

# Synergistic Effects of Music and Neuromodulation in Patients with Disorders of Consciousness: Protocol for a Randomised, Sham-Controlled, Single-Session Study

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## BACKGROUND

- **Disorder of consciousness (DoC):**
  - Coma
  - Unresponsive wakefulness syndrome,
  - Minimally conscious state (1-3).
- Current treatments are **limited** (4,5).
- Promising approaches, although modest results.
  - **Music** → engages the auditory system (6).
  - Transcranial alternating current stimulation (**tACS**) → modulate motor system oscillations (7,8).
- Combining music with tACS may strengthen the **auditory-motor network**.

**Objective:** to test if **motor tACS** applied **synchronously** with **music** improves behavioural, and (neuro)physiological outcomes, compared to sham stimulation, in patients with DoC.

## HYPOTHESIS & EXPECTED OUTCOMES

- Increase behavioural signs of consciousness
  - Improvement in physiological measures (heart rate variability)
  - Higher functional connectivity (alpha modulation).
- These changes are expected to be **higher after the synergistic condition** due to the auditory-motor coupling.

## IMPACT

- Unravel the **mechanism of auditory-motor coupling** on the recovery of patients with DoC.
- Bring forward a **novel therapeutic strategy** in this population.

## METHODS

- Multicentre, randomised, sham-controlled, four-arm, crossover, single-session study.
- 35 patients with prolonged DoC (> 18 years) with acquired brain injury.
- **Experimental conditions** (Figure 1): pseudo-random order, 1-week washout

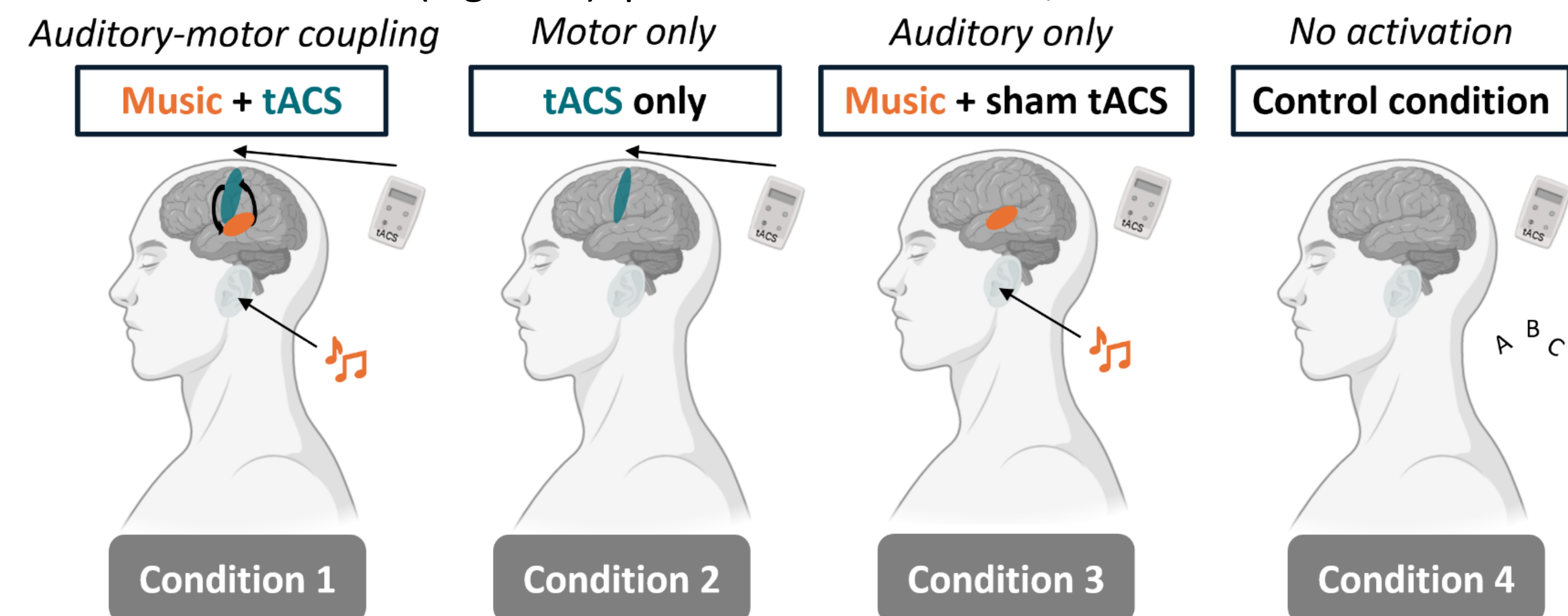
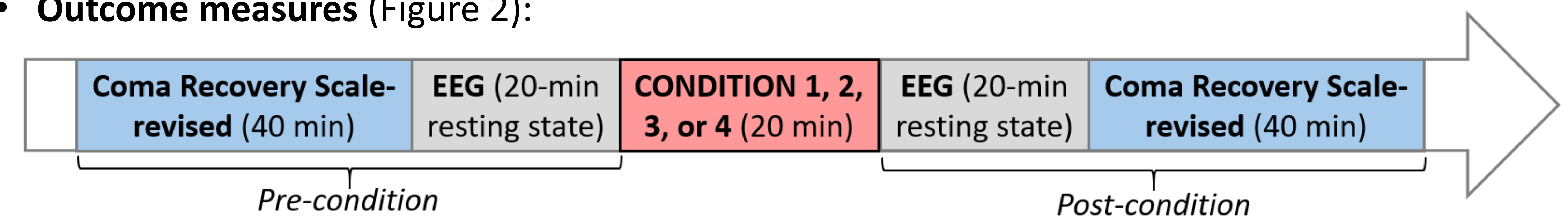


Figure 1. Overview of experimental conditions and activation mechanisms

- **Stimulation parameters**
  - Music: preferred music type (+/- 10% of 1.67 Hz).
  - tACS: 2 mA peak-to-peak, over primary motor cortex of dominant hand (or most preserved hemisphere), frequency of the beat.
- **Outcome measures** (Figure 2):



During: heart rate & video recordings

Figure 2. Timeline of outcome measures

## EXPECTED TIMELINE

Expected **start** and **end** of data collection: October 2025 – March 2027.