EFFECTS OF BRAIN ENDURANCE TRAINING ON ENDURANCE EXERCISE PERFORMANCE

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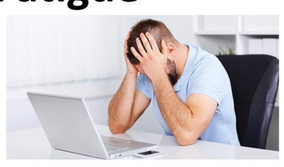
INTRODUCTION

Mental Fatigue ➡ **Impaired Physical Performance**



- Mental fatigue impairs endurance exercise performance (Van Cutsem et al, 2017)
- Engaging in cognitive tasks during exercise (i.e., **Brain Endurance Training** (BET)) can develop resilience to mental fatigue and improve physical performance compared to physical training alone (Marcora et al, 2015)
- Only this one study to date has demonstrated the effectiveness of BET and the underlying mechanisms have yet to be determined.

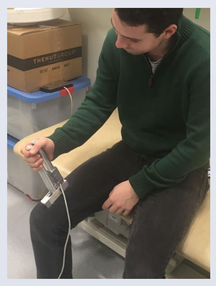
AIMS

1) To investigate if BET enhances endurance performance over physical training alone.

2) To investigate potential mechanisms.

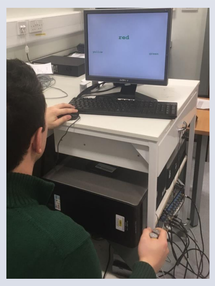
METHODS

Pre-training: 36 participants completed a rhythmic handgrip task requiring generation of as much force as possible once a second for 5 minutes, performed under 3 counter-balanced conditions: following 10 minutes of a 2-back memory/attention task (**subsequent**); while performing a 2-back task (**concurrent**); and on its own (**solo**). Cardiac activity (ECG), electromyographic (EMG) forearm activity, pre-frontal cerebral haemodynamic (near infrared spectroscopy), and force were continuously recorded.



Subsequent Task: 10 min **2-back** cognitive test followed by 5 min physical performance task.

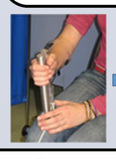
Solo Task: 5 min physical task.



Concurrent Task: 5 min **2-back** (non-dominant hand) and physical task (dominant hand).

Experimental Protocol:

Pre-intervention Testing

Control Exercise only	**BET** Exercise & Cognitive Task
	 

6 Weeks training intervention
x4 ~30 minute sessions per week

Post-intervention Testing

Training: Participants (randomized to a Control or BET group) completed 24 (over 6 weeks) submaximal hand contractions sessions (c. 15 min of exercise). The BET group also completed concurrent cognitive tasks (2-back, word incongruence Stroop) that imposed demands on attention, memory and response inhibition processes. **Physical workload was matched between the 2 groups**. Both physical and cognitive tasks became progressively more challenging each week.

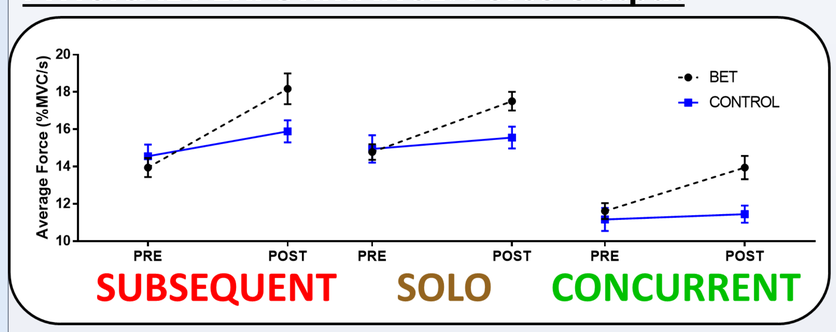
Post-training: Repetition of the pre-training protocol.

Measures of motivation, rate of perceived exertion (RPE), mental exertion, mental fatigue and mood were collected via self-report throughout.

Experimental Design: 2 Group (**BET**, **Control**) x 2 Session (Pre, Post) x 3 Task [x Time] ANOVAs.

