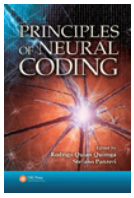

Principles of Neural Coding

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Chapter 6. Synchronization Measures

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6 Synchronization Measures

Thomas Kreuz

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6.1 INTRODUCTION

Measuring synchronization between two or more recorded signals is an essential task in the analysis of neurophysiological data. It is important in two major scenarios (simultaneous and successive recordings) and can involve various spatial and temporal scales.

In the most common scenario different signals are recorded *simultaneously*. If these signals exhibit a high degree of similarity they are "synchronous" in the classical sense of the word, which is derived from Greek and describes similar events "occurring in the same time" (Pikovsky et al., 2001, p. xvii). Examples for this scenario include various types of multichannel setups where the same kind of signal is recorded at different spatial locations. This signal can be macroscopic such as the electroencephalogram (EEG) or the magnetoencephalogram (MEG), mesoscopic such as the local field potentials (LFP), or microscopic such as multiunit recordings of individual neurons.

On the *macroscopic level* the degree of synchronization (or sometimes desynchronization) is typically compared for different conditions. Changes of synchronization can occur on rather large temporal scales (e.g., in dependence on the state of vigilance or with respect to the circadian rhythm, see Kreuz et al., 2004) or in a more transient manner (e.g., event-related EEG/MEG synchronization and desynchronization, see Pfurtscheller and Lopes da Silva, 1999). Of clinical