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Abstract:

Background: The perimenopausal period is associated with higher risk for various mood disorders. Resting-state EEG (rsEEG) brain oscillatory activity has been associated with various neuropsychological disorders and behaviors but has not been assessed in perimenopausal women.

Aim: This study aimed to evaluate quantitative relationships between psychometric properties and rsEEG rhythms (δ, θ, α, and γ powers) in perimenopausal women.

Methods: A cross-sectional correlational descriptive study was conducted to quantitatively analyze the correlations among rsEEG low to high band activity (δ, θ, α, and γ powers) and psychometric properties for 14 perimenopausal women. Participants completed a psychological inventory comprised of a State Anxiety Inventory (SAI), Depression Inventory (DI), Behavioral Inhibition Scale (BIS), and short-form UPPS Impulsive Behavior Scale (IS) before EEG recording.

Results: Results showed that impulsivity was positively related to the β power, symmetrical at most channels (frontal, temporal, central, parietal, and occipital regions; p <.05), but did not relate to the δ, θ, α, and γ powers. The brainwave low to high bands, δ, θ, α, β, and γ power, were not associated with DI, SAI, or BIS scores.

Conclusions: This study’s findings suggest that significantly enhanced resting-state beta activity is a trait marker of impulsivity in perimenopausal women. This finding has potential implications for preclinical or clinical evaluation of perimenopausal women.

Keywords: Electroencephalography (EEG), Perimenopausal women, Psychometric properties
Introduction

Perimenopause is a part of a woman’s transition into menopause and encompasses the final years of her reproductive life. The Stages of Reproductive Aging Workshop (STRAW) divided the adult female life into three broad phases: reproductive, menopausal transition, and postmenopause. Perimenopause is marked by fluctuations in reproductive hormones, which can subsequently lead to mood disorders and other psychiatric issues. Research has suggested that stages of hormonal fluctuations during a woman’s lifespan run parallel with an increased risk of mood disturbances. Women between 45 and 55 years of age experience a life phase known as “the window of vulnerability,” during which mental health problems, such as anxiety and depressive symptoms, can develop. Furthermore, women in perimenopause often experience emotional changes, such as irritability, sadness, lack of motivation, fatigue, and mood swings. These emotions have a major influence on social cognitive processes, which, in turn, influence life outcomes. A better understanding of this life period, which every woman passes through, can be gained through the efforts of neuroscientists to detect biomarkers of the early stages of cognitive decline and work on the implications of brain oscillations in the biological and psychological sciences. However, limited evidence on such oscillations has been gathered from preclinical, perimenopausal women.

Characterization of resting-state EEG (rsEEG) brain oscillatory activity is a practical methodology used in the study of human behavior. Clinically, EEG signals have been used as valuable indicators of psychological characteristics. rsEEG signals are composed of multiple waves cycling at different frequencies: δ (0.5–4 Hz), θ (4–8 Hz), α (8–13 Hz), β (13–30 Hz), and γ (31–40 Hz). Essentially, human behavior begins in the brain, and quantitative EEG (qEEG) signals can be interpreted and clinically applied to evaluate brain function. A network of brain regions known as the “default mode network” shows increased brain activity even in the resting state, thereby reflecting spontaneous cognitive processes. Spontaneous activity and its various rhythms appear to correlate with psychometric properties that are relevant to psychological factors in physical health and illness and are postulated to play a key role in neuropsychiatric diseases. Quantitative spectral analysis of rsEEG provides an efficient, convenient, and relatively inexpensive way to study the relationships between brain activity and behavior. Through observations of brain rhythms and considering their tagged functional roles, we attempt to reveal how activity across rsEEG frequency bands is associated with the psychological characteristics of perimenopausal women. Such work is necessary, as this
potential neural entrainment is not completely covered in literature. Thus, the examination of resting-state EEG data may enhance our understanding of basic brain function.

