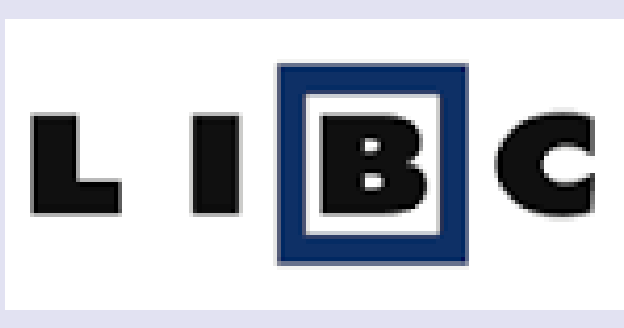# Neural oscillatory dynamics of social feedback processing in women

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[4]Institute of Psychology, Erasmus University, Rotterdam, The Netherlands.
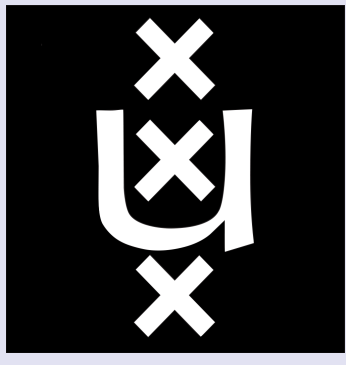
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Background & Rationale

Rhythmic changes in theta power during social exclusion in Cyberball have recently been interpreted as a neural signature of social pain[1,2]. However, neural activity in Cyberball's exclusion block may have been confounded by expectancy violation. Here we dissociated participants' expectancies about social evaluation from the social evaluative outcome itself. We examined the following questions:

1. **Is theta power a neural signature of social pain?**
2. **Is theta power increased in females who are more sensitive to social evaluation?**
3. **Which stage in information processing is most sensitive in detecting social evaluative discomfort?**

Method

* 56 healthy female undergraduates (age in years = 19.67)
* 64-channel Biosemi EEG acquisition
* 160 trials (50% social rejection feedback)
* Reference scheme: Current source density transformation
* Time-frequency decomposition via Morlet Wavelets
* Baseline: -500 to -200 ms pre-trial interval
* Frequencies of interest: Delta (1-4 Hz), Theta (4-8 Hz), Alpha (8-13 Hz), Beta (13-25 Hz)
* Source modeling of theta power: weighted minimum norm estimate (Brainstorm package)
* Questionnaires: social anxiety, self-esteem, depression, rejection sensitivity, behavioral inhibition

Behavioral results: participants predicted social acceptance on 55.6% (SD= 8.70) of the trials

speed of judgments did not differ between feedback prediction type (mean diff. =10.2 ms)

