Clinical Trial Protocol
Iranian Registry of Clinical Trials

07 Nov 2026

Comparing Short- and Long-term Effects of Non-Invasive Direct and Alternating Current Brain Stimulation at Theta, Beta and Gamma Frequencies on Motor Learning in Healthy Adults

Protocol summary

Study aim

Comparison of the Short- and Long-Term Effects of Direct and Alternating Non-Invasive Brain Stimulation at Theta, Beta, and Gamma Frequencies on Motor Learning in Healthy Adults Helping to identify the most effective type and frequency of brain stimulation for different stages of motor learning, particularly by distinguishing between the processes of skill acquisition and skill consolidation.

Design

A randomized, parallel-group, single-blind clinical trial will be conducted on 75 patients. Randomization will be performed using the Sealed Envelope website with a balanced block randomization method.

Settings and conduct

The study will be conducted at the School of Rehabilitation Sciences, Iran University of Medical Sciences, in two sessions separated by 48 hours. Sealed and sequentially numbered envelopes will be used for blinding and provided to the participants by the secretary. The Serial Reaction Time Test (SRTT) will be used to assess the level of learning.

Participants/Inclusion and exclusion criteria

Healthy individuals aged 18–40 years, without diseases or conditions affecting neuromotor function or other confounding factors, who are unable to correctly recall the motor sequence.

Intervention groups

Participants will be assigned to five groups: transcranial direct current stimulation (tDCS), transcranial alternating current stimulation (tACS) at frequencies of 5 Hz (theta), 20 Hz (beta), and 70 Hz (gamma), and a control group.

Main outcome variables

Mean reaction time (RT), Mean response accuracy, Normalized skill index (NSI)

General information

Reason for update

Acronym

Direct current brain stimulation: tDCS, Alternating Current Brain Stimulation: tACS

IRCT registration information

IRCT registration number: **IRCT20260923071166N1**
Registration date: **2026-09-30, 1405/07/08**
Registration timing: **prospective**

Last update: **2026-09-30, 1405/07/08**
Update count: **0**

Registration date

2026-09-30, 1405/07/08

Registrant information

Name

Fatemeh Askari chenari

Name of organization / entity

Country

Iran (Islamic Republic of)

Phone

+98 21 5636 9803

Email address

fatemeh80.a@gmail.com

Recruitment status

recruiting

Funding source

Expected recruitment start date

2026-10-22, 1405/07/30

Expected recruitment end date

2027-10-22, 1406/07/30

Actual recruitment start date

empty

Actual recruitment end date

empty

Trial completion date
empty

Scientific title
Comparing Short- and Long-term Effects of Non-Invasive Direct and Alternating Current Brain Stimulation at Theta, Beta and Gamma Frequencies on Motor Learning in Healthy Adults

Public title
Comparing Effects of Non-Invasive Direct and Alternating Current Brain Stimulation on Motor Learning

Purpose
Supportive

Inclusion/Exclusion criteria

Inclusion criteria:
Healthy individuals (both sexes) Age 18–40 years No history of neurological disorders, including epilepsy and seizures, traumatic brain injury, or migraine No orthopedic, neurological, or rheumatological injury/disorder that limits the upper extremity No cognitive or perceptual impairments (Mini-Mental State Examination more than 24) No uncorrected visual impairments No use of medications affecting the central nervous system No psychiatric disorders such as anxiety or depression requiring medication No vigorous physical activity within two hours prior to the experiment No consumption of coffee or caffeine within two hours prior to the experiment No history of activities requiring high manual dexterity, such as playing the piano, or playing video games Not pregnant No sleep disorders No intracranial implants or cardiac pacemakers

Exclusion criteria:
Unwillingness to cooperate Conscious memorization of the sequence and its correct recall

Age
From **18 years** old to **40 years** old

Gender
Both

Phase
N/A

Groups that have been masked

- Participant

Sample size
Target sample size: **75**

Randomization (investigator's opinion)
Not randomized

Randomization description

Blinding (investigator's opinion)
Single blinded

Blinding description
Numbered, sealed, opaque envelopes will be used for allocation concealment and will be provided to participants by the study secretary. Participants will be blinded to their group allocation and will not know whether they have been assigned to the sham control group or one of the active intervention groups. The therapist administering the intervention and the outcome assessor will not be blinded.

Placebo
Used

Assignment
Parallel

Other design features

Secondary Ids

empty

Ethics committees

1

Ethics committee

Name of ethics committee
Research Ethics Committees of School of Rehabilitation Sciences, Iran University of Medical Sciences

Street address
Research and Technology Deputy, Iran University of Medical Sciences, Hemmat Expressway

City
Tehran

Province
Tehran

Postal code
1449614535

Approval date
2026-08-18, 1405/05/27

Ethics committee reference number
IR.IUMS.REHAB.REC.1405.025

Health conditions studied

1

Description of health condition studied
Motor Learning

ICD-10 code

ICD-10 code description

Primary outcomes

1

Description
Mean reaction time (RT)

Timepoint
Reaction time: Assessed at baseline, 35 minutes after stimulation, and 48 hours after stimulation.

Method of measurement
Reaction time Defined as the time interval between the presentation of the stimulus and the participant’s correct response.

2

Description
Mean response accuracy

Timepoint
Response accuracy: Assessed at baseline, 35 minutes after stimulation, and 48 hours after stimulation.

Method of measurement

Response accuracy Defined based on responses corresponding to the position of the black circle.

