Neuroassistive Technologies

Sk Resident

NeuroPlay-8Cap/NeuroPlay-6C

EEG headset and NeuroPlayPro software user guide

v1.9

2022

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Before getting started

This document is an operation manual for NeuroPlay EEG headsets and NeuroPlayPro software.

The whole line of the NeuroPlay series of headsets is available at www.neuroplay.ru and includes a wide range of devices: NeuroPlay-6C, NeuroPlay-8Cap and NeuroPlay-8M. Unless otherwise specified, the information given is correct for the entire line of products.

We recommend that you carefully read and understand this manual before using the products. The manual contains detailed information and instructions necessary for the proper and safe operation of the products.

Due to continuous product improvement, specifications and software are subject to change without notice.

Please inform the manufacturer of any errors or malfunctions you have encountered while using the products and software.

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Safety warnings and precautions

Please take note of the safety instructions to prevent any potential accident or misuse of the EEG headset.

Safety precautions are given in three forms as detailed below:

- *Contraindications* – failure to follow the instructions may cause personal injury
- *Precautions* – failure to follow the instructions may cause product damage
- *Warnings* – additional information or tips

Contraindications

Do not place electrodes on damaged or irritated skin areas

Do not use the devices for people who are allergic to silver or have hypersensitive skin. In these cases, we recommend that you consult a specialist

Do not touch the cable or the device with wet hands while charging – this may result in electric shock

Do not use the device for medical purposes - for health monitoring and diagnosis - either in a medical department or at home

Do not use the device during a thunderstorm (increases the risk of electric shock)

Safety precautions

Do not apply excessive force when plugging the charging cable into the device’s micro-USB port. When disconnecting the charging cable, pull it gently toward you without rocking it from side to side or up and down

Charge the device only with the included USB cable. Its connector is covered with soft plastic and ensures that the micro-USB port into the device remains intact

Do not use damaged chargers and outlets

Avoid any bends or damage to the charging cable

Do not expose this product to rain or moisture

This product is a highly sensitive electronic device. Avoid static discharges. Do not operate in strong electrostatic, electromagnetic or magnetic fields. The influence of these external fields can reduce the signal-to-noise ratio and result in noisy data unsuitable for further processing and analysis

Do not disassemble or repair the device on your own. In the event of damage, contact the manufacturer's technical support service

Keep the device and charging cable away from heating devices (kitchen and microwave ovens, radiators, etc.). The battery may explode if heated strongly

High and low temperatures can cause damage to the headset and the battery

The device must be operated in the temperature range from +1 to +40 °C and relative humidity of no more than 80% at a temperature of +25 °C. There must not be caustic substances (alkalis, acids, esters, etc.) and a high concentration of dust in the premises during operation

The product should be disposed of at designated collection points. Please contact your local authorities for further instructions on disposing of the product.

Acronyms used in this manual

BCI - brain-computer interface

OS - operating system

EEG - electroencephalogram (electrical activity of the brain)

Device specifications

Device assignment

NeuroPlay is intended to record the brain's biopotentials known as the electroencephalogram (EEG). In addition to brain signals, these biopotentials may contain artifacts, both physiological, i.e. caused by ocular and chewing muscles movements, and instrumental, such as cues from electrical devices, primarily lighting devices.

The recorded signals are transmitted wirelessly in real-time to a computer, tablet, or smartphone for further filtration and analysis, including calculation of spectra, rhythm indices, concentration and meditation indices and data files recording. Calculated real-time EEG characteristics can be used for biofeedback training in a set of built-in interactive games. These games are also available on braincomputer.io.

Intended use

NeuroPlay EEG headsets can be used to develop applications for:

- EEG recording
- concentration training ("beta-training")
- relaxation training ("alpha-training"), including various meditative practices
- neuropiloting (e. g. control of real and virtual objects using the brain-computer interface)
- sports and fitness
- sleep quality assessment
- industrial safety provision
- driver and passenger safety monitoring
- neuromarketing
- cybersports, etc.