The Social Judgment Paradigm

1. Fixation cross (500-1000 ms)
2. Cue (3000 ms)
3. Participant's prediction (3000 ms)
4. Peer Feedback (2000 ms)
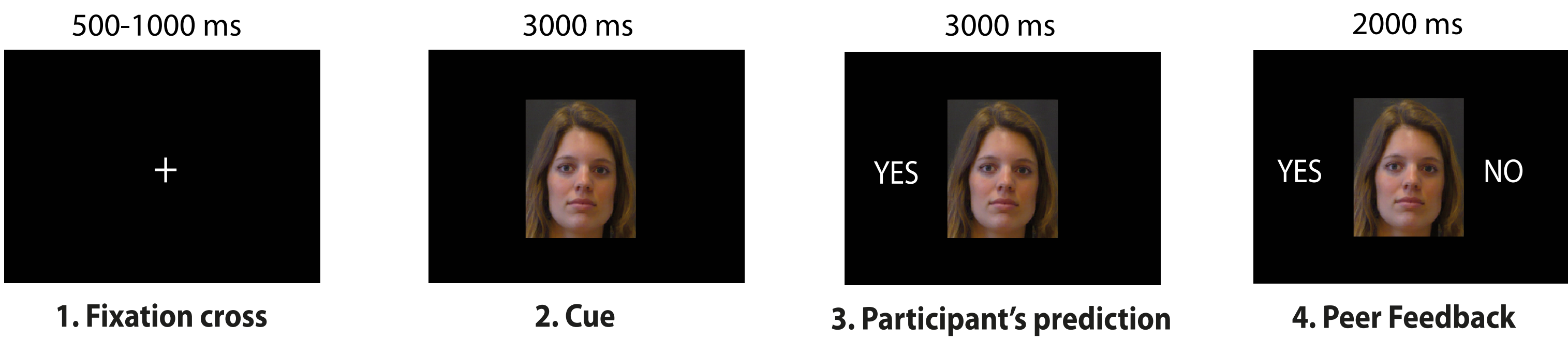
A cover story was used in which participants were led to believe that they have been evaluated by a panel of peers based on first impressions. During the experiment, photographs were shown of each member of the peer panel. For each photograph, the