Quantitative Analysis of the Cardiorespiratory System during Paced Respiration

Heike Leutheuser

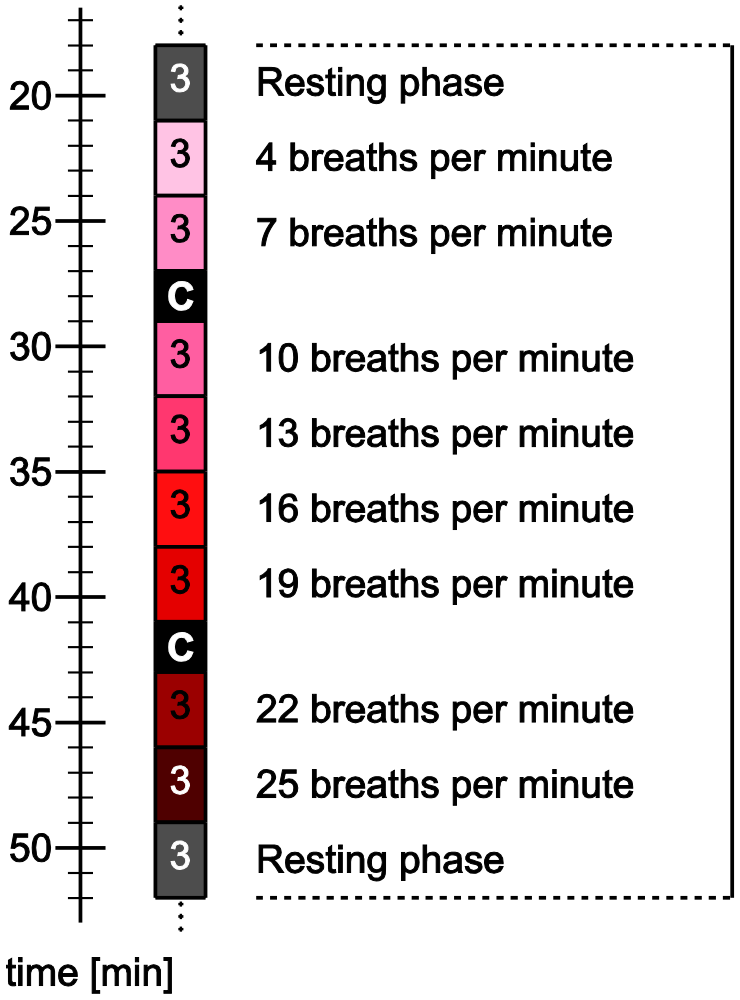
Max Schaldach-Stiftungsprofessur für Biomedizinische Technik
Friedrich-Alexander-Universität Erlangen-Nürnberg
Anästhesiologische Klinik, Universitätsklinikum Erlangen, Germany
METEAN, Fraunhofer IIS, Erlangen, Germany

