Modulating arm swing symmetry with cognitive load: a window on rhythmic spinal locomotor networks in humans?

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In healthy subjects, changes in arm swing symmetry while walking are observed when a cognitive dual task is added, with a tendency towards left-dominant arm swing as cognitive load increases. We applied a modified Stroop word / colour naming paradigm to investigate this effect in spinal cord injured (SCI) patients. Six patients with cervical SCI (cSCI), six with thoracic injuries (tSCI; all 12 patients AIS D) and 12 healthy, matched controls underwent 3D gait analysis while walking normally at a comfortable speed (NW) and when performing an additional congruent (CS) and incongruent (IS) Stroop task. Arm swing asymmetry index (ASI) – in which positive values indicate proportionally more movement on the left and vice versa – was calculated. Even in the baseline NW condition, all three subject groups showed larger arm movements on the left. In controls, ASI increased (NW: 13.7±6.3, CS: 16.6±6.4, IS: 19.6 ±7.8) as the task became more demanding. A larger shift in tSCI patients (NW: 15.8±6.0, CS: 23.4±3.8, IS: 30.7±4.4) was driven by a significant reduction in right wrist trajectory (p = 0.014), while cSCI patients showed a small reduction in mean ASI with high variability (NW: 14.2±10.7, CS: 9.3 ±13.5, IS: 6.0±12.9). The effect of the IS task on ASI compared to baseline (NW) was significantly different between tSCI (+12.5±6.3) and cSCI (-8.2 ±6.0) patients (p = 0.011). Disruption of the long propriospinal connections coordinating arm and leg movements during walking may explain the heightened sensitivity to manipulation of cognitive load in tSCI, while the more robust automaticity in cSCI may be due to impaired supraspinal inputs in the context of preserved intraspinal pathways.