



Impacts of physical activity and sleep on physiology following a mTBI



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INTRODUCTION

Recent studies suggest that a gradual increase of physical activity leads to shorter recovery time after mild Traumatic Brain Injury (mTBI).

PURPOSE: To determine the impacts of physical activity and sleep on excitatory (glutamate) and inhibitory (GABA) neurotransmitter concentration in the motor cortex and measures of excitability and inhibition of the corticospinal pathway following mTBI.

METHODS

Participants

- 5 healthy adults (2 females) ages 20.2 ± 1.1 years
- 5 concussed adults (2 females) ages 21.4 ± 2.8 years

Protocol

- Activity monitor, GT3X wrist ban worn on non-dominant wrist for 1 week starting 72 hours after injury of concussed participants.
- TMS and MRS measures taken at Baseline and 2 months.

Activity monitor

- Monitors evaluated for 5 days
- Activity and sleep scores detected using ActiLife software

Neurotransmitter Concentrations

- 3 Tesla Magnet
- Used for proton magnetic resonance spectroscopy ($^1\text{H-MRS}$)
- 3 minutes of tapping from first dorsal interosseous (FDI) to localize motor cortex (Fig. 1)
- Concentration of glutamate and GABA measured from motor cortex (Fig. 1)

Excitability + Inhibition

- Transcranial magnetic stimulation (TMS) applied to motor cortex
- Responses recorded FDI
- Amplitude of motor evoked potential (MEP) at rest = excitability (Fig. 2)
- Duration of cortical silent period (CSP) = inhibition (Fig. 2)

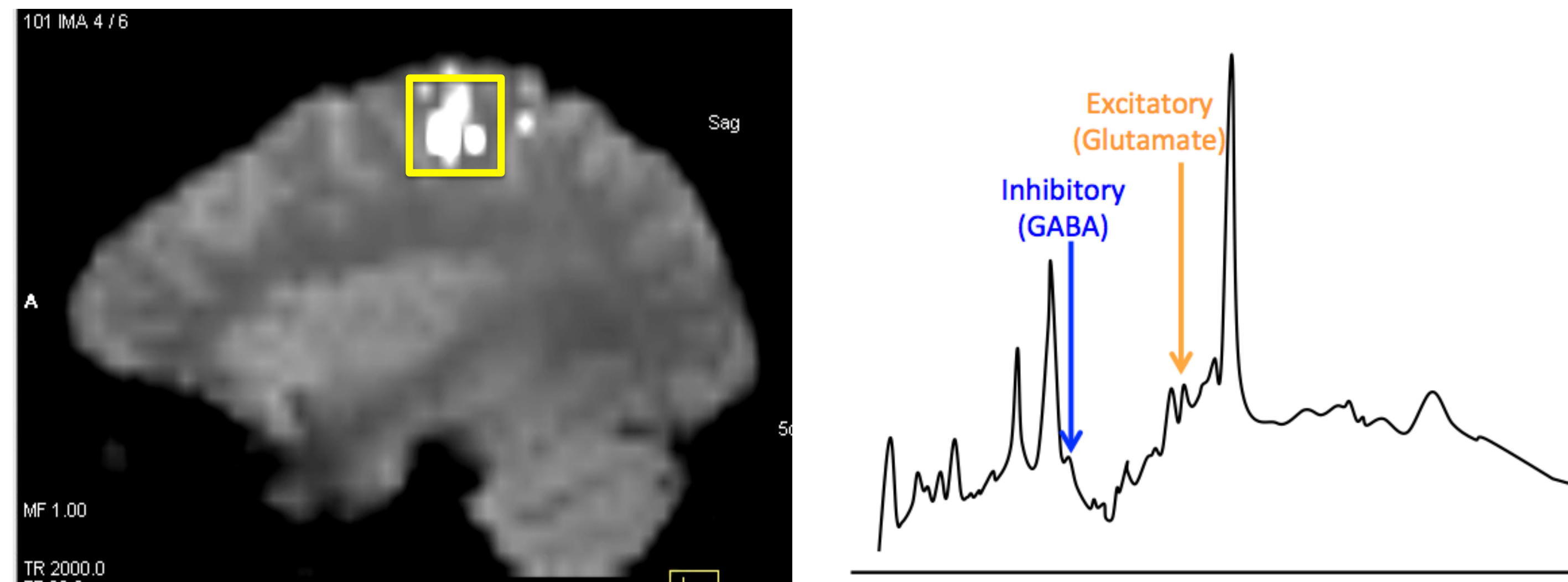


Figure 1: Functional localizer scan for voxel placement on motor cortex and example of glutamate and GABA spectrum. Left: Localizer scan (voxel size: $20 \times 20 \times 20$ mm). Right: The glutamate signal at 2.4 ppm and GABA signal at 3.0 ppm was quantified.

