

BACKGROUND

- Variability in experimental design and outcome reporting has resulted in inconclusive evidence surrounding the behavioural and neurological effects of transcranial direct-current stimulation (tDCS) (1,2)
- Functional near-infrared spectroscopy (fNIRS) is an effective neuroimaging approach to investigate the brain's response to neurostimulation (3)

AIMS

- To critically evaluate studies combining tDCS and fNIRS
- To provide an overview of cortical hemodynamic responses to neurostimulation

METHODS

- Systematic review of Embase, MEDLINE and PsycINFO was conducted with cross-references from Google Scholar (Fig. 1)
- Last date of literature search was 12 July 2019
- Following deduplication and exclusions, qualitative analysis of included studies was performed

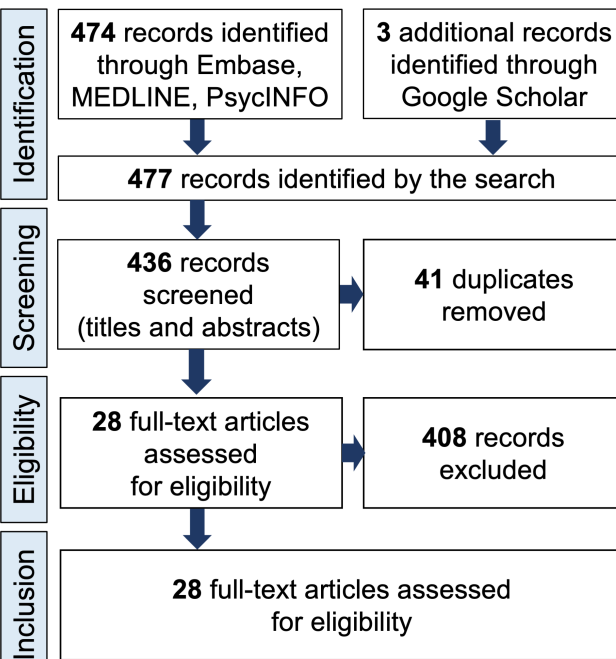


Figure 1 - PRISMA diagram of study selection process

Literature Findings

- 28 papers were reviewed: 22 in healthy individuals (9 involving rest, 13 with tasks) and 6 in the clinical setting
- Recent emergence of studies combining tDCS and fNIRS was observed (Fig. 2)

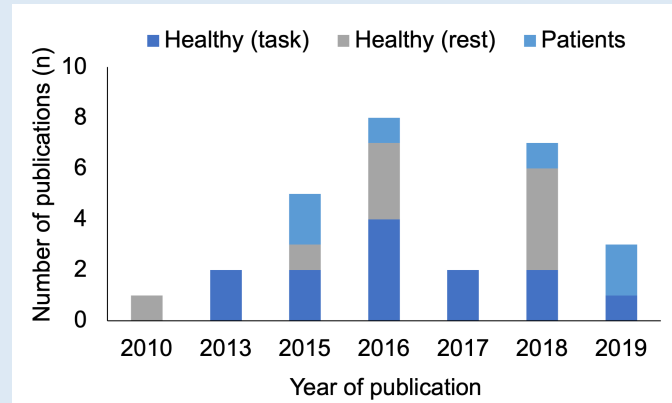


Figure 2 - Number of publications utilising a combined tDCS and fNIRS montage by year

Methodological Approaches

- Significant heterogeneity in parameters of combined fNIRS and tDCS montages was identified (Fig. 3)

