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Integrating the Impacts of Ovarian Hormones on Brain and Behavior: Implications for Women's Wellbeing

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Abstract

Hormones exert significant control over brain functions. Hormonal fluctuations during the menstrual cycle are one of the most systematic and recurring changes experienced by half of human populations. However, findings on the impacts of these hormones are disconnected and often contradictory. This may be due to differences in methodologies, the opposite pattern of fluctuations in these hormones, their widespread neuronal effects, and brain homeostatic mechanisms. To overcome these shortcomings, this review combines findings across synaptic and cellular, systems, cognitive, behavioral, social level to examine how hormonal changes affect the nervous system and behavior more holistically. To that end, it also investigates the effect of exogenous hormone exposure caused by contraceptive usage, which disturbs the interdependent fluctuations. This analysis reveals that estradiol and progesterone have strong effects at the cellular and systems levels, but the impacts on cognition and behavior are inconsistent and limited, partially due to the brain's homeostatic mechanisms and counteractive effects of the two hormones. As a result, behavioral stability should be considered separately when interpreting hormonal effects. This idea is further

supported by studies showing clear effects of contraceptives on cognition and behavior. These findings highlight the importance of integrative approaches in investigating hormonal effects on the brain and can be used to fight against the dogma that the menstrual cycle and hormonal changes extensively affect behavior. Future research should combine hormone measurements, neuroimaging techniques, and behavioral testing across the cycle to better understand the above interactions and provide a clinical perspective for hormonal health.

Keywords: ovarian hormones, menstrual cycle neuroscience, brain homeostasis, hormonal contraceptives

Introduction

The menstrual cycle acts as a biological indicator for how sex hormones influence the brain and behavior. Over the 28-days period, fluctuations in ovarian hormones, primarily estradiol and progesterone, affect not only physiology but also the brain's functional connectivity, cognition, and emotions. Considering that nearly half of the population experience these fluctuations regularly for half of their life, it is essential to explore neural and behavioral changes due to the menstrual cycle. Moreover, understanding how the menstrual cycle and hormones interact with the neuronal elements in the brain contributes to insights in neuroscience and women's health more generally.

Understanding the influences of the menstrual cycles on the brain is very challenging because of the fact that sex hormones impact the nervous system across levels, from synaptic to cellular to systems. At the synaptic and cellular levels, estradiol and progesterone interact with neurotransmitters and alter receptor expression, synaptic plasticity, and neurogenesis

(Barth et al., 2015; Bendis et al., 2024). Critically, progesterone can balance estradiol's effects, showing the importance of hormonal balance (Baudry et al., 2013). At the systems level, neuroimaging studies have identified phase-dependent brain activity such that estradiol activates the hippocampus and progesterone activate the fronto-striatal region while reducing amygdala response (Pletzer et al., 2019; Derntl et al., 2008). Effects on cognition and behavior are mixed. Although some studies have demonstrated differences in spatial ability and emotion regulation, meta-analysis work have found no consistent differences across the phases (Hausmann et al., 2000; Wu et al., 2014; Jang et al., 2025). At the social level, hormonal fluctuations tend to influence affiliation and cooperation tendencies. (Anderl et al., 2015; Makhanova et al., 2025).

Together, these findings illustrate that ovarian hormones' influence extends from molecular signaling to social behaviors, shaping individuals' lives. However, understanding these impacts remains challenging because hormonal effects are multilayered, temporary, and dependent on context. To be more specific, estradiol and progesterone act through both genomic and neurotransmitter pathways that interact with each other and vary across brain regions. Importantly, during the late follicular and luteal phases, estradiol and progesterone show inverse fluctuations, where the former decreases sharply and the latter increases, making it difficult to determine the independent contribution of each hormone to the effects on neural systems. Moreover, the influence can be masked by environmental factors such as emotions, so identical hormonal changes may produce different outcomes across or within individuals. These strongly suggest that investigating the effect of hormones across levels requires integrative and complex methods.

However, most prior studies often isolate one level, either molecular, cognitive, or social, instead of looking at them as a whole. Moreover, methodologies for measuring the impacts are inconsistent across studies, as some rely on self-reported cycle phases rather than hormonal assays and the experimental paradigms used to measure cognitive abilities vary extensively. In addition, many studies have overlooked how cellular level differences affect behaviors, and solely focused on the molecular aspect. As a consequence, there is only partial understanding of how ovarian hormonal changes shape cognition and behavior. Finally, despite a few reviews trying to combine results across levels (Sundström Poromaa & Gingnell, 2014; Le et al., 2020), these analyses remain descriptive, focusing on summarizing hormonal effects within each level without connecting them.