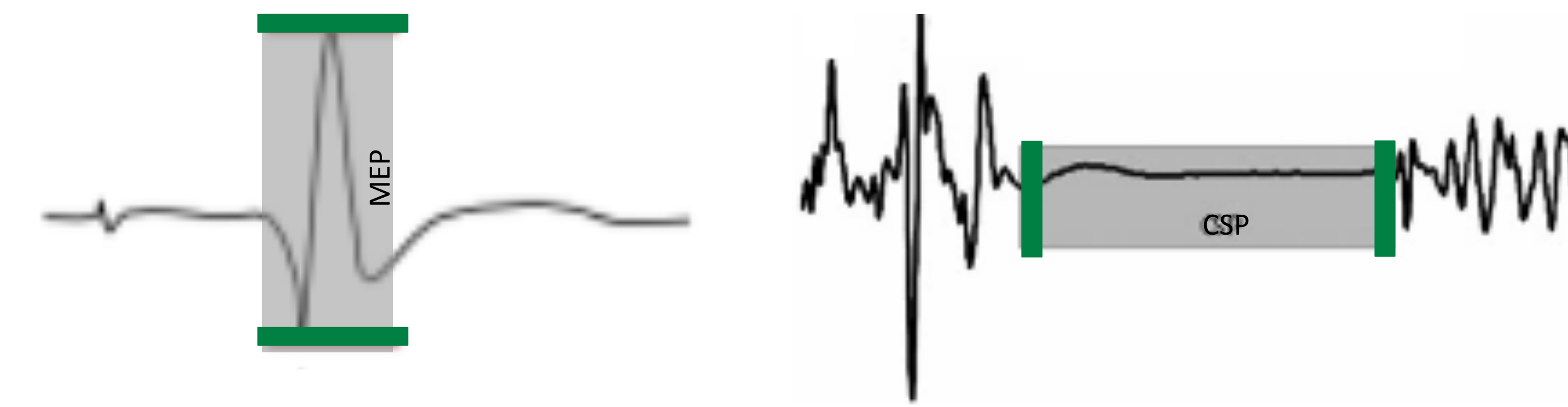


Figure 2: Sample recording of MEP and CSP evoked responses. Left: Excitability was assessed through the peak-to-peak amplitude of the MEP. Right: Inhibition was assessed through the CSP duration.

