Characterising changes in brain activity during retinopathy of prematurity screening

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Introduction

Retinopathy of prematurity (ROP) screening is a clinically essential procedure thought to be painful and distressing for the infant[1]. However, as infants cannot report their pain experience, surrogate measures of pain are needed. Noxious-evoked brain activity has been previously recorded in infants in response to heel lance[2], and is sensitive to analgesic modulation[3]. Tonic pain in adults elicits changes in spectral power[4]. Here we investigate the changes in brain activity evoked by ROP screening and relate these changes to a validated infant pain scoring system[5] (Premature Infant Pain Profile-revised; PIPP-R)

Aims

To characterise nociceptive brain activity in infants undergoing ROP screening

Study 1

Methods

- Electroencephalography (EEG), heart rate, respiratory rate, and oxygen saturations were continuously recorded before, during and after ROP screening in 13 premature infants. Facial expression was recorded before and after examination.
- Ethical approval and parental consent were gained prior to all studies. EEG was recorded at the Cz, CPz, C3, C4, FCz, Oz, T3 and T4 electrode sites, referenced to Fz with ground on the forehead.
- EEG data were transformed to the frequency domain by fast Fourier transform, and analysed to quantify relative spectral power at the Cz electrode. Physiological & behavioural data were used to calculate PIPP-R scores.

Results

Figure 1: Change in relative power before and after ROP screening was calculated for each spectral band (delta <4Hz; theta 4-8Hz; alpha 8-12Hz; beta 12-20Hz) for (A) each subject & (B) group mean.

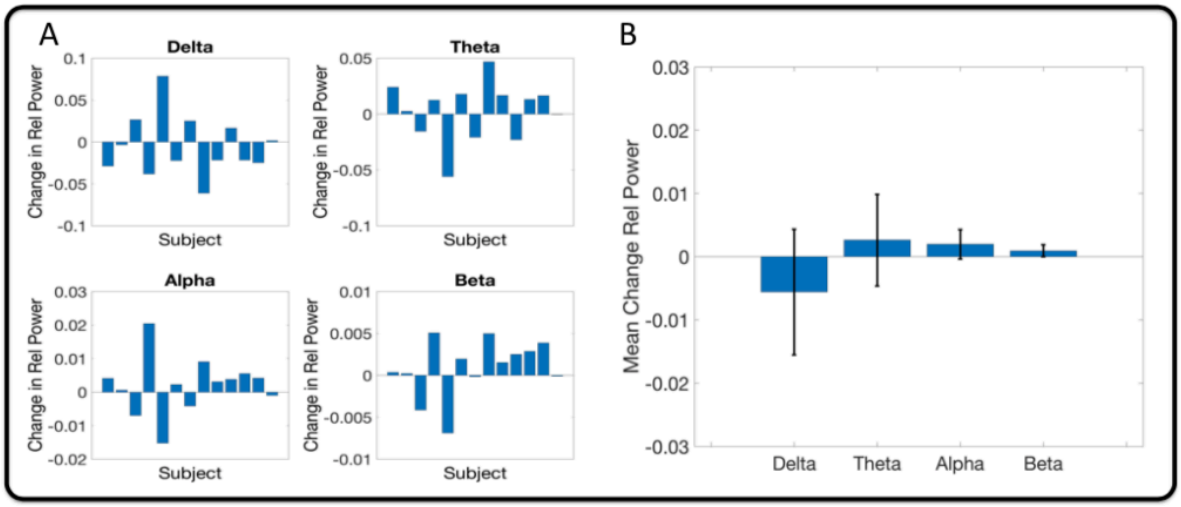
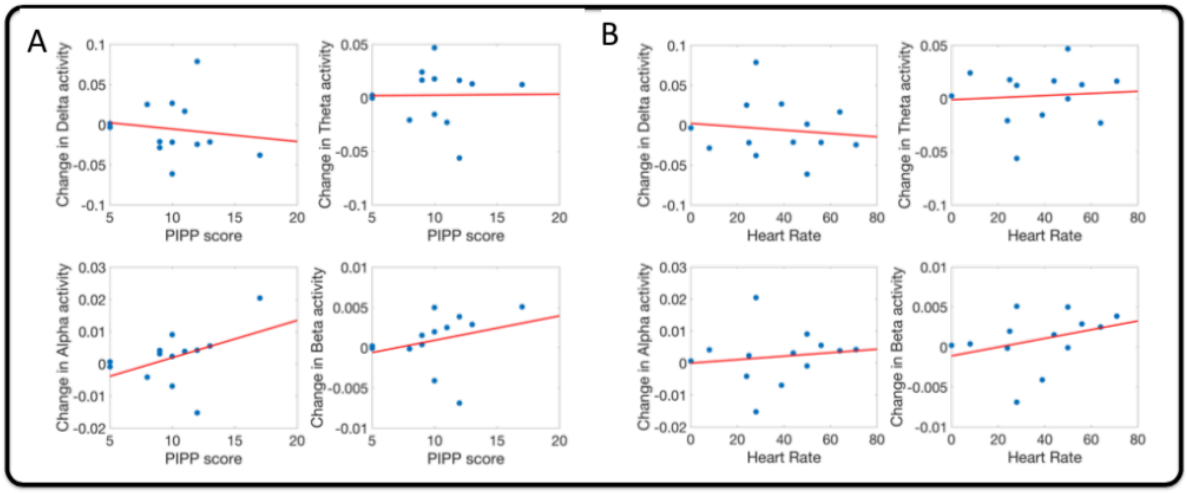


