REPORT: 報告：

RESEARCH OF INDICATORS OF FUNCTIONAL STATE OF A BODY EXPOSED TO THE ELECTROMAGNETIC RADIATION OF A MOBILE PHONE AND THE POSSIBILITY OF THEIR CORRECTION IN THE PRESENCE OF AN AIRES RESONATOR

暴露於行動電話電磁輻射下之機體功能狀態指標研究及在存在 AIRES 共振器情況下進行校正的可能性

Researcher: Doctor of Biological Sciences Rybina L.A.

研究者：生物學博士 里碧娜 L.A.

Abstract 摘要

The object of the study is mainly male volunteers at the age of 21 (12 out of 15 people). The methodological framework consisted of physiological and statistical research methods, as well as the calculation of fractal dimension. The purpose of the work was to assess the characteristics of the bioelectric activity of the brain when exposed to the electromagnetic radiation of a modern mobile phone in the following modes: “waiting” (I), “talk” without sound (II), “talk” without sound in the presence of a resonator (III). Studies of changes in the brain’s bioelectrical activity during Scenario III suggested the possibility of compensating for the physiological consequences of exposure to a mobile phone. Based on the results obtained, the following conclusion was drawn: In the event of negative influence from electromagnetic fields and radiation, the AIRES resonator contributes to proactive activation of the body’s own adaptive processes.

本研究對象主要為 21 歲男性志願者（15 人中有 12 人為男性）。方法學框架包括生理學與統計學研究方法，並進行分形維數的計算。本研究目的在於評估當代行動電話電磁輻射下腦部生物電活動的特徵，針對下列模式進行比較：「等待」模式（I）、「通話」但無聲音模式（II）、以及在存在共振器情況下之「通話」但無聲音模式（III）。對於情境 III 中腦部生物電活動變化的研究，表明有可能補償行動電話暴露所致的生理後果。根據所得結果得出以下結論：在電磁場與輻射產生負面影響時，AIRES 共振器有助於主動啟動機體自身的適應性過程。

TABLE OF CONTENTS 目錄

LIST OF ABBREVIATIONS: 縮寫表：

AbsAmpl - absolute value of the amplitude ($\mu\mathrm{V}$)

AbsAmpl - 振幅的絕對值（ $\mu\mathrm{V}$ ）

AbsPwr - absolute power value = power spectral density $(\mu\mathrm{V}^2)$

AbsPwr - 絕對功率值 = 功率譜密度 $(\mu\mathrm{V}^2)$

BEA - bioelectric activity

BEA - 生物電活動

WHO - World Health Organization

WHO - 世界衛生組織

HV - hyperventilation **HV - 過度換氣**
DFV - value of the dominant frequencies (Hz)

DFV - 主要頻率值（Hz）

MP - mobile phone

MP - 行動電話

MP+ - mobile phone in the presence of an AIRES resonator

MP+ - 帶有 AIRES 共振器時的行動電話

AT - after test

AT - 測試後

SHF - electromagnetic radiation in the centimeter band

SHF - 公分波段的電磁輻射

FA - functional asymmetry of the brain

FA - 大腦功能不對稱性

CNS - Central nervous system

CNS - 中樞神經系統

ECG - electrocardiogram **ECG - 心電圖**
EMR - electromagnetic radiation

EMR - 電磁輻射

EMF - electromagnetic field

EMF — 電磁場

EEG - electroencephalogram

EEG — 腦電圖（electroencephalogram）

SAR - specific absorption rate

SAR — 特定吸收率

INTRODUCTION 引言

Background variations in cosmic-helio-geomagnetic fields play a leading role in arranging the rhythm-setting factors that ensure the stability of life on Earth. The widespread introduction of additional technogenic sources of electromagnetic radiation into everyday life has led the planet to a mass of negative consequences, including the disruption of the stable existence of the ecosystem as well as defects in a complex system of reactions aimed at maintaining the rhythmostasis and dynamic constancy of biological organisms' internal environment. Disorganization causes any organism to be in a state of stress, the direct path to development of disease. For supercomplex organic systems, which include humans, compensation for changes in environmental factors is possible due to the activation of its own systems responsible for the body's adaptation to external conditions, not only to natural cosmo-helio-geomagnetic variations, but also to new technogenic electromagnetic influences that have already become permanent environmental factors. At the moment, there is an urgent need for the reconstruction of old and/or the creation of new structural and dynamic adaptation programs that increase the body's resistance to external influences with markedly unusual characteristics, increased plasticity of the body, and the ability to restructure the body's rhythmic component in order to maintain the dynamic stability of the body's internal environment.

背景中宇宙—日—地磁場的變化，在安排那些確保地球生命穩定的節律設定因子方面，扮演著主導角色。額外人為（technogenic）電磁輻射來源被廣泛引入日常生活，已使地球面臨一連串負面後果，包括破壞生態系統的穩定存在，以及損害一套複雜反應系統，該系統旨在維持生物體內部環境的節律恆定與動態穩定。這種失序使任何生物體處於壓力狀態，直接導向疾病的發展。對於包括人類在內的超複雜有機系統而言，透過啟動自身負責適應外在條件的系統，可以補償環境因子的變化，不僅是對自然的宇宙—日—地磁變化，亦包括已成為常態環境因子的新興人為電磁影響。 目前迫切需要重建舊有的與／或創建新的結構與動態適應方案，以提升機體對具明顯非典型特性之外來影響的抵抗力、增強機體的可塑性，並具備重組機體節律成分的能力，從而維持機體內部環境的動態穩定。

Cellular communications are a significant source of technogenic electromagnetic fields. The fact that mobile phone radiation has a negative influence is not in doubt by anyone ($1, 2, 3$). That said, we cannot eliminate the use of mobile communications from our lives. Accordingly, protecting the body from a mobile phone's electromagnetic radiation remains one of the most pressing topics of modern life, calling for humankind's intellectual and production efforts to be directed toward the development of technologies and devices that minimize the negative consequences of exposure to electromagnetic radiation, including from mobile phones. The industry currently offers a large selection of protective devices that use:

行動通訊是人為電磁場的一個重要來源。沒有人會懷疑手機輻射具有負面影響（ $1, 2, 3$ ）。儘管如此，我們無法將行動通訊從生活中剔除。因此，保護機體免受手機電磁輻射仍是現代生活中最緊迫的課題之一，這需要人類將智慧與生產力投入於開發能將暴露於電磁輻射（包括手機所產生者）負面後果降到最低的技術與裝置。產業目前提供了大量採用以下方式的防護裝置：

the absorbing properties of materials: wax, felt, paper, synthetic films;

材料的吸收特性：蠟、氈、紙、合成薄膜；

reflective materials such as metal foil on insulating substrates made of synthetic materials;

如覆蓋在合成材料絕緣基底上的金屬箔等反射性材料；

textiles embedded with metallic threads;

織物中嵌入金屬線；

conductors in various shapes with antenna properties: bracelets, necklaces, fobs...;

各種形狀具天線特性的導體：手環、項鍊、護身符……；

various types of diffraction gratings;

各類繞射光柵；

deflecting devices - metallic products without coatings and in insulators;

偏轉裝置——無塗層且為絕緣體的金屬製品；

various resonators: spirals, cones, pyramids; electromagnetic pulse generators. Unfortunately, not all of the proposed devices have proven their effectiveness in relieving the negative consequences of EMR exposure for a human while using a mobile phone.

各類共振器：螺旋、錐體、金字塔；電磁脈衝發生器。不幸的是，並非所有提出的裝置都已被證實在使用行動電話時能有效緩解電磁輻射對人體的負面影響。

The purpose of this work was to assess the effectiveness of using an AIRES resonator to protect the central nervous system from the negative influence of a mobile phone's EMR.