Technical specifications

	NeuroPlay-6C	NeuroPlay-8Cap
Channels (according to «10-20» EEG system)	6+2: Fp1, Fp2, T3, T4, O1, O2, GND (forehead), REF (left earlobe)	8+2: F3, F4, C3, C4, P3, P4, O1, O2, GND (forehead), REF (left earlobe). Channel placement can be manually changed
Electrode coating	Ag/AgCl, ~350 working cycles, no gel required	
Electrode schema	monopolar	
Electrode types	flat (forehead), short-spiked (temporal), long-spiked (occipital)	
Data transfer	Bluetooth 4.0 (BLE), up to 15 meters	
Sampling rate	125 Hz	
Input bandwidth	0,5-50 Hz (-3dB level)	
Input range	±300 μV	
Self-noise	3-4 μV peak-peak	
Battery life in standby mode	not less than 100 days	
Battery life in acquisition mode	not less than 20 hours	
Weight	not more than 85 g	
Supported OS	Windows 10+ x64, Ubuntu/Manjaro 20+, macOS 10+ Android 10+, iOS 15+	
Charging	5 V, 150 mA, max charge time ≤5 hours	
Headband/helmet material	neoprene	

User device requirements

Requirements for desktop computers

- OS: Windows 10+ x64, macOS 10.15+, Ubuntu/Manjaro 20+
- CPU: Intel Core i3-3240 or better
- RAM (minimum): 4 Gb
- Hard disk space (minimum): 1 Gb
- Screen resolution (minimum): 1024x768
- Built-in Bluetooth module or at least one USB 2.0 port for a Bluetooth USB-adapter

Requirements for smartphones or tablets

- OS: Android 9+, iOS 15+
- Screen resolution not less than 320x420
- Bluetooth 4 support

Charge requirements

Any USB port (5V, ≥100 mA).

Label description

The label on the NeuroPlay-6C contains the following information:

- device model
- serial number

The label on the NeuroPlay package contains the following information

- manufacturer
- device model
- symbols

Using the headset

Channel (electrode) placement

NeuroPlay is a wireless EEG-bioamplifier with dry active electrodes (no electroconductive gel is required).

