

Cardiopulmonary Analysis of Sleep Apnea Based on Weighted Limited Penetrable Visibility Graph

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Cardiopulmonary coupling (CPC) has been recognized as an important and low-cost technique for in-home sleep monitoring in recent years. Clinically, sleep staging is a prior for evaluation of sleep state, especially for the sleep disorders, such as sleep apnea. However, there are few studies on CPC-based characteristic parameters that could be applied to sleep staging.

In this study, inspired by the Visibility Graph and complex networks, we mapped the CPC strength of different sleep stages for 18 sleep apnea patients into networks and calculated characteristic parameters using Weighted Limited Penetrable Visibility Graph (WLPVG), including the average clustering coefficient C , the characteristic path length L , the clustering coefficient entropy E_c , the distance distribution entropy E_d , the weighted clustering coefficient entropy E_{C_w} and the weight distribution entropy E_w . Each characteristic parameter was compared among different sleep stages.

Results showed the significant variation of characteristic parameters during different sleep stages. In particular, the characteristic path length L out of six parameters presented high sensitivity for capturing the difference in cardiorespiratory system between wake stage and deep sleep stage.

This study explored the mechanism of the cardiorespiratory dynamic system during sleep and supported an interpretable basis for subsequent sleep staging.

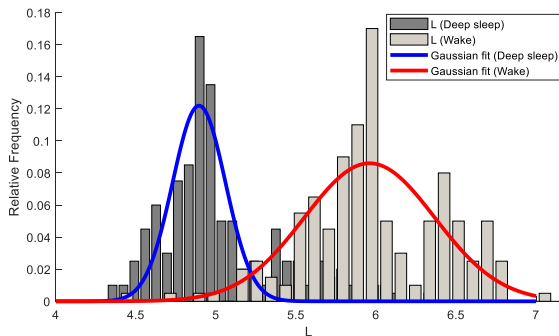


Fig: The relative frequency histogram of characteristic path length L in wake and deep sleep stages