本研究的目的在於評估使用 AIRES 共振器保護中樞神經系統免受行動電話電磁輻射負面影響的有效性。

LIST OF PARTICIPANTS, RESEARCH SCOPE AND METHODOLOGY

參與者名單、研究範圍與方法論

Table 1 presents the list and scenarios. 15 subjects participated in the studies on a voluntary basis, based on informed consent, and in accordance with the ethical standards of the World Medical Association's Declaration of Helsinki (2000): 13 men and three women, with the predominant age of 21 years (10 out of 15) (see Table 1). The studies were carried out in March-April 2020 during days when the helio-magnetic environment was calm. EEGs and ECGs were recorded using the Encephalan 13103 software package with built-in programs for recording and analyzing EEGs and ECGs. The brain's BEA (EEG) was recorded using 16 monopolar leads in accordance with the internationally-recognized 10-20 system in the $0-70\ \mathrm{Hz}$ transmission band with 250 Hz frequency discretization. Electrodes were placed symmetrically in the areas of the prefrontal ($\mathrm{Fp1}, \mathrm{Fp2}$), postfrontal (F3, F4), frontotemporal (F7, F8), central (C3, C4), middle temporal (T3, T4), posttemporal (T5, T6), parietal (P3, P4), and occipital (O1, O2), areas, with joined reference electrodes being placed on the earlobes. The even-numbered electrodes are on the right. The GSM standard was chosen not only because and not so much because of its wide distribution, but mainly because time-division multiple access is used to organize the "telephone - base station" communication channel, which makes it possible to select frequencies that coincide with the frequencies of the brain's own bioelectric activity: gamma, alpha, delta ($317\ \mathrm{Hz}, 8.35\ \mathrm{Hz}, 2.00\ \mathrm{Hz}$).

表 1 列出了名單與場景。共有 15 名受試者在知情同意下自願參與研究，並遵循世界醫學會《赫爾辛基宣言》（2000 年）的倫理標準：13 名男性與 3 名女性，年齡以 21 歲為主（15 人中有 10 人）（見表 1）。研究於 2020 年 3 月至 4 月進行，選在日磁環境平靜的日子。使用內建腦電圖與心電圖記錄與分析程式的 Encephalan 13103 軟體套件記錄 EEG 與 ECG。腦部生物電活動（EEG）以 16 個單極導聯按國際公認的 10–20 系統記錄，於 $0-70\ \mathrm{Hz}$ 傳輸頻帶、250 Hz 取樣頻率下進行。電極對稱置於前額（ $\mathrm{Fp1}, \mathrm{Fp2}$ ）、額後（F3、F4）、額顳（F7、F8）、中央（C3、C4）、中顳（T3、T4）、顳後（T5、T6）、頂葉（P3、P4）與枕葉（O1、O2）區域，連接參考電極置於耳垂。偶數編號電極位於右側。 选择 GSM 標準並非僅僅因其廣泛分佈，而主要是因為該標準使用時分多工（time-division multiple access）來組織「手機—基站」通信通道，這使得可以選擇與大腦自身生物電活動頻率相重合的頻率：伽馬、阿爾法、德爾塔（ $317\ \mathrm{Hz}, 8.35\ \mathrm{Hz}, 2.00\ \mathrm{Hz}$ ）。

EEGs were recorded according to the scenarios presented in Table 1: I - baseline EEG (60s), "eyes open (10s) - eyes closed" test, baseline EEG with eyes closed (60s), MP powered on - "waiting" mode (300s); II - baseline EEG (60s), "eyes open (10s) - eyes closed" test, baseline EEG with eyes closed (60s), MP powered on - "talk" mode without sound, III - baseline EEG (60s), "eyes open (10s) - eyes closed" test, baseline EEG with eyes closed (60s), MP(+) powered on with a

腦電圖根據表 1 所示情境記錄：I—基線腦電圖（60 秒）、「睜眼（10 秒）—閉眼」測試、閉眼基線腦電圖（60 秒）、手機開機—「待機」模式（300 秒）；II—基線腦電圖（60 秒）、「睜眼（10 秒）—閉眼」測試、閉眼基線腦電圖（60 秒）、手機開機—「通話」模式但無聲；III—基線腦電圖（60 秒）、「睜眼（10 秒）—閉眼」測試、閉眼基線腦電圖（60 秒）、手機(+)開機並配有

resonator - "talk" mode without sound. The subjects did not know scenarios II or III were used during the study.

共振器—「通話」模式但無聲。受試者並不知道研究中使用了情境 II 或 III。

Five random 5 -second segments were analyzed in each scenario test. The spectral power density (AbsPwr), index (relative power value), and dominant amplitude values (DFV) were evaluated across ranges. The significance of the results obtained was assessed using the nonparametric Wilcoxon test.

在每種情境測試中隨機分析了五個 5 秒片段。評估了各頻段的頻譜功率密度（AbsPwr）、指數（相對功率值）及主導振幅值（DFV）。所得到結果的顯著性使用非母數 Wilcoxon 檢定進行評估。

RESULTS AND DISCUSSION 結果與討論

The obtained results and their statistical processing are presented in Tables 2-7. As you can see, the group of participants has a large spread in the values of the analyzed indicators and EEG patterns: a so-called "flat" EEG was recorded in 3 people, and a highly synchronized EEG was also recorded in 3 people. Due to the small size of the group, outliers were not discarded. As a result, the statistical analysis was carried out using nonparametric statistical criteria. The effect of the influence of a mobile phone's EMR depends both on the individual level of a person's functional state and on the location of the user and the distance between the user and the base station. The maximum radiation power is observed in "waiting" and "calling" modes (4.5). Accounting for these facts, we performed a comparative analysis of the baseline BEA values and those recorded in "waiting" mode (Tables 2-3). The mobile phone's searches for a base station and the communication with it were reliably reflected in the study participants' EEGs (Table 7). After the third or fourth minutes of exposure to the mobile phone, there was an increase in the total absolute value of power in the slow-wave ($2-6\ \mathrm{Hz}$) part of the spectrum. A frequency shift in the alpha range towards the bias of the lowfrequency component was accompanied by a decrease in the value of the absolute total power. Following mobile phone exposure, the EEG indicators returned to their initial values. Apparently, the coincidence of the frequencies of the GSM-900 standard and the frequencies of the brain's bioelectric activity provokes a shortterm deactivation of brain processes. However, the longer and more often a person uses cellular communication, the more likely is the accumulation of changes in dynamic disturbances in the EEG, and, as a consequence, the development of behavioral disability, which has been indicated by researchers who studied the influence mobile phone EMR on the EEGs of children (2).

