differences Between Central and Midline Electrodes

Authors :***Chieh-Ju Kuo*** [1]、***Yang-An Chuang*** [1、2]、***Han-Yun Chang*** [1、2*]

1 Department of Psychology, College of Medical and Health Sciences, Asia University.
2 Clinical Psychological center, Asia University Hospital, No. 222, Fuxin Rd., Wufeng Dist., Taichung City 413505, Taiwan.
**Corresponding authors: Han-Yun, Chang; Email: ta8001017@asia.edu.tw*

Background

Sleep and emotional disorders have been shown to profoundly affect individuals' emotional regulation abilities. However, most studies have focused on negative emotions, with relatively little attention paid to the neural mechanisms underlying positive emotional recall. Brain oscillations play a crucial role in sleep, emotional regulation, and deep memory integration, providing physiological insights into the interaction between sleep and emotions. Therefore, this study aims to investigate the differences in brain oscillations during positive emotional recall among individuals with varying sleep and emotional conditions.

Methods

A total of 108 participants aged 18 to 65 were recruited and classified into three groups based on the Pittsburgh Sleep Quality Index (PSQI) and Beck Depression Inventory-II (BDI-II):

1. Sleep and Emotion Comorbidity Group (PSQI > 6 and BDI ≥ 20)
2. Sleep Disturbance Only Group (PSQI > 6 and BDI < 20)
3. Healthy Control Group (PSQI ≤ 6 and BDI < 20)

Electroencephalography (EEG) was used to record brain activity during positive emotional recall and baseline conditions. The analysis focused on the amplitude variations of brain oscillations across the Central (C3, C4), Midline (Fz, Cz, Pz), Frontal (F3, F4), Parietal (P3, P4), and Occipital (O1, O2) regions. The Mann-Whitney U test was employed to examine group differences.

Results

In the Central electrode region, the Delta power of the healthy control group was significantly lower than that of the sleep and emotion comorbidity group, suggesting that healthy individuals recruit fewer deep neural integration resources during positive recall.

In the Midline electrode region, the Delta power of the sleep and emotion comorbidity group was significantly lower than that of the sleep disturbance only group, possibly reflecting difficulties in emotional regulation or abnormal neural resource allocation during emotional evaluation and recall（1).

Table 1: Between-group Comparison of Healthy control group and Sleep and emotion comorbidity group Differences

Electroencephalographic (EEG) indicators	Between-group		Mann-Whitney U test	
	HC（$N=36$）	CSDD（$N=36$）		
	M (SD)	*M (SD)*	U Statistic	Z-Score
DeltaCentral	**-11.3(22.86)**	**-5.12(17.36)**	**496.50**	**-1.71**
DeltaMidline	-1.72(12.05)	-4.50(7.96)	523.00	-1.41
DeltFrontal	-10.66(52.48)	-4.79(11.81)	617.00	-0.35
DeltaParietal	-12.61(62.01)	-6.19(12.08)	588.00	-0.68
DeltaOccipital	-27.24(103.11)	-15.97(45.43)	599.00	-0.55

Table 2: Between-Group Comparison of Sleep and emotion comorbidity group and Sleep disturbance only group Differences

Electroencephalographic (EEG) indicators	Between-group		Mann-Whitney U test	
	CSDD（$N=36$）	SD（$N=36$）		
	M (SD)	*M (SD)*	U Statistic	Z-Score
DeltaCentral	-5.12(17.36)	-9.69(23.18)	568.00	-0.90
DeltaMidline	**-4.50(7.96)**	**-0.64(5.15)**	**499.50**	**-1.67**
DeltFrontal	-4.79(11.81)	0.42(13.47)	544.00	-1.17
DeltaParietal	-6.19(12.08)	-2.57(7.69)	521.50	-1.43
DeltaOccipital	-15.97(45.43)	-5.51(14.24)	577.00	-0.80

Discussion

These findings support the role of Delta oscillations as a key neural marker in emotional recall processes and reveal that sleep and emotional comorbidities may alter neural recruitment patterns during positive emotional processing(1、2). Future research should further explore the interaction between Delta oscillations, emotional valence, and arousal to deepen our understanding of the neural mechanisms underlying emotion regulation.

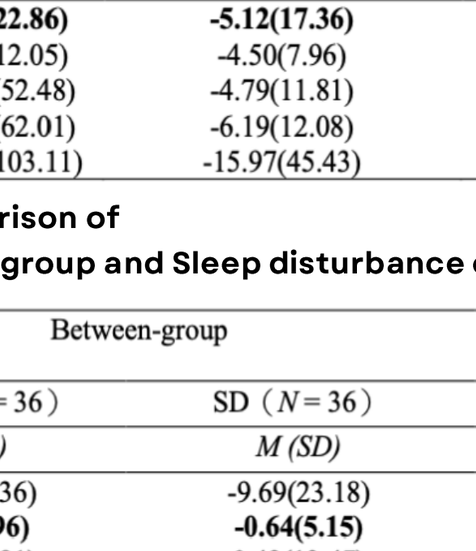

Figure 1： EEG activity showed significant effects in the DeltaCentral and DeltaMidline regions

References

1. Klados, M. A., Frantzidis, C., Vivas, A. B., Papadelis, C., Lithari, C., Pappas, C., & Bamidis, P. D. (2009). A framework combining delta event-related oscillations (EROs) and synchronisation effects (ERD/ERS) to study emotional processing. *Computational intelligence and neuroscience*, *2009*(1), 549419. https://doi.org/https://doi.org/10.1155/2009/549419
2. Flamand, M., Boudet, S., Lopes, R., Vignal, J. P., Reyns, N., Charley-Monaca, C., ... & Szurhaj, W. (2018). Confusional arousals during non-rapid eye movement sleep: evidence from intracerebral recordings. *Sleep*, *41*(10), zsy139. https://doi.org/10.1093/sleep/zsy139

Disclosure of Conflict of Interest
Name of first author: Kuo Chieh-Ju
I have no COI with regard to the presentation.