Self-report inventories have become the most prevalent method used to assess psychological characteristics. The psychological inventories used in this study were chosen according to common psychological characteristics experienced during perimenopause and the early stages of aging\textsuperscript{12-15}. These scales have been widely used in psychological research or clinical practice, and their validity and reliability have been well-established. (1) The Center for Epidemiologic Studies-Depression scale (CES-D; \textbf{DI}) was developed by the National Institute of Mental Health and measures depressive symptomatology in the general population. (2) The State-Trait Anxiety Inventory is an introspective psychological self-report inventory relating to anxiety, as assessed across two dimensions: state and trait\textsuperscript{16}. State anxiety (\textbf{SAI}) denotes negative mood, reflecting a “transitory emotional state or condition of the human organism.” (3) The behavioral inhibition system (\textbf{BIS}) assessment attributes sensitivity to signals of punishments\textsuperscript{17}, and heightened BIS sensitivity may increase one’s risk of developing anxiety or depressive disorders\textsuperscript{18}. (4) The modified short version of the UPPS Impulsive Behavior Scale (\textbf{IS}) assesses impulsive behaviors, which are commonly related to a sense of urgency, sensation seeking, and a lack of premeditation and perseverance\textsuperscript{14,19}. Thus, four inventories—the \textbf{DI}, \textbf{SAI}, \textbf{BIS}, and \textbf{IS}—were included in our study.

In the present study, we planned to investigate the relationship between neuropsychological assessment and quantitative rsEEG band power in perimenopause women. This cross-correlation of EEG frequency bands and psychometric properties aimed to examine whether there are potential neurophysiological trait markers for specific psychological characteristics in non-clinical perimenopausal women.

\textbf{Method}

\textbf{Participants and ethical considerations}

This was a cross-sectional correlational study. All procedures were performed in accordance with the Institutional Review Board of CGMH. A total of 14 right-handed individuals aged between 46 and 54 years old ($M_{age} = 51$ years) participated in the experiment. We recruited participants by posting advertisements around the community in Tao Yuan, Taiwan. All subjects were within the menopausal transition, as characterized by the Stages of Reproductive Aging Workshop
Participants reported that they had irregular menstrual cycles but were not menopausal, as defined as not having experienced menstruation or blood discharge in the past year. Participants were excluded if they (1) had used oral contraceptive pills or hormone therapy in the past year or (2) had a history of neurological, psychiatric, or personality disorders, including premenstrual dysphoric disorder, as evaluated using the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Before the experiment, all participants were asked to refrain from consuming alcohol for at least 48 hours, caffeine and tobacco for 12 hours, and engaging in physical activity for 6 hours. Written informed consent was obtained from each participant prior to the experiment.

**EEG recording**

Participants were tested in a light-controlled and sound-attenuated room. Spontaneous brain activity was recorded continuously for three min while participants relaxed and stayed awake with their eyes closed. The study was conducted using Encerphalan-EEGR-19/26 computerized EEG (Version 5.4-16-2.0, Medicom MTD). EEG activity was recorded from 19 sites—Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, T3, T4, T5, T6, P3, P4, Pz, O1, and O2—within the standard 10–20 system, covering symmetrical brain areas: the anterofrontal, frontal, anterotemporal, temporal, posterior temporal, central, parietal, and occipital regions (Figure 1). EEG and EOG were recorded at a sampling rate of 256 Hz/sec and band-pass filtered at 70–250 Hz.

Each recording was visually screened to remove epochs with head movements and eye blinks, after which a computer-based rejection algorithm discarded any epochs with activity greater than ± 75 μV in amplitude. Accepted epochs were used as baselines, and their fast Fourier transforms were averaged in five selected frequency bands: delta (δ; 0.5–4 Hz), theta (θ; 4–8 Hz), alpha (α; 8–13 Hz), beta (β; 13–30 Hz), and gamma (γ; 31–40 Hz). The relative power of each band and the ratios of each region were calculated. Relative power was calculated as the ratio of the total power of a band to that of all bands from delta to gamma (0.5–40 Hz). The relative power value (RPV, %) was averaged from non-artifact 4-sec signals, which were gathered at about 20–45 epochs from different brain areas.

**Neuropsychological measures**

We administered a questionnaire before EEG recording that comprised four inventories. (1) The Center for Epidemiologic Studies-Depression Scale (DI), which includes 20 items. Scores were weighted from 1 to 4, with a rating of four indicating the highest level of depression. Total scores
ranged from 20 to 80. (2) The State Anxiety Inventory (SAI), which contains 20 items. Scores were weighted from 1 to 4, with a rating of four indicating the highest level of anxiety. Total scores ranged from 20 to 80. (3) The BIS, which comprises seven items probing the degree of anxiety felt when confronted with punishment cues. It was rated on a 4-point Likert scale (range: 1–4). A high BIS score was associated with high negative affect in response to punishment. (4) The short-form impulsive behavior scale (IS), which includes 16 items. Each receives a weighted score of 1 to 4, with a rating of four indicating the highest level of impulsivity. Total scores ranged from 16 to 64. These inventories were well estimated Cronbach’s alpha value and has been used for basic and clinical settings to detect and measure the functional manifestations.

