**Supplementary Materials**

**S.1. Further Background on Transfer Entropy (TE)**

TE is expressed as a specific version of Kullback-Leibler divergence [1] i.e., the relative entropy [2]:

where parameter (referred to as delay embedding i.e., the lagged history) is the assumed time that the information transfer needs to get from X to Y and represents the past of Y. Similarly, refers to the past of X while incorporating the delay embedding (ibid). This equation quantifies the degree to which the history of X predicts the current state of Y beyond the degree to which Y could be predicted by its own history, or equivalently [3]:

where and give conditional entropy of Y at time n given its -lag history and conditional entropy of Y at time n given its own and X’s -lag history.

In essence, TE quantifies the deviation from generalized Markov property , where represents the probability of occurrence of , given occurred. If this deviation is small, then the state of is assumed to have minimal or no relevance on the transition probabilities of [4], thereby implying an absence and/or a non-significant effect of on .

It is worthy of note that unlike MI that measures correlation (i.e., a measure of synchrony while taking into account the linear and nonlinear relations), TE is explicitly and strictly non-symmetric under exchange of the role of the interacting processes [5]. In other words, .

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