SUPPLEMENTARY DATA

Impaired Frontoparietal Connectivity in Traumatic Individuals with Disorders of Consciousness: A Dynamic Brain Network Analysis

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METHODS

1. Time-varying multivariate adaptive autoregressive (TV-MVAAR) model

For each time series, the TV-MVAAR model was calculated with the following equation:

$$X(t) = \sum_{i=1}^{p} A(i,t)\,\mathrm{X}(t-i) + \mathrm{E}(t) \quad (1)$$

where $X(t)$ is the data vector over the whole time window, $A(i,t)$ is the matrix of the TV-MVAAR model coefficients estimated by the Kalman filter algorithm, $E(t)$ is the multivariate independent white noise, and p is the model order, which can be automatically determined from the Akaike Information Criterion (AIC) with a range of 2 to 20:

$$AIC(\mathrm{P}) = \ln[\det(\Sigma) + 2M^2 p/N] \quad (2)$$

where M is the number of the time series, p is the optimal model order, N is the time point and Σ is the covariance matrix. The observation and state equations were then solved by a recursive least-squares algorithm with a forgetting factor.

2. ADTF

Based on the time-varying coefficients estimated from (1), $H(f,t)$ can be further derived from the frequency domain expression of $A(i,t)$. The H_{ij} element of $H(f,t)$ represents the directed information flow from the j-th to the i-th element for each time point t:

$$A(f,t)X(f,t) = E(f,t) \quad (3)$$

$$X(f,t) = A^{-1}(f,t)E(f,t) = H(f,t)E(f,t) \quad (4)$$

where $A(f,t) = \sum_{k=0}^{p} A_k(t)\,\mathrm{e}^{-j2\pi f\,tk}$ is the frequency domain expression of model coefficients at time point t, and $X(f,t)$ and $E(f,t)$ are the transformations of $X(t)$ and $E(t)$ in the frequency domain.

The normalized ADTF describing the directed information flow from the j-th to the i-th element is defined as with the ADTF values between (0, 1):

$$r_{ij}^2(f,t) = \frac{\left|H_{ij}(f,t)\right|^2}{\sum_{m=1}^{n}\left|H_{im}(f,t)\right|^2} \quad (5)$$

The integrated ADTF is defined as the average ADTF values over the frequency bands of interest:

$$\Theta_{ij}^2(t) = \frac{\sum_{k=f_1}^{f_2} r_{ij}{}^2(k,t)}{f_2 - f_1} \quad (6)$$

Further details on the ADTF method can be found in previous studies [1]. Considering the frequency band of interest in emotion regulation, 0.1-30 Hz was selected as the range of the average ADTF values to serve as the directed information flow [2,3].

RESULTS

Figure S1. A contains the grand average ERPs at three midline electrode sites (Fz, Cz, and Pz) in the healthy control group. The N1 waveforms at these three electrodes for two different stimuli types were most prominent in frontotemporal areas. The typical LPP complex at Pz, ranging from 400 to 1000 ms, was evoked by affective prosody stimuli. The scalp distribution of the waveform peaks is displayed in Figure S1.B and demonstrates that the LPP peaks over parietal-occipital and central sites.

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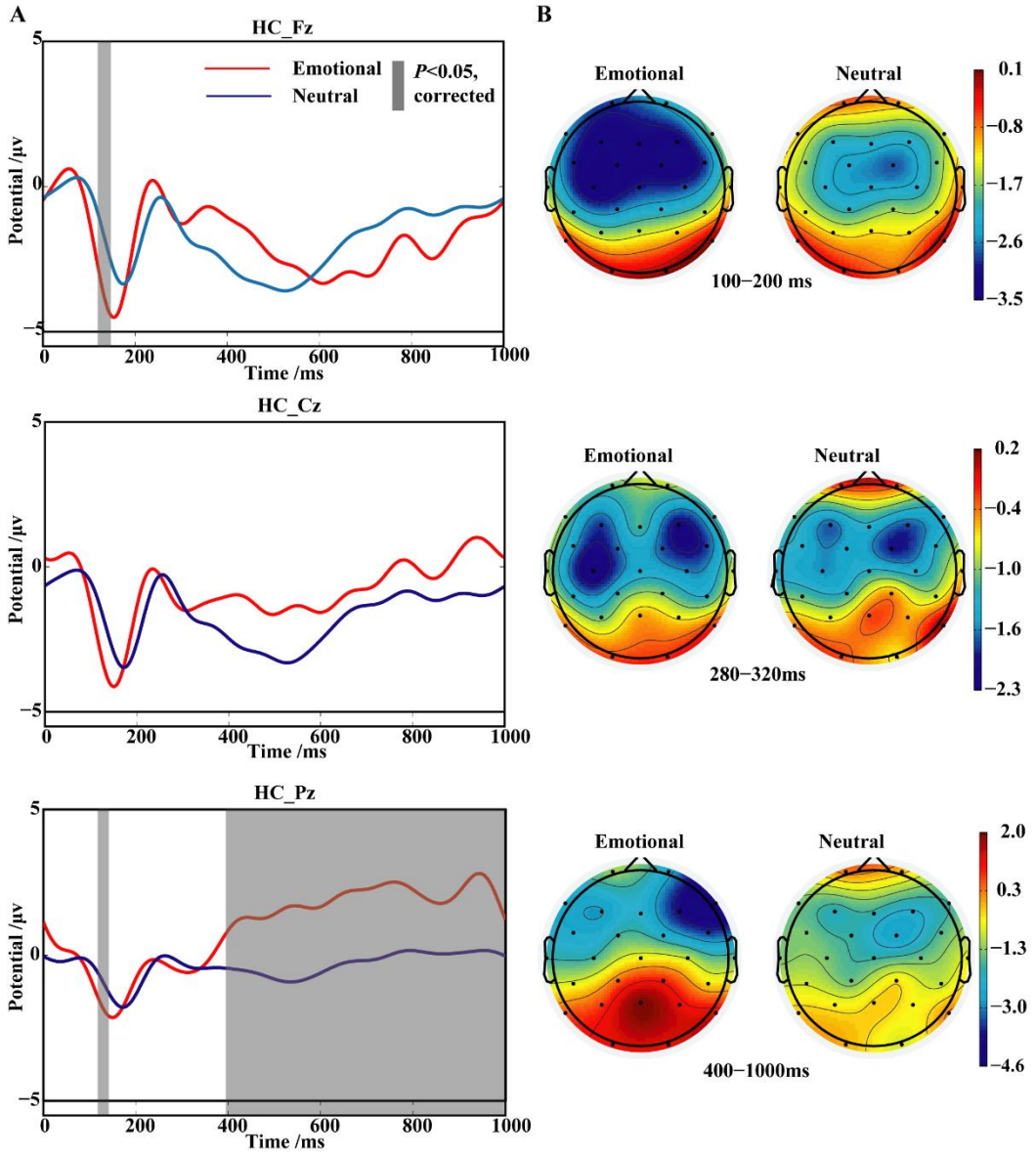