所得結果及其統計處理列於表 2–7。如您所見，受試者群體在所分析指標與腦電圖模式上的數值分布甚廣：有 3 人記錄到所謂的「平坦」腦電圖，而亦有 3 人記錄到高度同步化的腦電圖。由於樣本數較少，離群值未被剔除。因此統計分析採用了非參數統計準則。手機電磁輻射（EMR）的影響既取決於個體的功能狀態水平，也與使用者所在位置及使用者與基地台之間的距離有關。最大輻射功率出現在「待機」與「撥號」模式（4.5）。考量到這些事實，我們對基線腦電生物電位（BEA）值與「待機」模式下記錄到的值進行了比較分析（表 2–3）。手機搜尋基地台及與之通訊的過程在受試者的腦電圖中有可靠反映（表 7）。 在曝露於行動電話電磁輻射的第三或第四分鐘時，譜中慢波（ $2-6$ Hz ）部分的總絕對功率值增加。阿爾法頻段向低頻成分偏移的頻率轉移，伴隨著絕對總功率值的下降。行動電話曝露結束後，腦電圖指標回復到初始值。顯然，GSM-900 標準的頻率與腦部生物電活動的頻率相吻合，會激發短暫的腦功能去活化。然而，個人使用行動通訊的時間越長、頻率越高，腦電圖中動態干擾變化累積的可能性就越大，進而導致行為能力受損——這一點已由研究行動電話電磁輻射對兒童腦電圖影響的研究者所指出（2）。

A different picture was revealed when analyzing changes in the BEA in “talk” mode (Tables 3-4 in Fig. 1). Here we see a strong dependence of the BEA response on the influence of mobile phone EMR. The increase in the EEG’s slowwave rhythmic component was more pronounced in persons with a “flat” EEG, the most labile in vegetative reactions with respect to the entire range of external

當分析「通話」模式下的腦生物電活動（BEA）變化時（圖 1 表 3–4），呈現出不同的圖景。我們在此看到 BEA 反應對行動電話電磁輻射影響的強烈依賴性。腦電圖（EEG）慢波節律成分的增加在具有「平坦」腦電圖的人身上更為顯著，這些人在整個外界刺激範圍內的植物性反應最為易變。

influences, and not only to EMR (Fig. 3). As a rule, these individuals are more prone to chronic fatigue syndrome and asthenic syndrome. Still, it was possible to identify the general trend of changes in BEA under exposure to mobile phone EMR: a significant drop in power in the EEG’s alpha range in response to exposure to mobile phone EMR, as well as a shift in the dominant frequency in the alpha range of the low frequency region: $8.5-9.2$ Hz. As noted in the previous report, the response to external physical influences is an evolutionarily fixed property of biological systems when a certain level of change is reached. After that, the system switches to another, more cost-effective response. That is why the most pronounced changes are observed in the alpha range, which is dominant in the EEG and closely related to the analysis of incoming information and behavioral responses (6, 7). However, a decrease in the frequency of the dominant rhythm may have a negative effect with prolonged use of a mobile phone. This hazard can be avoided by minimizing the impact of mobile phone EMR by reducing the duration of use of “talk” mode or, if this not possible, by activating the adaptive processes of the body.

影響，而不僅僅是電磁輻射（圖 3）。通常這類個體較容易罹患慢性疲勞症候群與乏力症候群。然而，仍可識別在暴露於行動電話電磁輻射下腦生物電活動（BEA）變化的一般趨勢：暴露於行動電話電磁輻射時，腦電圖（EEG）α波段功率顯著下降，且α波段的主導頻率向低頻區域偏移： $8.5-9.2$ Hz 。如先前報告所述，對外在物理影響的反應是生物系統在進化中固有的特性，當變化達到某一臨界水平後，系統會切換到另一種更具成本效益的反應。因此在 EEG 中佔主導且與來訊資訊分析與行為反應密切相關的α波段觀察到最明顯的變化（6, 7）。然而，主導節律頻率的下降在長期使用行動電話時可能產生負面影響。 此危害可透过減少手機「通話」模式的使用時間以降低電磁輻射的影響來避免；若無法減少通話時間，則可啟動身體的調適性機制以因應。

Changes in BEA values (a significant increase in AbsPwr in the alpha range) are presented in Table 6, reflecting the special features of EEG changes upon exposure to mobile phone EMR in the presence of an AIRES resonator (Figures 1 and 3), indicate the activation of one’s own defense mechanisms against the negative influences of EMR. Responding to a harmful factor, the brain increases the power of the dominant alpha rhythm, also increasing its frequency. In addition, the spindle-shaped modulation of alpha wave amplitude and the appearance of spindle-shaped bursts of low-frequency beta activity are more pronounced. The increase in the spindle-shaped modulation of alpha wave amplitude indicates, in the formation of total alpha activity, an increase of cortical sources, which produce the appearance of a higher-frequency component. At the same time, bursts of beta activity reflect the involvement of regulatory formations of the diencephalic level. Comparative analysis (Tables 5 and 6) accounting for the correlation dimension and entropy (Fig. 7, 8) showed that the more jagged the peaks of alpha waves due to beta activity, the higher the correlation dimension indicator, which makes it possible to assert that current information is processed at a higher speed and more accurately. In other words, in the presence of an AIRES resonator, a mobile phone’s external EMR transforms from a negative factor into a factor that harmonizes the functional state of the central nervous system, the body's central control system, with the essential state of the environment.

表 6 中列出 BEA 值變化（阿爾法範圍內 AbsPwr 顯著增高），反映在 AIRES 諧振器存在下暴露於手機電磁輻射時腦電圖變化的特殊性（圖 1 與圖 3），顯示出個體針對電磁輻射不良影響所啟動的自我防禦機制。對有害因子的反應中，大腦提高了優勢阿爾法節律的功率，並且其頻率也有所提高。此外，阿爾法波振幅的紡錘形調製以及低頻貝塔活動紡錘形爆發的出現更為明顯。阿爾法波振幅紡錘形調製的增加表明，在總體阿爾法活動的形成中，皮質源的增加導致了高頻分量的出現。同時，貝塔活動的爆發反映了間腦層級調節結構的參與。考慮到相關維數與熵的比較分析（圖表 5 與 6）（圖...） 7、8）顯示，當由於貝塔活動使阿爾法波的波峰變得越來越鋸齒狀時，相關維數指標越高，這可用以斷定資訊被以更高速度且更精確地處理。換言之，在存在 AIRES 共振器的情況下，手機的外來電磁輻射由一個負面因素轉變為一個使中樞神經系統──身體的中央控制系統──的功能狀態與環境的本質狀態相協調的因素。

CONCLUSION **結論**

Using the example of the influence of a mobile phone's EMR, we analyzed how the human brain's BEA, the chief link in the regulation of the body's structural and dynamic processes, responds to the external multifrequency influence of technogenic EMR. The influence of a mobile phone's EMR on the human brain's BEA indicators that reflect a decrease in the level of functional state of the central nervous system has been reliably demonstrated. A group of persons possessing socalled "flat" EEGs, who respond most acutely to the disorganizing influence of a mobile phone's EMR, was identified.

以手機電磁輻射的影響為例，我們分析了人類大腦腦電生物電活動（BEA）——作為調節身體結構與動態過程的主要環節——如何對技術性多頻電磁輻射的外來影響作出反應。已可靠地證明，手機電磁輻射對反映中樞神經系統功能狀態下降的人類大腦 BEA 指標具有影響。我們還識別出一組具有所謂“平坦”腦電圖的人，他們對手機電磁輻射的擾亂性影響反應最為敏感。

Comparative analysis of the influence of of a mobile phone's EMR on EEG indicators in the presence of an AIRES resonator and outside of its presence made it possible to conclude that the presence of the AIRES resonator minimizes the negative influence of a mobile phone's EMR

比較分析在有無 AIRES 共振器存在下，行動電話電磁輻射對腦電圖指標影響的差異，使得得出結論：AIRES 共振器的存在可將行動電話電磁輻射的負面影響降至最低。

, involving regulatory structures of the diencephalic level in the response. Thus, the presence of an AIRES resonator creates the conditions for the formation of structural and dynamic consistency with the current level of the functional state of the central nervous system and the biological organism's habitat, following the minimum variations in the dominant frequencies of the environment.

涉及間腦水平的調節結構作為反應的一部分。因此，AIRES 共振器的存在創造了條件，使中樞神經系統功能狀態當前水平與生物有機體生活環境在結構與動態上達成一致，並以環境主導頻率的最小變動為依歸。

The obtained results provide reliable evidence of the effectiveness of using AIRES resonators to minimize the negative effects of external technogenic fields and radiation.