Figure 2: The change in relative power for each spectral band was correlated to the PIPP-R score (A) and heart rate (B)



ROP screening increases brain activity in the alpha, beta & theta bands, and decreases delta band activity

In Study 1, there was a trend toward correlation between increased brain activity in alpha and beta bands and increased pain score and heart rate. Since increase in beta power has been reported in the adult literature in response to tonic pain[5], we hypothesised that in infants, beta power may increase after ROP screening, and may correlate with pain score and heart rate.

Study 2

Methods

- 11 Premature infants underwent ROP screening with recording as for Study 1.

Results

Figure 3: The change in relative beta power before and after ROP screening was calculated for (A) each subject & (B) group mean.

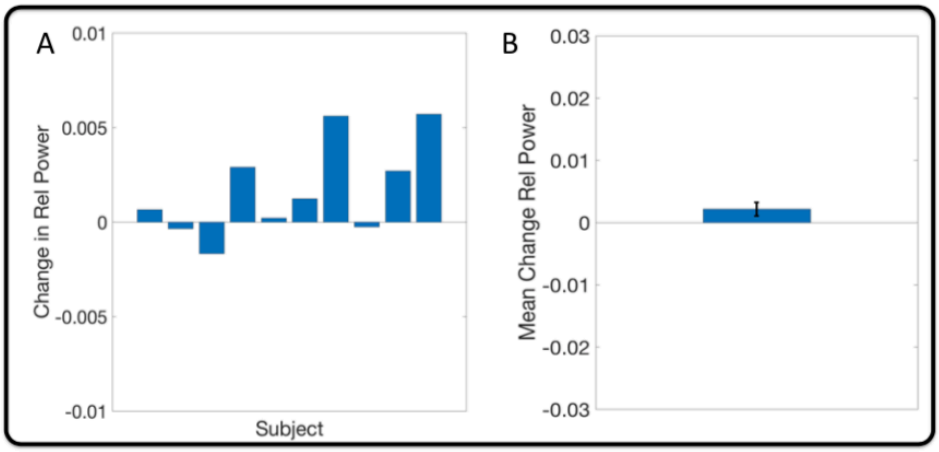
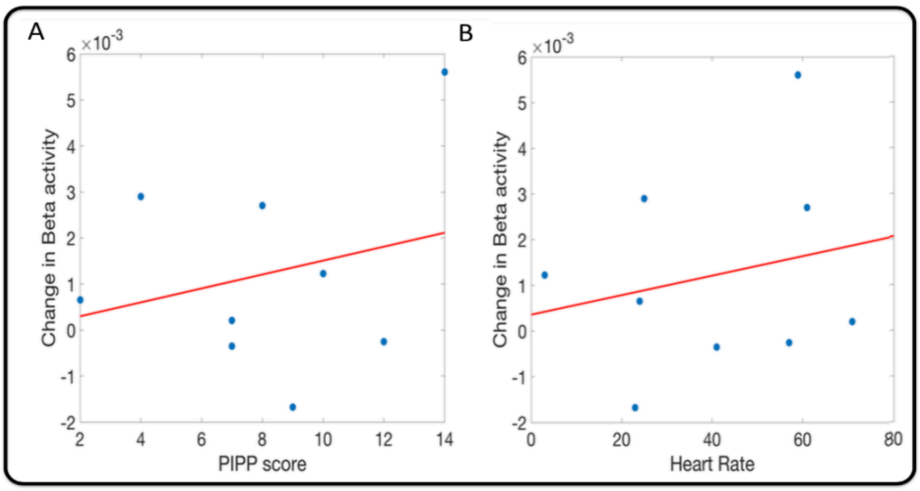


Figure 4: The change in relative beta power was positively correlated to the PIPP-R score (A) and heart rate (B)



Conclusions

- Tonic pain, as elicited by ROP screening, increases beta activity in the infant brain. Changes in beta activity correlate with pain-related physiological changes. This observation is reproducible across two populations of premature infants.
- Future directions for this work include investigating how combinations of EEG features are influenced by tonic pain, and investigating how changes in spectral power correlate with previously characterised noxious-evoked brain activity.
- Fully characterising brain activity changes to such complex, longer duration procedures will improve understanding of the impact on the infant, including the time taken to return to baseline brain activity and physiological state, which may ultimately lead to improved pain management in this vulnerable population.

References:

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