EEG-BASED NEURAL VARIABILITY AND INHIBITORY CONTROL ACROSS THE MENSTRUAL CYCLE: A HORMONE-VALIDATED LONGITUDINAL STUDY

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Growing evidence in neuroimaging studies increasingly indicates that interactions between women's sex hormones and neural processes such as excitation–inhibition balance, emotional processing, and cognition vary across the menstrual cycle. One proposed mechanism involves allopregnanolone, a neuroactive metabolite of progesterone that acts as a potent modulator of the GABAergic system. Allopregnanolone enhances inhibitory neurotransmission and reduces neural excitability, potentially contributing to variability in cognitive control across the menstrual cycle. However, there is still a lack of densely sampled longitudinal data that would reveal the dynamics of electrophysiological parameters across the menstrual cycle, largely due to limited temporal sampling and insufficient hormonal confirmation.

This study implements a high-resolution longitudinal case design to examine phase-dependent variability in neural activity and inhibitory control across the menstrual cycle in a healthy woman. Data were collected at six time points: early and late follicular phases, ovulation and early, mid, and late luteal menstrual phases. Salivary samples were obtained at each session to quantify progesterone concentrations and enable more precise identification of luteal phase timing in the menstrual cycle.

Resting-state electroencephalogram (EEG) was recorded with eyes open and closed, to analyse alpha-band activity and the aperiodic slope as markers of global neural activity and excitation–inhibition balance. Inhibitory control and attentional processes were assessed using a Go/No-Go paradigm measuring response inhibition and reaction times (RT). Additionally, the Barratt Impulsiveness Scale (BIS-11) and the Well-Being Questionnaire (WBQ) were administered during the early follicular and late luteal phases. The late luteal phase is commonly associated with premenstrual symptoms and rapid progesterone changes, whereas the early follicular phase is typically linked to symptom attenuation and improved subjective well-being.

By combining dense temporal sampling with hormonal validation and multimodal neurobehavioral assessment, this study provides a fine-grained characterization of within-person variability across the menstrual cycle.