Association between Cognitive Impairment and Heart Rate Dynamics in Response to Cognitive Dual Task Load

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Autonomic dysfunction refers to an imbalance in the autonomic nervous system (ANS) control over the heart, brain, and their interactions, which is linked to mild cognitive impairment (MCI). Previous research showed that autonomic function (i.e., sympathetic/parasympathetic modulations) highly correlates with cognitive ability, specifically with executive function, memory, and attention, and autonomic dysfunction may predict late in life cognitive decline. In the current study, we used heart rate (HR) dynamics (changes in HR in response to cognitive load) as a measure of ANS performance. As the cognitive load, we implemented an upper-extremity function (UEF) that combines repetitive elbow flexion at a consistent, self-selected pace with a concurrent cognitive task of counting backward by threes. In the UEF setup, we isolate motor and HR assessments one to each side of the body (right arm movement while ECG is measured from the left chest), allowing accurate assessment of HR characteristics during physical activity. HR was measured using a wearable ECG sensor (Faros, 1000 Hz) with two electrodes, one on the upper mid-thorax near the clavicle and the other inferior to the left rib cage. We recruited a sample of older adults including those with MCI (n=10, age=71±5) and cognitively normal participants (CN) (n=17, age=72±6). Participants started by resting for 3 minutes, followed by UEF for 3 minutes, and another 3 minutes of resting recovery. Results showed significant differences in HR dynamics, characterized by a 37% smaller increase in HR in response to UEF and a 72% slower recovery to the baseline after the task among MCI (p<0.03, effect size=1.01±0.34). HR variability (HRV) measures, including root mean square of successive differences between heartbeats (RMSSD) during the rest period showed weaker effect size for differentiating between cognitive groups (0.33±0.11). Results supported the value of including HR dynamics as a novel module for screening cognitive impairment.

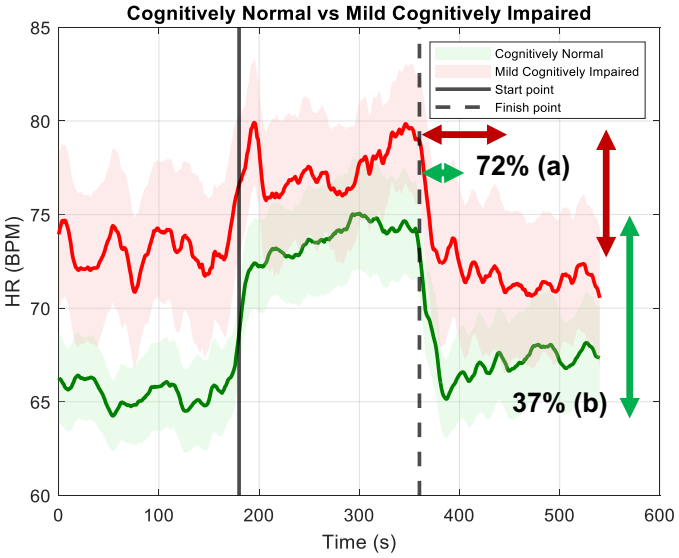

Figure. Mean and standard deviation of HR response to UEF across cognitive groups: (a) 72% slower recovery rate for MCI; and (b) 37% smaller HR increase in MCI (p<0.03).