

## Introduction

- Previous literature has identified that both mental overexertion and complete rest are associated with delays in concussion recovery, highlighting the importance of cognitive pacing (Brown, 2014; Thomas, 2015).
- Concussion causes vascular and metabolic dysfunction resulting in reduced cognitive function (Giza, 2014).
- Cognitive pacing and breaks from mental activity during concussion recovery can allow the brain to re-energize, and reduce the metabolic strain on the brain post-concussion.
- However, cognitive pacing can be a challenge for patients and clinicians as daily mental activity is difficult to quantify.
- Electroencephalography (EEG) has been shown to allow for real-time, accurate measurements of cognitive exertion.
- Neurovine has developed a novel mobile application which links to our novel portable EEG headband and a heart rate monitor to guide cognitive pacing, and sub-threshold exercise at home during concussion recovery.
- **Objective:** To understand how Neurovine's novel EEG-driven technology may inform cognitive pacing during concussion recovery.

## The Neurovine Technology

- The Neurovine technology consists of an EEG headband and heart rate monitor linked to our mobile application to be used as an aid to the concussion recovery process.
- The EEG headband and heart rate monitor work with personalized machine learning algorithms to monitor brain and physical activity.
- As a user performs tasks throughout the day at home, the technology will monitor this activity, calculate their expendable brain energy, and send an alert when it is time to take a "brain break" to avoid overexertion.
- The heart rate monitor links with the mobile application to encourage and guide patients to do sub-threshold exercise at home during their recovery.



## Methodology

- Concussion patients aged 14-65 whose concussion had occurred within the previous 12 months were recruited for this study.
- Participants attended one baseline session and two follow-up sessions at 6 weeks and at 12 weeks (or until cleared to return to full activity).
- Following baseline calibrations, participants were asked to use the technology whenever they performed clinician-recommended cognitive tasks for up to 12 weeks.
- Concussion symptom, mental health, and self-efficacy data were collected using standardized tools (SCAT5, PHQ-9, GAD-7, NIH Self-Efficacy) at baseline, 6 weeks, and at the final follow-up.
- Participants also provided qualitative feedback on the technology using a 7-point Likert scale (strongly disagree to strongly agree).
- **Statistics:** Paired t-tests were used to compare symptom, mental health and self-efficacy data between pre- and post-tech use.

## Results

- To date, 22 concussion participants have enrolled in the study, but only six participants (avg. age = 42 years; 6 female) had completed the full 12-week protocol at the time of poster submission.
- Preliminary results from participants who completed the full protocol indicate:
  - a significant decrease in PHQ-9 depressive symptoms ( $p < 0.05$ ) and in SCAT5 symptom scores ( $p < 0.05$ ) between pre- and post-tech use
  - a non-significant decrease in GAD-7 anxiety symptoms ( $p = 0.1$ ), and a non-significant increase in NIH self-efficacy ratings ( $p = 0.7$ ) between pre- and post-tech use
- The technology was rated 5/7 (71.4%) for helping participants to better understand their mental and physical capacity during recovery.

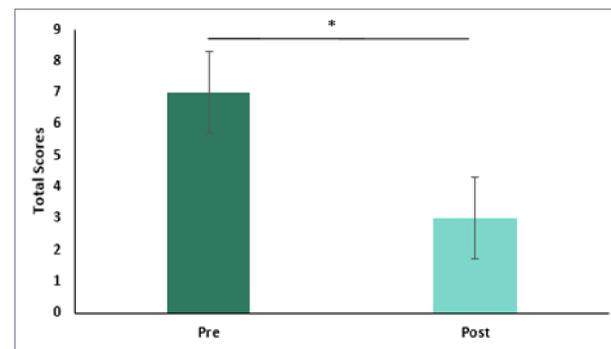


Figure 1. PHQ-9 Symptom Scores Pre vs Post Tech Use.  
\* $p < 0.05$ . Data expressed as mean  $\pm$  SEM

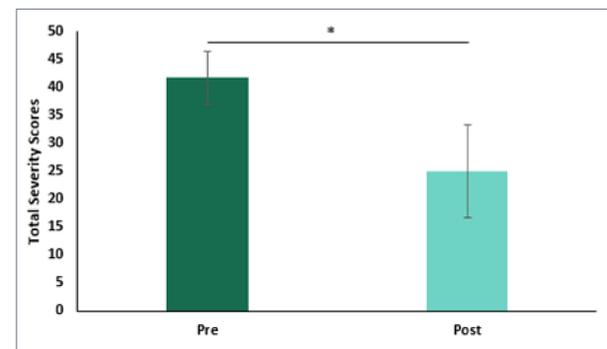


Figure 2. SCAT5 Symptom Severity Scores Pre vs Post Tech Use.  
\* $p < 0.05$ . Data expressed as mean  $\pm$  SEM

## Conclusion

- These results indicate that the Neurovine technology may provide better insight and understanding of cognitive pacing during recovery, which may have a positive effect on recovery trajectories and mental health.
- This study is ongoing, and it is expected that more concrete results will be determined as data collection continues.

## References

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## Acknowledgements

The research team would like to thank all our participants and clinic partners for taking the time to participate in this study. We would also like to thank the rest of the Neurovine team and mentors for the development of this technology, as well as Jaston Stockall and Sean Denroche for their assistance with data collection.

## Next Steps

- The subjective feedback collected during this study has been vital in refining and improving the machine learning algorithms, the mobile app interface, and the comfort, design and functionality of a new EEG headband
- The new EEG headband has been greatly improved in design, comfort as well as adding accelerometers, and gyroscopes to allow for balance training and vestibular rehabilitation components.
- We will be using the new EEG headband as well as our refined mobile application and a clinician portal for an upcoming registered randomized controlled trial that will launch in 2022.



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