RESULTS

Physical Activity

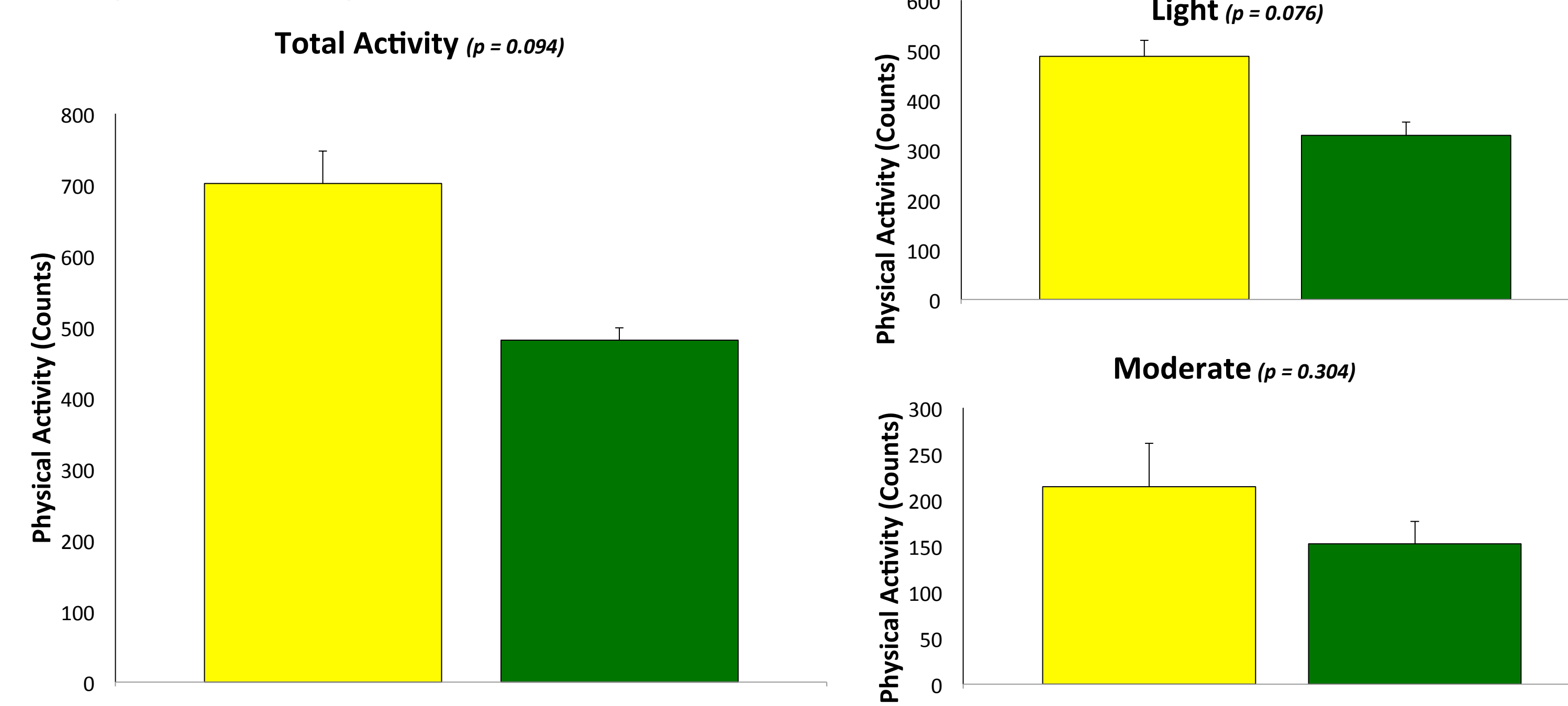


Figure 3: Physical Activity levels. Left: Total daily physical activity averaged across 5 days ($p = 0.09$). Top Right: Total light activity averaged across 5 days ($p = 0.076$). Bottom Right: Total moderate activity averaged across 5 days ($p = 0.30$). Controls had greater physical activity counts for Total, Light and Moderate but not statistically significant.