RESULTS

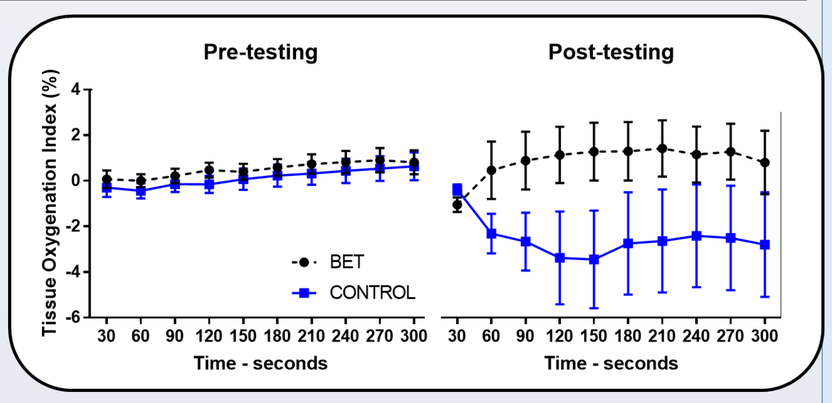
PHYSICAL PERFORMANCE: Force Output



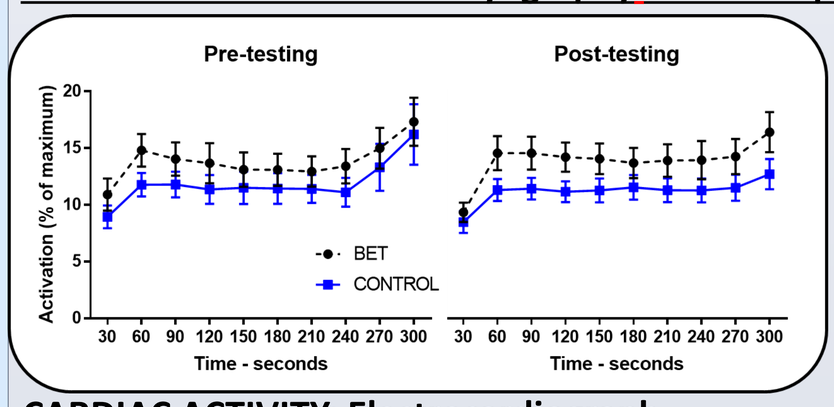
All participants improved following training ($p<.001$), with BET improving more than Control ($p=.001$).

BRAIN HAEMODYNAMICS: Near Infrared Spectroscopy

Increased performance in Controls was associated with reduced pre-frontal cortex oxygenation over time relative to pre training and post-training BET group responses ($p<.05$).



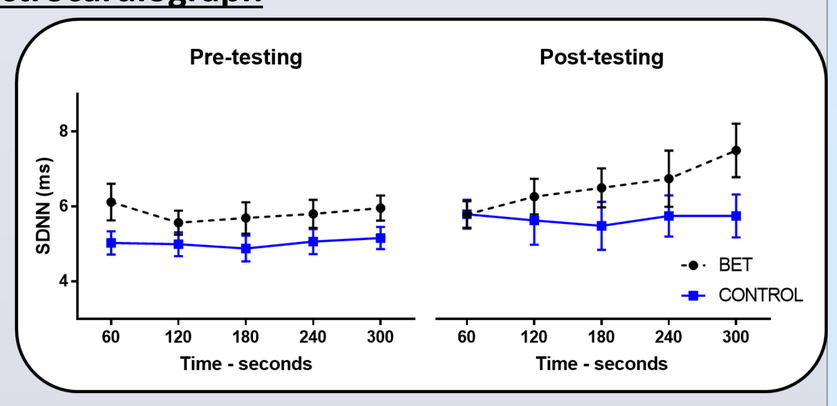
MUSCLE ACTIVITY: Electromyography – Flexi Carpi Radialis



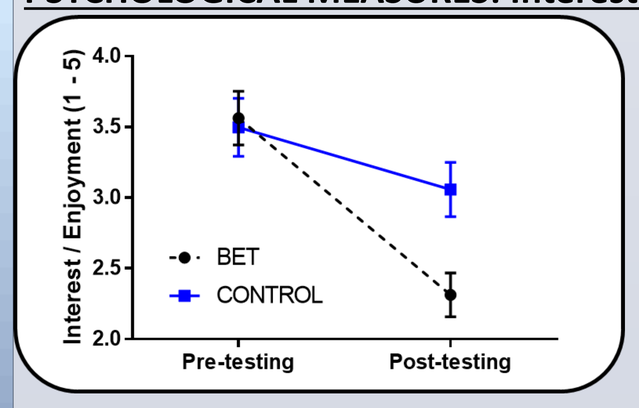
The signal was rectified and normalised as a percentage of the MVC activity. No main effects for group, task or training.

CARDIAC ACTIVITY: Electrocardiograph

Heart rate variability (SDNN) increased more in the BET group, over time, post training ($p<.05$), suggesting less effort during the tasks.



PSYCHOLOGICAL MEASURES: Interest / Enjoyment



Interest and enjoyment of the tasks declined more in the BET group following training ($p=.01$). All other self-reported measures for RPE, motivation, mental exertion, fatigue and vigour were similar between groups and unaffected by the type of training.

DISCUSSION

- Six weeks of brain endurance training improved physical performance more (23%) than physical training alone (5%).
- This higher performance in the BET group was achieved for the same heart rate, muscle activity, motivation and RPE as the Control group.
- The performance increase in the BET group occurred without a decrease in pre-frontal oxygenation (as was seen in control group), while the increase in heart rate variability in the BET group post training (relative to Controls) indicates a reduction in sympathetic nervous system activity.
- The reduction in interest and enjoyment for BET relative to Control, post training, suggests a need for more challenging and exciting tasks.

References:

Van Cutsem J, et al., (2017). Sports Medicine, doi:10.1007/s40279-016-0672-0

Marcora S, et al. (2015). ACSM Annual meeting. San Diego.