Differences in oscillatory EEG activity distribution associated with depression

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Poster # 844.5, Y15, Wed-PM
Society for Neuroscience, 2008, Washington D.C.

OBJECTIVES

1. Decompose EEG data from 302 subjects comprising subjects with major depressive disorder (MDD), previous episode(s) of MDD or non-depressed controls.

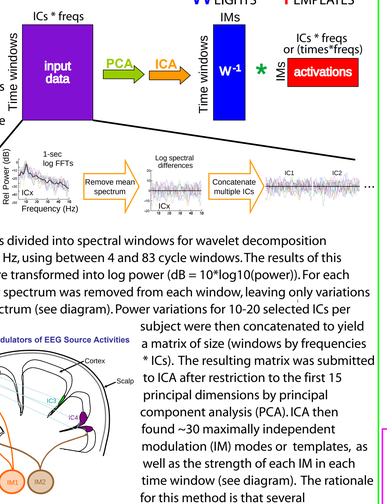
2. Identify independent modulators of spectral power that vary in spatial distribution betwen depressed and non-depressed subjects.

METHODS

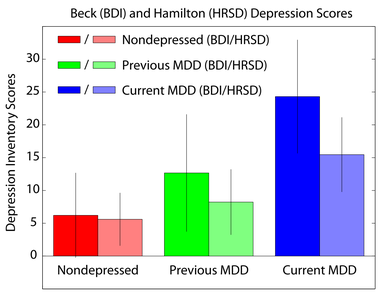
SUBJECTS AND TASK.
The 302 subjects were recruited, with approval from the local institutional human subjects review board, from all introductory psychology classes at the University of Arizona, Tucson. All students completed a Beck Depression Inventory (BDI) mass survey and selected subjects were then interviewed using the Structured Clinical Interview for the DSM-IV (SCID) and the Hamilton Depression Ratings Scale (HRSD). Those students who qualified were invited to participate in the EEG experiment which included coming to the laboratory on four separate occasions, being fitted with 64 scalp electrodes and sitting for approximately 30 minutes for the EEG recording. Resting EEG was recorded for 16 total minutes, alternating between **eyes open and closed** in one of two counterbalanced orders. Between the 8-min blocks of resting eyes open/closed, subjects performed a **directed facial action** task wherein contraction of specified facial muscles was described to subjects and their task was to mimic these contractions as closely as possible and hold the expression for 1 minute. Subjects were informed that the contractions were meant to help the experimenters understand the impact of muscle contraction on EEG recordings, but in fact each facial contraction was **characteristic of a particular emotion** (happiness, sadness, fear or anger) and the true intention of the task was to determine whether depressed subjects responded differently to the known feedback effects of posed emotional facial expressions.

All subjects were interviewed by a trained rater and classified, based on current DSM-IV criteria, either as **currently depressed, previously depressed**, or **free of past or present depression**. The Hamilton Rating Scale for Depression (**HRSD**) and the **BDI_II** were administered on the intake day.

