Instituto Universitario de Investigación de Ingeniería de Aragón
Universidad Zaragoza

XIII JORNADA DE JÓVENES INVESTIGADORES/AS DEL I3A

BSICoS Biomedical Signal Interpretation & Computational Simulation

Effects of Transcutaneous Spinal Cord Stimulation on Autonomic Nervous System Regulation

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INTRODUCTION

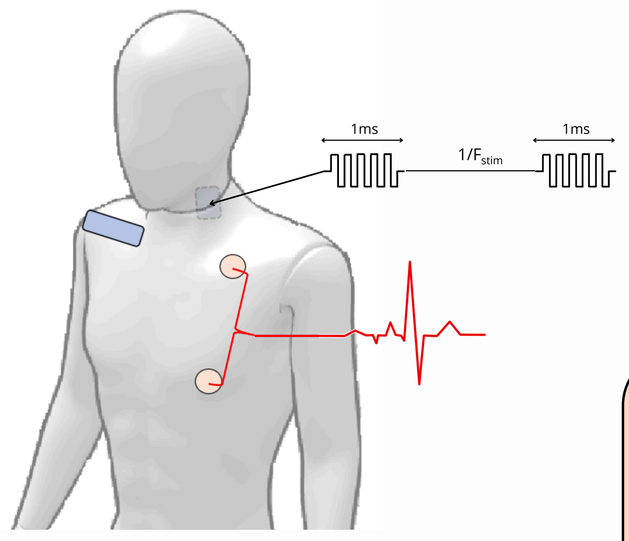
Transcutaneous spinal cord stimulation (tSCS) is a promising technique to treat motor disorders. In some cases, it could replace traditional invasive stimulation, which is both risky and expensive [1].

At present, we lack fundamental information about how tSCS interacts with the function of different systems in the human body. Among other factors, due to its non-specificity.

The autonomic nervous system (ANS) may be modulated by stimulation [2], which may explain some of the effects of this technique.

Objective: To study how tSCS delivered at different frequencies affects the function of the ANS

EXPERIMENTAL DESIGN



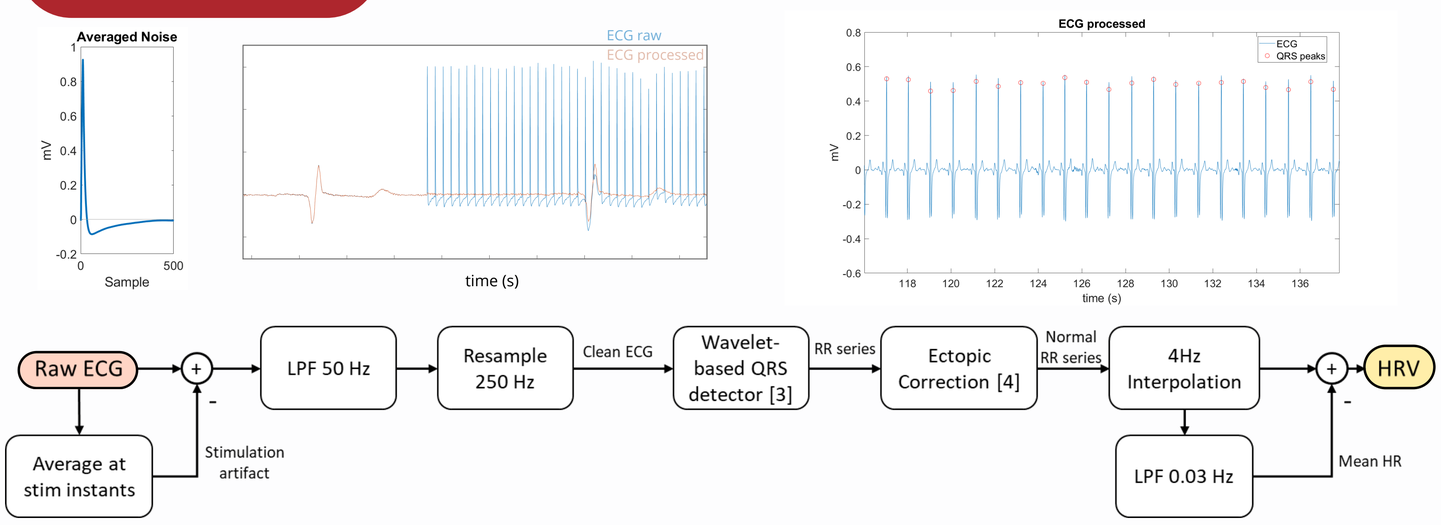
x7

5 min recordings

4 different conditions:
- No stimulation
- Stimulation at 7 Hz
- Stimulation at 20 Hz
- Stimulation at 45 Hz

The ECG of the subjects was acquired using a bipolar lead following the main line of the heart from V1 to V4. For the tSCS, an electrode was placed in the posterior neck region (C6 level), and another one on the clavicle of the dominant side.

PROCESSING



Time domain metrics
- Mean Heart Rate (*HRM*)
- Standard deviation of Normal Intervals (*SDNN*)
- Standard deviation between adjacent normal beats (*SDSD*)
- Proportion of normal RR interval differences greater than 50 ms between consecutive beats (*pNN50*)

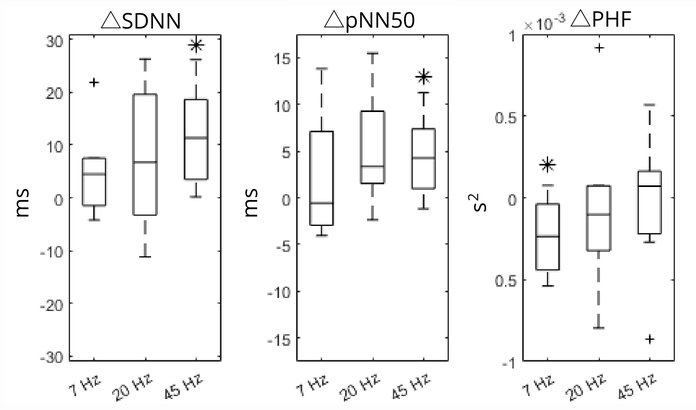
Frequency domain metrics
- Power at High Frequency (0.15-0.4 Hz) (*PHF*)
- Power at Low Frequency (0.04-0.15 Hz) (*PLF*)
- Ratio between low and high frequency (*PLF/PHF*)
- Normalized PHF (*PHFn*)
- Normalized PLF (*PLFn*)

Wilcoxon signed-rank test

Metrics

RESULTS

Differences compared to control situation:
- 7 Hz: ⬇PHF
- 20 Hz: No significant differences
- 45 Hz: ⬆SDNN, ⬆pNN50



Boxplots showing the **variation** of three HRV metrics **compared to a control** value, under three stimulation conditions (7 Hz, 20 Hz, and 45 Hz). From left to right: SDNN, pNN50, PHF. Asterisks (*) indicate significant differences ($p<0.05$).

The three of them (PHF, SDNN, pNN50) are **parasympathetic** nervous system markers

** Studying the **central part** of the stimulation, **no significant differences** were observed for any of the metrics*

CONCLUSSIONS & FUTURE WORK

stimulation of nearby structures (e.g. vagus nerve) or indirect effects due to sensation induced by stimulation?

Parasympathetic activity ⬆ at 45 Hz / ⬇ at 7 Hz → **Frequency-specific** effects of tSCS on the ANS

Effects disappear when the beginning and end of the record are ignored. → Potential **confounding effects** of stimulation-induced **surprises** → Need of a **time-frequency** analysis

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