所得結果提供了可靠證據，顯示使用 AIRES 共振器能有效將外來人為場與輻射的負面影響降到最低。

Candidate of Biological Sciences

生物科學候選人

L. Rybina

BIBLIOGRAPHY **參考書目**

Odinaev F.I., Odinaev Sh.F., Shafiev Sh.I., Shutova S.V. Electromagnetic radiation and human health. 2015.

Odinaev F.I., Odinaev Sh.F., Shafiev Sh.I., Shutova S.V. 電磁輻射與人體健康。2015。

Votyaeva O.A., Teksheva L.M., Kurganskiy A.M. Physiological and hygienic assessment of the influence of mobile phones of various radiation intensity on the functional state of the brain of children and adolescents by the method of electroencephalography. Tomsk State University Bulletin. 2016. Issue 3(168). pp. 210-213

Votyaeva O.A., Teksheva L.M., Kurganskiy A.M. 以腦電圖法對不同輻射強度之行動電話對兒童與青少年腦功能狀態影響的生理與衛生學評估。湯斯克州立大學學報。2016。第 3 期（168）。第 210-213 頁

Evstafiev V.N., Skiba A.V., Gozhenko S.A. Outlooks for the development of mobile cellular communications. Pressing problems of transport medicine. 2017. No. 3 (49). 133-137

Evstafiev V.N., Skiba A.V., Gozhenko S.A. 行動蜂窩通信發展展望。運輸醫學的緊迫問題。2017。第 3 期（49）。133-137

Pobachenko S.V., Ponomarev A.V. Comparative evaluation of the impact of activation of the main cellular communication standards on the human brain's electrogenesis. Biomedical radio electronics. 2010. No. 3. pp. 2-9

Pobachenko S.V., Ponomarev A.V. 主要蜂窩通信標準激活對人體大腦電生成功能影響的比較評估。生物醫學無線電電子學。2010。第 3 期。第 2-9 頁

Zubrilkin A.I., Pobachenko S.V., Ponomarev A.V. Biotropy of the parameters of active radiation of mobile phones. Proceedings of higher educational institutions. Physics. 2012. Vol. 55, No. 8/3 pp. 3-9

Zubrilkin A.I., Pobachenko S.V., Ponomarev A.V. 行動電話主動輻射參數的生物效應。高等院校論文集。物理學。2012。第 55 卷，第 8/3 期，第 3-9 頁

Hamblin D.L., Wood A.W. Effects of mobile phone emission on human brain activity and sleep variables. International Journal of Radiation Biology. 2002. Vol. 78, No. 8? pp. 659-669

Hamblin D.L., Wood A.W. 行動電話輻射對人類大腦活動及睡眠變數的影響。國際輻射生物學期刊。2002。第 78 卷，第 8 期？第 659-669 頁

Croft, R.J., Hamblin D.L., Spong J. et al. The effect of mobile phone electromagnetic fields on the alpha rhythm of human electroencephalogram. Bioelectromagnetics. 2008/ No. 1. pp. 1-10

Croft, R.J., Hamblin D.L., Spong J. 等人。行動電話電磁場對人類腦電圖阿爾法節律的影響。Bioelectromagnetics。2008 年 / 第 1 期。第 1–10 頁

APPENDIX 附錄

Table 1: SCENARIO TABLE TABLE 1

表 1：情境表 表 1

\captionsetup{labelformat=empty}

No. 編號	SURNAME	BASELINE1 2020 基線 1 2020	WAITING 2020 等待 2020	MP 2020	MP(+) 2020	SURNAME	BASELINE2	MP 20-19	MP(+) 20-19
1	BELOUSOV	25.3	25.03.	26.03	27.03	BELOUSOV	25.03	26.03	27.03
2	VOROBYEV	19.3	19.03	24.03	20.03	VOROVIEV	19.03	24.03	20.03
3	GRIGORIEV	20.3	20.03	25.03	24.03	GRIGORIEV	20.03	25.03	24.03
4	KOZLOV	19.3	19.03	20.03	24.03	KOZLOV	19.03	20.03	24.03
5	KUZNETSOV	05.03	05.03	13.03	12.03	KUZNETSOV	05.03	13.03	12.03
6	LOSEV	25.3	25.03.	26.03	27.03	LOSEV	25.03	26.03	27.03
7	NABIEV	26.3	26.03.	-	27.03	ODINTSOV	19.03	20.03	24.03
8	ODINTSOV	19.3	19.03	20.03	24.03	PROCHIK	19.03	24.03	20.03
9	POPOVKI	26.3	26.03.	27.03	-	RYBIN	02.03	05.03	05.03
10	PROCHIK	19.3	19.03	24.03	20.03	FEDOR.O.	13.03	20.03	11.03
11	RYBIN	02.3	02.03	05.03	03.03	SHICHKIN	25.03	26.03	27.03
12	RYBINA	12.03	12.03	16.03	18.04	BARDAKOV	12.04	18.04	12.04
13	FEDOR.O.	13.03	13.03	20.03	11.04.	KAZAKOV	11.04	11.04	19.04
14	FEDOR.A.	11.03	11.03	13.03	11.04	MASYUKOV	11.04	11.04	12.04
15	SHICHKIN	25.3	25.03.	26.03	27.03	TARANOV	11.04	11.04.	12.04.

BASELINE - AFTER EYES CLOSED - Base1 (4 min)+ Base2 ($4-5$ min) = MP powered on in "waiting" mode;

基線 - 閉眼後 - Base1（4 分）+ Base2（$4-5$ min）= MP 開機於「等待」模式；

MP - AFTER EYES CLOSED MP powered on. = "talk" mode without sound;

MP - 閉眼後 MP 開機。= 無聲的「通話」模式；

MP(+) - AFTER EYES CLOSED MP (microprocessor) powered on. = "talk" mode without sound

MP(+) - 在閉眼後微處理器(MP)開啟。= 無聲的「通話」模式

Table 2: BASELINE(1) BEA VALUES

表 2：基線(1) 腦生物電活動(BEA)值

\captionsetup{labelformat=empty}

		AbsPwr **絕對功率**		Relative power value **相對功率值**		DFV		
	SURNAME	$\Delta+\theta$	α	$\Delta+\theta$	α	Δ	θ	α
1	BELOUSOV	323,78	396,51	24,19	34,61	2,71	6,21	9,91
2	VOROBYEV	168,46	387,71	17,43	25,51	2,92	6,01	10,71
3	GRIGORIEV	165,29	138,96	24,88	16,81	1,14	2,17	10,97
4	KOZLOV	205,07	68,74	12,99	34,33	2,31	5,08	10,18
5	KUZNETSOV	327,78	243,66	24,49	21,16	3,02	7,19	9,25
6	LOSEV	444,95	300,07	29,17	20,17	2,54	6,58	9,38
7	NABIEV	247,81	14,79	10,56	52,53	2,23	4,16	9,54
8	ODINTSOV	277,88	279,89	16,51	31,64	2,91	5,51	10,73
9	POPOVKI	248,99	24,19	1,97	5,42	2,35	5,69	10,82
10	PROCHIK	230,68	720,95	21,2	45,54	2,82	4,73	9,82
11	RYBIN	329,4	693,53	15,65	28,31	2,26	5,45	10,67
12	RYBINA	161,77	1361,76	10,16	45,28	2,53	4,11	10,31
13	FEDOR.o.	405,93	1479,42	15,57	42,48	2,61	6,15	9,26
14	FEDOR.A.	513,44	1669,09	18,05	34,33	2,81	6,48	10,21
15	SHICHKIN	475,13	273,05	17,3	26,45	1,97	5,42	12,08