To overcome these shortcomings and provide a comprehensive account of the menstrual cycles' influence on the brain and behavior, here I summarize and synthesize experimental findings across three neuronal levels, synaptic and cellular, systems, and connect them to behavioral, cognitive, and social findings about the impact of the menstrual cycle. Importantly, by integrating cellular mechanisms underlying the impacts of estradiol and progesterone with changes in functional connectivity and cognition, I clarify some of the observed inconsistencies and provide new insights.

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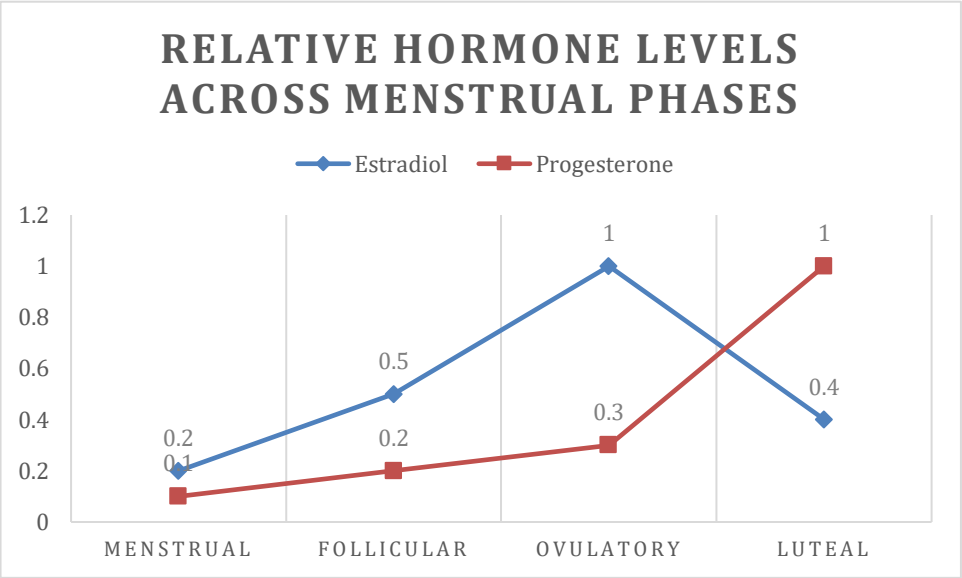
Figure 1.

Qualitative levels of two main hormones over different phases of the menstrual cycle (adopted from Reed & Carr, 2000). Plot shows the relative levels of estradiol and progesterone across the menstrual cycle (a.u.). Estradiol level gradually increases and peaks at ovulation, while progesterone level is low until the luteal phase.



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Synaptic and cellular mechanisms of estradiol and progesterone effects

At the most fundamental level, estradiol and progesterone affect neural signaling and plasticity through multiple receptor pathways. Both estradiol and progesterone act through genomic and non-genomic mechanisms. More specifically, estradiol uses classical nuclear estrogen receptors that alter gene transcription genomically, or membrane-bound receptors that initiate intracellular cascades non-genomically. Similarly, progesterone uses classical nuclear genomically receptors and a membrane protein non-genomically (Barth et al., 2015).

Beyond receptor signaling, the two hormones have widespread effects on neuromodulatory systems. Estradiol modulates serotonergic, dopaminergic, and glutamatergic transmission by altering receptor density, transporter expression, and synaptic efficacy (Bendis et al., 2024). Progesterone and its metabolites balance these effects by causing GABAergic inhibition, preventing hyperexcitability and anxiety. Such changes affect the balance between excitation and inhibition, especially in regions such as the hippocampus, amygdala, and prefrontal cortex, as reflected in ovarian hormone fluctuations causing measurable neural activity changes in these regions (Dubol et al., 2021). Together, these findings demonstrate that estradiol and progesterone coordinatively modulate the neurotransmitter pathways.