participant had to predict whether the peer liked or disliked the participant. Thereafter, participants were show peer feedback signaling social acceptance or rejection that was either congruent or incongruent with prior predictions. [adapted version of (3), also see (4)]
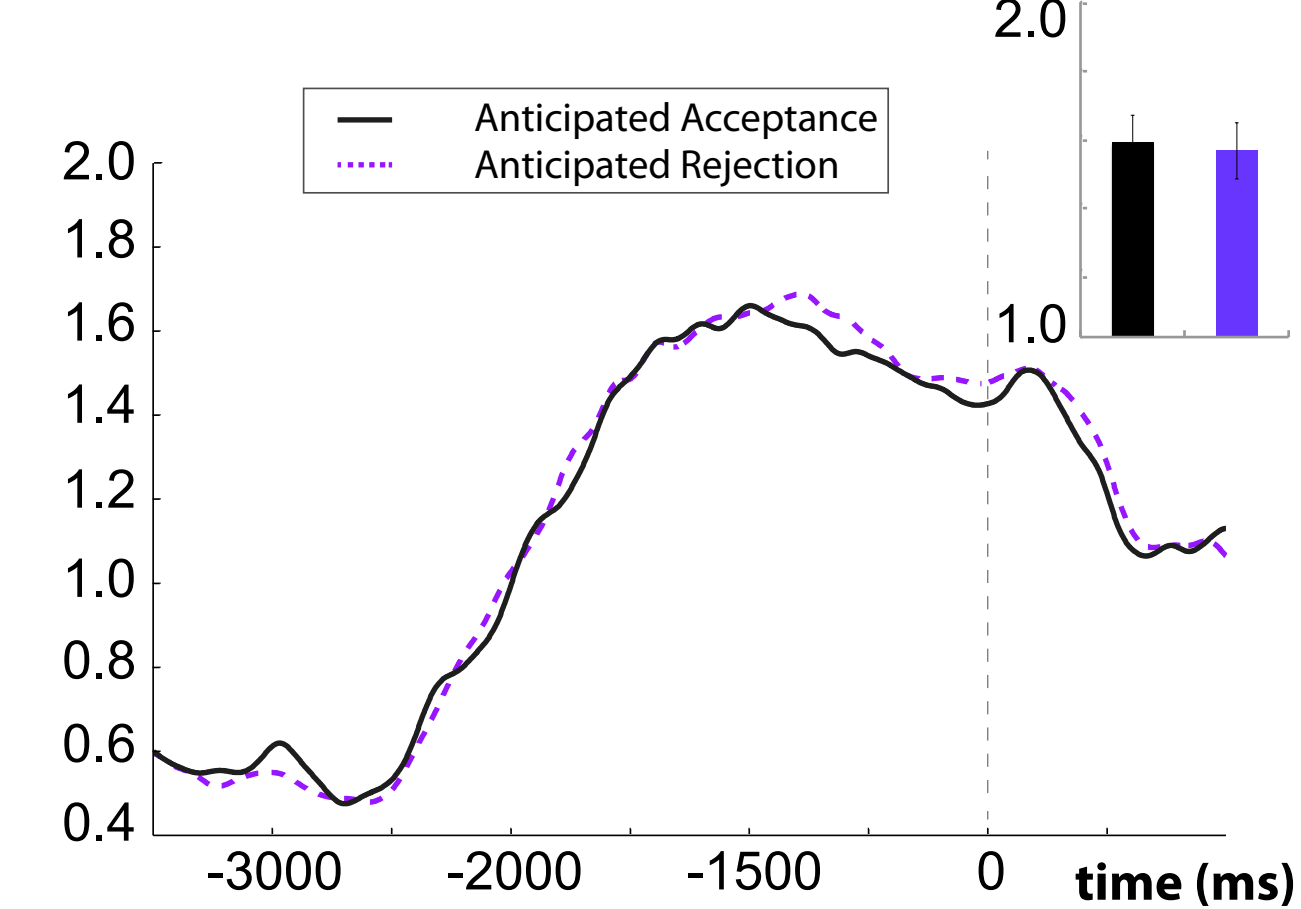
Results: Feedback Anticipation
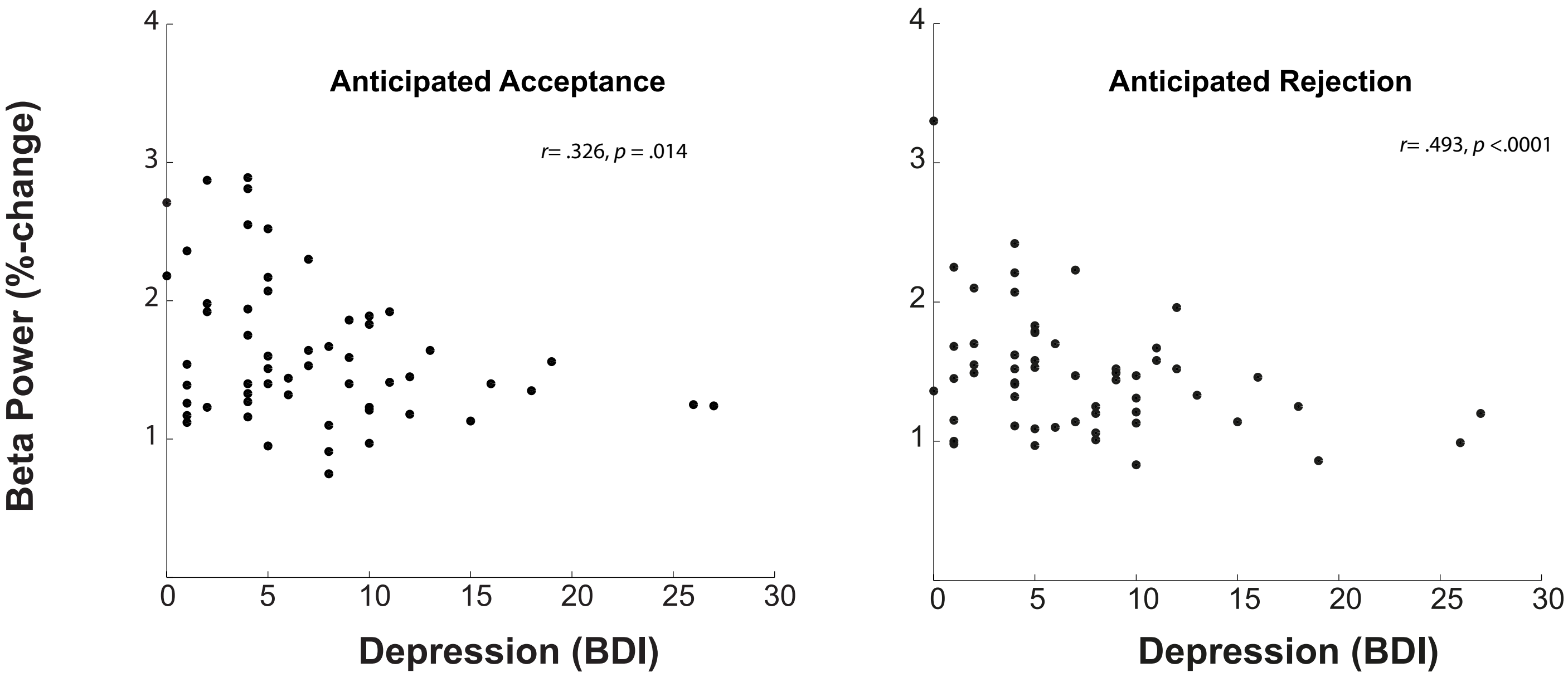
A. Time-frequency oscillatory activity

