Multiscale entropy analysis of combined EEG-fNIRS measurement in preterm neonates

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Abstract

In nature, biological systems such as the human brain are characterized by complex and non-linear dynamics. One way of quantifying signal complexity is Multiscale Entropy (MSE), which is suitable for structures with long-range correlation at different time scales. In developmental neuroscience, MSE can be taken as an index of brain maturation, and can differentiate between healthy and pathological development. In our current work, we explored the developmental trends of MSE on the basis of 30 simultaneous EEG – fNIRS recordings in premature infants between 27 and 34 weeks of gestational age (wGA). To explore potential factors impacting MSE, we determined the relation between MSE and the EEG Power Spectrum Density (PSD) and Spontaneous Activity Transients (SATs). As a result, via wGA, the MSE calculated on the EEG increases, thus reflecting the maturational processes in the brain networks, whereas in the fNIRS, MSE decreases, which might indicate a maturation of the brain blood supply. Moreover, we propose that the EEG power in the beta band (13 – 30 Hz) might be the main contributor to MSE in the EEG. Finally, we highlight the importance of SATs in determining MSE as calculated from the fNIRS recordings.

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