Using psychophysiology and interoception to understand emotional change after traumatic brain injury.

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Introduction

- Altered emotional and social behaviours are amongst the most frequent and debilitating sequelae of TBI for patients and caregivers
- Poor social outcomes can occur relatively independently of cognitive recovery
- Normal societal functioning is a powerful determinant of return to work, social reintegration and quality of life post-TBI
- Interoception is the process by which we generate our feeling states
- TBI patients have been shown to be impaired in non-emotional interoception
- Generalised failure in interoception linked to alexithymia, which in turn accounts for a significant proportion of aggression in TBI

Aim

- to understand whether there is a fundamental problem with processing all physical signals or a specific problem with processing signals relating to emotion in patients with socioemotional dysfunction after TBI
- to assess brain-body interactions through
  - non-emotional signals (heartbeat at rest)
  - physiological signals in dynamic states (experiencing emotion))
    - Subjective (Visual analogue scale (VAS) ratings)
    - Objective (heart rate variability (HRV) and galvanic skin response (GSR))

Method

37 msTBI patients were recruited from specialist clinics if the carer/relative endorsed items on the Barsuglia social dysfunction questionnaire. 40 age matched healthy controls were also recruited.

- **At rest**
- Interoceptive accuracy (a and b) with judgements of performance/interoceptive sensibility after each trial on a Visual analogue scale (VAS).

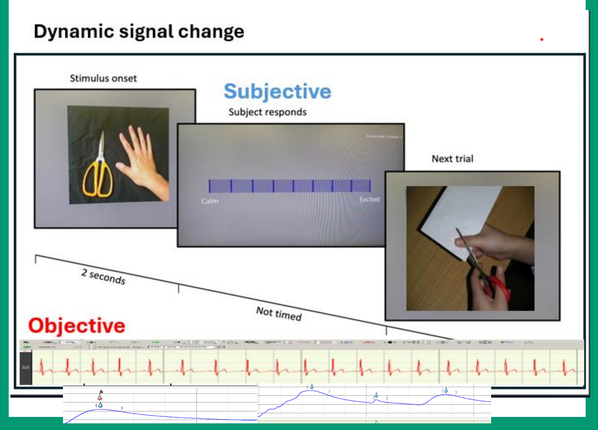
a. Heartbeat Tracking

b. Heartbeat discrimination

Sensibility-accuracy correspondence is generated from b) discrimination task and confidence measures. Area under the receiver operated curve represents interoceptive awareness.

- **Dynamic states**
- Empathy invoking images were presented with subjective report on a VAS scale of how painful the image is and the intensity of their internal response
- Continuous ECG & GSR recording was performed before and during the task for HRV and skin conductance responses (objective response)

Dynamic signal change



Results

•Self report questionnaires: msTBI patients were significantly more alexithymic (p<0.0001), less empathic (p=0.0002) and more aggressive (p=0.0173) than the control group (Figure 2).

•There were no significant differences between the groups' performance on measures of non-emotional interoception at rest.

•There were no significant differences in the subjective ratings of responses between groups using either scale. The groups were reliably able to differentiate painful from non painful images (p<0.0001).

•At rest, the HRV as measured by rmssd was not significantly different between the groups (p=0.0587 at rest) or during the tasks (Figure 1). During the task the HRV spectral characteristics were not significantly different between groups (normalised low frequency power (p=0.069) and high frequency (0.055). (see Figure 2).

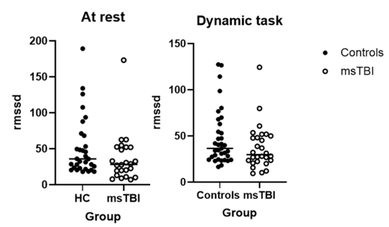


Figure 1: rmssd at rest was calculated from recordings of >1 minute in duration. Task rmssd was an average across 4 sessions of images (total 256 images, 50% painful)

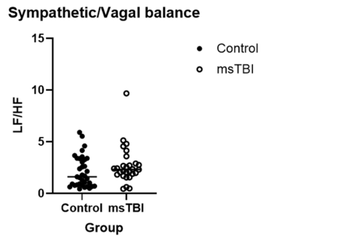
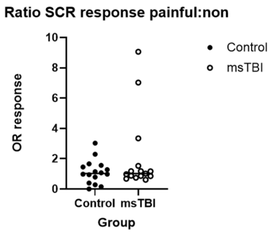


Figure 2: Sympathetic vagal balance represented as ratio of Low frequency (LF) to High frequency (HF) power. Spectral characteristics were averaged across 4 sessions of images (total 256 images, 50% painful)

- Phasic responses on the GSR signal were marked as significant if they occurred 1-4 seconds after the presentation of an image. An odds ratio of likelihood of responding to a painful versus a non painful image was generated (see figure 3). There was no significant difference between groups



- *Figure 3: Odds Ratio (OR) of summed SCR size for the 128 painful versus the 128 non painful images. OR of 1 denotes equal likelihood and size of response to painful/non painful images. >1 indicates increased response to painful versus nonpainful images*

Conclusion

Despite the recruited disease group having significant emotional differences from healthy controls as captured by questionnaire responses, there was neither a significant difference in their non-emotional interoceptive abilities at rest nor their subjective ratings of empathy inducing images. There was a non significant trend towards autonomic differences during the task in the msTBI cohort potentially representing a shift in sympatho-vagal balance. Modelling techniques are being applied to determine to what extent an individual's physiological response relate to their emotional and social dysfunction.

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