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Investigating Cytochrome c Oxidase Activity and Hemodynamic Responses During TMS Using Broadband NIRS

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■ Study Overview

Introduction: Broadband Near-Infrared Spectroscopy (bNIRS) is a non-invasive, non-ionizing technique that enables bedside, in vivo monitoring of the hemodynamic and metabolic activity of the cerebral cortex [1].

Objective: This study aims to evaluate the efficacy of bNIRS in measuring functional responses to transcranial magnetic stimulation (TMS).

Methods: A miniature broadband NIRS system was employed across three TMS sessions targeting the right frontal pole. Thirty-one healthy participants (N = 31) underwent two intervention arms—continuous theta burst stimulation (cTBS) and intermittent theta burst stimulation (iTBS)—against a sham comparator.

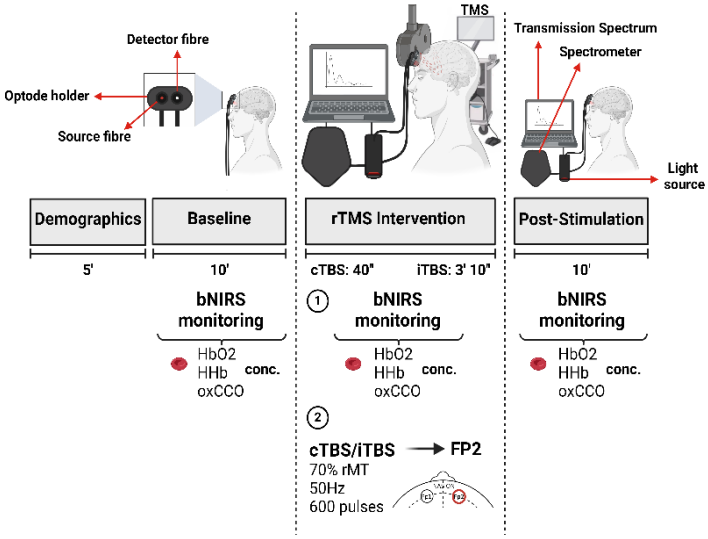

Figure 1: *Schematic of bNIRS-TMS pairing during session procedure. bNIRS monitoring was conducted over a 20-minute period, with TMS intervention administered at the 10-minute mark.*

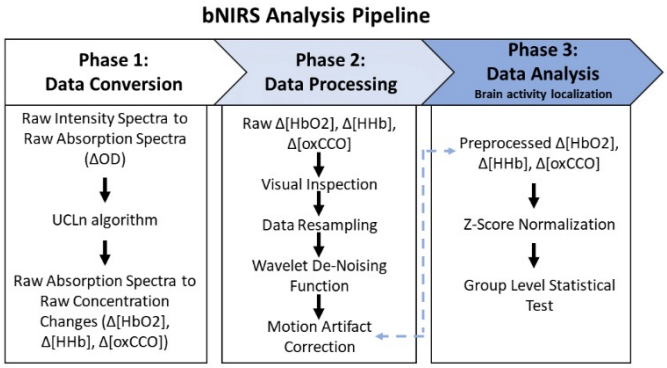

Figure 2: *Flow chart illustrating the bNIRS data analysis pipeline, from raw data acquisition to statistical analysis.*

■ Results and Discussions

cTBS Effects:

- Increased ΔHBO_2, ΔoxCCO (P<0.001)
- Decreased ΔHHB (P<0.001)
- Suggests neural activation and effective modulation [2].
- Excitatory-like effects may result from altered neurovascular coupling or compensatory excitatory responses within the frontal pole [3].

iTBS Effects:

- Decreased ΔHBO_2, ΔHHB (P<0.001)
- Increased ΔoxCCO (P<0.001)
- Suggests heterogeneity in neurovascular-metabolic responses across individuals [4].

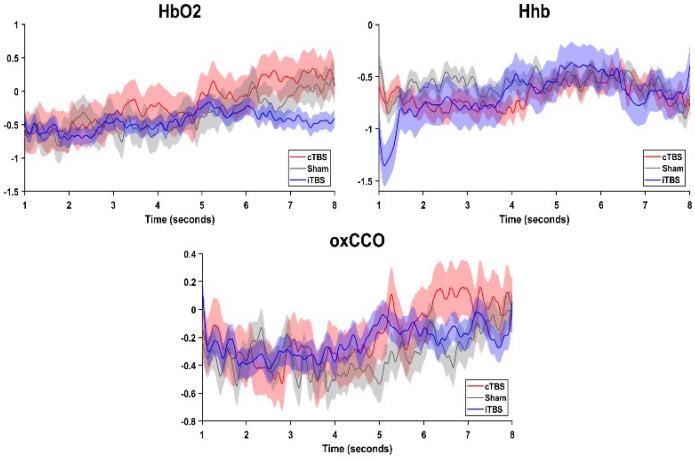

Figure 3: *Mean changes (lines) and standard deviations (shaded areas) in oxyhemoglobin (ΔHBO_2), deoxyhemoglobin (ΔHHB), and cytochrome c oxidase (ΔoxCCO) following cTBS (blue), iTBS (red), and sham (grey) conditions. Data was smoothed using a Savitzky-Golay filter for visualisation purposes only.*

■ Conclusion

This study demonstrates that bNIRS effectively captures neural modulation following TMS. Findings highlight the utility of bNIRS in monitoring neurovascular and metabolic changes during brain stimulation and underscore the importance of accounting for regional differences in neurovascular coupling and individual variability in future neuromodulation protocols.

■ References:

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