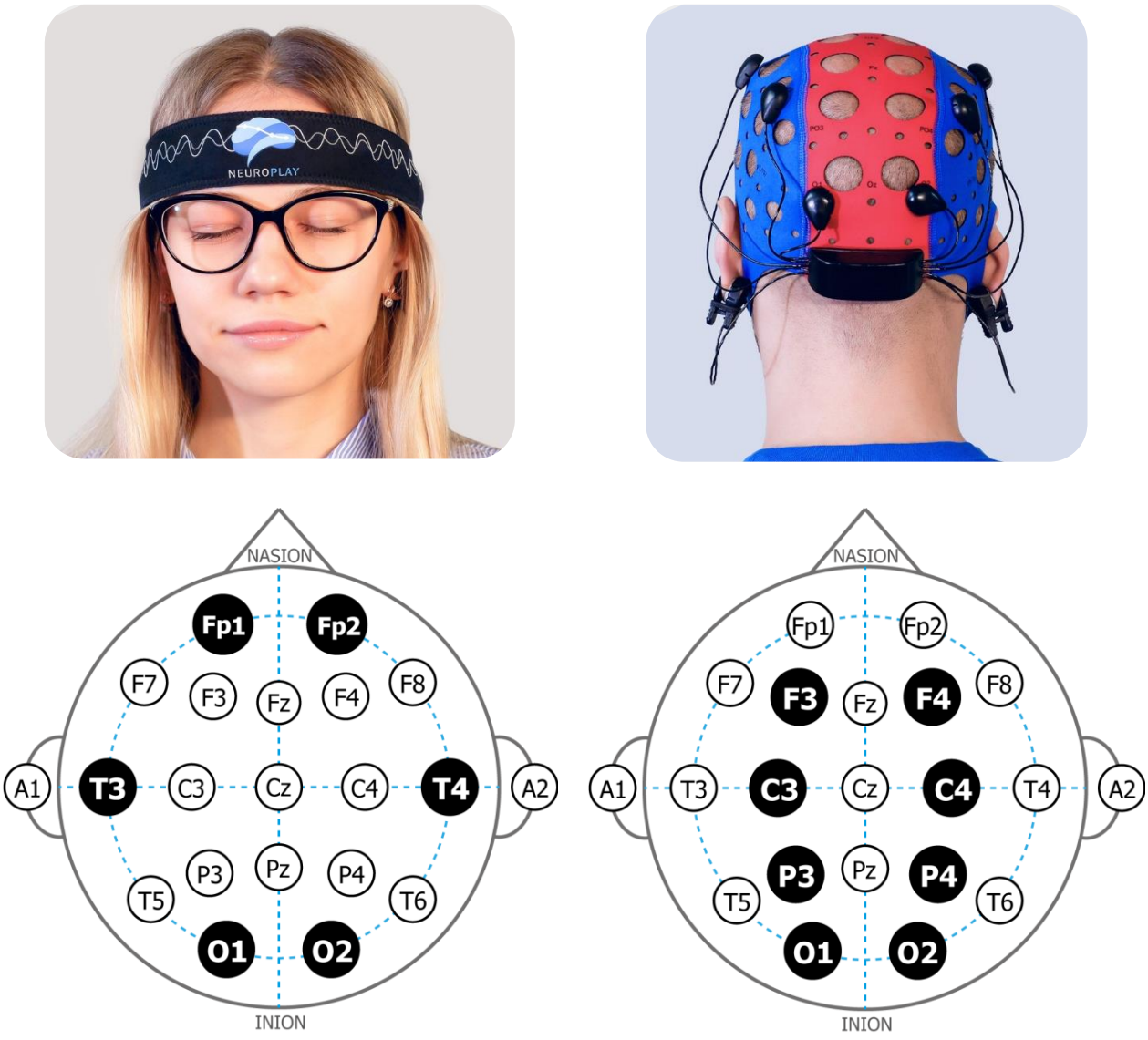


Fig. 1. NeuroPlay-6C (top left), NeuroPlay-8Cap (top right), electrode placement according to 10-20 EEG system (under each device)

NeuroPlay-6C: • Fp1 and Fp2 – forehead area (aside GND) • T3 and T4 – temporal area • O1 and O2 – occipital area	NeuroPlay-8Cap: • F3 and F3 – upper forehead area (aside GND) • C3 and C4 – parietal area • P3 and P4 – upper parietal area • O1 and O2 – occipital area
• GND (ground) – forehead area center (at the FpZ/Fz position)	
• REF (referent) – left earlobe clamp (A1)	

Headset status indicator

All NeuroPlay bioamplifiers are equipped with a light indicator on the back of the housing. Forms of indication states are given below (Table 1):

No indication	The device is either in "sleep mode" or its battery is discharged. Shake the device to activate (an internal accelerometer wakes it up). The status LED will start blinking green rarely. Be sure to charge the battery in case no LED indication appeared after shaking.
Rare green blinks (once per 3 seconds)	Ready to connect
Frequent green blinks (once per second)	Scanning for devices / Connection is being established
Flashing green blinks (flashes)	The data is being transmitted to a computer or smartphone.
Red light (in any of the above states)	The battery is running out. Stop using the device and be sure to charge the battery

Table 1. LED-indication of NeuroPlay EEG headset status

Standby mode and activation

NeuroPlay headsets are not equipped with a power switch. For energy saving, the device automatically retires to sleep mode after a certain period of time. In this mode, the status LED is off. The standby time lasts not more than 100 days.

The device is activated by the built-in accelerometer. Slightly shake the device to wake it. After that, the LED indicator starts flashing green once every 3 seconds. The headset automatically retires to sleep mode in case no user device (smartphone/PC) is connected to the headset within 15 minutes.

Preparing for use

Once the device is activated (the status indicator blinks green occasionally), it is ready for use. Connect to the software within 15 min after activation (see also "NeuroPlayPro software" for detailed information on connection settings).

After connection, the device enters the acquisition mode and transmits data to the paired device (the status indicator blinks frequently). The standby time of the headset in the data capture mode is about 24 hours.

It is recommended that the user's head and hair are clean (wash the head in case of dirty or greasy hair; do not use nail polish or other styling products) to ensure good signal quality. The user's forehead must be degreased and the face (forehead) must be washed off from makeup. It is recommended that the forehead and left earlobe are treated with a degreasing solution (e.g. alcohol-ether mixture).

Since no electroconductive substance such as gel or physiological solution is applied when using NeuroPlay headsets, there is no need to treat the hair after using the headset.

After-usage maintenance

Use cases:

1. Individual
2. Shared (multi-user)

Individual use implies the same person to use the device continuously for numerous days. Clean the headset of visible dirt using a soft cloth every 10 uses.

