Premenstrual Distress and Frontal Alpha EEG Asymmetry

Eynav Elgavish, Dara Halpern, & John J.B. Allen
University of Arizona

Abstract

Trait and state frontal EEG asymmetry were assessed in healthy college women as a function of menstrual phase, to determine whether resting or state-elicited changes in asymmetry differentiate women high versus low in menstrual-related distress. Frontal EEG asymmetry was recorded at rest and during affective picture viewing, once during luteal and once during follicular phases, in counterbalanced order. EEG Alpha band power was derived in 11 homologous scalp electrode pairs from 23 right handed female participants, 12 highly variable in mood according to scores on the Menstrual Distress Questionnaire, and 11 female controls. Women reporting low premenstrual distress exhibited greater relative left frontal activity at rest than women high in premenstrual distress, ($p<0.05$), an effect that was not qualified by reference scheme nor phase of cycle (follicular versus luteal). State frontal EEG asymmetry as a function of picture valence revealed no effects of interest, including no modulation as a function of picture valence. This pattern replicated across two analyses: one set including all pictures based on normative ratings, and the other set only pictures where subjects rated the pictures consistent with normative ratings. This failure to find EEG changes as a function of picture valence replicates prior work in the lab.

The finding that relatively less left trait frontal activity characterizes those high in menstrual distress is consistent with a diathesis-stress model for menstrual-related dysphoria.

Introduction & Background

- Resting frontal EEG asymmetry has been hypothesized to relate to approach-related and withdrawal-related emotion and motivation (Coan & Allen, 2004; Davidson 1993, 1998):
  - left anterior cortical region is hypothesized to be part of a neural system that promotes positive emotions and approach-directed motivation to attractive cues and appetitive goals.
  - right anterior region is hypothesized to be part of a neural system that facilitates negative emotions and withdrawal-directed responses to aversive or threatening stimuli.
- Individual differences in resting frontal brain asymmetry predict subsequent emotional responses (Wheeler et. al., 1993, & Fox and Davidson, 1988), and possibly risk for psychopathology (Henriques and Davidson, 1991 and 1990; Allen et al., 1993; & Gotlib et al., 1998).
- There is a growing area of research on estrogen's effect on frontal brain asymmetry; however, this research has mostly been conducted in non-human animals.
- There exists a small body of research on sex differences in EEG asymmetry and another small body of research on the effect of hormones on the EEG activity of women, with a focus on the relationship between anxiety, psychophysiological variables and the menstrual cycle in healthy women.
- Studies of the effects of hormones on EEG, however, did not examine frontal brain asymmetry. One study did focus on the use of positive, negative and neutral pictures during different phases of the menstrual cycle as event related potentials (ERPs) were recorded. They found that the pleasantness of all pictures was rated highest during the estrogen phase of the cycle (follicular phase), which supports the use of these pictures in the current study.
- A study conducted by Baehr, Rosenfeld, Miller, & Baehr (2004) observed two monthly cycles for five women diagnosed as having Premenstrual Dysphoric Disorder (PMDD) and one monthly cycle for five non-PMDD control subjects. Asymmetry percent scores for the five PMDD women, and for the five control subjects before and after the Luteal phase were typically within the normal non-depressed range, however the asymmetry scores for the PMDD group fell into the negative range during the Luteal period while the control subjects remained stable

Present Study

- The present study sought to integrate these literatures, by assessing whether resting and state-elicited frontal EEG asymmetry differentiates subjects high in menstrual-related dysphoric mood from those low in such menstrual-related distress.
- Present Study Questions:
- Does resting frontal electroencephalography (EEG) asymmetry vary as a function of menstrual cycle and self-reported premenstrual mood variability?
- Do phase of cycle and menstrual distress status interact to influence valence and arousal ratings of pictures?

Procedure

- Participants: 12 right handed high distress participants and 11 right handed controls.
- Selection Criteria: (a) extreme scores on the MDQ Negative Affect Scale. (b) No use of psychotropic medications; (c) No chart diagnosis of a psychological disorder and/or disorders affecting the nervous system
- Menstrual cycle phase ascertained by determining current phase of cycle, by counting backwards from the first day of the next menses
- Two visits to the lab, one late luteal, one follicular:
- Physiological recording (EEG)
- Picture presentation (IAPS): 30 Pictures in randomized order, 10 positive, 10 neutral and 10 negative.

Sample IAPS Pictures

Pleasant

Neutral

Unpleasant

Methods

- ❑Resting and task-related (IAPS viewing) EEG alpha power asymmetry scores were derived from 11 homologous scalp electrode pairs
- ❑Files screened for artifacts (98% inter-rater agreement)
- ❑Power extracted by FFT, based on overlapping two-second epochs (resting) or one-second epochs (IAPS)
- ❑Asymmetry = Ln(Right)-Ln(Left) Alpha (8-13 Hz) Power.
- ❑Data averaged by condition: Resting, and for IAPS, pleasant, unpleasant, neutral
- ❑ Data analyzed for each of 3 reference schemes (CZ, LM, AR)

Results Q & A

Question: Does resting frontal EEG asymmetry vary as a function of menstrual cycle and self-reported menstrual-related mood variability?