Sleep

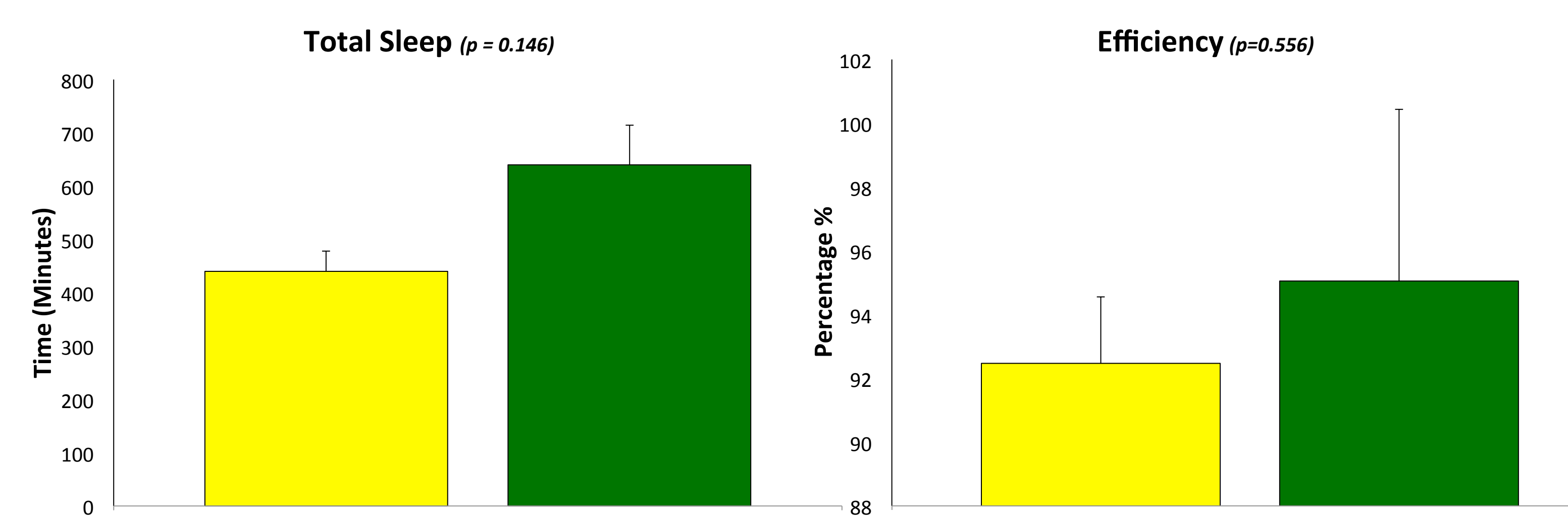


Figure 3: Sleep time and Efficiency. Left: Total daily sleep time of 5 days ($p = 0.146$). Right: Efficiency of sleep for 5 days ($p = 0.56$). Concussed group had greater Total Sleep Time and sleep Efficiency but not significant.

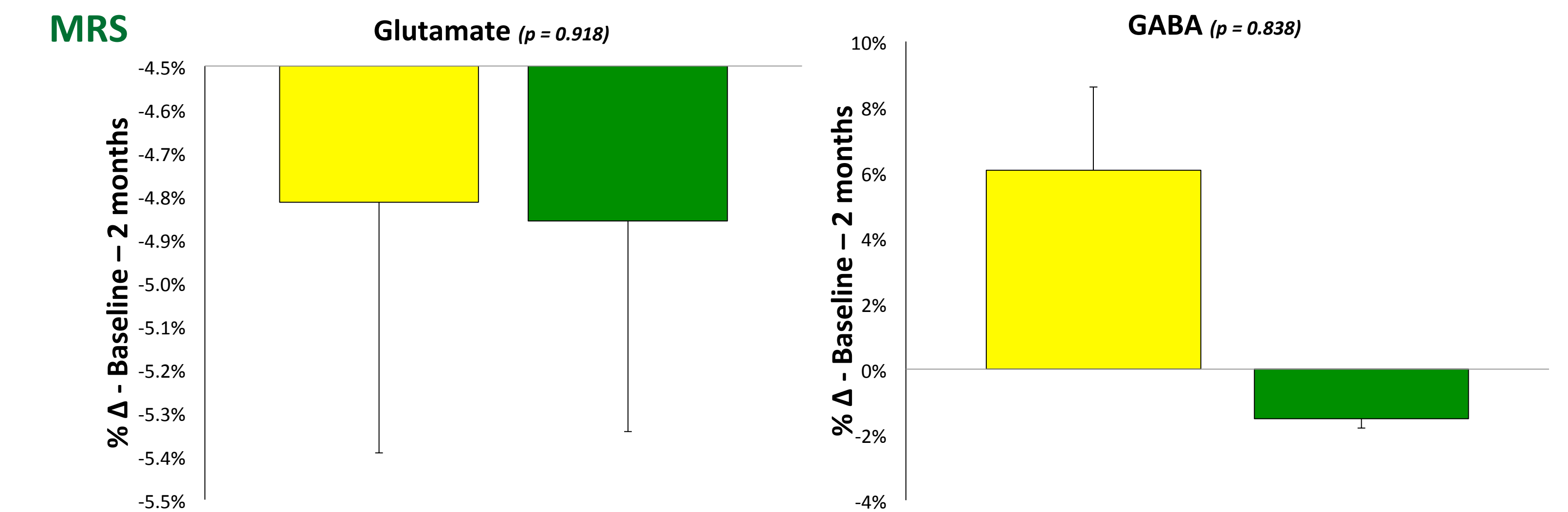


Figure 4: Glutamate and GABA concentration in motor cortex. Left: Change in glutamate concentration across 2 months was similar between groups ($p=0.73$). Right: Change in GABA across 2 months was similar between groups ($p=0.42$).