### B. Beta power (15-25 Hz)

p=.034

C. Alpha power (8-13 Hz)

- Anticipated Acceptance
- Anticipated Rejection
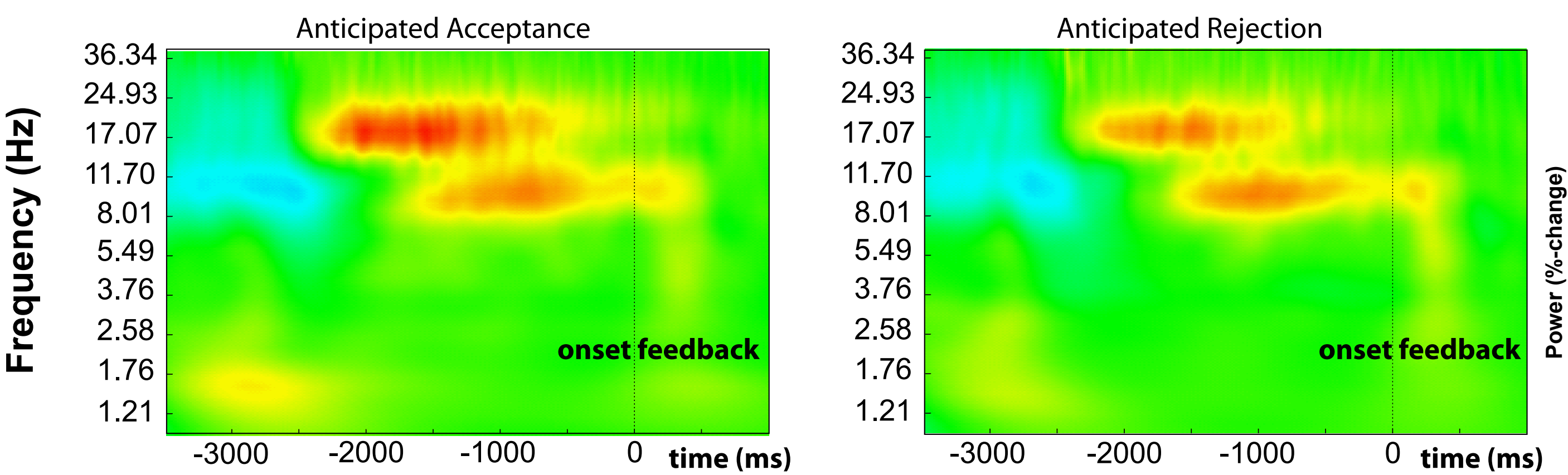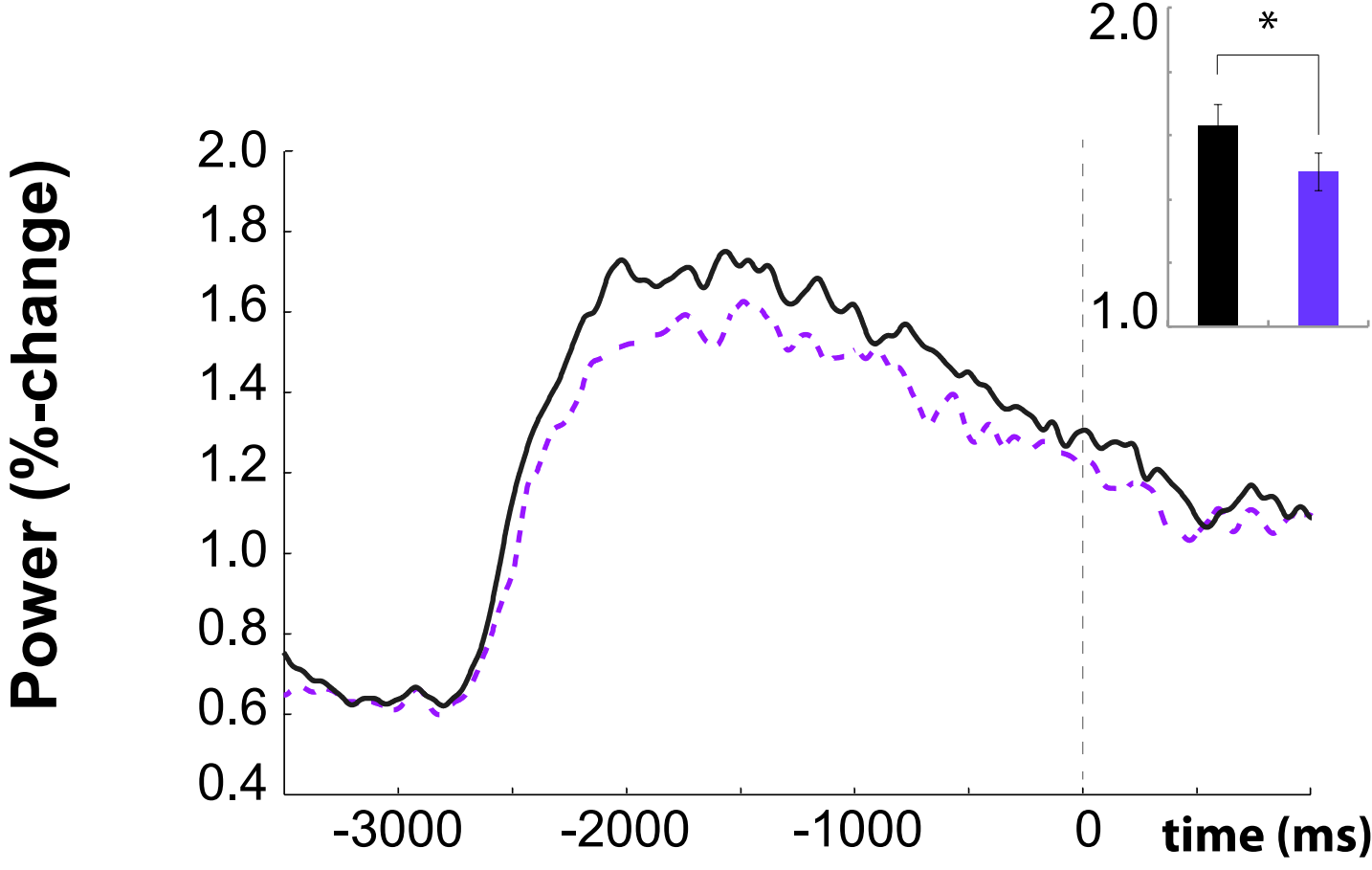
D. Correlation analyses: beta power with depression