Outline

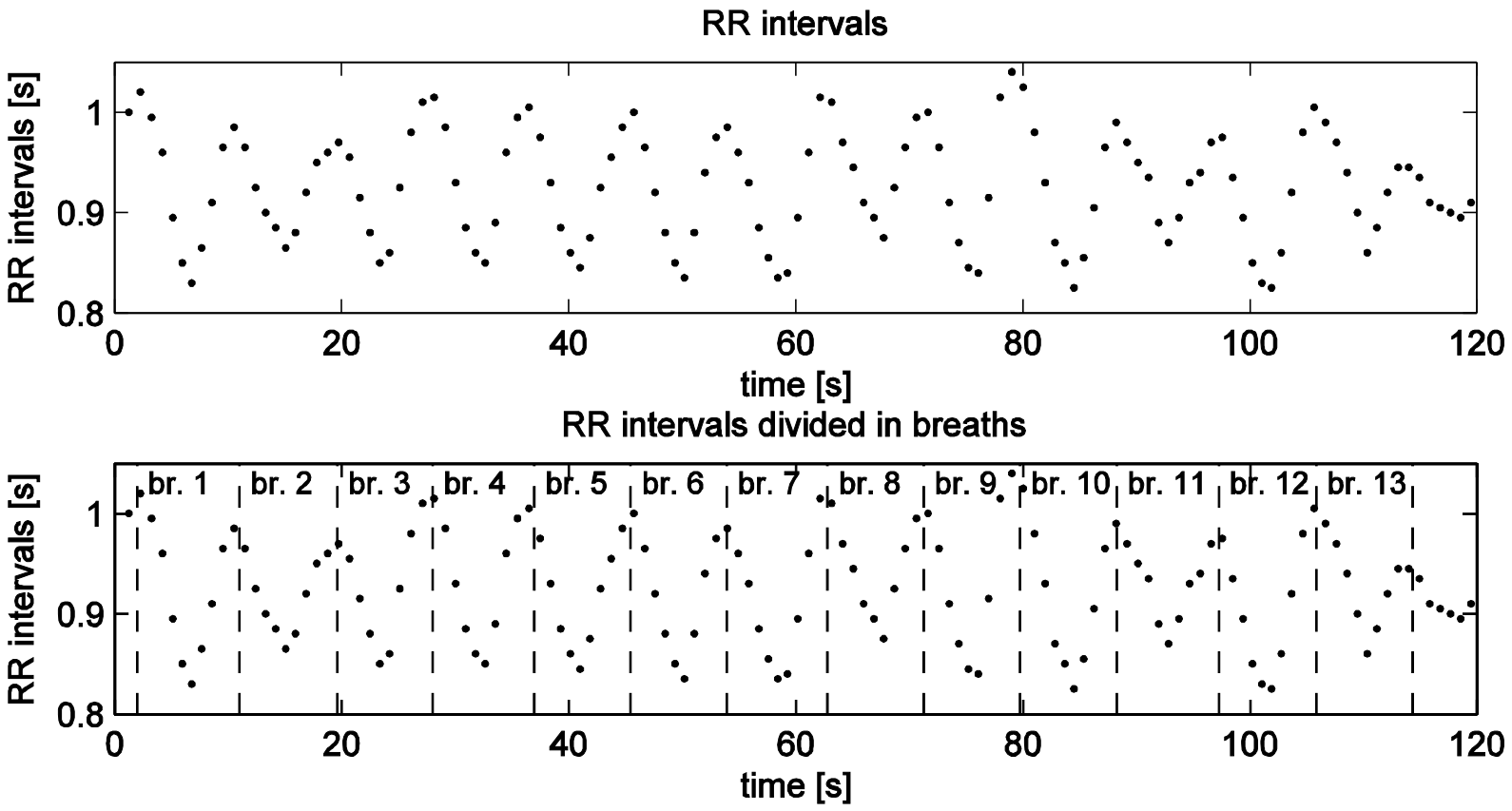
- Clinical trial
- Methods
- Results (pattern analysis)
  - Variation of RR intervals over time
  - Respiratory sinus arrhythmia
  - Phase relationships
- Summary

Clinical trial

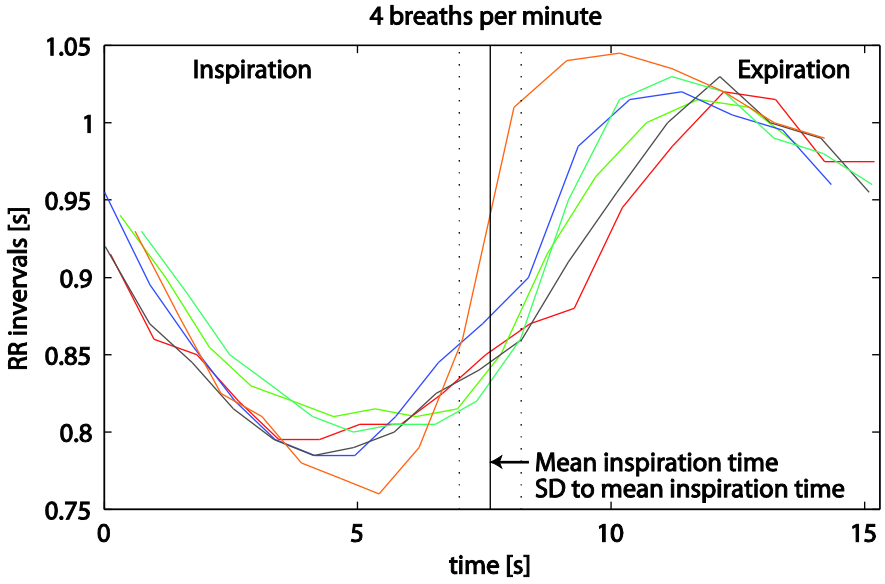
- Subjects
  - young, healthy volunteers
  - 7 female and 18 male
  - age 25.8 ± 3.3 yrs
  - BMI 23.9 ± 3.7 kg/m²
- Biosignals
  - ECG (electrocardiogram)
  - respiratory flow