One of the most consistent cellular effects of estradiol is that it promotes synaptic plasticity and neurogenesis. Experimental and imaging studies reveal that estradiol increases dendritic spine density and synaptogenesis in hippocampal and prefrontal neurons, which contribute to learning and memory (Hara et al., 2015). In contrast, progesterone often acts as a counterpart that attenuates or reverses estradiol-induced synaptic growth. During the luteal phase, its conversion to allopregnanolone enhances the efficiency of GABA A subunit

receptors, which increases tonic inhibition and adjusts the threshold for neuron firing (Gilfarb & Leuner, 2022). This highlights the importance of estradiol–progesterone balance for maintaining synaptic stability and preventing overexcitability (Baudry et al., 2013).

Together, the findings reveal that estradiol and progesterone balance each other in regulating neural plasticity. Estradiol enhances excitatory transmission, synaptic growth, and network adaptability, while progesterone modulates inhibitory balance and structural consolidation. The interplay of the two hormones produces cyclical neural flexibility, linking molecular signaling to cognitive functions across the menstrual cycle. These cellular-level mechanisms provide a foundation for understanding systems level changes in connectivity.

Systems mechanisms of estradiol and progesterone effects

Estradiol and progesterone not only influence individual synapses, but also the coordination of neural networks across the menstrual cycle. In this way, the molecular mechanisms allow these hormones to control large-scale brain activation. Briefly at the systems level, ovarian hormones influence complex patterns of brain activation and connectivity in multiple regions that are related to memory, emotion, and cognition. Moreover, fluctuations in these hormones have been shown to cause a differential in brain activity measured by functional neuroimaging, particularly in the hippocampus, amygdala, and prefrontal cortex.

During the pre-ovulatory phase, when estradiol levels are the highest, neural activation in the hippocampal and fronto-parietal circuits are enhanced, which is associated with improved performance on learning and memory tasks (Pletzer et al., 2019). These findings are consistent with those at the synaptic level, showing that estradiol increases dendritic spine

density and excitatory transmission. In contrast, during the luteal phase, when progesterone levels are the highest, the fronto-striatal networks are activated, enabling improved behavioral regulation and executive control (Hidalgo-Lopez & Pletzer, 2021). Such complementary patterns suggest that estradiol and progesterone cause cyclical transitions of neural flexibility and stability.

The amygdala, a region responsible for processing emotions and threats, is particularly sensitive to hormonal changes. During the follicular phase with low progesterone level, activation of the amygdala is typically stronger, and gradually decreases as progesterone levels increase, revealing that progesterone has an inhibitory effect on emotions (Derntl et al., 2008), which aligns with evidence in the synaptic level that progesterone enhances GABAergic inhibition. Interestingly, it has been shown that individuals with primary dysmenorrhea, which show structural and functional abnormalities in the amygdala, respond differently to hormonal changes (Yang et al., 2019). Similarly, estradiol enhances limbic-frontal coupling during positive emotion processing, suggesting that hormonal influences on the amygdala-prefrontal network is related to emotional regulation. Moreover, symptoms such as premenstrual dysphoric disorder results in atypical sensitivity to GABA A sub active neurosteroids during the late luteal phase, which alters brain responses to emotions (Stiernman et al., 2023) The impact of above hormones on amygdala could be due to different subtypes of GABA A receptors, even though the exact influence of these subtypes are unknown. For example, subtypes containing the alpha-2 and alpha-1 subunits, which modulate anxiety and fear conditioning respectively, are present in high amounts in the amygdala and play major roles in regulating inhibition and emotional behavior (Lehner et al., 2010; Wiltgen et al., 2009).

Beyond local brain area activation, estradiol and progesterone also influence functional connectivity. For example, resting-state fMRI studies have shown that these hormones modulate the variability, integration, and complexity of major networks such as the default mode, salience, and executive control networks (Avila-Varela et al., 2024). Elevated estradiol levels are related to increased connectivity in memory and introspective networks, whereas high progesterone levels enhance coupling in attention and emotional stability circuits (Hidalgo-Lopez et al., 2021). Consistent effects have been found at the synaptic level, as estradiol increases glutamatergic plasticity and progesterone enhances tonic inhibition. Nevertheless, there are studies showing no significant changes in hippocampal connectivity across the menstrual cycle, while emphasizing substantial individual variability at resting state (Hidalgo-Lopez et al., 2020).

Together, these findings suggest that estradiol and progesterone act as regulators of large brain networks, partially through molecular and cellular mechanisms described earlier. The former enhances network integration, cognition, and memory, while the later strengthens inhibitory control and emotional regulation. This ensures the brain's plasticity and consolidation at the same time. The aforementioned findings on the system-level changes provide the foundation to investigate the behavioral and cognitive levels.

