

STUDY: Brainwaves and Cognitive Performance

THE FUNCTIONAL MEANING AND POSSIBLE PHYSIOLOGICAL BASIS OF THETA AND ALPHA OSCILLATIONS FOR COGNITIVE PERFORMANCE

W. KLIMESCH, PHD

DEPARTMENT OF PHYSIOLOGICAL PSYCHOLOGY, UNIVERSITY OF SALZBURG, SALZBURG, AUSTRIA

Introduction

Studies from our laboratory and other investigators indicate that different frequency bands in the theta and alpha range are associated with different types of cognitive processes. Whereas event-related changes in the theta band appear to be related to encoding and retrieval processes of a complex working memory system, the upper alpha frequency range responds selectively to sensory-semantic memory processes of a complex long-term memory system and the lower alpha band attentional processes.

Method

In a series of memory experiments spectral estimates for a resting period (resting power) and ERD/ERS during task performance were calculated. In addition, phase locking and evoked oscillations were measured by wavelet analyses.

Results

Findings from several experiments indicate that cognitive performance is superior when alpha ERD and resting power is large, but when theta ERS is large and resting power is small. Most interestingly, we have found a similar relationship for evoked oscillations and ERP components. In addition, recent results indicate that increased theta and alpha phase-locking is related to improved cognitive performance.

Discussion

The reported findings suggest that cognitive performance may be based at least in part by an interplay between the synchronous activation of three neuronal network systems: a working memory, attentional, and semantic memory system, each operating with a different frequency, the first in the theta (about 6 Hz), the second in the lower alpha (about 8 Hz), and the third in the upper alpha (about 12 Hz) frequency range. The implications of this theoretical framework are discussed by considering phase sensitive measures to analyze local and large scale integration processes between different neural networks.

Link:

<http://www.acure-group.com/research/article146.pdf>
