

Input-output Frequency Coupling and Sensitivity Spectral Measures of the Respiratory Sinus Arrhythmia System in Response to Increasing Respiratory Frequency

Alejandra Guillén-Mandujano¹, Salvador Carrasco-Sosa¹, Paola Coello-Caballero²

¹Universidad Autónoma Metropolitana-I, CDMX, México.

²Universidad Tecnológica de Chiapas, Tuxtla, México

To characterize the respiratory sinus arrhythmia mechanism (RSA) as a system, in 19 healthy subjects we assessed the effects of continuous and linearly increasing respiratory frequency (RF) from 0.05 to 0.8 Hz at constant tidal volume, in sitting (SIC) and standing (STC) conditions, on: the 90-s time-courses of the central frequency and power of the high-frequency components of RR ($_{CF}HF_{RR}$, $_{p}HF_{RR}$) and respiration ($_{CF}HF_{RES}$, $_{p}HF_{RES}$), estimated by a time-frequency distribution; the $_{CF}HF_{RES}$ - $_{CF}HF_{RR}$ relation, the time-courses of the difference between $_{CF}HF_{RES}$ and $_{CF}HF_{RR}$ ($\Delta_{CF}HF$) and $_{p}HF_{RR}$ - $_{p}HF_{RES}$ coherence (RSA_{CO}) as indexes of RSA input-output coupling (RSA_{IOC}), and alpha index (square root of $_{p}HF_{RR}/_{p}HF_{RES}$) as RSA sensitivity (RSA_S) measure.

The responses of RSA measures to chirped RF in SIC, presented three stages with distinctive effects and RF ranges: between 0.09-0.18 Hz, $_{CF}HF_{RR}$ was unchanged, $\Delta_{CF}HF=-0.10\pm 0.03$ Hz, RSA_{CO} of 0.77 ± 0.06 and abruptly rising RSA_S ; between 0.18-0.51 Hz, $_{CF}HF_{RR}$, $\Delta_{CF}HF$ (0.02 ± 0.04 Hz) and RSA_S changed proportionally to RF, with correlations of 0.97 ± 0.03 , 0.86 ± 0.10 and -0.81 ± 0.12 , regression intercepts of 49 ± 47 Hz, -0.87 ± 0.33 Hz, 245 ± 115 ms/l respectively, and RSA_{CO} of 0.92 ± 0.03 ; between 0.51-0.82 Hz, correlations of $_{CF}HF_{RR}$, $\Delta_{CF}HF$ (0.32 ± 0.06 Hz) and RSA_S with RF were -0.24 ± 0.64 , 0.79 ± 0.08 and -0.36 ± 0.67 respectively, with $RSA_{CO}=0.78\pm 0.08$. STC decreased RSA_{CO} ($p<0.02$), correlations ($p<0.01$) and intercepts ($p<0.03$) of $_{CF}HF_{RES}$ - $_{CF}HF_{RR}$, $RF-\Delta_{CF}HF$ and $RF-RSA_S$ relations in the 0.18-0.51 Hz range.

In SIC and STC, RSA_{IOC} and RSA_S measures vary as a function of RF, showing three consecutive stages of some change, proportional change and no change, in distinctive RF ranges, specifically: in the low RF range, reduced RSA_{IOC} and RSA_S overshoot; in the medium one, strong correlations of RF with all RSA measures and high RSA_{CO} , although $_{CF}HF_{RR}$ is smaller than RF; and in the high RF range, decreased RSA_{IOC} and RSA_S . Baroreflex activation significantly depresses RSA_{IOC} and RSA_S measures in the three stages.