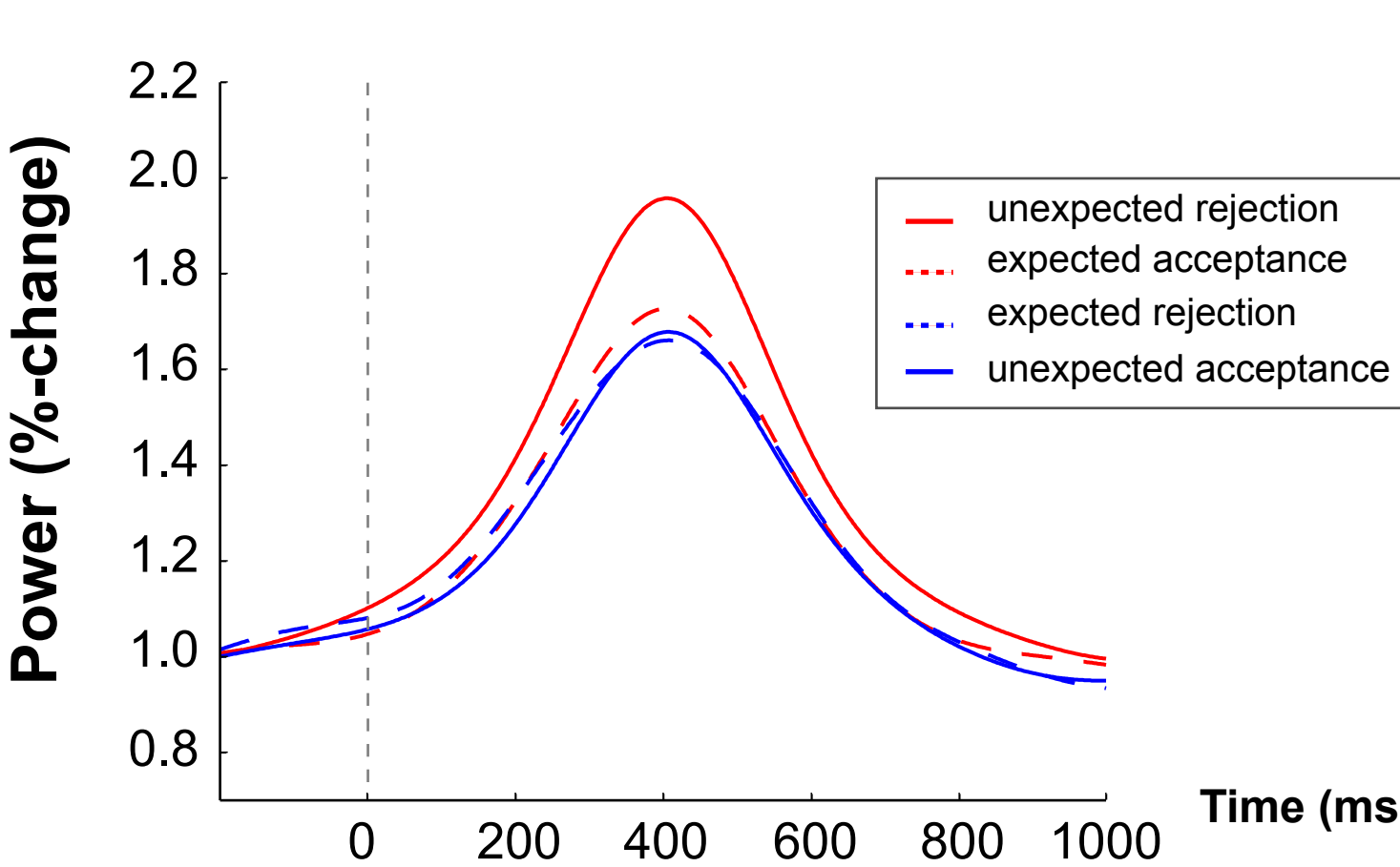Anticipated Acceptance: r= .326, p = .014

