

Decomposing the Mutual Information Rate of Heart Period and Respiration Variability Series to Assess Cardiorespiratory Interactions

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Heart rate variability results from the coupled activity of the cardiovascular and cardiorespiratory systems, which have their own internal regulation mechanisms but also interact with each other and with the autonomous nervous system to preserve homeostasis. In this work, the assessment of these physiological mechanisms is carried out decomposing the Mutual Information Rate (MIR), an information-theoretic measure of the interdependence between coupled processes, into terms of entropy rate or conditional mutual information related respectively to complexity and causality measures. These measures are computed using a non-parametric approach based on nearest-neighbours. The proposed framework is first tested on simulated autoregressive processes and then applied to experimental data consisting of heart period and respiratory time series measured in healthy subjects monitored at rest and during head-up tilt. Our results evidence that MIR decomposition is able to highlight the interdependence of short-term physiological mechanisms of cardiorespiratory interactions during postural stress.