Sleep RR-Interval U-patterns and Their Correlation to Movement Events

S. Yazdani*,[1], A. Cherqui[1], N. Bourdillon[2], G. Millet[2], and J.-M. Vesin[1]

1-ASPG, Swiss Federal Institute of Technology, Lausanne, Switzerland
2-ISSUL, Faculty of Biology and Medicine, UNIL, Lausanne, Switzerland

Purpose: Sleep analysis has received an ever-increasing attention in recent years, with works demonstrating the negative physiological consequences of sleep deprivation such as hypertension, cognitive impairment …. While numerous studies have been performed in the context of sleep analysis, ECG-based ones have relatively received less attention. Recently, a study investigated a phenomenon, called "U-patterns", occurring in the RR-interval time series during sleep [1]. These U-shaped decrease-increases in the RR-intervals typically have a duration of 20 to 40 seconds with a minimum decrease of 15% in the local RR-interval mean value. The aim of this work is to investigate the relation between U-patterns and movement events to the context of sleep deprivation.

Methods: Over a span of 17 days, 15 healthy subjects (22.1 ± 1.7 yrs., 7 males) participated in a study comprised of three subsequent stages. First, a baseline phase of seven days, during which the subjects slept normally. Immediately after, a sleep deprivation phase with a duration of three days, during which participants slept only three hours per night. Finally, in a 7-day recovery phase subjects went back to their normal baseline sleeping routine. Subjects underwent polysomnographic (PSG) data acquisition while sleeping.

U-patterns were extracted from RR-intervals while movement events were extracted from different channels of the PSG. Their relative temporal layout was studied to determine whether U-patterns are caused due to subject movement during sleep or vice versa.

Results: U-patterns were present in all participating subjects and recurrent within the RR-intervals. Our preliminary results suggest that U-pattern/movement events are highly correlated (86%), and surprisingly, always initiated by U-patterns with movement events terminating before the termination of their respective U-patterns. Furthermore, observations revealed that, in the "sleep-deprivation" phase, there was a significant difference between the onset (likewise offset) delays of movement events w.r.t their corresponding U-patterns. Detailed results are reported in Table 1.

Table 1 – Onset (offset) delays between U-Patterns and Movement Events, for each phase of the study.

Movement Source from PSG	Onset Delays (s)			Offset Delays (s)		
	Baseline (mean $\pm$ std)	Sleep Deprivation (mean $\pm$ std)	Recovery (mean $\pm$ std)	Baseline (mean $\pm$ std)	Sleep Deprivation (mean $\pm$ std)	Recovery (mean $\pm$ std)
EMG	8.9 ± 1.5	14.9 ± 3.3	8.0 ± 2.2	15.9 ± 4.7	8.5 ± 2.0	14.7 ± 3.1
Thorax	8.1 ± 1.6	13.2 ± 3.1	7.6 ± 1.7	13.1 ± 2.3	7.9 ± 1.8	12.9 ± 2.2
EEG C3	11.0 ± 2.9	14.6 ± 2.8	11.4 ± 5.0	13.8 ± 5.3	10.7 ± 3.3	14.2 ± 3.5
EEG C4	9.4 ± 3.2	15.9 ± 3.2	10.5 ± 4.3	14.4 ± 4.3	9.9 ± 1.8	14.2 ± 3.1

[1]   S. Yazdani, A. Cherqui, N. Bourdillon, G. Millet, and J.-M. Vesin. 'Analysis of U-Shape Patterns in RR-Interval Time Series during Sleep', Computing in Cardiology (CinC) 2018.