Anticipated Rejection: r= .493, p <.0001

* Anticipation of social feedback coincides with increased power of beta and alpha oscillations.
* A significant increase in beta power was observed for anticipated social acceptance vs. social rejection.
* Alpha power did not differ between social acceptance and rejection predictions.
* Anticipatory beta power significantly decreased when females reported higher levels of depression.

Results: Feedback Processing

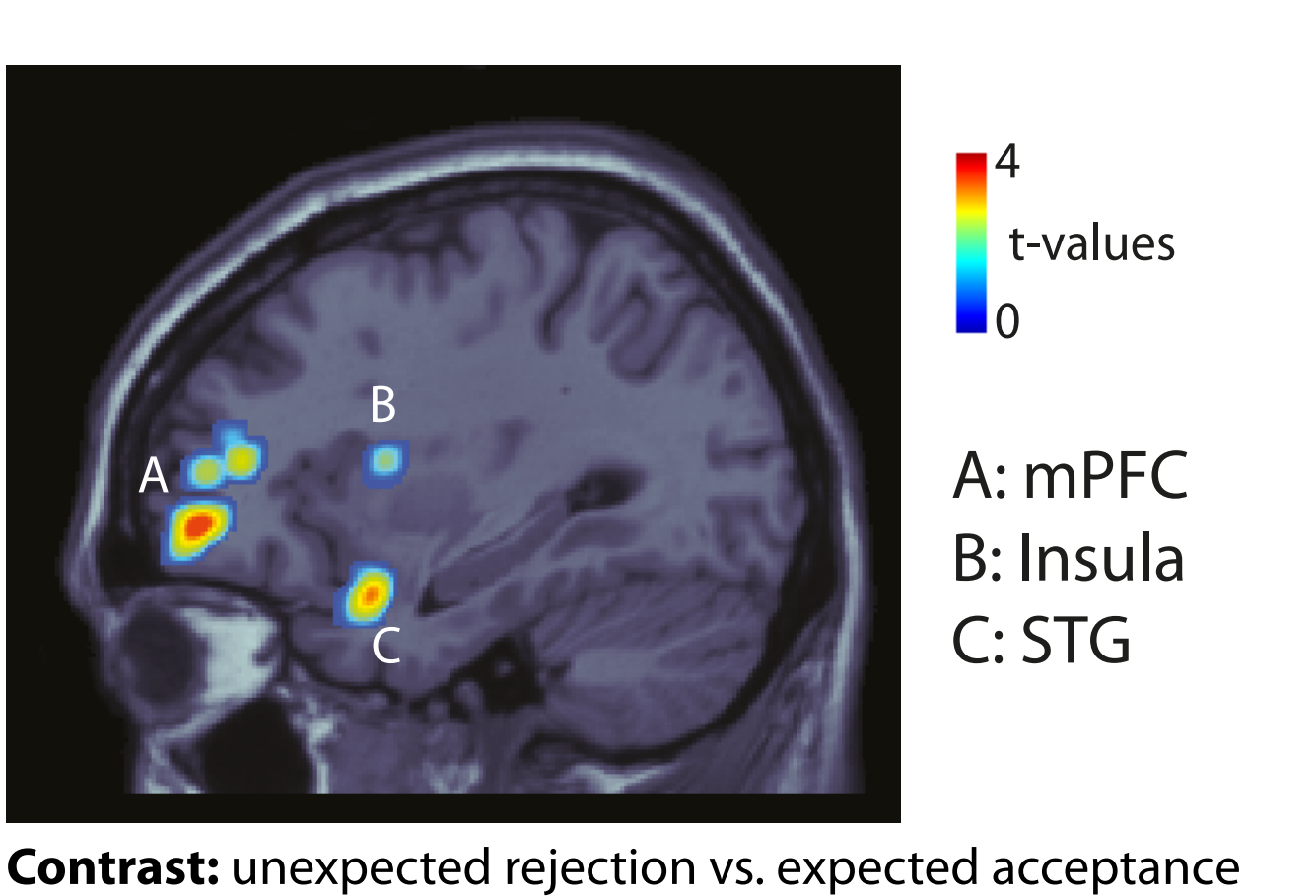### A. Time-frequency oscillatory activity