Answer: Yes, with respect to self-reported menstrual-related mood variability, but not with respect to phase of menstrual cycle.

- ❑Asymmetry scores at three frontal regions and one anterior temporal region were examined in a 4 (Region: F78, F34, FTC12, T34) by 2 (Menstrual Phase) by 2 (Menstrual Distress Group) by 3 (reference scheme) mixed-model repeated measures analysis of variance
- ❑A main effect of group F (1, 21) = 4.4, p<0.05 was qualified by interaction with region F (3,19) = 3.5, p<0.05, revealing that although high distress subjects had relatively less left frontal activity, the effect was especially pronounced at FTC and anterior temporal sites (Figure 1).
- ❑The effect was consistent across all reference schemes, however, there was no interaction with phase.

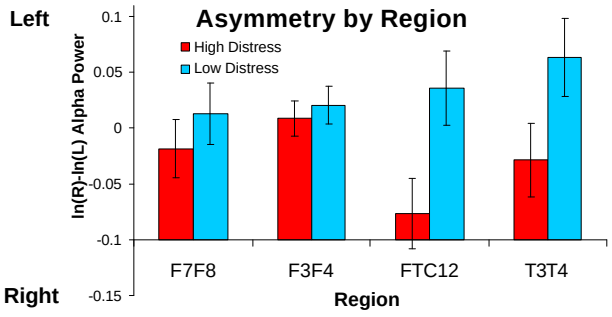


Figure 1: EEG asymmetry at four frontal regions, collapsed across phase and reference scheme. Women reporting low distress have higher trait relative left frontal activity. Higher asymmetry scores (ln(R) – ln(L) alpha) reflect greater relative left activity, as less alpha is assumed to reflect greater activity. Groups differ significantly at the FTC region (p<.03) and there is a trend (p < .07) for the groups to differ at the anterior temporal region.

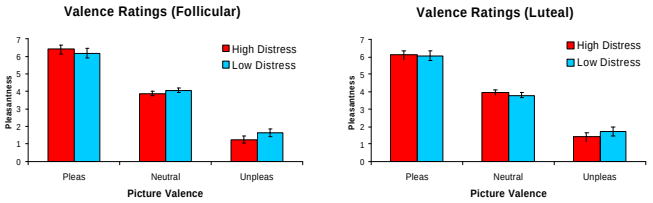
Copy Available at: http://apsychoserver.psych.arizona.edu

Question: Do phase of cycle and menstrual distress status interact to influence valence and arousal ratings of pictures?

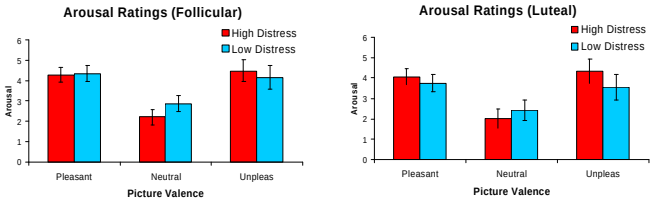
Answer: No. A 2 (Menstrual Distress Group) by 3 (Picture Type) by 2 (Menstrual Phase) ANOVA for both valence ratings and arousal ratings revealed only a significant effect of Picture Type, generally in the absence of any effects involving Menstrual Phase or Menstrual Distress Group.

- ❑ Main effect of Picture type on Valence ratings (F[2,20]=158.1, p<.001)
- ❑ Main effect of Picture type on Arousal ratings (F[2,20]=24.7, p<.001)
- ❑ There was, however, a main effect of phase on arousal ratings, F(1,21)=5.1, p<.05, indicating that across picture type and across groups, pictures were rated as more arousing during the follicular phase.

Valence



Arousal



Discussion

Women reporting low distress exhibited greater relative left frontal-temporal activity at rest than women high in premenstrual distress, (p<0.05), an effect that was not qualified by reference scheme nor phase of cycle (follicular versus luteal).

- ❑ The finding that relatively less left trait frontal activity characterizes those high in menstrual distress is consistent with a diathesis-stress model for menstrual-related dysphoria.
- ❑ Thus in addition to evidence suggesting relatively less left frontal activity is a risk factor for depression, it may serve as a diathesis for a broader range of dysphoric mood including that of menstrual related dysphoria .
- ❑ The fact that IAPS ratings do not differ as a function of phase or MDQ status suggests that menstrual related dysphoria is manifest in areas other than the ratings of pictoral stimuli.

In contrast to Baehr et. al., we systematically assessed menstrual phase in all subjects, including controls. No subjects were on medication, and we had a larger sample size. A benefit of their study was the inclusion of a PMDD diagnosis for all subjects. It is unclear how many of our subjects would have met PMDD diagnostic criteria.

Future studies might profitably assess estrogen levels, sample more than one cycle, clinically diagnose PMDD subjects, include a larger sample, and expand recruitment to include women with and without major depressive disorder.