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Behavioral and Cognitive mechanisms of estradiol and progesterone effects

Many studies have found that fluctuations in ovarian hormones influence performance on cognitive tasks, such as memory, spatial ability, and emotion regulation. Nonetheless, in addition to individual variability, it is difficult to connect molecular, cellular, and systems-level effects of hormones to general cognitive performance. This is mainly because most studies on the impact of menstrual cycles on cognition did not involve brain imaging.

In terms of visuospatial ability, an early study, which did not measure the levels of estradiol and progesterone, found a phase difference on the mental rotation test, where participants visualize three-dimensional objects and determine whether the rotated shapes are identical (Hausmann et al., 2000). Participants in this task exhibited higher scores during the menstrual phase and lower scores during the mid-luteal phase. Considering the dynamics of estradiol and progesterone levels in these two phases, the findings suggest that progesterone could negatively contribute to visuospatial ability. The results are consistent with progesterone's inhibitory effect on GABAergic transmission in the synaptic level.

Another study found the same pattern in implicit motor imagery using the hand laterality judgement task in which participants decide whether a rotated hand is left or right. Participants performed better in the follicular and luteal phases compared to the menstrual phase, such that higher estradiol levels were associated with better cognitive performance (Faustino Lacerda de Souza et al., 2022). Less task-specific studies have reported mixed findings on cognitive, sensory, and emotional functions across the menstrual cycle in females of childbearing age, especially for those with PMS (Farage et al., 2008), while others have

shown no difference in visuospatial or verbal sequential ability during the menstrual cycle (Gordon & Lee, 1993).

The inconsistency of these effects is well-captured by a few meta-analyses. One study reviewed a large body of research and concluded that current evidence does not support the idea that cognitive abilities fluctuate with hormones across the menstrual cycle (Jang et al., 2025). This suggests that the effects of estradiol and progesterone may be limited within small brain regions, or they may be different among individuals. Despite evidence supporting estradiol and progesterone modulation of neural circuits and different brain regions that influence learning, memory, and emotions, these effects might not directly turn into behavior changes.

Possible explanations for the stability of cognitive performance despite significant hormonal changes are homeostasis mechanisms or opposite effects of hormones on different brain areas involved in cognition. Another potential factor affecting cognitive performance is the changes in work load under hormonal fluctuations. During the mid-luteal phase, a recent study has shown that lower workload enhances cognitive performance, suggesting that progesterone may improve performance in easy tasks but not so consistently under high work load (Xu et al., 2022). These results highlight the notion that hormone effects at the social and behavioral level are dependent on the context of tasks.

Moreover, there are experimental works that investigate how estradiol and progesterone influence emotion regulation and recognition with mixed results. For example, one study reported that women generally show reduced effectiveness in emotion regulation success during the menstrual phase, revealing that the hormones influence emotional outcome (Wu et

al., 2014). Another study found that women with lower difficulty in emotion regulation showed greater control over anxiety during the late luteal phase (Manikandan et al., 2016), complementing the idea that individual differences should be taken into account when considering the effect of progesterone.

Together, findings at behavioral and cognitive levels seem contradictory. Some studies prove that progesterone is positively correlated with better cognitive performance, while others find evidence for the opposite or no effects at all. Estradiol shows similar patterns, enhancing motor imagery but has no significant influence on spatial ability. The variability may be due to substantial individual differences and inconsistent methods especially in terms of task difficulty and cognitive work load. As a result, behavioral measures alone may hide the mechanisms by which hormones impact the brain, which can be improved by using integrative approaches across levels.

Social mechanisms of estradiol and progesterone effects

Social behaviors such as cooperation, trust, attraction, and affiliation are often context-dependent, influenced by hormones, individual variability, and environmental cues. With regards to menstrual cycle, ovarian hormone fluctuations shape social behavior including the interpretation of social cues and cooperative preference. However, similar to effects on cognition, there is a shortage of studies that employed brain imaging to find possible relationship between social behavior and low-level neuronal effects of hormones. Another challenge is that some social behaviors show different changes across the menstrual phases, but others are relatively stable.

