Beta and Alpha Wave Oscillations Distinguish Between Dynamic Actions of Initiating and Terminating Eye-Contact with a Real Partner

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Introduction

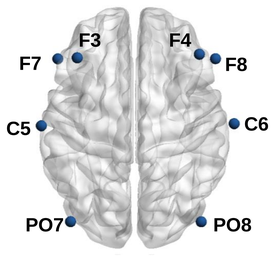
During interpersonal communication, eye-to-eye contact is often defined as the dynamic switch of eye-to-eye contact. Dynamic eye-to-eye contact has not been well studied with EEG due to the fact that eye motion related signals, such as eye blink and EOG artifacts, dominate and obscure the social communication related signal. Using hemodynamic signals acquired with Functional Near-Infrared Spectroscopy (fNIRS), we have recently reported that real eye-to-eye contact relative to gaze at the eyes in a picture of a face is associated with dedicated neural systems that signal live interactions[1]. EEG has been employed measuring the effect of eye contact [2,3]. Here we employ EEG to further probe the early neural events related to initiating and terminating live eye-to-eye contact by the partner.

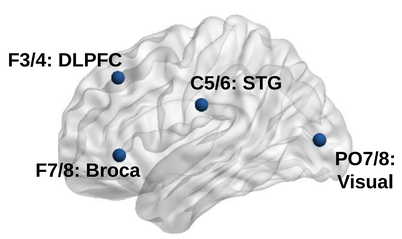
We compared oscillation bands of EEG signals for the two types of eye-to-eye contact events: 1) Onset (partner initiates eye contact), and 2) Offset (partner terminates eye contact). In both cases, the EEG signals were recorded without eye movement related artifact because the subject's eye remained stationary. We tested the hypothesis that these two event types are distinguished by frequency bands within the first second.

Methods

Subjects: Twenty-six adults (13 pairs, 22+/- 6 years old, 15% female, 100% right-handed[2] participated in the study. EEG data were obtained at Meiji University, Kawasaki, Japan. Four pairs were mixed gender and nine pairs were male-male. Two subjects were removed from analysis due to noisy EEG data, resulting in an effective 24 subjects.

EEG Acquisition: EEG recordings were obtained at a sample rate of 256 Hz from electrode positions at F3, F4, F7, F8, C3, C6, PO7, and PO8 according to the 10-20 standard EEG layout as shown in BrainNet viewer.





Frequency Bands and Artifact removal: EEG data were separated into frequency bands prior to analysis. Eye blink were removed from the raw EEG data using the ICA algorithm from EEGLAB. The frequency band data were first rectified before the event triggered average.

Delta	Theta	Alpha	Beta	Gamma
1-4 Hz	4-8 Hz	8-13 Hz	13-30 Hz	30-40 Hz

Table 1. Frequency band ranges.

Task: The task paradigm cued dyads to look at either the partner's eye ('eye' task) or at a fixation placed ten degrees to the side ('avert' task). With ear phones, Two subjects received separate audio commands of "eye" or "away" independent of each other. The inter-event interval was 1s or 1.8s. The experiment was divided into twelve 20-second blocks with 12s active period and 8 second rest period.

Dyad dynamic events: We analyzed trials in which a subject had a fixed eye gaze while the partner either initiated or withdraw eye contact. Since the design is random, the observer could not anticipate the gaze change of the partner.

Results

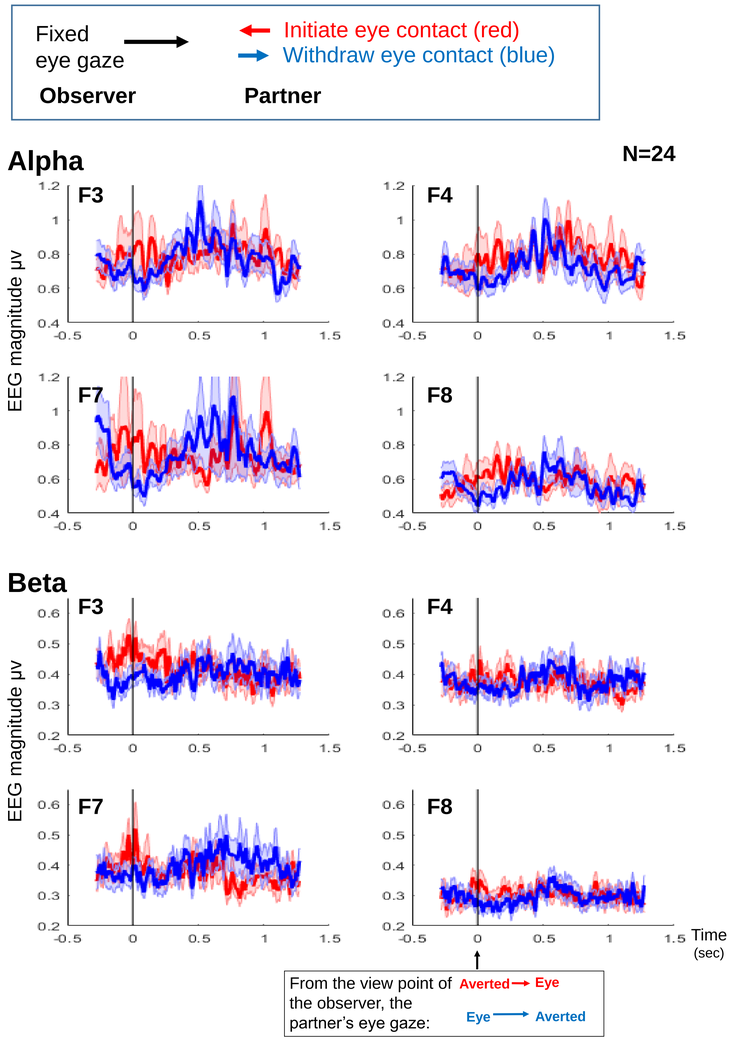


Figure 1. Mean and standard error of rectified EEG alpha/beta band signals. The y axis labels the electrodes.

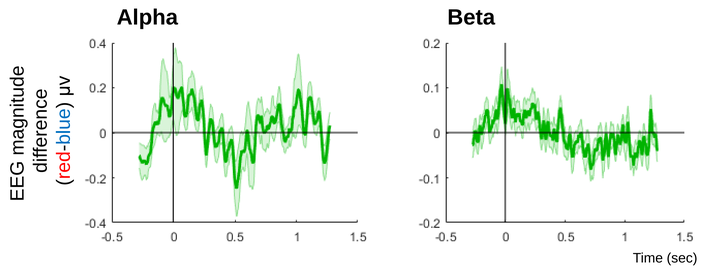


Figure 2. Mean and standard error of rectified EEG alpha and beta band signals. The difference between the eye contact onset events and the eye contact offset events (see Figure 1). Averaged across F3,F4,F7,F8 channels.

Conclusions

Here, with higher temporal specificity, our preliminary data suggest that frontal beta wave, as well as alpha wave oscillations, differentiates initiating and withdrawing eye contact events of the partner. These may represent early components of the social brain system.

References

1. Joy Hirsch, Xian Zhang, J. Adam Noah, Yumie Ono, Frontal temporal and parietal systems synchronize within and across brains during live eye-to-eye contact, In NeuroImage, Volume 157, 2017, Pages 314-330
2. Gale, A., Spratt, G., et.al. (1975) EEG Correlates of eye contact and interpersonal distance. Biological Psychology. Dec;3(4):237-45
3. Hietanen, J., Leppanen, J., et al.. (2008) Seeing direct and averted gaze activates the approach-avoidance motivational brain systems. Neuropsychologia, 46(9):2423-30.

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