Figure 1. Electrode Placement Based on International 10–20 System.

Analysis
Descriptive statistical analyses were used for the neuropsychological assessments (SAI, DI, BIS, and IS) and baseline spectrum power of δ, θ, α, β, and γ activity (RPV %) at each channel. Consequently, we evaluated the quantitative relationships between psychometric properties and rsEEG rhythms (δ, θ, α, and γ powers). Pearson’s approach was used to evaluate whether correlations existed between the power of the five frequency bands and participants’ neuropsychological scores (SAI, DI, BIS, and IS) at the 19 sites. The significance level threshold was set at \( p < 0.05 \). The average correlation coefficients of the 19 sites were used to subsequently elucidate whether any specific type of brain wave activity was highly correlated with
psychometric properties in perimenopausal women. All statistical analyses were conducted using SPSS version 17.0.

**Results**

**Descriptive statistics**

Means and standard deviations (mean ± SD) of participants’ scores for the DI AI, BIS, and IS, were 35.21 ± 5.81, 31.57 ± 8.37, 20.57 ± 3.16, and 34.71 ± 5.03, respectively. The resting spectrum power of δ, θ, α, β, and γ activity (RPV %) at each channel is shown in Table 1.

**Relationship between brain activity and behavior**

The resting brain oscillation for δ, θ, α, β, and γ presented different findings in relation to the four inventory scores via Pearson’s correlation analysis (Table 2). The IS was positively related to β power activity of the symmetrical results for almost all the brain regions (frontal, temporal, central, parietal, and occipital regions; \( r = 0.58 \) to 0.84, all \( p < 0.05 \)). Relatively, DI, AI, and BIS scores did not show obvious correlations with the δ, θ, α, β, and γ powers, respectively (Table 1). Figure 2 shows that the whole-brain resting-beta power could have a specific function in predicting the strength of impulsivity in perimenopausal women (\( p < 0.01 \)). The whole-brain resting activity for δ, θ, α, β, and γ showed no significant correlations with DI, SAI, and BIS scores (\( p > 0.05 \); Figure 2.).
Table 1. The RPV (Relative Power Value, %) at each channel from rsEEG rhythms in perimenopause women; The RPV were analyzed at eye close 3min resting state for each channel. Five selected frequency bands were Delta (δ; 0.5-4 Hz), Theta (θ; 4–8 Hz), Alpha (α; 8-13 Hz), Beta (β; 13-30 Hz), and Gamma (γ; 31-40 Hz).

| Channel | Delta       | Theta       | Alpha       | Beta        | Gamma       |
|---------|-------------|-------------|-------------|-------------|-------------|
| FP1     | 32.025385   | 14.33539    | 23.47385    | 21.37462    | 23.54       |
| FP2     | 33.841538   | 14.09308    | 22.21154    | 21.27923    | 8.35        |
| F7      | 25.641538   | 13.21846    | 24.41846    | 24.8869     | 11.41692    |
| F3      | 18.974615   | 15.25385    | 29.4562     | 26.55769    | 9.4708      |
| Fz      | 19.9923     | 16.78923    | 31.10769    | 24.87231    | 7.063846    |
| F4      | 21.315385   | 15.31077    | 29.19846    | 26.19462    | 7.7877      |
| F8      | 33.6254     | 13.13       | 22.01615    | 22.56846    | 8.426154    |
| T3      | 15.949231   | 10.46539    | 22.76462    | 31.84385    | 18.1992     |
| C3      | 14.93       | 14.43769    | 29.83077    | 30.50923    | 9.961538    |
| Cz      | 15.213077   | 37.60       | 32.47692    | 27.94769    | 6.898462    |
| C4      | 16.287692   | 15.05615    | 67.130      | 51.88       | 17.610      |
| T4      | 19.740769   | 11.66769    | 21.91077    | 32.49539    | 13.81923    |
| T5      | 20.783846   | 9.7823      | 24.89846    | 29.86       | 13.60462    |
| P3      | 18.671538   | 12.83462    | 27.7423     | 31.85615    | 8.6         |
| Pz      | 16.023846   | 15.25154    | 29.36769    | 32.2831     | 6.8662      |
| P4      | 15.985385   | 13.2738     | 27.5623     | 34.92       | 8.022308    |
| T6      | 14.011538   | 11.0838     | 26.5562     | 35.49539    | 12.49385    |
| O1      | 17.686923   | 11.16308    | 20.74615    | 32.26769    | 17.50077    |
| O2      | 14.5        | 11.35       | 22.40308    | 37.07077    | 14.22462    |

