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Effects of non-invasive brain stimulation on brain activity and brain chemicals in healthy adults

Submission date 14/05/2026	**Recruitment status** No longer recruiting	[_] Prospectively registered [_] Protocol [_] Statistical analysis plan [_] Results [_] Individual participant data [X] Record updated in last year
Registration date 14/05/2026	**Overall study status** Completed	
Last Edited 20/10/2026	**Condition category** Other	

Plain English summary of protocol
Not provided at time of registration

Contact information

Type(s)
Principal investigator, Public, Scientific

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Additional identifiers

Study information

Scientific Title
Effects of intermittent theta burst stimulation compared with sham stimulation on magnetic resonance imaging and neurochemical measures in the visual cortex of healthy adults

Study objectives

This study aimed to systematically evaluate the effects of a single session of standard intermittent theta burst stimulation (iTBS) on the healthy human visual cortex, with a focus on its neurochemical, physiological, and temporal characteristics. Specifically, the objectives were to:

1. Assess neurochemical effects of iTBS:
Determine whether iTBS modulates cortical metabolite levels, including Glx and GABA+, measured using magnetic resonance spectroscopy (MRS).
2. Examine changes in excitation/inhibition (E/I) balance:
Evaluate whether iTBS alters the Glx/GABA+ ratio as an index of cortical excitatory–inhibitory balance.
3. Evaluate effects on cortical excitability:
Investigate changes in cortical excitability using phosphene threshold (PT) measurements.
4. Characterize temporal dynamics of stimulation effects:
Assess neurochemical and physiological changes across multiple post-stimulation time points (0.5 h, 3.5 h, and 24 h).
5. Compare expected plasticity effects with prior rTMS findings:
Determine whether a single session of iTBS induces measurable plasticity-like effects in the visual cortex, in contrast to previously reported effects of 10 Hz high-frequency rTMS.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 19/01/2016, Institutional Review Board of National Yang Ming Chiao Tung University (No. 155, Sec. 2, Linong St, Taipei City, 112, Taiwan; +886 (0)228267000; irb.ym@nycu.edu.tw), ref: YM104122E

Primary study design
Interventional

Allocation
Randomized controlled trial

Masking
Blinded (masking used)

Control
Placebo

Assignment
Parallel

Purpose
Basic science

Study type(s)

Health condition(s) or problem(s) studied
Healthy volunteers

Interventions
Current interventions as of 20/10/2026:
Participants were randomly assigned to either an intermittent theta burst stimulation (iTBS) group or a sham-control group. The order of active and sham stimulation sessions was counterbalanced across participants using computer-generated randomization. Each participant underwent two stimulation sessions, separated by one week, according to their assigned experimental condition (active iTBS or sham), in a parallel-group design. The active stimulation consisted standard iTBS delivered over the occipital cortex (visual cortex). The iTBS protocol followed the conventional theta burst pattern, consisting of bursts of high-frequency stimulation (3 pulses at 50 Hz) repeated at 5 Hz (i.e., every 200 ms). Each iTBS train lasted 2 seconds and was repeated every 10 seconds for a total of 20 trains, resulting in 600 pulses in total. A fixed stimulation intensity of 50% maximum stimulator output (MSO) was used for all participants, corresponding to approximately 100% phosphene threshold (PT) on average. Coil positioning was guided and maintained over the visual cortex throughout the session. For the sham-control condition, stimulation was delivered using the sham coil. All participants received only one stimulation session, and all subsequent neurochemical and physiological measurements were conducted at predefined post-stimulation timepoints.

Previous interventions:
Participants were randomly assigned to either an intermittent theta burst stimulation (iTBS) group or a sham-control group. The order of active and sham stimulation sessions was counterbalanced across participants using computer-generated randomization. The active stimulation consisted of a single session of standard iTBS delivered over the occipital cortex (visual cortex). The iTBS protocol followed the conventional theta burst pattern, consisting of bursts of high-frequency stimulation (3 pulses at 50 Hz) repeated at 5 Hz (i.e., every 200 ms). Each iTBS train lasted 2 seconds and was repeated every 10 seconds for a total of 20 trains, resulting in 600 pulses in total. Stimulation was delivered at 100% of the participant's phosphene threshold (PT). Coil positioning was guided and maintained over the visual cortex throughout the session. For the sham-control condition, stimulation was delivered using the sham coil. All participants received only one stimulation session, and all subsequent neurochemical and physiological measurements were conducted at predefined post-stimulation timepoints.

Intervention Type
Device

Phase
Not Applicable

Drug/device/biological/vaccine name(s)
Magstim Rapid², 3T Siemens MRI Scanners

Primary outcome(s)
1. 1H magnetic resonance spectroscopy (MRS) measured using MRS-derived neurometabolite concentrations at baseline, 0.5 h, 3.5 h, and 24 h after iTBS/sham stimulation

2. TMS-based phosphene threshold (PT) assessment measured using phosphene threshold at baseline and multiple post-stimulation timepoints (0 h, 4.5 h, and 24 h)

Key secondary outcome(s)

Completion date
31/10/2020

Eligibility

Key inclusion criteria
1. Healthy adults with no history of neurological, medical, visual, or cognitive impairments
2. No contraindications to MRI or TMS, such as a history of seizures or epilepsy, metallic implants, implanted electronic devices (e.g., pacemakers), or pregnancy

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit
20 Years

Upper age limit
35 Years

Sex
All

Total final enrolment
24

Key exclusion criteria
1. A history of neurological, medical, visual, or cognitive impairments
2. Any contraindications to magnetic resonance imaging or transcranial magnetic stimulation, including a history of seizures or epilepsy, metallic implants, implanted electronic devices such as pacemakers, or pregnancy
3. Unable to reliably perceive phosphenes
4. Magnetic resonance imaging or magnetic resonance spectroscopy data did not meet established quality assurance standards

Date of first enrolment
29/04/2016

Date of final enrolment
31/10/2019

Locations

Countries of recruitment
Taiwan

Sponsor information

Organisation
National Yang Ming Chiao Tung University

ROR
https://ror.org/00se2k293

Funder(s)

Funder type

Funder Name
Ministry of Science and Technology, Taiwan

Alternative Name(s)
Ministry of Science and Technology, R.O.C. (Taiwan), Ministry of Science and Technology of Taiwan, MOST

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location
Taiwan

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available