Effects of 8-weeks of Aerobic Exercise Intervention on Fitness and Neuroplasticity in Aging Adults: Preliminary Results of an Ongoing Trial

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1 - Background, Aims and Hypotheses

- Aerobic exercise is known to promote cognitive brain health in aging adults, but the exact mechanisms are not fully elucidated.
- Studies in animal models and humans have attributed exercise-mediated cognitive improvements to two main mechanisms: **neuroplastic changes** in the nervous system measured by enhanced synaptic activity; and increased **cardiovascular fitness**, which would mediate local increased blood flow, release of trophic factors and promote structural change

Aims

- We aimed to assess both neuroplasticity and cardiovascular fitness in sedentary aging individuals who participated in an 8-week progressive exercise intervention.

Outcomes

- **Primary:** neuroplasticity assessment utilizing transcranial magnetic stimulation (TMS)
- **Secondary:** cardiorespiratory fitness measures (maximal walking velocity and distance, estimated VO2peak, and heart rate recovery) derived from the Incremental Shuttle Walking Test (ISWT)

Hypotheses

- **H1)** We hypothesized that neuroplasticity and cardiorespiratory fitness would improve from pre to post-intervention, and that there would be a positive relationship between the two.

Inclusion criteria

- (1) aged ≥ 55 years; (2) sedentary (defined as 'low' category using the International Physical Activity Questionnaire (IPAQ) short last 7 days); (3) no clinically detectable cognitive impairment (MoCA score ≥ 24 and CDR score of 0)

Sample	12 individuals
Age, *mean (SD)*	59.5 (3.7)
Gender, %	58.3% Female
Education, %	41.7% College
Weight, *mean (SD)*	179.1 (26.6)
BMI, *mean (SD)*	29.7 (4.3)
Ethnicity, %	66.7% Hispanic
MoCA, *mean (SD)*	25.9 (2.1)
IPAQ (METs)	308.6

2 - Experimental Setup

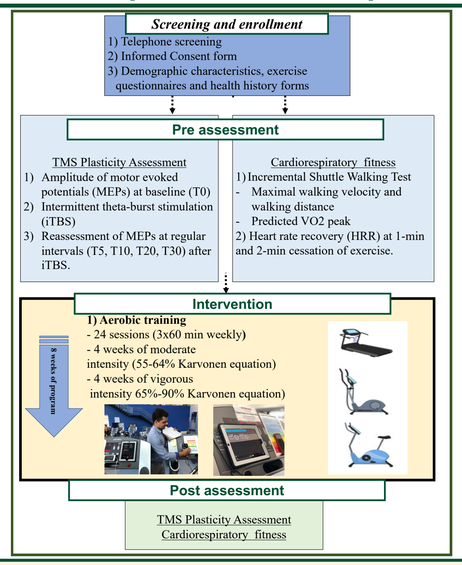


Figure 01. *Study design*

3 - TMS to assess LTP-like Plasticity in humans

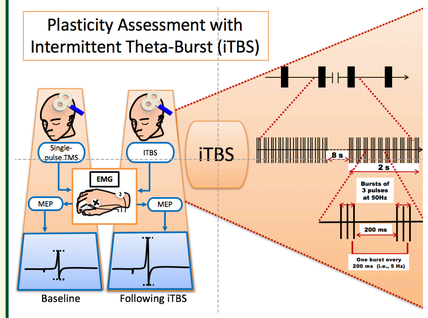
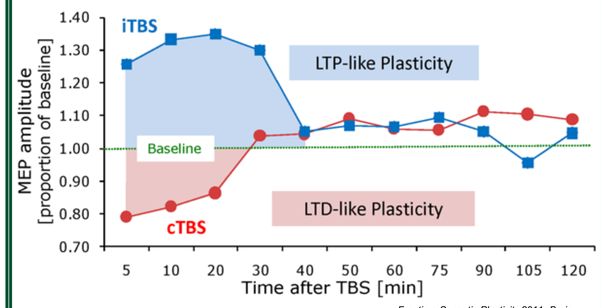