Supplementary Figure 1. **Grand average ERP components in healthy controls.** Grey bars indicate regions of significant difference between conditions (P<0.05, FDR corrected). (A) At electrode Fz, emotional sound evoked increased N1, and at Pz, an emotion-evoked LPP was observed. (B) The scalp topography during the three time periods of interest, corresponding to N1, P3a, and LPP, respectively.

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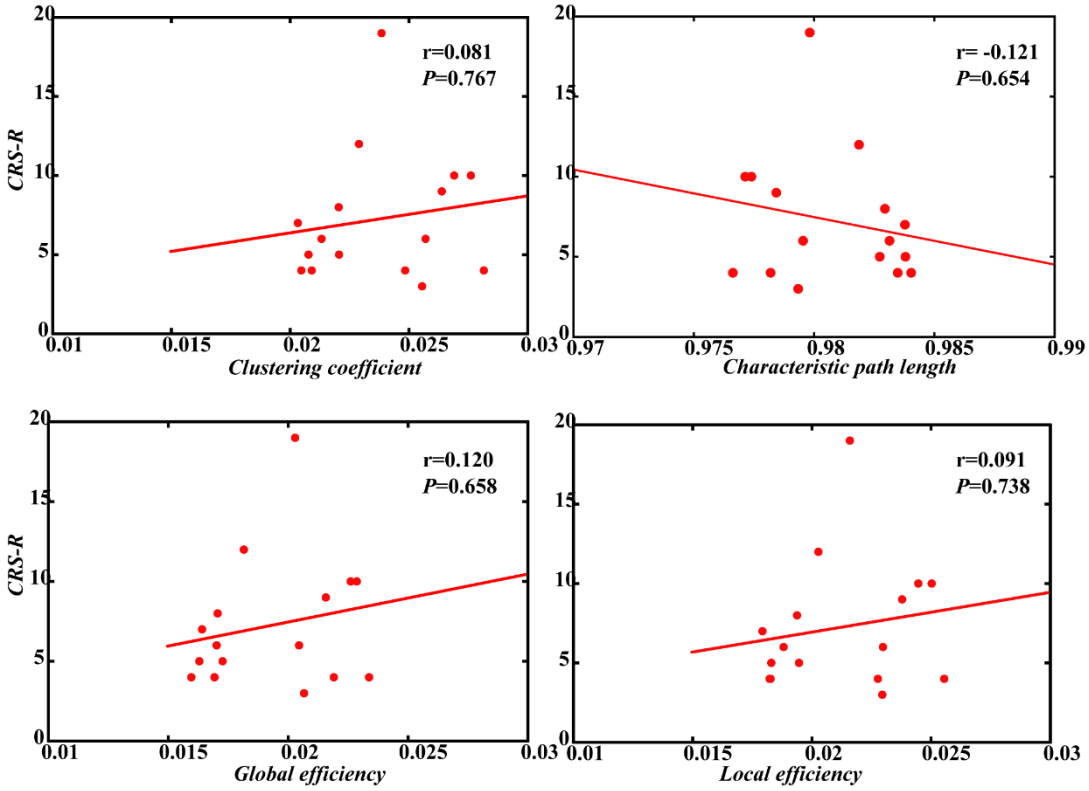

Supplementary Figure 2. No significant linear correlations existed between brain network properties and CRS-R total scores in patients with nontraumatic DOC.

References

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