BETA FREQUENCY BURST - ELEMENTARY EVENT OF ATTENTION SPAN

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Since Berger's [3] first observation the reduced amplitude of alpha EEG activity has been shown to accompany the behavioral arousal. In the half of the century the central scanning model has been proposed as a mechanism for sampling and coding sensory information in different cerebral structures with alpha frequency rhythm (see [4] for review). With still better recording resolution other frequencies (beta) were proposed to scan for more detailed structure of the sensory stimuli and the reduction of the corresponding alpha and beta amplitudes was found proportional to the increasing structural complexity of the stimuli [6]. Most recently, the gamma synchronized activity was described as putative mechanism scanning sequentially through the cortex during perceptual tasks [8].

In opposition to the old scanning models developed in human experiments, intracortical recordings from animals showed increase of coherence of high frequency activity (beta and gamma) between scarcely distributed cortical sites during feature integration processes [1, 5, 10]. This highly organized activation pattern which replaces the low-amplitude global oscillations of the same frequencies observed during spontaneous activity may explain why the overall skull-EEG amplitude decreased during perceptual tasks.

In order to study the oscillatory activity within the sensory systems of behaving animals we have developed two experimental paradigms. During the classical conditioning paradigm we found that the power within beta frequency band of the micro-EEG recorded in the barrel cortex of the rat, increased with first aversive reinforcement [9]. Similarly, we observed that micro-EEG recorded from many sites in lateral geniculate nucleus and primary visual cortex of cats attending to visual stimuli during differentiation task contained an enhanced amount of power within the beta band as compared to activity observed during auditory or erroneously ended visual trials [2]. This last finding allowed us to attribute the observed beta activity to the attentive state of the visual system. In both experimental situations the beta activity comprised of short, 100 ms - 1 s bursts of oscillations. The mean frequency of their appearance, amplitude and average duration increased during the periods of the experiments which required animal's attention [11]. Finally, we found that occurrence of beta bursts was correlated in time with gamma-frequency bursting.

By calculating the normalized cross-correlation coefficient with zero lag between band-pass filtered (16-24 Hz) EEG signals we found that during nonvisual situations the recordings from most electrode sites within the cat's visual system show positive synchronization indicating oscillatory rhythm of general nature. In periods requiring visual attention the synchronization changed toward negative values of Pearson coefficient with an exception of few recording sites from which highly significant, positive synchronized activity was observed.

In a separate experiment on human subjects we adopted the simple differentiation task from the cat paradigm and studied the high resolution EEG. Both the alpha and beta power of signals recorded from occipital cortex decreased during visually as compared to auditory attentive situations as predicted by hypothesis requiring scarce organization pattern of cortical activity during increased attention. Since signals of the same three resonance frequencies (alpha, beta and gamma) are enhanced within different sensory channels of different species in similar experimental circumstances it is postulated that they may also serve similar behavioral functions.

I would put forward the hypothesis that attention within sensory systems utilizes bursts of beta frequency in order to activate the required part of neural network by means of a frequency potentiation mechanism [7]. Such bursting would provide a necessary background activation to allow a momentary binding of specific cell assemblies [10] with gamma synchronized oscillations.

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