In case of shared use, it is necessary to observe hygienic requirements and wipe both the inner surface of the neoprene headband and the surface of all electrodes (including the ear electrode) after each use with a soft cloth moistened with alcohol or alcohol-ether solution. Do not allow moisture to get inside the device.

Since frequent treatment may cause faster degradation of the electrode material, pay specific attention to the surface condition of the electrodes. Replace the electrodes with new ones as soon as silver and silver chloride mixture coating has lost its integrity and the under-surface structure of the electrodes becomes visible. The coating provides at least 350 use cycles for each electrode.

Battery charging

Charge the battery if the status LED turns red.

A full charging cycle lasts no more than 5 hours.

After the battery is charged the device automatically enters sleep mode.

Do not apply excessive force when plugging the micro-USB cable into the device micro-USB port. When disconnecting the charging cable, pull it gently toward you without rocking it from side to side or up and down.

NeuroPlay software

A variety of software tools can be used to work with the NeuroPlay headsets – the choice of application depends on the user's goals.

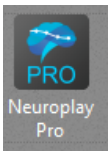
Several applications are available at https://neuroplay.ru/en/support/ (in *Applications and Downloads* section): NeuroPlayPro, NeuroPlay, Cortex.

NeuroPlayPro is the most versatile software supported on a variety of platforms. This software offers a user-friendly interface for cognitive training and biocontrol. Cortex is more oriented to scientific research and only available for Windows.

NeuroPlayPro installation

Download the desktop version of NeuroPlayPro at neuroplay.ru/en/: choose the appropriate version depending on your OS (Windows, Linux, macOS). For Android, download our app from Google Play Market. For iOS, download our app from the AppStore.

Run the installer and follow the instructions. The application icon appears on your computer's desktop once the installation is complete.



User interface

The application window has several tabs on the left:

- *Device* – headset connection and settings. Signal, spectrum and rhythms representation, meditation, concentration and discrete mental states
- *Games* – the built-in access to https://braincomputer.io.
  Log in to use games, tests and training features.
- *Records* – EDF/BDF files browser.
- *Settings* – application settings
  About – software information, link to API, the newest version of this user manual and changelog.

Connecting to NeuroPlay headsets

Click the “Start searching” button on the application’s startup screen to get the list of available NeuroPlay devices, their serial numbers, number of channels and sampling rates.

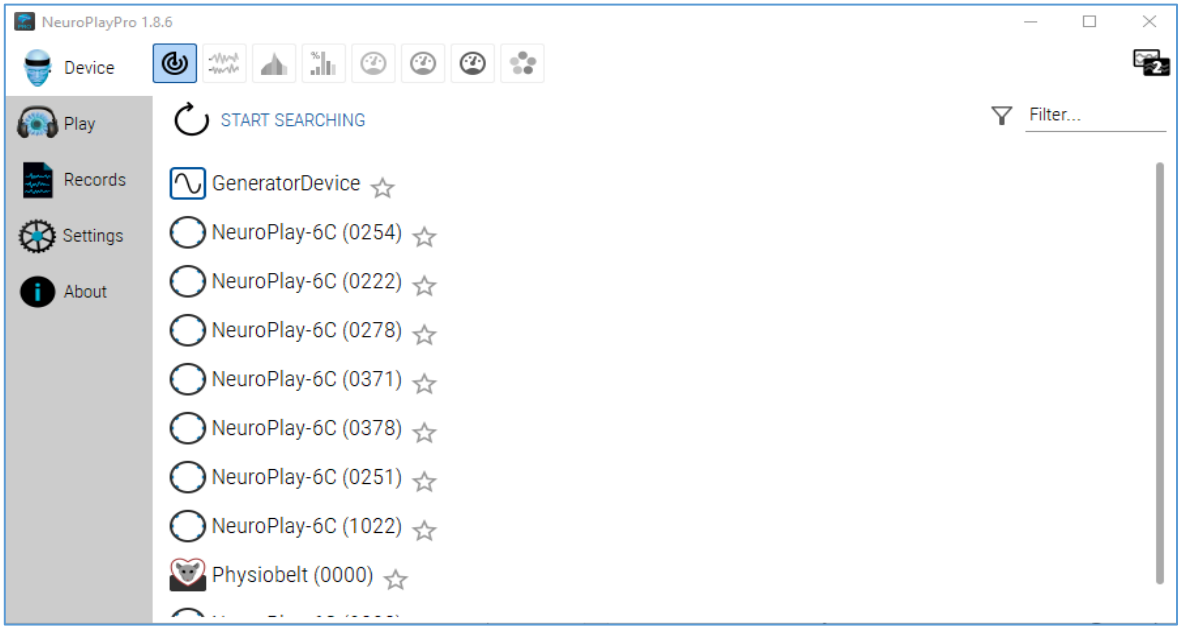


Fig. 2. Device search page

To enable quick connection to a certain device, click the “Favorite” (star) icon. Connection to this device will be automatically established once it becomes available.