3

Description
Normalized skill index (NSI)
Timepoint
Normalized skill index Assessed at baseline, 35 minutes after stimulation, and 48 hours after stimulation.
Method of measurement
It is calculated as the number of correct responses in each block divided by the total number of responses (correct + incorrect), multiplied by 100.

Secondary outcomes

empty

Intervention groups

1

Description
Intervention group: Participants in the transcranial direct current stimulation (tDCS) group will receive stimulation at an intensity of 1 mA, corresponding to a current density of 0.05 mA/cm². The active electrode will be placed over the primary motor cortex (M1) of the dominant hemisphere, while the reference electrode will be placed over the supraorbital area contralateral to the non-dominant hand.
Category
Rehabilitation

2

Description
Intervention group: Participants in the transcranial alternating current stimulation (tACS) group will receive stimulation at a frequency of 5 Hz and an intensity of 1 mA, corresponding to a current density of 0.05 mA/cm², with a 30-second ramp-up and a 30-second ramp-down. The active electrode will be placed over the primary motor cortex (M1) of the dominant hemisphere, while the reference electrode will be placed over the supraorbital area contralateral to the non-dominant hand.
Category
Rehabilitation

3

Description
Intervention group: Participants in the transcranial alternating current stimulation (tACS) group will receive stimulation at a frequency of 20 Hz and an intensity of 1 mA, corresponding to a current density of 0.05 mA/cm², with a 30-second ramp-up and a 30-second ramp-down. The active electrode will be placed over the primary motor cortex (M1) of the dominant hemisphere, while the reference electrode will be placed over the supraorbital area contralateral to the non-dominant hand.
Category
Rehabilitation

4

Description
Intervention group: Participants in the transcranial alternating current stimulation (tACS) group will receive stimulation at a frequency of 70 Hz and an intensity of 1 mA, corresponding to a current density of 0.05 mA/cm², with a 30-second ramp-up and a 30-second ramp-down. The active electrode will be placed over the primary motor cortex (M1) of the dominant hemisphere, while the reference electrode will be placed over the supraorbital area contralateral to the non-dominant hand.
Category
Rehabilitation

5

Description
Control group: Participants will receive stimulation at an intensity of 1 mA, corresponding to a current density of 0.05 mA/cm². The stimulation will be discontinued after a 30-second ramp-up period. The active electrode will be placed over the primary motor cortex (M1) of the dominant hemisphere, while the reference electrode will be placed over the supraorbital area contralateral to the non-dominant hand.
Category
Rehabilitation

Recruitment centers

1

Recruitment center
Name of recruitment center
School of Rehabilitation Sciences, Iran University of Medical Sciences
Full name of responsible person
Roya KhanMohammadi
Street address
Madadkaran Street, Shah Nazari Street, Mother Square, Mirdamad
City
Tehran
Province
Tehran
Postal code
1348715459
Phone
+98 21 2222 2059
Email
dr.rkhanmohammadi96@gmail.com

Sponsors / Funding sources

1

Sponsor
Name of organization / entity
Iran University of Medical Sciences

Full name of responsible person
Majid Safa
Street address
5th Floor, Iran University of Medical Sciences, Hemmat Highway
City
Tehran
Province
Tehran
Postal code
1449614535
Phone
+98 21 8862 2703
Email
safa.m@gmail.com

Grant name

Grant code / Reference number

Is the source of funding the same sponsor organization/entity?
Yes

Title of funding source
Iran University of Medical Sciences

Proportion provided by this source
100

Public or private sector
Public

Domestic or foreign origin
Domestic

Category of foreign source of funding
empty

Country of origin

Type of organization providing the funding
Academic

Person responsible for general inquiries

Contact

Name of organization / entity
Iran University of Medical Sciences
Full name of responsible person
Fatemeh Askari chenari
Position
Student
Latest degree
Bachelor
Other areas of specialty/work
Physiotherapy
Street address
No. 35, alley 33, Imam musa kazem street, Eslamshahr
City
Eslamshahr
Province
Tehran
Postal code
3313794575
Phone
+98 21 5636 9803
Fax
Email
Fatemeh80.a@gmail.com

Person responsible for scientific inquiries

Contact

Name of organization / entity
Iran University of Medical Sciences
Full name of responsible person
Roya KhanMohammadi
Position
Assistant Professor
Latest degree
Ph.D.
Other areas of specialty/work
Physiotherapy
Street address
Madadkaran Street, Shah Nazari Street, Mother Square, Mirdamad, Tehran
City
Tehran
Province
Tehran
Postal code
1348715459
Phone
+98 21 2222 7124
Email
Dr.rkhanmohammadi96@gmail.com

Person responsible for updating data

Contact

Name of organization / entity
Iran University of Medical Sciences
Full name of responsible person
Fatemeh Askari chenari
Position
Student
Latest degree
Bachelor
Other areas of specialty/work
Physiotherapy
Street address
No. 35, alley 33, Imam musa kazem street, Eslamshahr
City
Eslamshahr
Province
Tehran
Postal code
3313794575
Phone
+98 21 5636 9803
Fax
Email
Fatemeh80.a@gmail.com

Sharing plan

Deidentified Individual Participant Data Set (IPD)
Undecided - It is not yet known if there will be a plan to make this available

Study Protocol

Undecided - It is not yet known if there will be a plan to make this available

Statistical Analysis Plan

Undecided - It is not yet known if there will be a plan to make this available

Informed Consent Form

Undecided - It is not yet known if there will be a plan to make this available

Clinical Study Report

Undecided - It is not yet known if there will be a plan to make this available

Analytic Code

Undecided - It is not yet known if there will be a plan to make this available

Data Dictionary

Undecided - It is not yet known if there will be a plan to make this available