A HEARTBEAT AWAY FROM CONSCIOUSNESS: HEART RATE ENTROPY CAN ASSESS CONSCIOUSNESS

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1. Background

- Healthcare differs if patient is unresponsive (UWS) or minimally conscious (MCS)
- 35% clinical diagnosis error which can impact life and death decisions
- Neuroimaging helps, but is expensive and difficult in daily clinical setting
- Heart and brain’s Central Autonomic Network (CAN) are connected in a two-way dynamic interaction through the Autonomic Nervous System (ANS):

Can we better diagnose by monitoring the heart?

2. Methods

From heart rate to multi-scale entropy to COMPLEXITY INDEX in the short term (CI) and long term (CII):

- Conducted on 14 UWS and 16 MCS sedated patients as assessed by the Coma Recovery Scale – Revised (CRS-R) acquired since 2008 up to 2017.
- Patients were matched for age, gender, etiology and onset.
- Electrocardiographic activity (ECG) and photoplethysmographic sensor (PPG) were acquired for 10 minutes, simultaneously with MRI (3T Siemens Magnetom TrioTim).
- PPG and ECG were cleaned with a Fourier Transform (SigView software) and multi-scale entropy was calculated (HRV Advanced Analysis software v2.2). CI was calculated as the area under the sample entropy timescale curve.
- MRI T1 and EPI BOLD were preprocessed with SPM12 and 2nd-level correlation analyses were calculated with CONN 17f with CI, and CII, as covariates of interest in a parametric regression.

3. Results

3.1. MCS have higher CI than UWS on average

Group-wise, MCS show higher CI (1-3.346, p<0.001) and CI (1-4.095, p<0.001) compared to UWS using a Mann-Whitney’s test.

3.2. CI correlates with CAN fMRI connectivity recovery

- CI correlates with F1 <-> Superior Frontal Gyrus (red), PC <-> Temporal Gyrus & Insula (blue) connectivities.

3.3. CI reliably discriminates MCS from UWS

One-R classifier with 10-fold cross-validation:
- CI, selected as the best predictor
- 90% accuracy, 7% false positive and 13% false negative rates
- In comparison, Zero-R (always predicting MCS) has 53% accuracy
- Lower error than clinical consensus

4. Conclusion

- Complexity Index has high discriminative power and low false negative rate
- Might provide an inexpensive way to diagnose MCS & UWS and screen/monitor CAN connectivity changes
- Future: should investigate in a bigger cohort and in acute patients

5. Bibliography & Acknowledgements


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