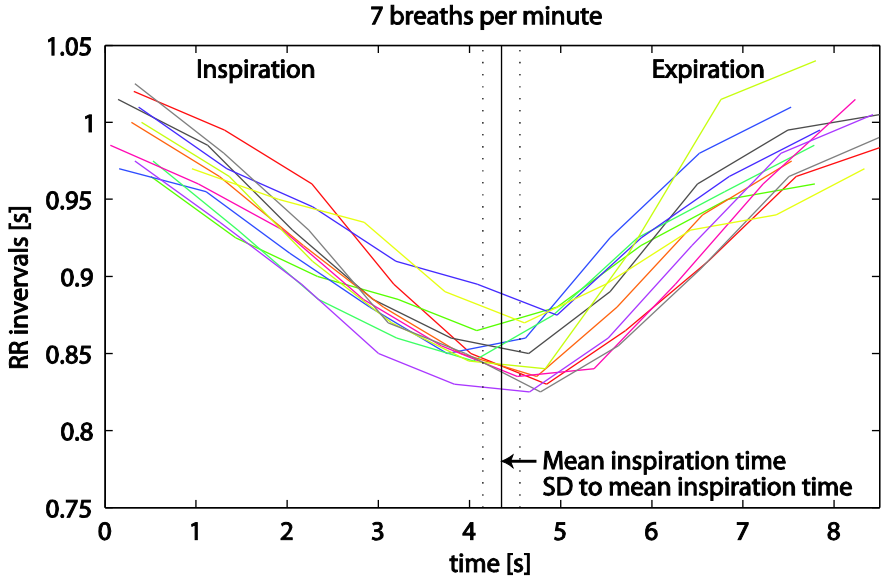


Methods


RR intervals
RR intervals [s]
1
0.9
0.8
0
20
40
60
80
100
120
time [s]
RR intervals divided in breaths
br. 1
br. 2
br. 3
br. 4
br. 5
br. 6
br. 7
br. 8
br. 9
br. 10
br. 11
br. 12
br. 13
RR intervals [s]
1
0.9
0.8
0
20
40
60
80
100
120
time [s]

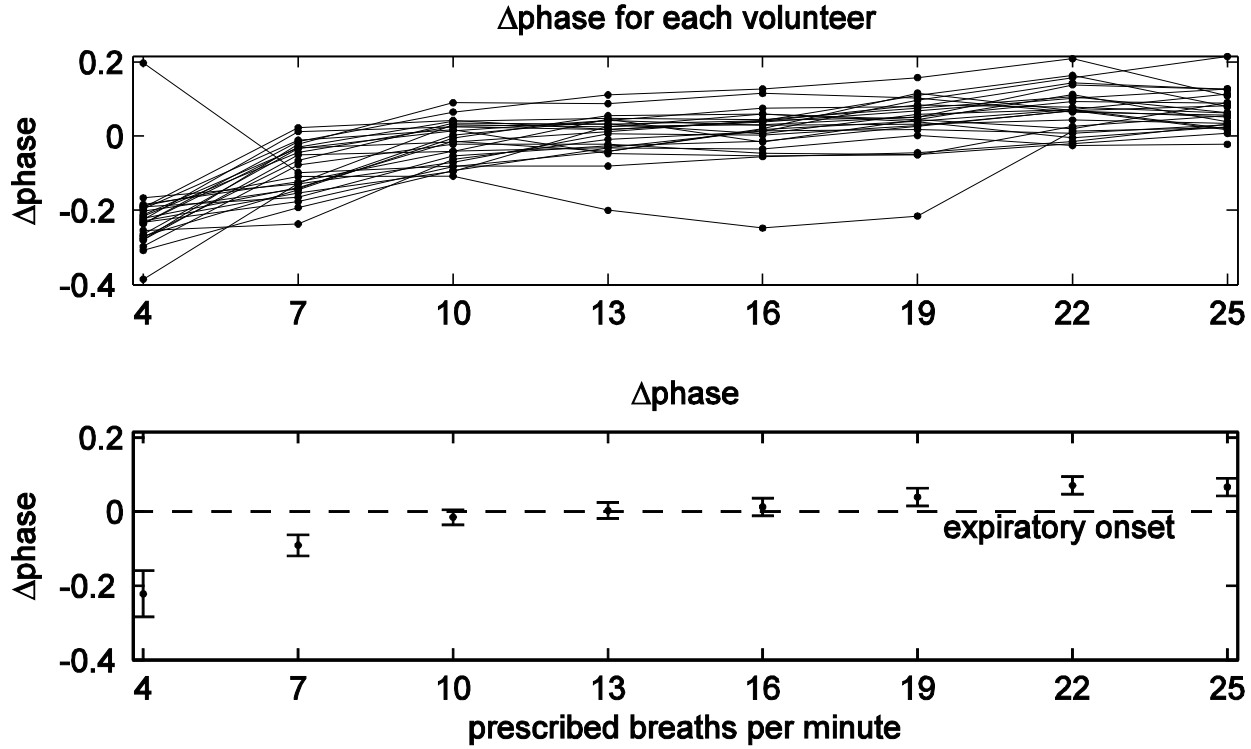
Results – Variation of RR intervals over time