Table 3: TABLE 2 **表 3：表 2**

\captionsetup{labelformat=empty}

AbsAmp **絕對振幅**		
Δ	θ	α
136,05	187,12	279,96
135,84	117,06	204,71
116,26	83,33	126,31
54,64	125,71	283,51
121,64	94,04	140,53
180,11	112,72	106,09
130,89	112,57	396,21
113,82	91,38	153,55
162,83	106,33	309,13
165,51	7,22	297,41
154,79	172,11	206,12
65,05	124,54	344,53
133,46	173,61	383,82
206,61	182,35	358,71
205,61	182,75	358,71

BEA VALUES IN "WAITING" MODE TABLE 3

「等待」模式下的腦電活性值 表 3

		AbsPwr **絕對功率**		Relative power value **相對功率值**		DFV			AbsAmp		
	SURNAME	$\Delta+\Theta$	α	$\Delta+\Theta$	α	Δ	θ	α	Δ	θ	α
1	BELOUSOV	348,51	93,08	20,37	17,73	2,72	6,34	9,89	107,11	183,11	188,11
2	VOROBYEV	533,24	66,16	22,43	12,35	2,66	4,93	8,88	186,22	174,27	89,38
3	GRIGORIEV	318,11	54,56	48,99	6,75	3,06	4,84	9,26	154,79	119,41	82,01
4	KOZLOV	267,51	48,22	36,34	10,76	2,35	5,45	9,16	105,18	97,19	77,51
5	KUZNETSOV	305,57	274,47	33,22	27,42	2,79	6,13	8,58	142,64	131,91	153,02
6	LOSEV	486,65	85,11	48,01	8,63	2,52	4,85	8,82	145,89	195,04	361,57
7	NABIEV	248,61	147,66	10,51	52,93	2,23	6,16	9,58	130,89	182,57	206,21
8	ODINTSOV	109,03	114,98	16,98	19,22	2,66	4,71	9,28	79,93	80,11	113,18
9	POPOVKI	384,29	106,01	37,13	10,25	2,58	5,17	10,04	126,72	126,17	114,18
10	PROCHIK	315,77	49,98	42,26	5,92	2,27	4,56	8,67	135,01	147,73	78,56
11	RYBIN	253,59	857,74	11,01	23,87	2,06	4,03	10,06	116,99	127,78	313,13
12	RYBINA	354,48	718,66	28,82	10,77	2,55	5,35	8,71	111,7	166,08	121,17
13	FEDOR.o.	316,11	742,66	15,72	33,06	3,16	5,26	8,55	141,49	137,05	290,79
14	FEDOR.A.	379,75	716,91	15,64	33,7	2,51	4,31	10,0	143,47	164,19	295,09
15	SHICHKIN	475,13	99,29	39,95	8,68	4,93	5,42	9,89	152,49	154,92	83,63

BASELINE(2) BEA VALUES **基線(2) 腦電生物電活動值**

Table 4: TABLE 4 **表 4：表 4**
\captionsetup{labelformat=empty}

		AbsPwr **絕對功率**		Relative power value **相對功率值**		DFV			AbsAmp **絕對振幅**		
	SURNAME	$\Delta+\Theta$	α	$\Delta+\theta$	α	Δ	θ	α	Δ	θ	α
1	BELOUSOV	323,78	396,51	24,19	34,61	2,71	6,21	9,91	136,05	187,12	279,96
2	VOROBYEV	168,46	387,71	17,43	25,51	2,92	6,01	10,71	135,84	117,06	204,71
3	GRIGORIEV	165,29	138,96	24,88	16,81	1,14	2,17	10,97	116,26	83,33	126,31
4	KOZLOV	205,07	68,74	12,99	34,33	2,31	5,08	10,18	54,64	125,71	283,51
5	KUZNETSOV	327,78	243,66	24,49	21,16	3,02	7,19	9,25	121,64	94,04	140,53
6	LOSEV	444,95	300,07	29,17	20,17	2,54	6,58	9,38	180,11	112,72	106,09
7	ODINTSOV	277,88	279,89	16,51	31,64	2,91	5,51	9,54	130,89	112,57	396,21
8	PROCHIK	230,68	720,95	21,21	45,54	2,82	4,73	10,73	113,82	91,38	153,55
9	RYBIN	329,41	693,53	15,65	28,31	2,26	5,45	10,82	162,83	106,33	309,13
10	FEDOR.O.	405,93	1479,92	18,05	34,33	2,81	6,48	9,26	133,46	173,61	383,82
11	SHICHKIN	475,13	273,05	17,31	26,45	1,97	5,42	9,81	205,61	182,35	358,71
12	BARDAKOV	361,89	1107,96	13,45	41,54	2,21	5,63	9,81	154,22	135,66	359,36
13	KAZAKOV	529,88	882,06	23,07	36,68	2,41	5,77	10,09	154,89	187,59	314,32
14	MASLUKOV	513,44	1669,09	18,05	34,33	2,81	6,48	10,21	206,61	182,35	358,71
15	TARANOV	509,15	1546,26	16,28	47,92	2,12	6,59	10,54	205,61	182,75	358,71

Table 5: BEA VALUES IN MP MODE TABLE 5

表 5：MP 模式下的腦電生物電位值 表 5

\captionsetup{labelformat=empty}

		AbsPwr **絕對功率**		Relative power value **相對功率值**		DFV			AbsAmp **絕對振幅**		
	SURNAME	$\Delta+\Theta$	α	$\Delta+\theta$	α	Δ	Θ	α	Δ	θ	α
1	BELOUSOV	348,51	93,08	20,37	17,73	2,72	6,34	9,89	107,11	183,11	188,11
2	VOROBYEV	533,24	66,16	22,43	12,35	2,66	4,93	8,88	186,22	174,27	89,38
3	GRIGORIEV	318,11	54,56	48,99	6,75	3,06	4,84	9,26	143,37	117,64	171,31
4	KOZLOV	267,51	48,22	36,34	10,76	2,35	5,45	9,16	105,18	97,19	77,51
5	KUZNETSOV	305,57	274,47	33,22	27,42	2,79	6,13	8,58	142,64	131,91	153,02
6	LOSEV	486,65	75,48	22,14	18,38	2,52	4,85	8,82	145,89	195,04	361,57
7	ODINTSOV	248,61	147,66	10,51	52,93	2,23	6,16	9,58	130,89	182,57	206,21
8	ODINTSOV	109,03	114,98	16,98	19,22	2,55	6,41	10,24	79,93	80,11	113,18
9	PROCHIK	384,29	106,01	37,13	10,25	2,58	5,17	10,04	126,72	126,17	114,18
10	RYBIN	315,77	49,98	42,26	5,92	2,27	4,56	8,67	135,01	147,73	78,56
11	FEDOR.O.	253,59	857,74	11,01	23,87	2,06	4,03	10,06	197,02	163,58	260,61
12	BARDAKOV	678,34	106,86	28,82	10,77	2,55	5,35	8,71	111,7	166,08	121,17
13	KAZAKOV	479,89	73,08	15,72	33,06	3,16	5,26	8,55	141,4	137,05	290,79
14	MASLUKOV	161,12	129,31	15,64	33,7	2,51	4,31	10,0	143,47	164,19	295,09
15	TARANOV	357,63	188,55	39,95	8,68	4,93	5,42	9,89	152,49	154,92	83,63