TMS

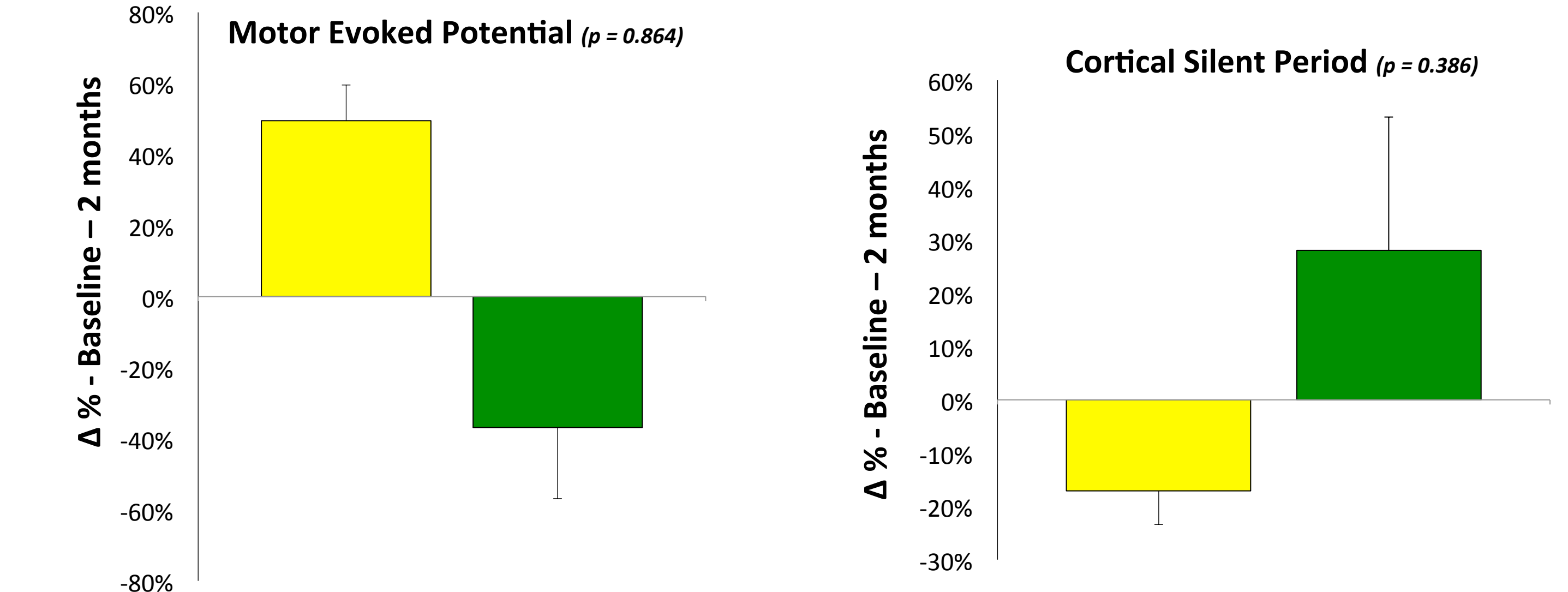


Figure 5: MEP amplitude and CSP duration. Left: The change in amplitude of the motor evoked potential across 2 months was not significantly different between groups ($p=0.87$). Right: The change in the CSP duration across 2 months was not significantly different between groups ($p = 0.39$).

Table 1: Relationships between activity and physiological measurements

	Total PA	Light PA	Moderate PA	Total Sleep	Sleep Efficiency
Δ Glutamate	$R^2=0.08$ $p=0.47$	$R^2=0.10$ $p=0.73$	$R^2=0.02$ $p=0.20$	$R^2=0.10$ $p=0.95$	$R^2=0.0004$ $p=0.29$
Δ GABA	$R^2=0.01$ $p=0.25$	$R^2=0.02$ $p=0.36$	$R^2=0.15$ $p=0.25$	$R^2=0.003$ $p=0.5$	$R^2=0.10$ $p=0.45$
Δ MEP	$R^2=0.02$ $p=0.63$	$R^2=0.003$ $p=0.88$	$R^2=0.18$ $p=0.22$	$R^2=0.02$ $p=0.77$	$R^2=0.01$ $p=0.79$
Δ CSP	$R^2=0.20$ $p=0.16$	$R^2=0.10$ $p=0.32$	$R^2=0.30$ $p=0.08$	$R^2=0.25$ $p=0.22$	$R^2=0.05$ $p=0.63$

DISCUSSION and CONCLUSIONS

- We report no relationship between activity and sleep measures and TMS measures of cortical excitability or inhibition nor $^1\text{H-MRS}$ measures of glutamate and GABA.
- Further testing with additional subject is necessary.