Consequences of violated simultaneity on the concept of causality

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Inferring causal interaction structures in networks of dynamical processes is of particular interest in neurosciences. Since simultaneity of measurements cannot be guaranteed, we investigate its implications for causality, in particular Granger-causality based partial directed coherence, applied to linear and non-linear systems. We present three situations in which the naïve application of partial directed coherence leads to misleading results. We discuss possible solutions to this end. We also address the question how Granger-causality can be applied to measured data in this context.