Table 6: BEA VALUES IN MP+ MODE TABLE 6

表 6：MP+ 模式下的 BEA 值 表 6

\captionsetup{labelformat=empty}

		AbsPwr 絕對功率		Relative power value 相對功率值		DFV			AbsAmp 絕對振幅		
	SURNAME	$\Delta+\Theta$	α	$\Delta+\Theta$	α	Δ	θ	α	Δ	θ	α
1	BELOUSOV	391,23	765,53	18,91	36,25	2,33	5,66	10,47	137,11	168,55	300,53
2	VOROBYEV	422,28	96,89	22,06	5,15	2,61	5,05	10,62	175,47	146,16	108,87
3	GRIGORIEV	196,23	107,71	27,2	16,7	2,71	5,36	10,89	113,39	98,01	114,91
4	KOZLOV	413,65	115,81	37,65	11,21	2,23	5,81	10,6	163,23	157,47	120,54
5	KUZNETSOV	201,94	276,38	19,87	25,82	2,4	5,31	9,11	99,64	121,38	183,52
6	LOSEV	276,25	176,7	35,08	21,82	2,66	5,95	10,19	125,93	135,42	144,31
7	ODINTSOV	191,25	239,46	18,35	24,21	2,17	4,88	10,99	113,63	85,52	157,19
8	PROCHIK	591,42	318,26	39,41	19,98	3,31	6,62	9,71	170,35	203,35	189,19
9	RYBIN	284,23	439,99	20,06	30,34	2,79	3,94	9,89	109,61	149,12	226,29
10	FEDOR.O.	443,41	915,05	19,47	32,36	2,62	7,03	8,58	130,89	191,45	314,93
11	SHICHKIN	226,86	364,89	23,41	31,41	2,41	5,22	11,41	115,82	108,97	199,83
12	BARDAKOV	208,61	201,49	22,4	17,44	2,37	4,49	8,85	98,3	123,28	157,531
13	KAZAKOV	677,35	62,65	50,59	6,41	2,32	5,23	9,21	222,11	160,03	87,28
14	MASLUKOV	275,74	253,03	31,68	18,8	2,69	5,46	10,67	164,38	136,13	161,22
15	TARANOV	306,34	166,64	23,87	12,22	3,02	5,51	10,07	122,54	149,37	138,49

Table 7: STATISTICAL PROCESSING OF PAIRWISE COMPARISION

表 7：成對比較之統計處理

\captionsetup{labelformat=empty}

BASELINE and waiting 基線與等待	Wilcoxon Matched Pairs Test Marked tests are significant at p <. 05000 威爾可森配對符號檢定 標記的檢定在 p < .05000 時具有顯著性			
	Valid 有效 N	T	Z	p-value p 值
AbsPwr Baseline alpha and AbsPwr Waiting alpha 絕對功率 基線 α 以及 絕對功率 等待期 α	15	16	2,499032	0,012454
Relative power value Baseline delta theta and Relative power value Waiting theta 相對功率值 基線 δ θ 以及 相對功率值 等待期 θ	15	16	2,499032	0,012454
Relative power value Baseline alpha and Relative power value Waiting alpha 相對功率值 基線 α 以及 相對功率值 等待期 α	15	10	2,839809	0,004514

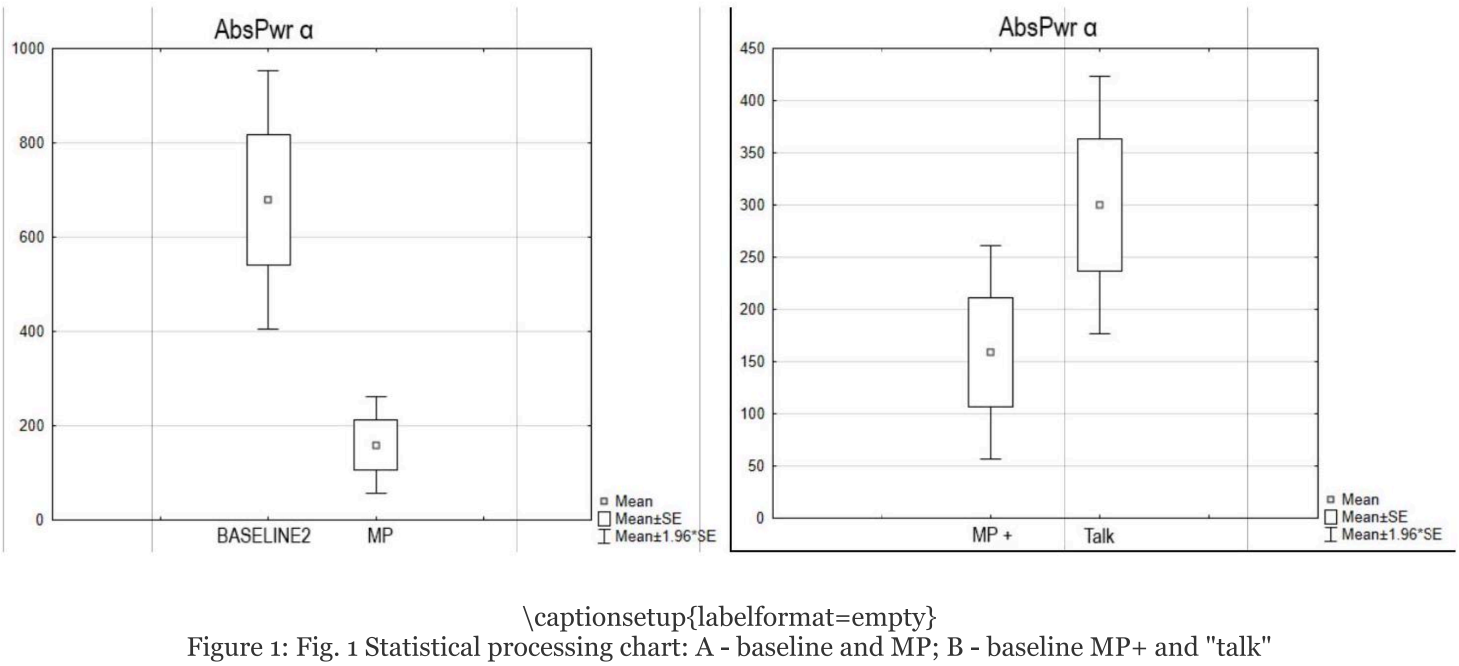
Table 8: TABLE 8 表 8：表 8

\captionsetup{labelformat=empty}

BASELINE2 and MP **BASELINE2 與 MP**	Wilcoxon Matched Pairs Test Marked tests are significant at p <. 05000 **Wilcoxon 配對樣本檢定 標記的檢定在 p < .05000 時具顯著性**			
	Valid **有效** N	T	Z	p-value **p 值**
AbsPwr a and AbsPwr a **AbsPwr a 與 AbsPwr a**	15	10	2,839809	0,004514
Relative power value α and Relative power value a **Relative power value α 與 Relative power value a**	15	15	2,555828254	0,010593997

Table 9: TABLE 9 **表 9：TABLE 9**
\captionsetup{labelformat=empty}

MP+ and Talk **MP+ 與 Talk**	Wilcoxon Matched Pairs Test Marked tests are significant at p <. 05000 Marked tests are significant at p <. 05000 **威爾科克森符號等級檢定 標記的檢定在 p < .05000 時顯著 標記的檢定在 p < .05000 時顯著**			
	Valid **有效** N	T	Z	p-value **p 值**
AbsPwr a and AbsPwr a **AbsPwr a 和 AbsPwr a**	15		18	0,017059



\captionsetup{labelformat=empty}
Figure 1: Fig. 1 Statistical processing chart: A - baseline and MP; B - baseline MP+ and "talk"

