Marking recovery: Can 3D-MOT Training Modulate Neuroplasticity and Inflammatory Biomarkers in Adults with Moderate-Severe Traumatic Brain Injury?

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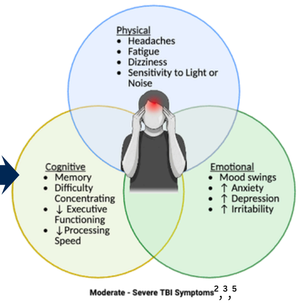
Introduction

What is Traumatic Brain Injury?

Traumatic brain injury (TBI) occurs when an external force jolts the brain inside the skull.[2]

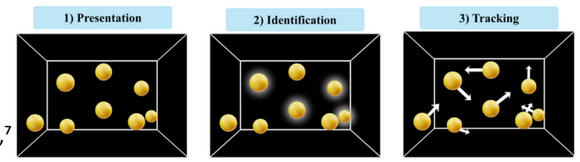
Traumatic brain injury (TBI) is a leading cause of disability worldwide, with approximately **69 million** individuals acquiring a TBI each year. [1]



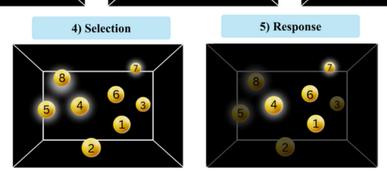
NeuroTracker

3D-multiple object tracking (3D-MOT) is a visual-spatial cognitive training task[6,7].

Targets and isolates cognitive domains such as:[6,7]



- **Working Memory**
- **Attention**
- **Processing Speed**



Biomarkers of Interest

BRAIN DERIVED NEUROTROPHIC FACTOR (BDNF)
Brain repair and **neuroplasticity**
- Important for learning, memory, and recovery after brain injury [8]

INTERLEUKIN-6 (IL-6)
- A cytokine released by immune and glial cells, it exhibits **pro-inflammatory** and some anti-inflammatory properties [3,4]

INTERLEUKIN-10 (IL10)
Anti-inflammatory regulator [4]
- Suppresses excessive inflammation
- limit tissue damage After TBI [3]

TNF-A
Pro-inflammatory signal Released by immune cells and microglia [3,4]
- Amplifies inflammatory cascades Post-TBI [4]

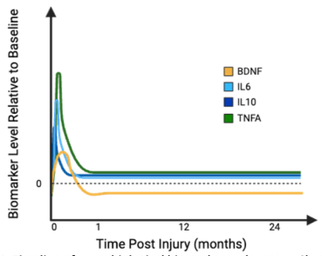


Figure 1. Timeline of neurobiological biomarkers relevant to Chronic effects of msTBI Relative biomarker trajectories following a concussion over a 24-month period. TNF-α and IL-6 spike rapidly after injury and can remain elevated for over a year. IL-10 peaks acutely but typically normalizes within one week. However, IL-10 levels may become elevated again if the brain experiences a sustained chronic immune response. BDNF has a spike at the time of injury and then drops after 25 hours and typically remains there in more severe cases. Low acute BDNF levels predict poor functional recovery six months post-TBI. Figure created by BioRender. All trajectories are illustrative and not to exact scale.

Objectives

1. Investigate whether a 5-week **Neurotracker** training intervention **increases BDNF** and **IL10** serum levels and **decreases IL6 and TNFA** serum levels in individuals with **moderate to severe TBI**

2. Investigate whether **individual** improvement in **NeuroTracker scores** correlate with **biomarker levels** in serum

Methodology

Adults with a history of moderate to severe TBI were recruited and randomized into a 3D-MOT intervention or waitlist control group.

Collect Baseline Samples (Blood)

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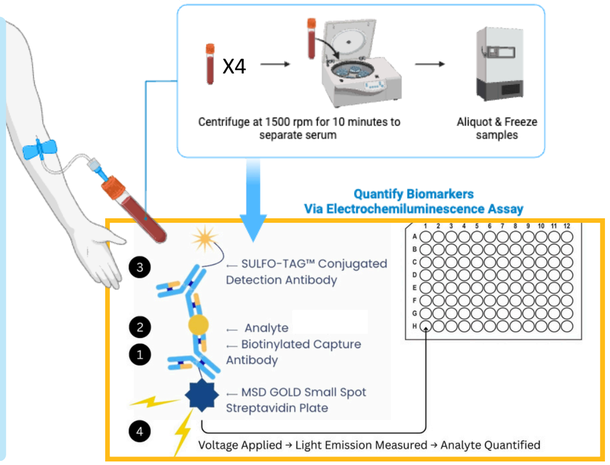
5 - week intervention of Neurotracker - 3 sessions 2x a week OR active Control