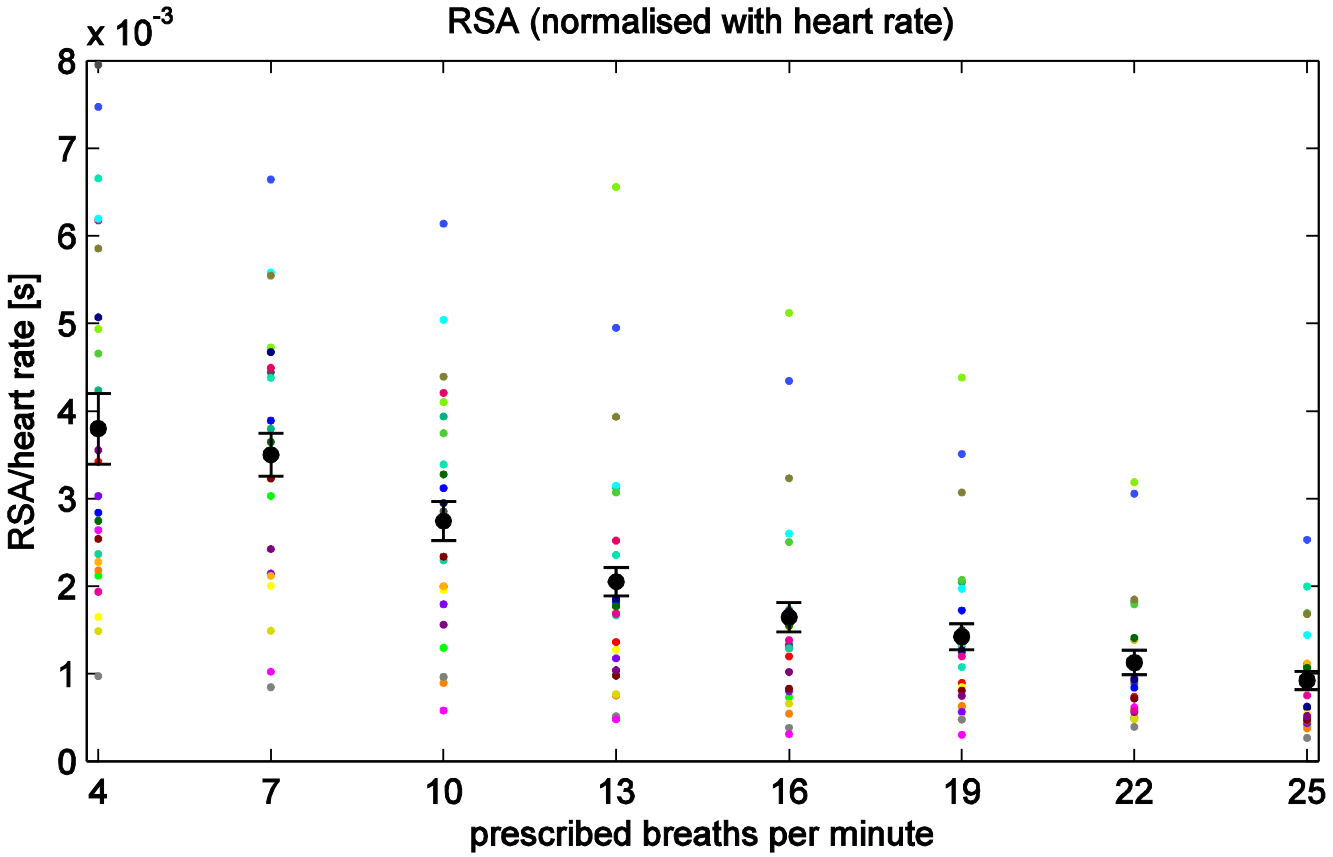
Course of Δphase

- Δphase is the difference between expiratory onset and minimum RR interval.
- A negative Δphase means that minimum RR interval occurs during inspiration.

