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Can caffeine chewing gum and watching and imagining golf movements improve putting and iron shot performance after mental fatigue?

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Registration date 13/10/2026	**Overall study status** Completed	
Last Edited 12/10/2026	**Condition category** Other	

Plain English summary of protocol
Not provided at time of registration

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Study information

Scientific Title
Effects of caffeine chewing gum and asynchronous action observation and motor imagery on golf putting and 7-iron performance following mental fatigue in novice golfers: a randomised, placebo-controlled, 2 × 2 factorial, four-period crossover trial

Study objectives
The primary objective of this study is to investigate the acute effects of caffeine chewing gum (200 mg) and asynchronous action observation and motor imagery (A-AOMI), administered separately and in combination, on golf putting accuracy and 7-iron performance following experimentally induced mental fatigue in novice golfers.

Specifically, the study aims to:
1. Examine the main effect of caffeine chewing gum on golf putting and 7-iron performance.
2. Examine the main effect of A-AOMI on golf putting and 7-iron performance.
3. Investigate the interaction between caffeine chewing gum and A-AOMI to determine whether

their combined effects differ from the sum of their individual effects.
4. Explore subjective mental fatigue, physiological responses, and individual differences in baseline mental representation as supplementary outcomes or explanatory factors.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 21/08/2026, Teaching Committee of the Faculty of Health Sciences and Sports, Macao Polytechnic University (5HV2+CP8, R. de Luís Gonzaga Gomes, Macau, 999078, China; +853 8599 6333; tlsiu@mpu.edu.mo), ref: FCSD/DPPESS-006/2026

Primary study design
Interventional

Allocation
Randomized controlled trial

Masking
Blinded (masking used)

Control
Placebo

Assignment
Crossover

Purpose
Treatment, Acute effects of caffeine chewing gum and asynchronous action observation and motor imagery (A-AOMI), administered independently and in combination, on golf putting accuracy and 7-iron performance following experimentally induced mental fatigue in novice golfers.

Study type(s)

Health condition(s) or problem(s) studied
Acute mental fatigue and golf-specific motor performance in healthy novice golfers.

Interventions
This study will employ a randomised, placebo-controlled, 2 × 2 factorial, four-condition crossover design to investigate the acute effects of caffeine chewing gum and asynchronous action observation and motor imagery (A-AOMI) on golf performance following mental fatigue.
Each participant will complete one familiarisation and baseline assessment session followed by four experimental sessions, separated by a planned 7-day washout period. The order of the four experimental conditions will be assigned using a balanced randomisation sequence.
The four experimental conditions will be:
1. CAF + A-AOMI: 200 mg caffeine chewing gum combined with task-specific A-AOMI.
2. CAF + CON: 200 mg caffeine chewing gum combined with a neutral control task.
3. PLA + A-AOMI: Placebo chewing gum combined with task-specific A-AOMI.
4. PLA + CON: Placebo chewing gum combined with a neutral control task.
At each experimental visit, participants will complete baseline assessments and a standardised

pre-intervention warm-up assessment consisting of five putts and three 7-iron shots. Participants will then undertake a 30-minute Stroop task to induce mental fatigue. Following the Stroop task and a standardised seated recovery assessment, participants will chew either caffeine or placebo gum for 10 minutes and then discard it.
The A-AOMI intervention will consist of two task-specific segments, each lasting 3.5 minutes. Each segment will include brief technical instructions, first-person action observation, third-person action observation, and subsequently guided first-person kinaesthetic motor imagery. The neutral control tasks will be matched in duration without providing golf-specific action observation or motor imagery instructions.
Participants will first complete the 3.5-minute putting A-AOMI or neutral control task, immediately followed by 20 putts. After a standardised transition with two to three practice swings without hitting a ball, participants will complete the 3.5-minute 7-iron A-AOMI or neutral control task, immediately followed by 10 7-iron shots.
Putting performance will be assessed using ball-position coordinates (X and Y) and derived accuracy and consistency measures. No ZZT-derived putting measurements will be collected. The 7-iron outcomes will be recorded using FlightScope launch-monitor technology, including ball speed, clubhead speed, carry distance, total distance, smash factor, and lateral deviation.
Heart rate and heart rate variability will be assessed during three standardised seated recording periods: before the Stroop task, after the Stroop task, and following completion of the golf performance tests. Subjective mental fatigue, intervention adherence, and adverse events will also be assessed. Baseline mental representation will be assessed once during the initial baseline session only.

Intervention Type
Behavioural

Primary outcome(s)
1. Putting accuracy measured using Mean Radial Error (MRE) of golf putting, calculated as the mean Euclidean distance between the final ball position and the target using X and Y coordinates across 20 putts. Measured immediately after the task-specific intervention during each of the four experimental sessions, at the initial baseline assessment and immediately following the putting-specific intervention during each of the four experimental sessions (Periods 1–4, approximately 7 days apart)

2. 7-iron ball speed measured using a FlightScope launch monitor to calculate mean ball speed across 10 standardised 7-iron shots, at the initial baseline assessment and immediately following the 7-iron-specific intervention during each of the four experimental sessions (Periods 1–4, approximately 7 days apart)

Key secondary outcome(s)

Completion date
25/11/2026

Eligibility

Key inclusion criteria
1. Healthy adults aged 18–25 years
2. Novice or beginner golfers who are able to safely perform standardised golf putting and 7-iron shots
3. Normal or corrected-to-normal vision and the ability to distinguish the colours used in the

Stroop task
4. Able to understand and follow the experimental procedures, including the mental fatigue task, chewing gum intervention, and action observation and motor imagery instructions
5. Willing and able to attend one familiarisation/baseline session and four experimental sessions, with a planned 7-day washout period between consecutive experimental sessions
6. Able to comply with the pre-test restrictions, including abstaining from caffeine and alcohol for 24 hours before each experimental session
7. Willing to provide written informed consent before participation

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit
18 Years

Upper age limit
25 Years

Sex
All

Total final enrolment
0

Key exclusion criteria
1. History of cardiovascular disease, uncontrolled hypertension, clinically significant cardiac arrhythmias, epilepsy, or other medical conditions that may increase the risks associated with caffeine intake or physical activity
2. Known hypersensitivity, allergy, or intolerance to caffeine or any ingredient in the experimental chewing gum
3. Current use of medications that may interact with caffeine or substantially affect central nervous system activity, heart rate, or exercise responses
4. Musculoskeletal injuries or physical limitations that prevent safe performance of golf putting or 7-iron shots
5. Neurological or visual impairments that substantially interfere with performing the Stroop task or following action observation and motor imagery instructions
6. Pregnancy or breastfeeding
7. Oral or temporomandibular conditions that prevent safe chewing of gum
8. Inability or unwillingness to comply with the experimental schedule, washout periods, or pre-test restrictions
9. Participation in another intervention study that could interfere with the outcomes of the present trial

Date of first enrolment
20/10/2026

Date of final enrolment
23/10/2026

Locations

Countries of recruitment
China

Sponsor information

Organisation
Hainan Normal University

ROR
https://ror.org/031dhcv14

Organisation
Macao Polytechnic University

ROR
https://ror.org/02sf5td35

Funder(s)

Funder type

Funder Name
Hainan Normal University

Alternative Name(s)
HNU

Funding Body Type
Government organisation

Funding Body Subtype
Local government

Location
China

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available