theta power source activation
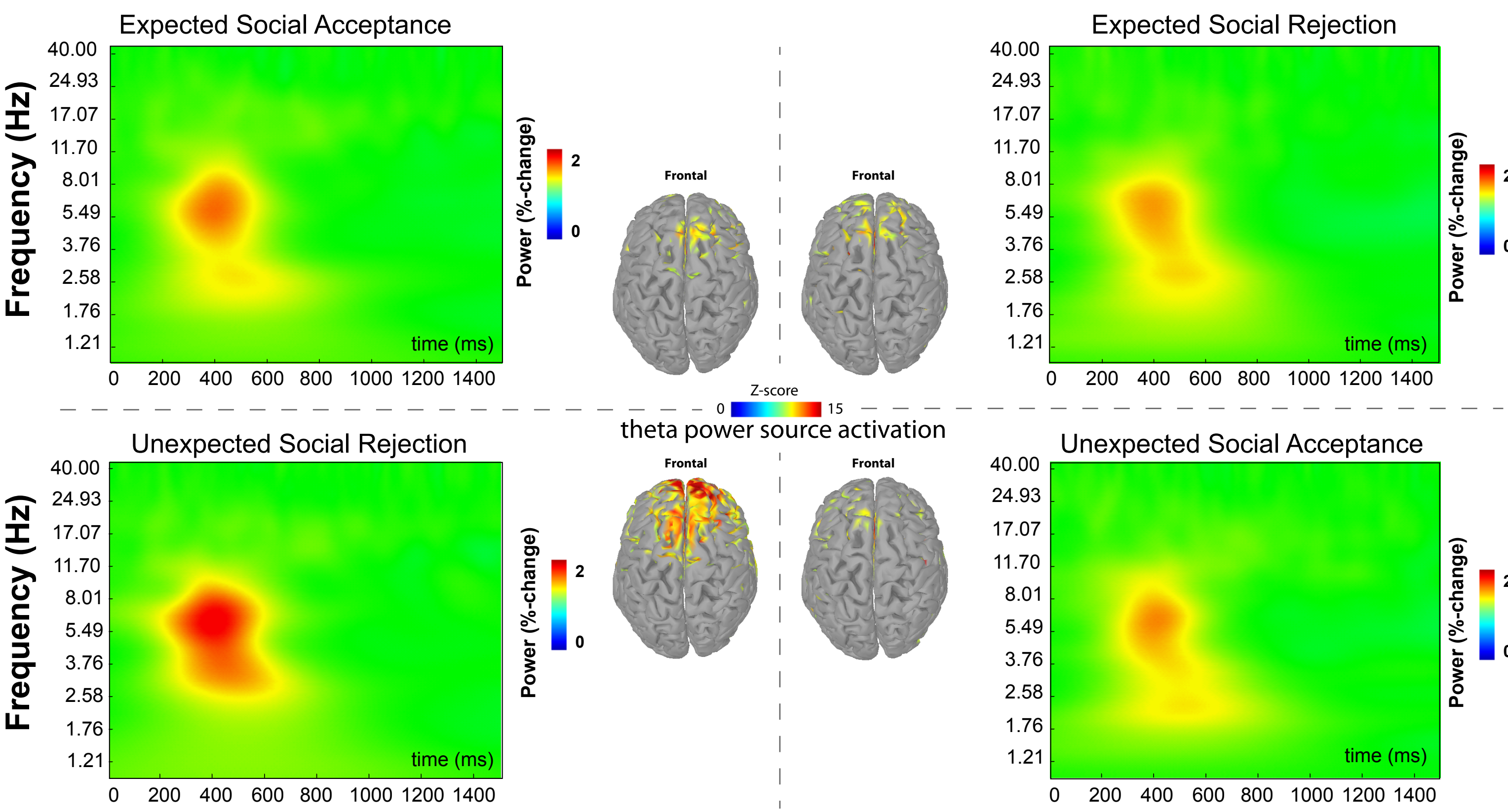
B. Peak feedback-related theta power (4-8 Hz)

- unexpected rejection
- expected acceptance
- expected rejection
- unexpected acceptance

C. Source estimation of theta power (4-8 Hz)

A: mPFC
B: Insula
C: STG

Contrast: unexpected rejection vs. expected acceptance

* A significant increase in theta power was observed when participants received unexpected social rejection feedback.
* Source modeling of theta power revealed a frontally distributed neural network, which was most active during the processing of unexpected social rejection feedback.
* Statistical comparison between the unexpected rejection (YN) vs expected acceptance (YY) conditions revealed a significant increase of activation in the medial prefrontal cortex, insula and superior temporal gyrus.

Conclusion

* Midfrontal theta oscillations respond significantly to processing of social rejection feedback, but only when this feedback is unexpected.

* Theta power during social evaluative feedback processing is not associated with individual differences in psychological constructs typically related to social evaluative distress.

* Beta power during social evaluative feedback anticipation is a putative neural marker of depression.

References

(1) Cristofori et al. (2013). Theta as the neural signature of social exclusion. Cerebral Cortex, 23, 2437-2447.

(2) Van Noordt et al. (2014). Social exclusion modulates event-related frontal theta and tracks ostracism in children. Neuroimage, 118, 248-255.

(3) Somerville et al. (2006). Anterior cingulate cortex responds differently to expectancy violation and social rejection. Nature Neuroscience, 9, 1007-1008.

(4) Van der Molen et al. (2014). Fear of negative evaluation modulates electrocortical and behavioral responses when anticipating social evaluative feedback. Frontiers in Human Neuroscience, 7, 936.

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