Overall, emotion recognition abilities remain largely stable in all phases of the menstrual cycle. For example, a study by Rafiee et al.(2023) found no significant differences in accuracy or sensitivity when they asked female participants to identify facial expressions in the late follicular or mid-luteal phases. Another but larger behavioral study also reported no change in emotion recognition ability across the menstrual cycle, regardless of the measuring method or displayed emotion type (Pletzer & Noachtar, 2023). Interestingly, a study that utilized economic games to measure trust, found that women were more cautious during the pre-ovulatory phase, such that the trust level in attractive male decreased as estradiol levels increased (Ball et al., 2013). Meanwhile, increased progesterone level from the menstrual to the mid-luteal phase was positively correlated with trust in unattractive female partners. These results demonstrate that estradiol and progesterone shape social behavior distinctively. Moreover, although hormones influence emotion processing at the systems level and impact trust behavior, some other social behaviors such as emotion recognition are not affected.

In contrast, there are studies that more clearly demonstrate social attraction and perception can be affected by the menstrual cycle. For example, it has been shown that during the follicular phase, women exhibit a stronger preference for males displaying social dominance (Senior et al., 2007). In addition, women not only judge social cues passively, but also influence social hierarchies passively by allocating higher status to dominant males.

Ovarian hormone fluctuations also influence cooperative decision-making and affiliative motivation. For example, studies on social value orientation (SVO) have found that women show more cooperative preference in the early follicular phase compared to the mid luteal phase (Anderl et al., 2015). This suggests a negatively correlated relationship between

estradiol and SVO scores. Other studies have found that, during the luteal phase, as progesterone level rises, the affiliative motivation to cooperate also tends to increase (Makhanova et al., 2025). These findings reveal opposing effects of estradiol and progesterone on social bonding.

The stability in emotion recognition can be attributed to certain synaptic and systems level mechanisms, through which estradiol and progesterone balance inhibitory and excitatory effects in the amygdala and moreover, modulate the functional connectivity across networks. This stability also aligns with the observed cognitive stability despite changes in the corresponding neural circuits. This is further supported by evidence from a neuroimaging study demonstrating that the menstrual cycle changes amygdala and prefrontal activation while leaving emotion recognition accuracy unchanged (Wang et al., 2017). Therefore, although estradiol and progesterone have significant measurable effects on some cognitive functions and social behaviors, the influences are limited, unlike the broad effects of these hormones at the cellular and systems level.

Figure 2.

Impacts of estradiol and progesterone across neuronal levels from synaptic to cellular to circuit and systems to behavior. Each circle represents different mechanisms at a given level; orange indicates the effect of estradiol and green indicates the effect of progesterone. At the synaptic level, estradiol improves synaptic plasticity and excitatory transmission, while progesterone prevents over-excitability in the neural networks. At the systems level, estradiol enhances network integration, increases information flow, and increases memory formation,

while progesterone stabilizes the networks and reduces amygdala reactivity. The two hormones jointly control emotion regulation and social behavior.

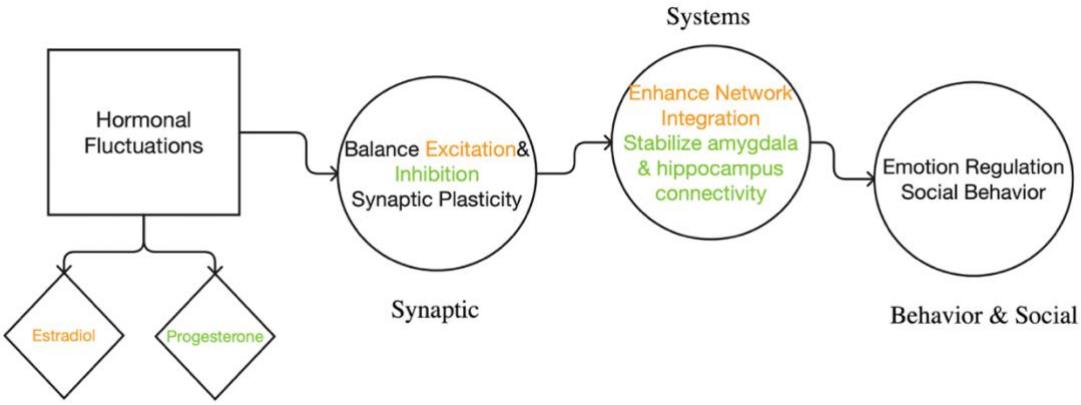

Figure 3.

Qualitative relative strength of estradiol and progesterone effects across neuronal levels, based on studies reviewed here. Overall, the effects of hormones seem to be smaller at higher levels.