Once the device is connected, other pages of signal processing and representation become available.

Signals and data quality control

The top area of the window consists of buttons corresponding to different types of signal representation modes – device search, raw signals, spectrums representation, rhythms, meditation, concentration and custom integral indexes.

In signal representation mode the software displays real-time EEG signals received from the chosen device (fig. 4).

To reduce artifacts from mains voltage we recommend the following settings to be set (Fig. 4): turn on the 50 Hz suppressor filter and set the bandwidth to 2 — 40 Hz.

Press the "cog wheel button" on the top right of the signal area to change the following parameters:

- Horizontal (mm/s) and vertical (μV/mm) signal display scale
- EEG filters: high pass filter (HPF), low pass filter (LPF), band-pass filter (BPF)

Push the “Record” button to start the record to an EDF file.

The battery status indicator and signal quality indicators are located to the left of the display settings button. Status indicator colors:

- Green - the signal is within the normal range
- Orange - the signal is slightly out of the normal range
- Red – noisy signal or artifacts caused by loose electrode-skin contact or electrode movement

In case an indicator turns red or orange do the following steps:

- Check the electrode-skin contact — slightly move the electrode to-and-fro and push it to ensure stable contact with the skin (hair may prevent the contact)
- Check the earlobe (REF) electrode contact

Upper right panel options (Fig 3.2.):

- Labels – text annotations during record
- Horizontal/vertical scale
- Displayed channel selection
- Data fixation (displayed data pause)

The button in the upper right corner opens a second data window. This window can be useful to monitor EEG during biofeedback sessions.