Table 1. The RPV (Relative Power Value, %) at each channel from rsEEG rhythms in perimenopause women; The RPV were analyzed at eye close 3min resting state for each channel. Five selected frequency bands were Delta (δ; 0.5-4 Hz), Theta (θ; 4–8 Hz), Alpha (α; 8-13 Hz), Beta (β; 13-30 Hz), and Gamma (γ; 31-40 Hz).
Figure 2. The $r$ value for psychometric score and each band ($r$ value derived average 19 channels). The IS positively related with beta power in cross-correlation analysis. Note: IS: Impulsivity Score; DI: Depression Inventory; SAI: State Anxiety Inventory; BIS: Behavioral inhibition sensitivity scale; **= significant at the $p$ level of 0.01
Table 2. The Pearson r value between psychological score and band power at each channel
Note: IS: Impulsivity Score; DI: Depression Inventory; SAI: State Anxiety Inventory; BIS: Behavioral inhibition sensitivity scale; * = significant at the p level < 0.05; **= significant at the p level of 0.01.

Discussion

Research had not yet clarified the association between spontaneous neural oscillations and neuropsychological evaluations for perimenopausal women. Thus, the present study conducted a quantitative investigation of the associations between rsEEG low to high band activity and psychological assessments of perimenopausal women. Results indicated that rsEEG beta power can be used to specifically predict the degree of impulsivity (as measured by the IS) of perimenopausal women, unlike other psychological characteristics. These findings have potential implications for preclinical or clinical evaluations of perimenopausal women.

Our results indicated a significant positive correlation between the rsEEG beta power and impulsivity (p < 0.01; Figure 2). No such consistent relationship was witnessed for the δ, θ, α, and γ powers. Previous studies have reported that beta activity is related to symptoms of brain...
over-arousal, such as anxiety, obsessiveness, sleep difficulties, and hyperactivity, in adults. The IS questionnaire was used to assess sense of urgency, premeditation, perseverance, and sensation seeking, all factors in impulsive behavior. Impulsivity is defined as an individual’s tendency to behave without forethought or regard for the consequences. Studies have revealed that impulsivity is associated with spindling beta activity in clinical conditions such as ADHD, epilepsy, or psychosis and in gambling disorder, including during hallucinations. Studies providing this evidence have tended to employ task-based methods, such as Go/NoGo and stop-signal tasks. However, the brain is constantly active, even at resting state, in the absence of external stimuli, and yet no reports have been made on the association between degree of impulsivity and resting-state EEG in perimenopausal women. Here, we evaluated the association between four self-report psychology inventories across broad frequency bands. We highlighted an intrinsic beta-power signature as an important correlate of degree of impulsivity, thereby making it a potential biomarker for perimenopausal women.

The spectral power distribution of each band is presented in Table 2. Spontaneous neural generators of brain activity have been widely reported, and the distributed patterns of fMRI activity that were correlated with power in different EEG bands overlapped strongly with those of functional connectivity. Consistent with previous studies, beta oscillation was mainly generated by a right-side network formed by the inferior parietal gyrus, superior and transverse temporal gyri, and postcentral gyrus. The bilateral parietal cortex has previously been identified as a generator of alpha activity and the parietal cortex as a generator of delta and theta oscillations. These cortical regions underly the electrodes showing relatively high activity in the respective bands in our middle-age perimenopausal female participants.

The main finding regarding the relation between spontaneous brain activity and scores of psychological tests was that the default beta power was positively related to IS. This phenomenon was symmetrically exhibited at 16 channels (r = 0.58 to 0.84, all p < 0.05), with a maximum correlation coefficient (r value) at the T4 channel (r = 0.84). T4 has been reported to mainly reveal activity in the middle temporal gyrus, which is connected by regional circuits with the amygdala, hippocampus, superior temporal gyrus, occipitobasal cortex, and orbital gyrus largely. The anatomical and functional organization of the temporal lobe involves impulse inhibition functions underlying trait impulsivity. The temporal lobe communicates with the hippocampus, playing a key role in the formation of impulsivity. These features may explain our finding that the maxima correlation coefficient of beta power with degree of impulsivity in
perimenopausal women was in the T4 region.