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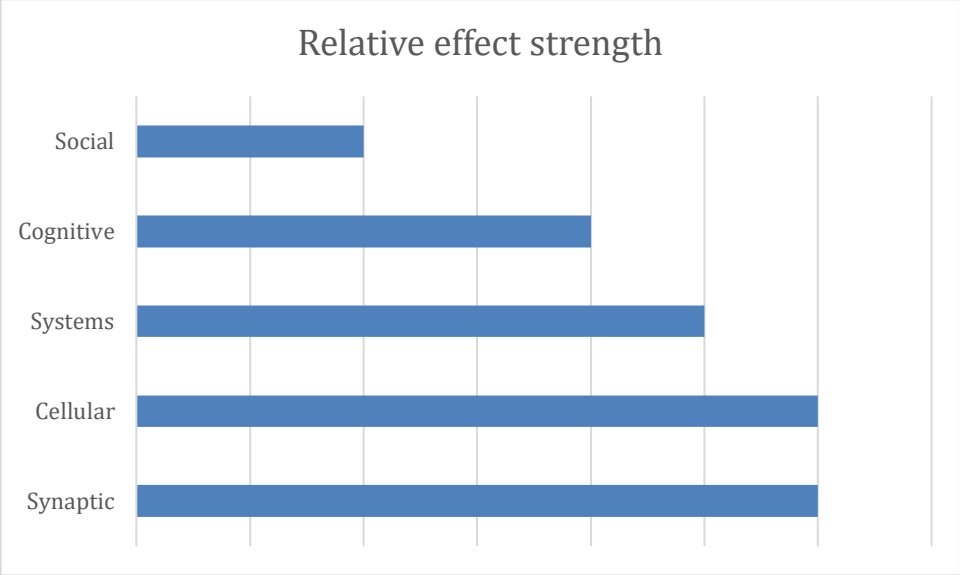

Interactions with Medications and Drugs

Hormonal contraceptives (HCs) can alter ovarian hormones and their neurosteroids derivatives, causing significant changes in brain activity. By understanding this influence from cellular to behavior levels, insights on how estradiol, progesterone, and the brain are affected by environmental factors can be gained. A review on the impacts of HCs on the brain concluded that HCs alter synaptic plasticity, stress and emotion circuits, and cognitive processes, depending on timing of medication and individual sensitivity to medication (Lacasse et al., 2024). Another recent review suggests that the effects can be understood as the combination of suppressed endogenous cycles and chronic exogenous hormone exposure. This is because exogenous hormones result in suppression of the hormone production cycle, which may significantly impact different neural circuits, controlling mood and cognition (Ashley & Tory, 2025).

At the systems level, resting-state fMRI studies have shown that HC usage can cause robust changes in the brain. For example, a study on 60 individuals found that oral

contraceptives reduced network modularity and system segregation, while altering the prevalence of specific neural circuits connectivity, specifically in dorsal attention, salience, and default-mode networks (Jensen et al., 2022). A placebo-controlled trial reported that oral contraceptive pills reduce the functional individuality of the brain, such that individual connectomes become more similar to each other while negative mood increases (Dolan, 2025). Moreover, an earlier work showed that the contraceptive pill users have reduced amygdala reactivity to negative emotional stimuli and dampened responsivity of threat circuits compared with naturally cycling women (Petersen & Cahill, 2015). Together, these studies demonstrate that the HCs can influence connectivity significantly in the amygdala and other neural networks, constraining the cyclical flexibility observed across the menstrual cycle (Max, 2024).

At the cognitive and behavioral level, HCs effects are specific rather than causing global changes. As mentioned above, some studies have reported changes in emotional memory and stress responsivity, but the effects are mixed or small on standard cognitive tasks, such as attention or visuospatial ability. A large-scale review shows that many contraceptives flatten the natural hormonal rhythms and cause blunting in mood and reward sensitivity fluctuations, which can be stabilizing for some individuals, but problematic for others (Lacasse et al., 2024).

Comparing above findings on the impacts of HC usage on cognitive and emotional performance with the lack of natural hormonal cycle impacts suggests that brain homeostasis mechanisms could be crucial in regulating the impacts of hormones on behavior and cognition.

