Increased Heart Rate Variability predicts fatigue before and after sleep deprivation and might be related to compensatory mechanisms in the CNS

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**Introduction:**
- Sleep deprivation has influences on several body functions.
- Cognitive fatigue, probably caused by a dysfunction of basal ganglia is increased after sleep deprivation.
- Brain structures involved with fatigue are interconnected with the supraspinal autonomic network, which again is involved in heart rate variability changes.

**Methods:**
- 10 minute HRV-measurement was obtained before and after night shift (nurses).
- Participants were asked about their subjective fatigue (verbal rating scale) before and after the night shift.
- Linear parameters (SDNN, rMSSD, TP, HF, LF, VLF, LF/HF) and nonlinear parameters (approximate entropy, Renyi entropy, Shannon entropy, and as fractal measures capacity dimension (Renyi Dimension D0) and information dimension (Renyi Dimension D1) were calculated.

**Results (1):**
- 23 participants, 79.2 % female, mean age 41 (25-63 years)
- Fatigue before nightshift: 12 (±14.8), after nightshift: 49 (± 20.13). Cluster analysis revealed two different groups, one with less fatigue (38.3 ±17.7) and one with increased fatigue (56.9 ±18.7).
- Higher fatigue after nightshift was predicted by higher SDNN 8 hour earlier (Fig2a). Participants with SDNN > 70 before nightshift had more frequently a fatigue score > 50 afterwards (p = 0.008, likelihood ratio 8,416, positive predictive value 87.5 %, negative predictive value of 73 %) (Fig2b).

**Results (2):**
- SDNN, RMSSD and Renyi entropy α = 0 and 1 before nightshift was significantly higher in persons with fatigue > 50 on the verbal rating scale after nightshift (Fig3a,b)
- SDNN, RMSSD and Renyi entropy with α = 1, 2 and 3 after nightshift was also increased in persons with higher fatigue (Fig 4a/b).
- Linear and nonlinear parameters in general were not statistically different before and after the night shift.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Low Fatigue</th>
<th>High Fatigue</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDNN before nightshift</td>
<td>54.1 ± 16.5</td>
<td>84.7 ± 18.8</td>
<td>0.009</td>
</tr>
<tr>
<td>SDNN after nightshift</td>
<td>48.1 ± 13.2</td>
<td>80.3 ± 12.4</td>
<td>&lt;0.001</td>
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<tr>
<td>RMSSD before nightshift</td>
<td>42.2 ± 19.7</td>
<td>90.1 ± 12.9</td>
<td>0.164</td>
</tr>
<tr>
<td>RMSSD after nightshift</td>
<td>35.5 ± 12.2</td>
<td>64.5 ± 10.6</td>
<td>0.004</td>
</tr>
<tr>
<td>Renyi entropy α = 0 before nightshift</td>
<td>6.616 ± 0.38</td>
<td>6.531 ± 0.37</td>
<td>0.051</td>
</tr>
<tr>
<td>Renyi entropy α = 0 after nightshift</td>
<td>5.07 ± 0.36</td>
<td>6.18 ± 1.6</td>
<td>0.001</td>
</tr>
<tr>
<td>Renyi entropy α = 1 (Shannon) before nightshift</td>
<td>5.39 ± 0.42</td>
<td>6.02 ± 0.34</td>
<td>0.119</td>
</tr>
<tr>
<td>Renyi entropy α = 1 (Shannon) after nightshift</td>
<td>5.31 ± 0.39</td>
<td>5.9 ± 0.23</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Renyi entropy α = 2 before nightshift</td>
<td>5.30 ± 0.41</td>
<td>5.70 ± 0.40</td>
<td>0.117</td>
</tr>
<tr>
<td>Renyi entropy α = 2 after nightshift</td>
<td>5.02 ± 0.41</td>
<td>5.39 ± 0.28</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Table 1: Linear and Nonlinear parameters associated with fatigue

**Discussion:**
- Our results indicate an association between higher SDNN, different entropy indices and fatigue.
- SDNN is a global parameter for heart rates variability and is increased eg. by exercise, but also by pathological factors like increased CRP.
- The increased SDNN might be caused by a compensation effort of the prefrontal cortex to control the anterior cingulated cortex (which known to be overactive in fatigue conditions, Fig 5).

**Reference:**
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