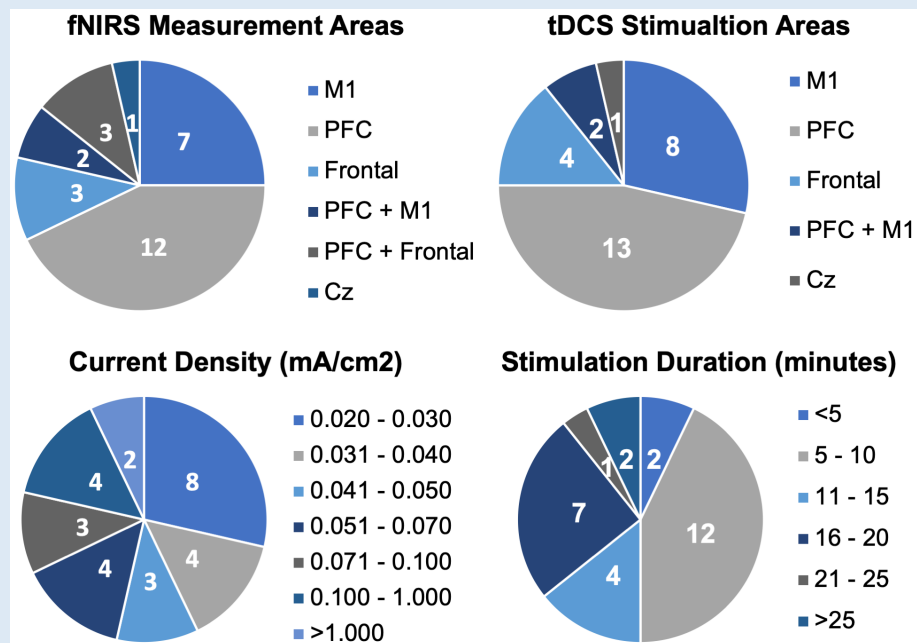


Figure 3 - Location of fNIRS monitoring, location of stimulation, current density, and stimulation duration utilised in the studies (n=28)

RESULTS

- Concurrent stimulation and fNIRS measurement were performed in 20 of 28 studies (Fig. 4), 22 studies recorded haemodynamic changes at the stimulation site

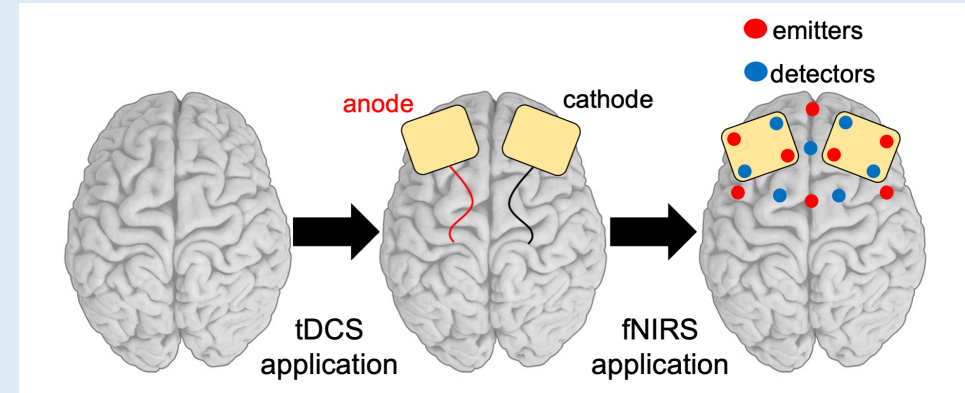


Figure 4 - An example of combined tDCS and fNIRS montage setup

Haemodynamic Responses

- Overall increase in cortical activation at the stimulation site was associated with rest condition (Fig. 5)
- Tendency for tDCS to increase HbO₂ was observed at stimulated M1 and PFC
- Less-pronounced general effect at non-stimulated brain regions was observed
- With motor tasks, decrease in HbO₂ at stimulated M1 was identified, while with cognitive tasks decrease in HbO₂ at stimulated PFC was observed
- During functional tasks, reduced cortical activation at the stimulation site was observed during online stimulation
- Offline and poststimulation effects lacked consistency through the cohort
- Clinical impact on patient populations and their symptom correlation was inconsistent

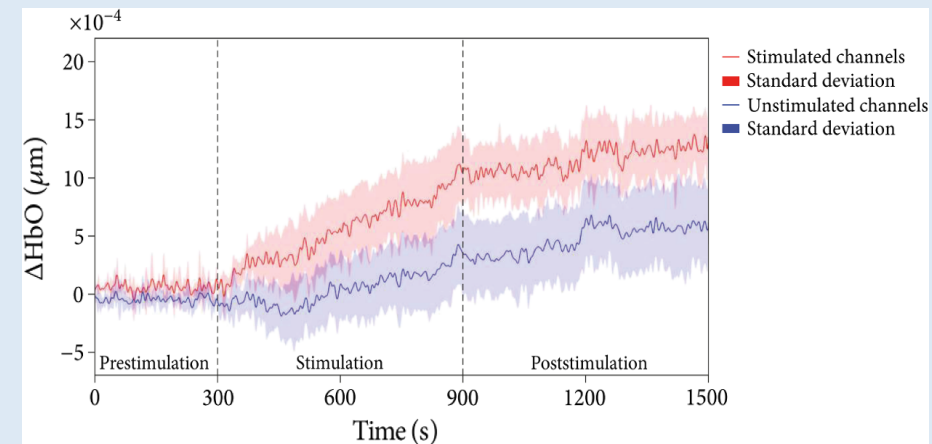


Figure 5 - Representative example of fNIRS HbO time series analysis during rest (adapted with permission from Yaqub et al., Complexity, 2018)

CONCLUSION

- The combination of tDCS and fNIRS is becoming an increasingly popular and promising technique to investigate neuromodulation
- Despite the high degree of methodological heterogeneity several consistent results across the included studies can be identified
- Further randomised controlled studies with standardised reporting and higher sample sizes are required to confirm existing evidence