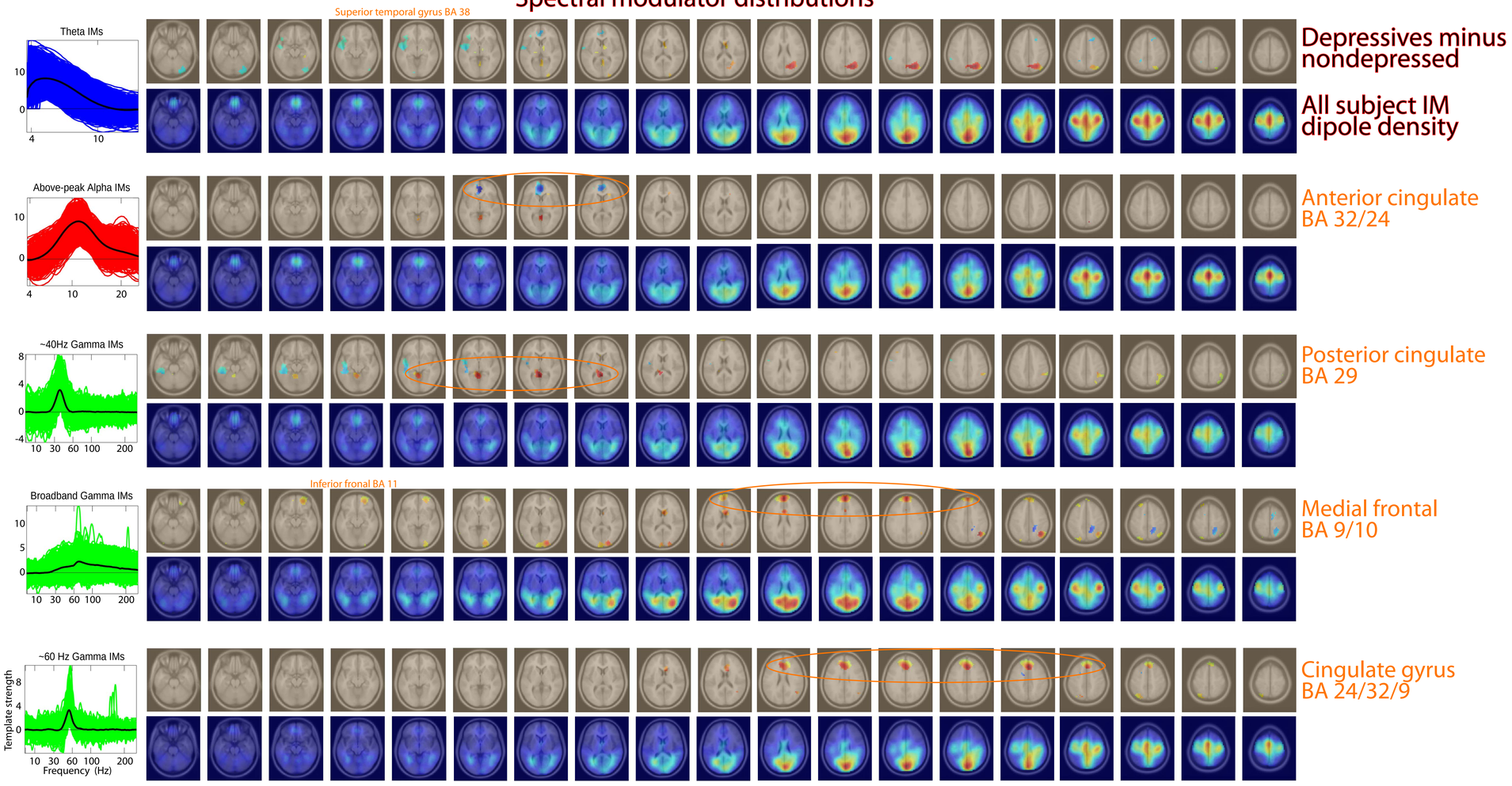
EEG ANALYSIS.
The data over all conditions were decomposed with independent component analysis (ICA) to find independent source activations with associated scalp projections. Data for each brain-derived independent component (IC) was divided into spectral windows for wavelet decomposition between 3 and 250 Hz, using between 4 and 83 cycle windows. The results of this decomposition were transformed into log power (dB = 10*log10(power)). For each IC, the mean power spectrum was removed from each window, leaving only variations from the mean spectrum (see diagram). Power variations for 10-20 selected ICs per subject were then concatenated to yield a matrix of size (windows by frequencies * ICs). The resulting matrix was submitted to ICA after restriction to the first 15 principal dimensions by principal component analysis (PCA). ICA then found ~30 maximally independent modulation (IM) modes or templates, as well as the strength of each IM in each time window (see diagram). The rationale for this method is that several multiplicative process influences (independent modulators) may be able to affect the activity spectra one or more cortical areas simultaneously (see diagram).



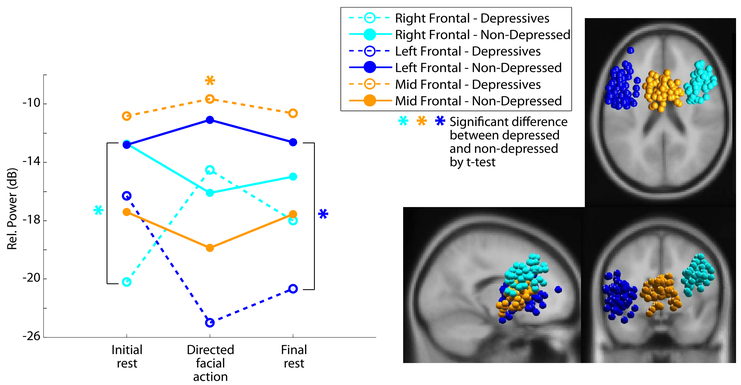
DEPRESSION SCORES



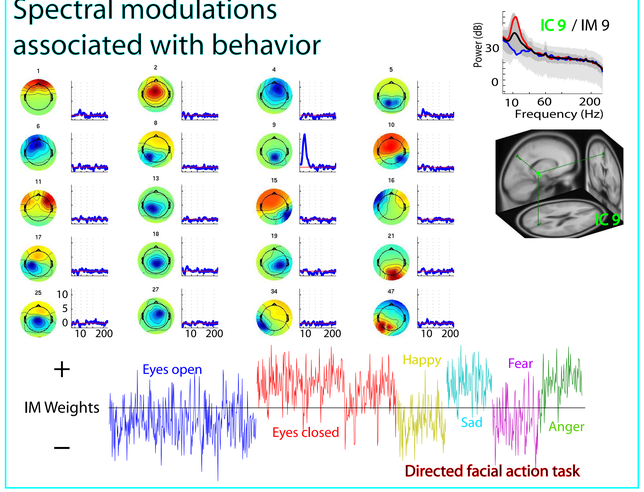
Spectral modulator distributions



Peak alpha magnitude differences across conditions and clinical groups



Spectral modulations associated with behavior



SUMMARY

1. ICA decompositions did not show any systematic differences in IC (EEG source) distribution between depressed and non-depressed subjects.

2. Spectral decomposition of IC activations revealed significant spatial differences in several frequency modulators including theta, alpha and gamma in depressed subjects.

3. Peak alpha magnitude changed by experimental condition showing that depressed subjects were more likely to show a decrease in left frontal alpha and an increase in right frontal alpha over the course of the session (less depressed??)