

Universality of Coupling Functions: describing the mechanisms of general anaesthesia

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Interacting dynamical systems abound in nature and science attempts to understand them as much as possible. Often, the interest is not only to understand the structure of systems, but also the functions and mechanisms that define and connect them. This is facilitated by *coupling functions* which contain detailed information about the functional mechanisms underlying the interactions and prescribe the physical rule specifying how an interaction occurs.

First we discuss the coupling functions as a universal concept which finds applications in diverse areas where interacting dynamical systems exist [1]. In addition to the number of theoretical studies, also many methods exist for reconstruction of coupling functions from data, which in turn allow for fruitful application in chemistry, biology, neuroscience, mechanics and secure communication.

Then we present a recent application of coupling function analysis on general anaesthesia [2]. Namely, the precise mechanisms underlying general anaesthesia are not well understood and pose number of open questions. To address some of them, we have studied anaesthesia induced by a widely used (intravenous) propofol and (inhalational) sevoflurane anaesthetics, computing cross-frequency coupling functions between *neuronal, cardiac and respiratory* oscillations in order to determine their mutual interactions. The phase domain coupling function revealed the form of the function defining the mechanism of an interaction, as well as its coupling strength. Using a method based on dynamical Bayesian inference [3,4], we have thus identified and analysed the coupling functions for six relationships. By quantitative assessment of the forms and strengths of the couplings, we have revealed how these relationships are altered by anaesthesia, also showing that some of them are differently affected by propofol and sevoflurane.

These findings, together with the novel coupling function analysis, offer a new direction in the assessment of general anaesthesia and neurophysiological interactions, and in the study of coupling functions in general.

References:

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