Effect of Sleep on Heart Rate Variability

-Payel Ghosh

Statistical Signal Processing-Fall 05

Overview

- Objectives
- Heart Rate
- Sleep: Significance of this study
- Data
- Methodology
- Results
- Conclusion

Objectives

- **Objective**: This study is aimed at finding how sleep affects the body, in terms of what is already understood about the heart rate PSD.
- The causes of heart rate variability have been researched a lot and co-related with the activity of the autonomic nervous system that affects blood pressure, respiration etc.
- Studied and compared the differences in heart rate PSDs of 7 subjects in awake and asleep states.

Heart Rate

- Measured with the Electrocardiogram (ECG).
- Definition: Times per minute that the heart contracts.
- RR (Inter beat interval) to HR (heart rate time series) conversion.

Heart Rate PSD

- Autonomous nervous system
  - Parasympathetic activity
    - Conservation of energy (reduction in HR, BP etc.)
  - Sympathetic Activity
    - Prepares the body for fear and flight. (increase in heart rate, respiration, BP)

Sleep: Significance of this study

- **Definition**: Dynamic state of consciousness characterized by rapid fluctuations in autonomic activity.
- **Gaps in our current knowledge**
  - Relatively new area of research (~50 years)
  - Understanding of autonomic activity during sleep is not clearly understood.
  - Autonomic activity understanding-based on observations of the heart rate and blood pressure.
Data
- Heart rate time series: 30-60 minute data.
- Awake state (posture: sitting)
- Asleep state (posture: lying down)
- Non-uniformly sampled at 1 Hz (approx.).
- 5 minute durations used for analysis.
- Local stationarity assumption.
  - Mechanisms responsible for heart rate variation are assumed to remain unchanged in this time period.

Data Preprocessing
- Uniformly re-sampled at 2 Hz

Methodology
Blackman-Tukey Periodogram

Methodology Continued
- Very low frequency components <0.02 Hz removed.
- Length of lag window: 75 points
- 40s Parzen window
- Confidence interval: 90%
- Low frequency power: Area under the PSD curve (0.04-0.15 Hz)
- High frequency power: Area under the PSD curve (0.15-0.5 Hz).

Results
- Subject 1

Results Continued
- Subject 2
Subjects 1 - 7

Results: Table

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Conclusion

- The balance of sympathetic/para-sympathetic activity of the heart for awake and asleep states of the 7 subjects was comparable. This was expected because the subjects were in resting state.
- Experiments with more number of subjects (in various other postures) should be performed before correlating physiological processes (that affect the shapes of the heart rate PSD) with sleep.

Thanks!

- Dr. James McNames.
- Reviewers for valuable feedback on my paper.

Questions?