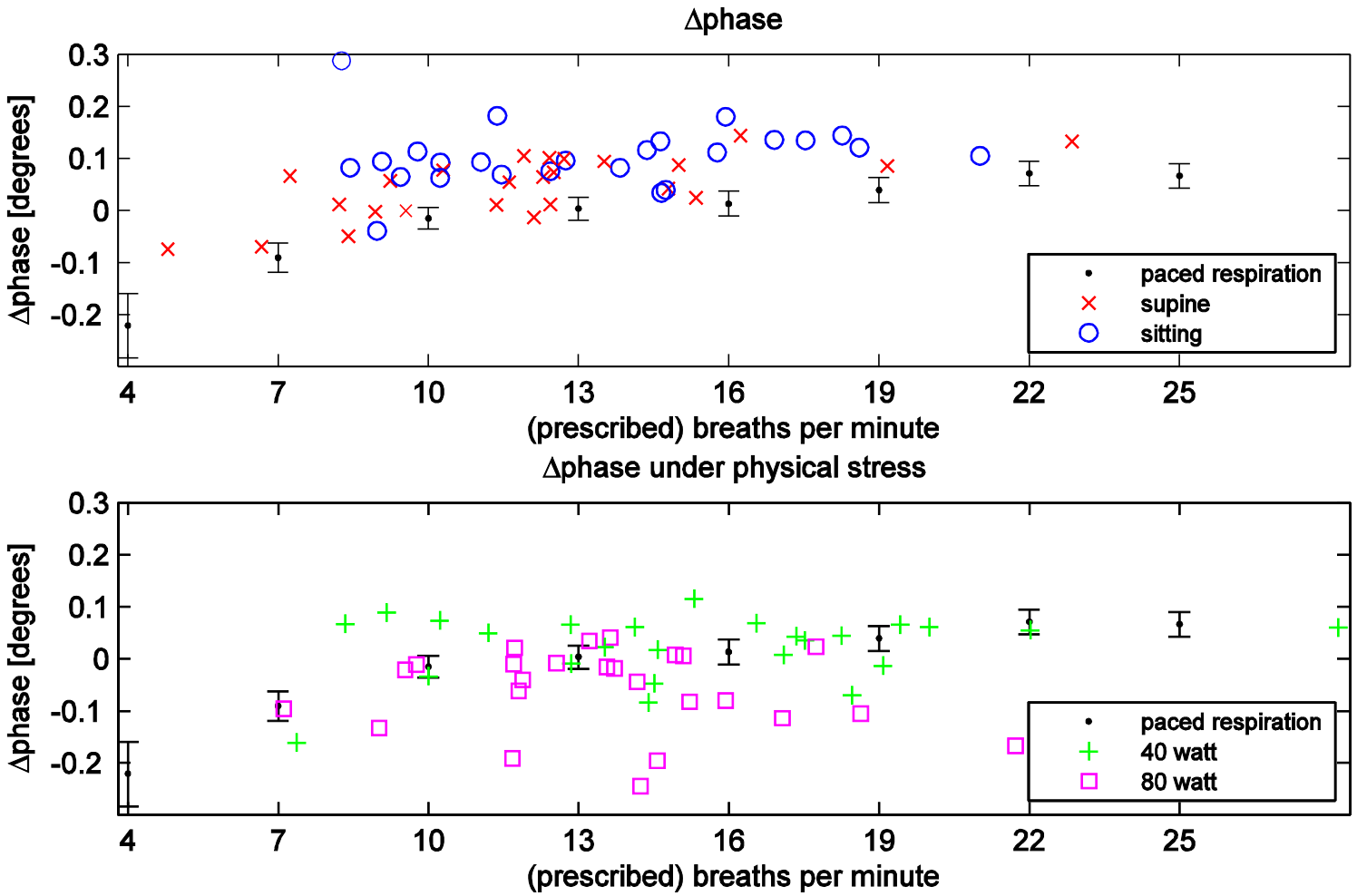


RSA dependency on breathing frequency

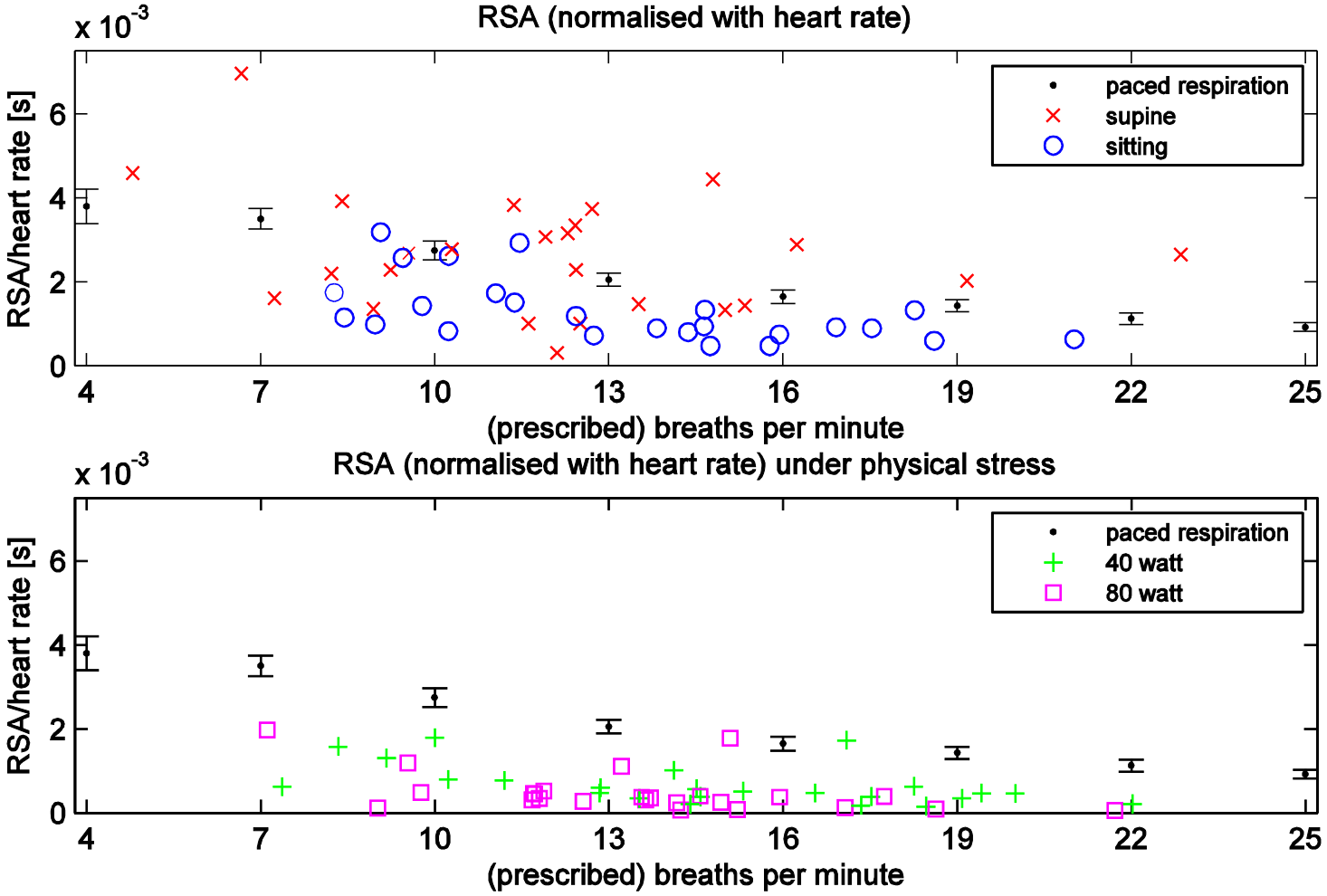
- Respiratory sinus arrhythmia (RSA) is the difference between the maximum and minimum RR interval within one breath.



Course of Δphase with values under rest or strain



Normalised RSA with values under rest or strain



Summary

- Cardioacceleration and cardiodeceleration within one breath
- Declining trend of RSA for breathing frequencies higher than 4 breaths per minute
- No direct relationship between physical stress and metronomic breathing

→ Respiratory flow and ECG recordings are sufficient enough to gain significant results