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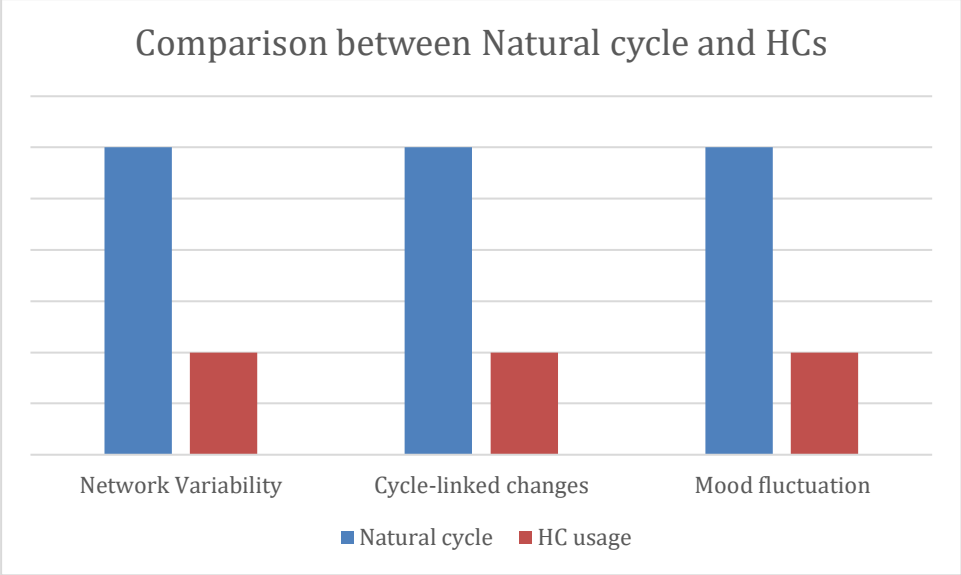
Figure 4

Qualitative estimation of network variability, cycle-induced changes, and mood fluctuations during natural and under HC usage, using findings from (Max, 2024) and (Jensen et al., 2022)



Conclusion

In order to provide a more unified account of how estradiol and progesterone, two main hormones involved in menstrual cycles, impact brain and behavior, here I review their impacts across synaptic, cellular, systems, behavior, and social levels. Our analysis reveals that, despite having strong significant influences on neuronal activity throughout the brain, estradiol and progesterone influences do not impact cognition and behavior consistently.

At the synaptic and cellular levels, estradiol promotes excitatory signaling whereas progesterone promotes inhibitory control, such that the two hormones balance each other. At the systems level, the hippocampal, fronto-striatal and amygdala connectivity are affected by

fluctuations of these hormones, suggesting that the two hormones regulate the flexibility and stability of the neural networks.

However, the behavioral and social levels show mixed findings. In some tasks, such as visuospatial working memory, performance was sensitive to hormonal changes, whereas in other tasks, such as emotion recognition, it remains stable across different menstrual phases. This pattern suggests that large neuronal changes caused by fluctuations of these hormones may not translate into consistent behavioral changes because of homeostatic and other mechanisms that differ across individuals. In addition, cognitive and social performance can be very sensitive to task difficulty. Importantly, both estradiol and progesterone levels change during late follicular and luteal phases, making it difficult to isolate a single hormone responsible for observed changes in a given phase. As a result, although the neural circuits are altered, only certain behaviors are affected and even so, those effects happen in a context-dependent manner.

The brain is able to generate stable behavior despite strong fluctuations in these two hormones perhaps because these hormones impact different brain systems in a concerted manner. This is supported by general findings on the effects of hormonal contraceptives where exogenous hormone administration causes suppression of endogenous hormones, affecting delicate balance between the two hormones, resulting in changes in brain networks and social behaviors. Interestingly, studies reviewed here suggest that although natural menstrual and hormonal cycles impact are more prominent at the synaptic, cellular, and system levels, the HC usage affects all neuronal levels and behavior robustly. These results also warrant greater awareness in clinical practice as such hormonal interventions can cause behavioral changes.

Moreover, better understanding of individual variability in contraceptive usage may allow more informed medical decision-making.

Caveats and shortcomings

Some important limitations should be considered in this review. First, although many reviewed studies describe the relationships between estradiol, progesterone, and neuronal or behavioral changes, these evidences are correlational rather than causal. The measured fluctuations in brain activity or behavior may not be directly caused by hormonal changes as many other variables change over the cycle independently of the hormones. For example, other factors such as stress, sleep, and context of tasks may influence the brain and result in the observed neural outcomes.

