

Dynamical Resonances and Synchronization of Auditory Stimuli and Evoked Responses in Multi-Channel EEG

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Perceptions of complex structures or other cognitive events are associated with synchronous oscillation of neural cell assemblies which take place in the 40 Hz domain and last for about 100 ms. We use EEG signals from 31 scalp electrodes to identify these short-term synchronization events. The challenge for audification applications is to make these relatively rare events perceptible in the background of incoherent signals from all electrodes. In a first approach we use an "Orchestra Paradigm" by assigning a different standard musical instrument (piano, flute, violin, glocken) to four of these electrodes. We can clearly discriminate transitions between uncorrelated activities of these areas and the events of short-term synchronization. We expect a general resonance principle to apply also in the inverse problem. The nonlinear resonance hypothesis of music perception was tested in an experiment comparing a group of musically sophisticated and a group of less sophisticated subjects. The prediction that weakly chaotic music entrains less complex brain wave (EEG) oscillations at the prefrontal cortex was confirmed by using a correlational dimension algorithm. Strongly chaotic (stochastic) and periodic music both stimulated higher brain wave complexity. More sophisticated subjects who prefer classical music showed higher EEG dimensions while less sophisticated subjects responded with a drop in brain wave complexity to rhythmical weakly chaotic music. Subjects' ratings of perceived complexity of the musical pieces followed mathematical (objective) structure of the music and did not reflect the changes in brain wave complexity. The results are interpreted in the context of an associated (Hebbian) network theory of nonlinear brain dynamics.