We reported analysis of the RPV of frequency bands in each channel using whole-brain averages, not carrying out derived analyses of these spectrum bands, such as their spatial coherence or asymmetry. The strength of our approach is that 20–45 epochs were obtained for each band for the statistical analysis, which helped determine the effect size and resulted in a high-reliability estimate. Further, apart from the correlation between β power and IS score, the cross-correlational findings of the current study identified no neurophysiological biomarkers for psychological characteristics in perimenopausal women. These observations further indicate that the qEEG methodology has discriminative power and offers objective, biological insight into cognitive processes, as it was able to reveal a lack of a significant relationship between δ, θ, α, γ powers and SAI, DI, and BIS scores in perimenopausal women. For the perimenopause emotional vulnerability that toward tracking band power modulation by various interventions such as neurofeedback or meditation for psychological well-being across the lifespan should be considered a women’s health issue.

Our study has several limitations. The study lacked a control group with which comparisons could be made of the association of the four self-report psychology inventories with activity in EEG frequency bands. The current study did not address activity in specific brain regions when analyzing affective function. Such as the DI, AI, and BIS would assembly surrounded links frontal alpha asymmetry had established in previously studies. Conceivably, more advanced analysis of selected regions in future could be used to perform more complex power ratio calculations to assess relationships of brain activity with psychological evaluations.

**Conclusion**

This study provides evidence that rsEEG β power specifically predicts impulsivity in perimenopausal women. This pilot study contributes a potential biomarker to assist future research on neurobehavioral estimation for perimenopausal women.

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**Authors’ contributions**
All authors contributed in designing the study, planning the analysis, and interpreting the results. All authors read and approved the final manuscript.

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**Availability of data and materials**
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Conflict of interest statement**
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
1. Santoro N. Perimenopause: From Research to Practice. *J Womens Health (Larchmt)* 2016; 25(4): 332-9.

2. Harlow SD, Gass M, Hall JE, et al. Executive summary of the Stages of Reproductive Aging Workshop +10: addressing the unfinished agenda of staging reproductive aging. *Climacteric* 2012; 15(2): 105-14.

3. Harlow SD, Gass M, Hall JE, et al. Executive summary of the Stages of Reproductive Aging Workshop + 10: addressing the unfinished agenda of staging reproductive aging. *Menopause* 2012; 19(4): 387-95.

4. Lin HL, Hsiao MC, Liu YT, Chang CM. Perimenopause and incidence of depression in midlife women: a population-based study in Taiwan. *Climacteric* 2013; 16(3): 381-6.

5. Freeman EW. Associations of depression with the transition to menopause. *Menopause* 2010; 17(4): 823-7.

6. Novaes C, Almeida OP, de Melo NR. Mental health among perimenopausal women attending a menopause clinic: possible association with premenstrual syndrome? *Climacteric* 1998; 1(4): 264-70.

7. Koike K, Yamamoto Y, Suzuki N, et al. Efficacy of porcine placental extract on climacteric symptoms in peri- and postmenopausal women. *Climacteric* 2013; 16(1): 28-35.

8. Andrews-Hanna JR, Reidler JS, Huang C, Buckner RL. Evidence for the default network's role in spontaneous cognition. *J Neurophysiol* 2010; 104(1): 322-35.

9. Karakas S, Barry RJ. A brief historical perspective on the advent of brain oscillations in the biological and psychological disciplines. *Neurosci Biobehav Rev* 2017; 75: 335-47.

10. Basar E. Brain oscillations in neuropsychiatric disease. *Dialogues Clin Neurosci* 2013; 15(3): 291-300.

11. Rogala J, Kublik E, Krauz R, Wrobel A. Resting-state EEG activity predicts frontoparietal network reconfiguration and improved attentional performance. *Sci Rep* 2020; 10(1): 5064.

12. Yu J, Rawtaer I, Fam J, et al. Sleep correlates of depression and anxiety in an elderly Asian population. *Psychogeriatrics* 2016; 16(3): 191-5.

13. Laredo-Aguilera JA, Carmona-Torres JM, Garcia-Pinillos F, Latorre-Roman PA. Effects of a 10-week functional training programme on pain, mood state, depression, and sleep in healthy older adults. *Psychogeriatrics* 2018; 18(4): 292-8.