圖 1：圖 1 統計處理圖表：A - 基線與 MP；B - 基線 MP+ 與「通話」

Figure 2: A **圖 2：A**
\captionsetup{labelformat=empty}

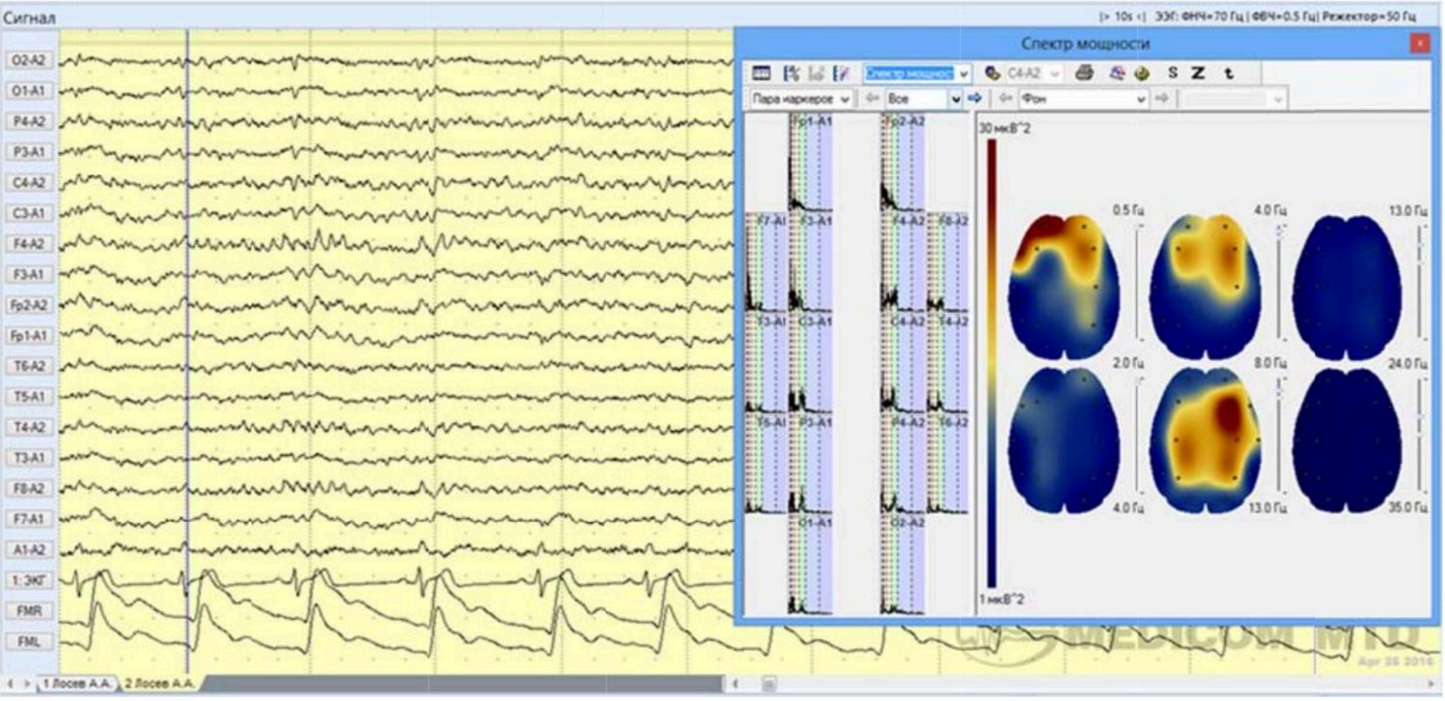


Figure 3: B 圖 **3：B**
\captionsetup{labelformat=empty}

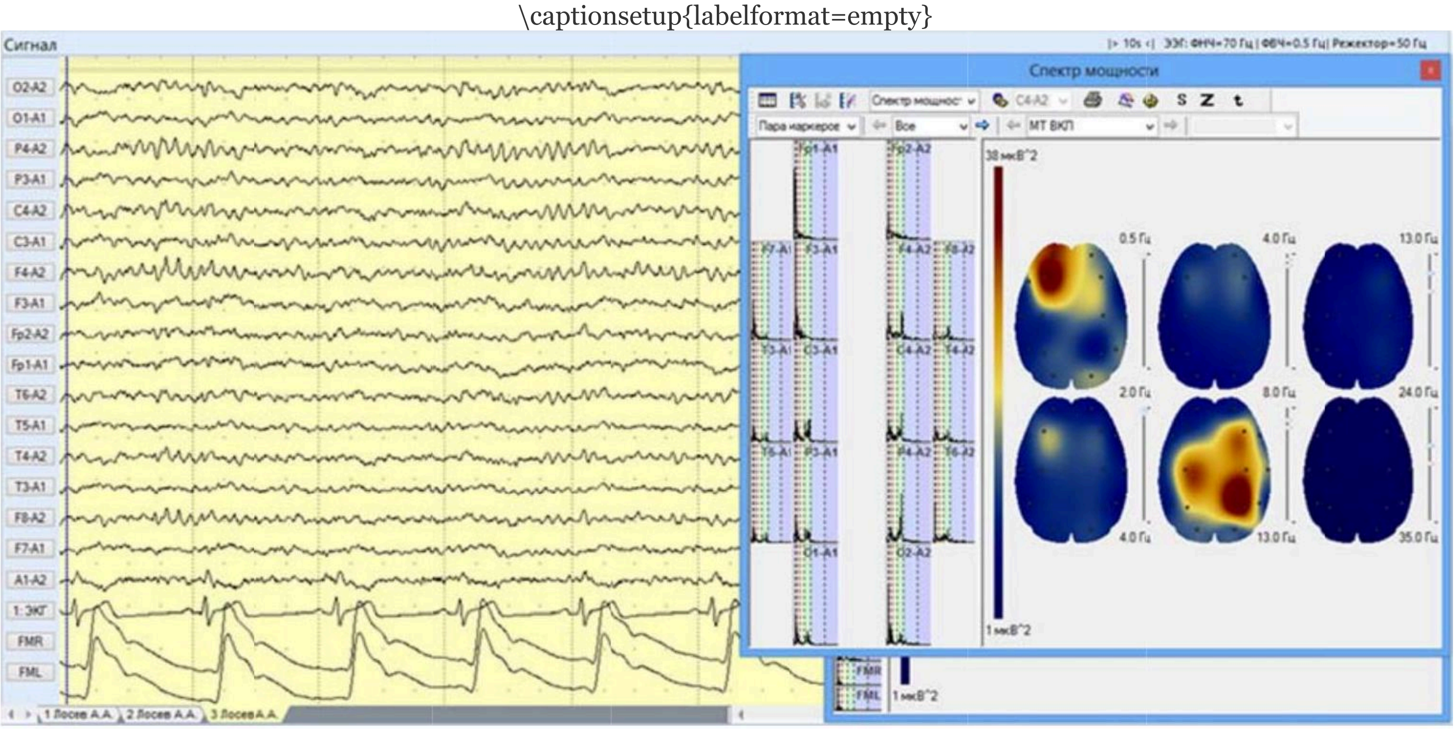


Fig. 2 EEG L-EVA: A - baseline; B - MP+

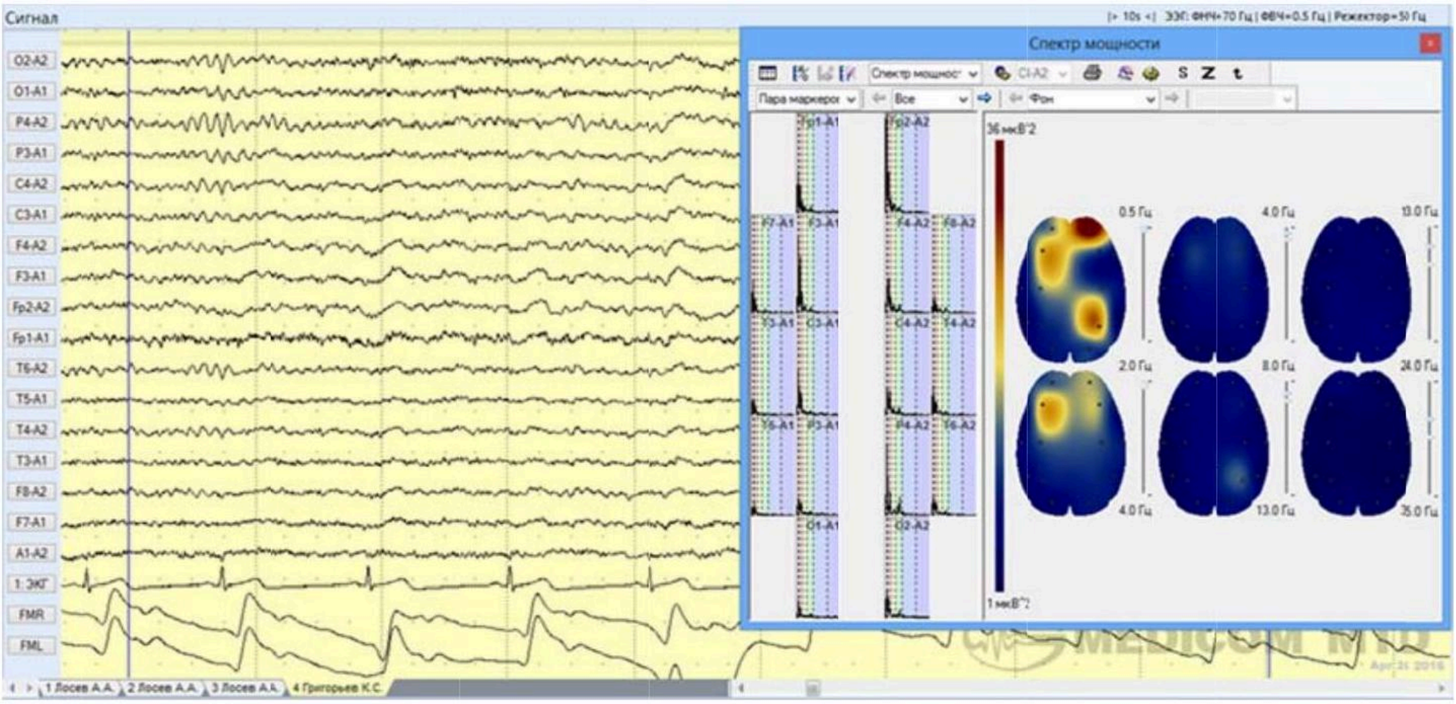
圖 2 腦電圖 L-EVA：A - 基線；B - MP+

L-ev1. Correlation dimension D2 and correlation entropy K2 for Column No. 1. Shift for the reconstructed phase space $t = 3$. The attractor converges well for a shift of $T = 3$

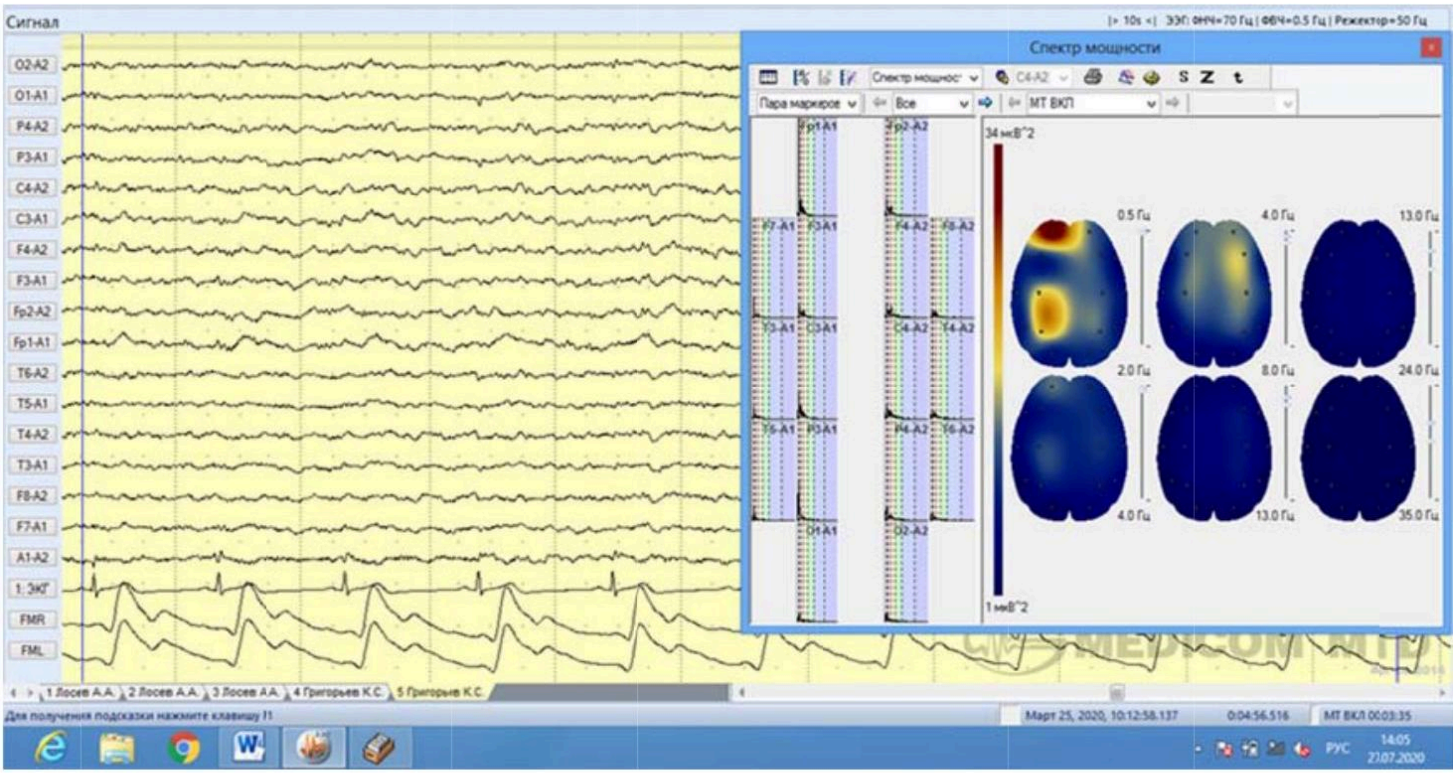
L-ev1。欄位 1 的相關維度 D2 與相關熵 K2。重構相空間的位移為 $t = 3$ **。當位移為** $T = 3$ **時，吸引子收斂良好**

	D2	K2, bit/s **K2，位元/秒**
L-ev1	6.56	129

A



B



\captionsetup{labelformat=empty}
Figure 4: Fig. 3 EEG G-EVA: A - baseline; B - MP+

圖 4：圖 3 腦電圖 G-EVA：A - 基線；B - MP+

G-ev1. Corr. dimension D2 and correlation entropy K2 for Column No. 1. Shift for the reconstructed phase space $t = 1$.

G-ev1。第 1 列的相關維度 D2 與相關熵 K2。重建相空間的延遲 $t = 1$ 。

	D2	K2, bit/s **K2，位元/秒**
G-ev 1	5.28	468

The attractor converges only for a very small shift ($t=1$). This suggests that there is a very weak correlation even between adjacent encephalogram potential values. Very high entropy suggests the same.

吸引子僅在非常小的延遲（ $t=1$ ）時收斂。這表明即使是相鄰的腦電圖電位值之間相關性也非常微弱。極高的熵值也支持相同的結論。

Figure 5: AbsPwr a **圖 5：AbsPwr a**
\captionsetup{labelformat=empty}