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Can caffeine chewing gum and watching and imagining golf movements improve bunker shots and driving 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 bunker-shot and driver performance following mental fatigue: a randomised, placebo-controlled, 2 × 2 factorial, four-period crossover trial

Study objectives

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 bunker-shot accuracy and driver performance following experimentally induced mental fatigue in golfers with basic experience in both skills.

Study type(s)

Health condition(s) or problem(s) studied
Acute mental fatigue and golf-specific motor performance in healthy golfers with basic experience in bunker shots and driver swings. The study investigates the effects of caffeine chewing gum and asynchronous action observation and motor imagery (A-AOMI) on bunker-shot accuracy and driving performance. No diagnosed medical condition is being investigated.

Interventions
This study will employ a randomised, placebo-controlled, 2 × 2 factorial, four-period crossover design to investigate the acute effects of caffeine chewing gum and asynchronous action observation and motor imagery (A-AOMI) on golf bunker-shot and driver performance following experimentally induced mental fatigue.
Each participant will complete one familiarisation/baseline assessment session and four experimental sessions separated by a planned 7-day washout period. The four experimental conditions will be administered in a balanced randomised sequence.
The four conditions are:
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.
During the initial baseline session, participants will complete 12 bunker shots and 10 driver shots following familiarisation and safety screening. At each experimental visit, participants will first complete baseline assessments, including four bunker shots and three driver shots, before undergoing a 30-minute Stroop task to induce mental fatigue.

Following the Stroop task and a standardised seated physiological assessment, participants will chew either caffeine or placebo gum for 10 minutes and then discard it.
The A-AOMI intervention consists of two task-specific segments, each lasting 3.5 minutes. Each segment includes brief technical instructions, first-person action observation, third-person action observation, guided first-person kinaesthetic motor imagery, and preparation for the subsequent performance task. The neutral control tasks will be matched in duration and will not contain golf-specific action observation or motor imagery instructions.
Participants will first complete the 3.5-minute bunker-specific A-AOMI or neutral control task, immediately followed by 12 bunker shots. After a standardised transition involving two to three practice swings without hitting a ball, participants will complete the 3.5-minute driver-specific A-AOMI or neutral control task, immediately followed by 10 driver shots.
Bunker-shot performance will be evaluated using a predefined 0–5-point scoring system for each shot, yielding a maximum total score of 60 points. Driver performance will be assessed using a FlightScope launch monitor, including ball speed, clubhead speed, carry distance, total distance, smash factor, and lateral deviation.
Heart rate and heart rate variability will be recorded during three standardised five-minute seated periods: before the Stroop task, after the Stroop task, and following the performance tests. Subjective mental fatigue, intervention adherence, and adverse events will also be assessed.

Intervention Type
Behavioural

Primary outcome(s)
1. Bunker-shot performance (12-shot total zonal score) measured using the total zonal score across 12 standardised bunker shots (range: 0–60 points), at the initial baseline assessment (12 bunker shots) and immediately following the bunker-specific intervention during each of the four experimental sessions (12 bunker shots per session; approximately 7 days between sessions)

2. Driver ball speed measured using a FlightScope launch monitor to calculate mean ball speed across 10 standardised driver shots, at the initial baseline assessment (10 driver shots) and immediately following the driver-specific intervention during each of the four experimental sessions (10 driver shots per session; approximately 7 days between sessions)

Key secondary outcome(s)
1. Bunker-shot escape success rate measured using the percentage of successful bunker exits across 12 standardised bunker shots, calculated as the number of shots successfully exiting the bunker divided by 12 and multiplied by 100. Higher percentages indicate better performance, at the initial baseline assessment and immediately after the bunker-specific intervention during each of the four experimental sessions (approximately 7 days apart)

2. Bunker-shot on-green success rate measured using the percentage of bunker shots finishing on the putting green across 12 standardised shots, calculated as the number of shots finishing on the green divided by 12 and multiplied by 100. Higher percentages indicate better performance, at the initial baseline assessment and immediately after the bunker-specific intervention during each of the four experimental sessions (approximately 7 days apart)

3. Driver clubhead speed measured using a FlightScope launch monitor to calculate the mean clubhead speed across 10 standardised driver shots, at the initial baseline assessment and immediately after the driver-specific intervention during each of the four experimental sessions (approximately 7 days apart)

4. Driver carry distance measured using a FlightScope launch monitor to calculate the mean carry distance across 10 standardised driver shots, at the initial baseline assessment and immediately after the driver-specific intervention during each of the four experimental sessions (approximately 7 days apart)

5. Driver total distance measured using a FlightScope launch monitor to calculate the mean total distance across 10 standardised driver shots, at the initial baseline assessment and immediately after the driver-specific intervention during each of the four experimental sessions (approximately 7 days apart)

6. Driver smash factor measured using FlightScope launch monitor to calculate the mean smash factor across 10 standardised driver shots, at the initial baseline assessment and immediately after the driver-specific intervention during each of the four experimental sessions (approximately 7 days apart)

7. Driver directional accuracy measured using mean absolute lateral deviation across valid driver shots, calculated from the absolute values of signed left/right lateral deviations recorded by FlightScope, at the initial baseline assessment and immediately after the driver-specific intervention during each of the four experimental sessions (approximately 7 days apart)

8. Subjective mental fatigue measured using a Visual Analogue Scale (VAS), at pre and immediately post the 30-minute Stroop task, following each task-specific A-AOMI or control segment, and after completion of the golf performance tests during each of the four experimental sessions

9. Heart rate variability (HRV) measured using Polar H10 heart rate sensor data to calculate of the natural logarithm of the root mean square of successive differences between normal-to-normal heartbeats (lnRMSSD), at three timepoints during each experimental session: T0 (before the Stroop task), T2 (after the Stroop task and before caffeine/placebo administration), and T6 (after completion of bunker-shot and driver performance tests).

Completion date
26/11/2026

Eligibility

Key inclusion criteria
1. Healthy adults aged 18–25 years
2. Golfers with basic experience in both bunker shots and driver swings, including previous bunker-shot instruction or practical experience
3. Able to safely perform standardised bunker shots and driver swings, as confirmed during the familiarisation and screening session
4. Normal or corrected-to-normal vision and the ability to distinguish the colours used in the Stroop task
5. Able to understand and follow the experimental procedures, including the mental fatigue task, chewing gum intervention, and action observation and motor imagery instructions

6. Willing and able to attend one familiarisation/baseline session and four experimental sessions, with a planned 7-day washout period between consecutive experimental sessions
7. Able to comply with the pre-test restrictions, including abstaining from caffeine and alcohol for 24 hours before each experimental session
8. 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. Insufficient experience or technical ability to safely perform standardised bunker shots or driver swings
2. 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
3. Known hypersensitivity, allergy, or intolerance to caffeine or any ingredient in the experimental chewing gum
4. Current use of medications that may interact with caffeine or substantially affect central nervous system activity, heart rate, or exercise responses
5. Musculoskeletal injuries or physical limitations that prevent safe performance of bunker shots or driver swings
6. Neurological or visual impairments that substantially interfere with performing the Stroop task or following action observation and motor imagery instructions
7. Pregnancy or breastfeeding
8. Oral or temporomandibular conditions that prevent safe chewing of gum
9. Inability or unwillingness to comply with the experimental schedule, washout periods, or pre-test restrictions
10. 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
25/10/2026

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