↓

Collect follow-up samples

↓

Collect follow-up 2 samples (Blood) - 5 weeks



Participant Demographics

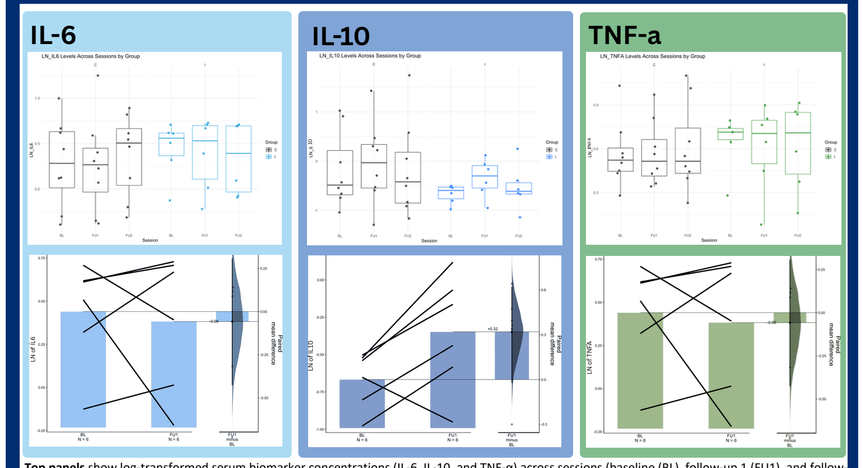
Participants were recruited through **ReachBC** and a partnership with the **Victoria Brain Injury Society**

Exclusion criteia
- Diagnosed neurodegenerative disorders
- Severe visual impairments
- Inability to complete cognitive assessments

Inclusion criteria
- More than 1 year since most recent TBI
- 19 years or older
- No previous use of Neurotracker
- Self reported moderate to severe TBI (msTBI)

msTBI Group	Participants (n)	Mean Age ± SD (years)	Female (n)	Male (n)
Control (C)	8	51.9 ± 20.3	2	6
Intervention (I)	6	54.0 ± 12.5	2	4

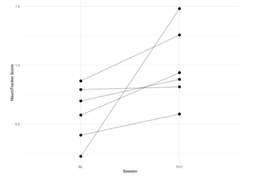
Preliminary Results



Top panels show log-transformed serum biomarker concentrations (IL-6, IL-10, and TNF-α) across sessions (baseline (BL), follow-up 1 (FU1), and follow-up 2 (FU2)) for the control (C, n = 8) and intervention (I, n = 6) groups. Points represent individual participants and boxplots display the distribution within each group and session. There are no detectable changes in biomarker levels in serum across the different time points. **Bottom panels** show paired Gardner–Altman estimation plots for the intervention group comparing baseline and follow-up 1 values. Lines connect individual participants, the grey bar represents the mean difference (FU1 − BL), and the adjacent bootstrap distribution depicts the sampling distribution of the mean difference with bias-corrected and accelerated 95% confidence intervals. After NeuroTracker training, the intervention group showed small changes in cytokine concentrations between baseline and FU1: IL-6 decreased by −0.058 [95% CI: −0.425, 0.306], IL-10 increased by 0.319 [95% CI: −0.020, 0.619], and TNF-α decreased by −0.042 [95% CI: −0.344, 0.191].

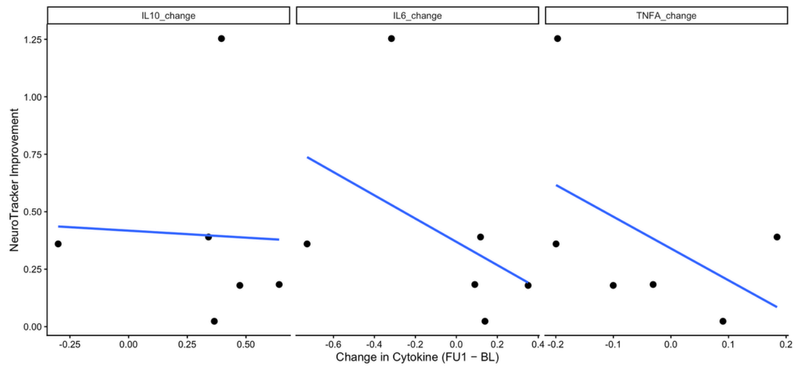
Preliminary Results

NeuroTracker scores significantly increase from Baseline to Follow-up



NeuroTracker scores for participants in the intervention group (n = 6) at baseline (BL) and follow-up 1 (FU1). The points represent individuals and the lines indicate within-subject changes across sessions. NeuroTracker performance increased significantly from BL to FU1 (Wilcoxon signed-rank test, V = 21, p = 0.031), with a mean improvement of 0.40 points.

Associations Between NeuroTracker Improvement and Biomarker Changes



Relationship between NeuroTracker improvement and changes in serum biomarker following training. Scatterplots show the association between change in biomarker concentrations (FU1 to BL) and improvement in NeuroTracker performance in the intervention group (n = 6). Each point represents an individual participant, and lines indicate linear trend. Spearman correlations indicated a moderate negative association between IL-6 change and NeuroTracker improvement (ρ = −0.66, p = 0.175), whereas weaker relationships were observed for IL-10 (ρ = −0.26, p = 0.658) and TNF-α (ρ = −0.26, p = 0.658). No significant correlations were found.

Findings and Future Directions

- **NeuroTracker training improved performance.**
  - Participants in the intervention group showed significant improvement from baseline to FU1 (V = 21, p = 0.031).
- **No clear group-level changes in inflammatory biomarkers were detected.**
  - IL-6 and TNF-α showed minimal change, while IL-10 showed a modest but non-significant increase.
- **IL-6 reductions may relate to training improvement.**
  - Exploratory analysis suggested a moderate negative association between IL-6 change and NeuroTracker improvement (ρ = −0.66).
- **Next steps will be to analyze more samples to include more participants.**
  - Larger sample size will allow for a more robust analysis.
  - BDNF will be analyzed using NULISA technology to get proper, in-range values.

References & Acknowledgements

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Poster created on March 4th , 2026

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