14. Rochat L, Delbeuck X, Billieux J, d’Acremont M, Van der Linden AC, Van der Linden M. Assessing impulsivity changes in Alzheimer disease. *Alzheimer Dis Assoc Disord* 2008; 22(3): 278-83.

15. Porcino J. Psychological aspects of aging in women. *Women Health* 1985; 10(2-3): 115-22.

16. Spielberger CD, Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. Manual for the State-Trait Anxiety Inventory. *Palo Alto, CA: Consulting Psychologists Press* 1983.

17. Carver CS, & White, T. L. Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality and...*
18. Harmon-Jones E, Allen JJ. Behavioral activation sensitivity and resting frontal EEG asymmetry: covariation of putative indicators related to risk for mood disorders. *J Abnorm Psychol* 1997; 106(1): 159-63.

19. Rochat L, Beni C, Billieux J, Azouvi P, Annoni JM, Van der Linden M. Assessment of impulsivity after moderate to severe traumatic brain injury. *Neuropsychol Rehabil* 2010; 20(5): 778-97.

20. Harlow SD, Gass M, Hall JE, et al. Executive summary of the Stages of Reproductive Aging Workshop + 10: addressing the unfinished agenda of staging reproductive aging. *J Clin Endocrinol Metab* 2012; 97(4): 1159-68.

21. Harlow SD, Gass M, Hall JE, et al. Executive summary of the Stages of Reproductive Aging Workshop + 10: addressing the unfinished agenda of staging reproductive aging. *Fertil Steril* 2012; 97(4): 843-51.

22. ES B. Impulsiveness subtraits: Arousal and information processing. In: Spence JT, Itard CE, editors *Motivation, emotion, and personality* Amsterdam: Elsevier 1985: 137–46.

23. Koelsch S, Sammler D, Jentschke S, Siebel WA. EEG correlates of moderate intermittent explosive disorder. *Clin Neurophysiol* 2008; 119(1): 151-62.

24. Herrera-Diaz A, Mendoza-Quinones R, Melie-Garcia L, et al. Functional Connectivity and Quantitative EEG in Women with Alcohol Use Disorders: A Resting-State Study. *Brain Topogr* 2016; 29(3): 368-81.

25. Lee JY, Park SM, Kim YJ, et al. Resting-state EEG activity related to impulsivity in gambling disorder. *J Behav Addict* 2017; 6(3): 387-95.

26. Ieong HF, Yuan Z. Resting-State Neuroimaging and Neuropsychological Findings in Opioid Use Disorder during Abstinence: A Review. *Front Hum Neurosci* 2017; 11: 169.

27. Li H, Zhao Q, Huang F, et al. Increased Beta Activity Links to Impaired Emotional Control in ADHD Adults With High IQ. *J Atten Disord* 2019; 23(7): 754-64.

28. Glushchenko VV. [Psychophysiological disturbances in attention-deficit hyperactivity disorder in adolescents]. *Zh Nevrol Psikhiatr Im S S Korsakova* 2010; 110(12): 9-12.

29. Deco G, Jirsa VK, McIntosh AR. Resting brains never rest: computational insights into potential cognitive architectures. *Trends Neurosci* 2013; 36(5): 268-74.

30. Deco G, Jirsa VK, McIntosh AR. Resting Brains Never Rest: Computational Insights into Potential Cognitive Architectures: (Trends in Neurosciences 36, 268-274, 2013). *Trends Neurosci* 2018; 41(3): 161.

31. Laufs H, Krakow K, Sterzer P, et al. Electroencephalographic signatures of attentional and cognitive default modes in spontaneous brain activity fluctuations at rest. *Proc Natl Acad Sci USA* 2003; 100(19): 11053-8.

32. Leroy A, Cheron G. EEG dynamics and neural generators of psychological flow during one tightrope performance. *Sci Rep* 2020; 10(1): 12449.

33. Chiang CT, Ouyang CS, Yang RC, Wu RC, Lin LC. Increased Temporal Lobe Beta Activity in
Boys With Attention-Deficit Hyperactivity Disorder by LORETA Analysis. *Front Behav Neurosci* 2020; 14: 85.

34. Ding WN, Sun JH, Sun YW, et al. Trait impulsivity and impaired prefrontal impulse inhibition function in adolescents with internet gaming addiction revealed by a Go/No-Go fMRI study. *Behav Brain Funct* 2014; 10: 20.
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