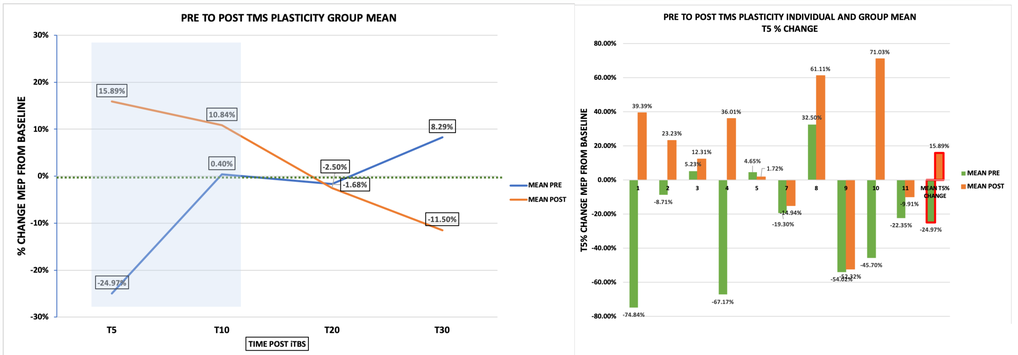
Figure 02. **Experimental setup for TMS-iTBS plasticity assessment:** Motor evoked potentials (MEPs) from single TMS pulses are recorded prior to and following the iTBS (parameters: bursts of 3 pulses delivered at 50Hz, every 200 ms [i.e., at 5 Hz] in blocks of 2 seconds interleaved by 8 sec rest.



Frontiers Synaptic Plasticity 2011; *Brain Topography* 2011; *Eur J Neurosci* 2012

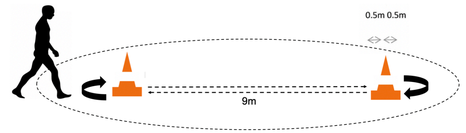
Figure 03. Example of iTBS protocol in humans resulting in a LTP-like plasticity response. **TMS Plasticity Assessment Graph:** MEPs are typically facilitated for a period of approximately 30 minutes post-iTBS. The greatest response is expected to occur at T5 and T10 post-iTBS.

4 - Most participants demonstrated increased response on the TMS Plasticity Assessment Post-Intervention



In the pre to post comparisons, there was an increase in neuroplasticity (%Δ pre-to-post-iTBS at T5, mean = 40.86%, p=.010)

4 - Incremental Shuttle Walking Test to assess cardiorespiratory fitness



Participant walk a distance of 10 meters around a marking between two cones, keeping to the speed indicated by the bleeps on the audio recording.

Heart Rate Recovery

Change in the heart rate from the peak of exercise to the heart rate after 1-min and 2-min cessation.

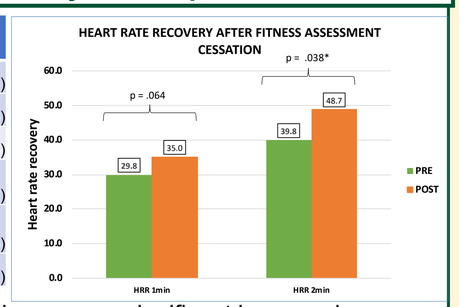
Estimated Peak VO_2

Peak VO_2 = 257 + (0.038 * ISWTD * body mass)

Dourado et al, 2012; r = 0.90; R2=0.81; p < 0.0001

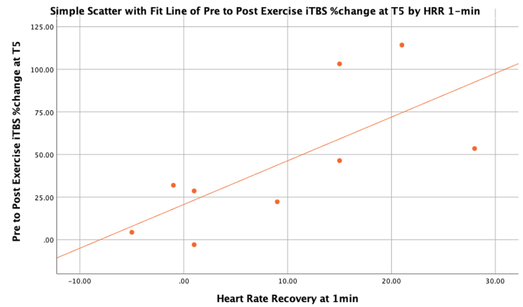
5 - Increased cardiorespiratory fitness post-intervention

	PRE mean (SD)	POST mean (SD)
ISWT Distance (m)	515 (128)	539 (104)
Maximal HR (bpm)	133.3 (15.9)	135.3 (16)
VO2 peak (L/min)	1.76 (.33)	1.85 (.23)
VO2 peak (L/kg/min)	22.9 (5.04)	23.8 (4.2)
HRR 1-min	29.8 (13.6)	35 (9.8)
HRR 2-min*	39.8 (12.8)	48.7 (12.1)



In the pre to post comparisons, there was a significant increase in cardiovascular fitness (HRR 2-min, mean diff= 10.73,p=.038)

6 - Strong positive correlation between cardiorespiratory fitness and neuroplasticity



A positive strong correlation was found between the change in neuroplasticity (%Δ pre-to-post-iTBS at T5) and the change in cardiovascular fitness (HRR 1-min, p=0.016, r=.765).

7 - Discussion, Conclusion and Clinical Relevance

- In this preliminary and ongoing trial, an 8-week progressive aerobic exercise intervention demonstrated increased neuroplasticity utilizing a TMS iTBS assessment.
- Early patterns in the data suggest that while there was an increase in neuroplasticity from pre to post intervention this was associated with increased cardiorespiratory fitness as measured by the HRR.
- As the study progresses, an increased sample size will improve statistical power and allow further analyses to be conducted.

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