Second, there is a potential interpretive bias toward positive findings while negative results are often ignored and not published. Studies that found significant changes are often emphasized and used as evidence, while null results are attributed to individual variability and methodological limitation. This bias may exaggerate the possible links between hormonal changes and neuronal changes across levels. Therefore, greater attention should be paid to null results to find more accurate relationships.

Finally, despite our effort to connect findings across levels, the conclusions are limited by factors such as differences in experimental paradigms, hormone measurement methods, task designs, and the lack of quantitative data across levels. Considering the importance of menstrual cycle research for neuroscience and women's health, future studies should use more

quantitative and integrative approaches to understand the impacts of estradiol and progesterone on brain and behavior.

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Glossary

Synaptic and cellular level

Allopregnanolone: A metabolite that increases inhibitory control and reduces neural excitability.

Dendritic spine: A small protrusion on a dendrite.

Dopaminergic transmission: Neural signaling through dopamine that modulates attention and motivation through the front striatal circuits

Estradiol: The primary estrogen hormone that enhances excitatory transmission.

GABA A sub receptor: A receptor complex that regulates inhibitory neurotransmission.

GABAergic inhibition: Suppression of neural activity due to the release of neurotransmitter GABA.

Genomic mechanism: Pathways for the effects of hormone through alteration of gene transcription.

Glutamatergic transmission: Neural signaling through glutamate. It supports long-term potentiation and regulates the network excitability.

Hippocampus: A brain region critical in memory and learning.

Luteal phase: Post ovulation stage of the menstrual cycle.

Neurogenesis: Formation of new neurons in the developed brain.

Non-genomic mechanism: Pathway for the effects of hormones through changes in membrane bound receptors and intracellular signaling.

Progesterone: A steroid hormone that regulates the menstrual cycle and supports pregnancy.

Serotonergic transmission: Neural signaling using serotonin.

Synaptic efficacy: Strength of signal transmission due to synaptic release.

Tonic inhibition: Continuous inhibition in the nervous system.

Systems Level

Amygdala: Brain structure involved in emotion, fear and stress responses.

Default mode network: A brain network most active during rest or reflective thinking.

Executive control network: A brain involving higher order cognitive functions like attention.

Fronto-striatal network: A brain network that connects the prefrontal cortex and the striatum, associated with behavior regulation and decision-making.

Neural plasticity: The brain's ability to reorganize the structures and connections in response to environmental cues.

Neurosteroids: Steroid hormones that influence excitability and inhibition.

Prefrontal cortex: A large brain region involved in decision making, emotion regulation, and memory.

Premenstrual dysphoric disorder (PMDD): Symptoms like mood swings, irritability, and emotional instability.

Primary dysmenorrhea: (PDM): A condition of painful menstruation.

Salience network: A brain network involving detecting emotional or environmental stimuli.

Synaptic plasticity: The ability of synapses to strengthen or weaken in response to activity.

Behavioral and Cognitive Levels

Cognitive performance: Outcomes on tasks measuring memory, attention, or reasoning.

Emotion regulation: Processes to modify emotional responses.

Hand laterality judgement task: A motor imagery task where participants decide whether a rotated hand is left or right.

Implicit motor imagery: Mental simulation of physical movements

Neuroticism: A personality trait that involves emotional instability and sensitivity

Spatial ability: Skills involved in spatial reasoning and skills such as mental rotation.

Visuospatial ability: Capacity to process visual and spatial information.

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Social Level

Affiliative motivation: The desire to form social connection and bonds.

Social value orientation (SVO): A method to measure whether individuals are cooperative, individualistic, or competitive in social interactions.

Dominance perception: Tendency to prefer socially dominant individuals

Emotion recognition: The ability to identify facial emotions.

Investment game: An economic task to measure risk taking behaviors and trust to others.

Prosocial behavior: Cooperative or altruistic actions toward others.

Interaction with Medications and Drugs

Chronic exogenous hormone exposure: continuous intake of synthetic hormones

Connectome: a map of functional connections in the brain

Endogenous cycle suppression: the process of how synthetic hormones inhibit the body's natural production of hormones

Functional individuality: the extent to which the brain connectivity pattern is unique

Hormonal contraceptives: medications containing synthetic estrogen or progestin to prevent ovulation

System segregation: the extent of major brain networks remains functionally distinct from each other.

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