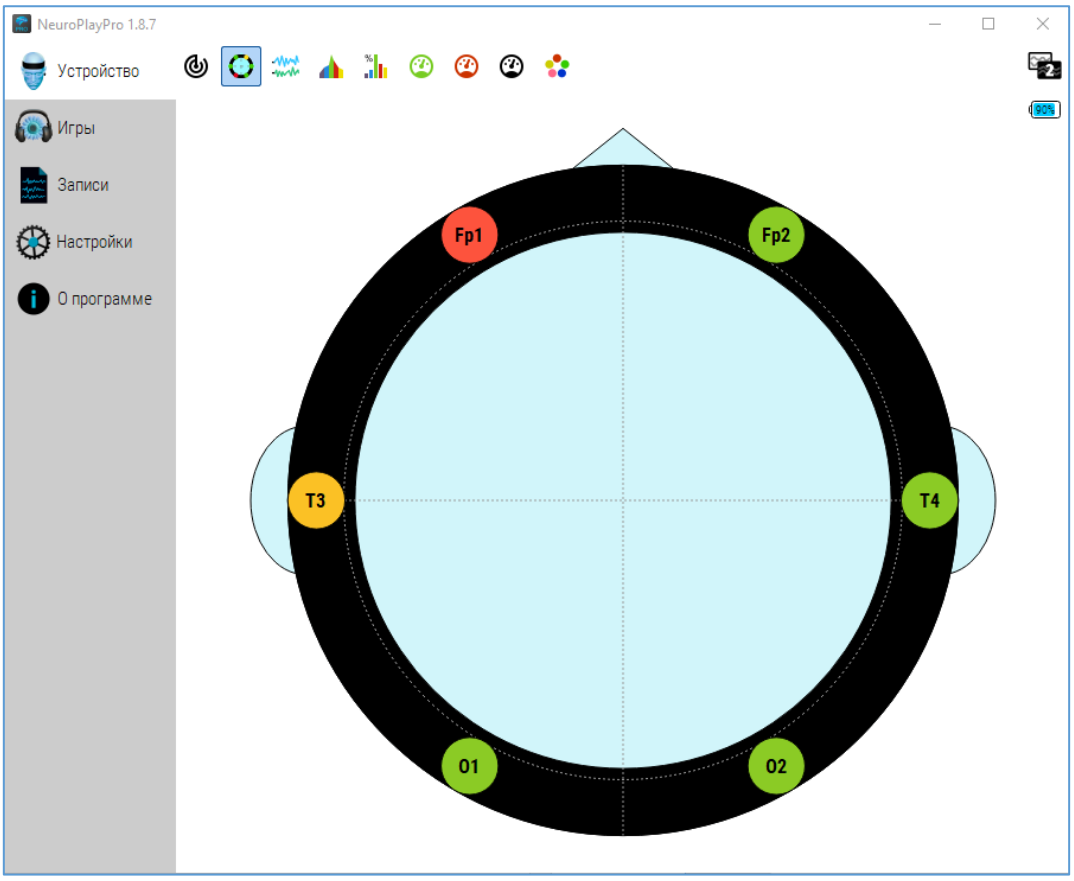


Fig. 3.1. Main page in signal quality mode (NeuroPlayPro)

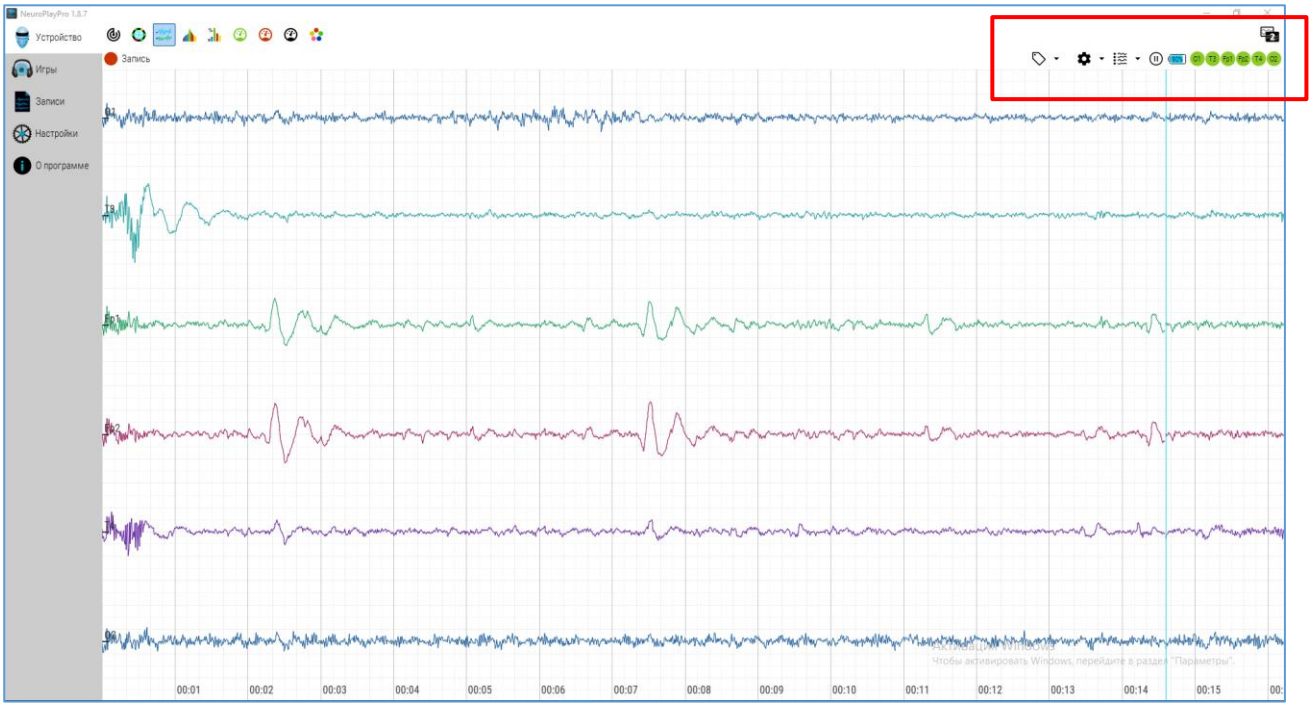


Fig. 3.2. Signal representation mode (NeuroPlayPro)

Games

Once good signal quality is established, proceed to the “Games” section (Fig. 4) to choose a game, listen to the introduction course on neuro training and biocontrol or read more on the project. User account and language drop-down menus are displayed in the top right corner of the window.

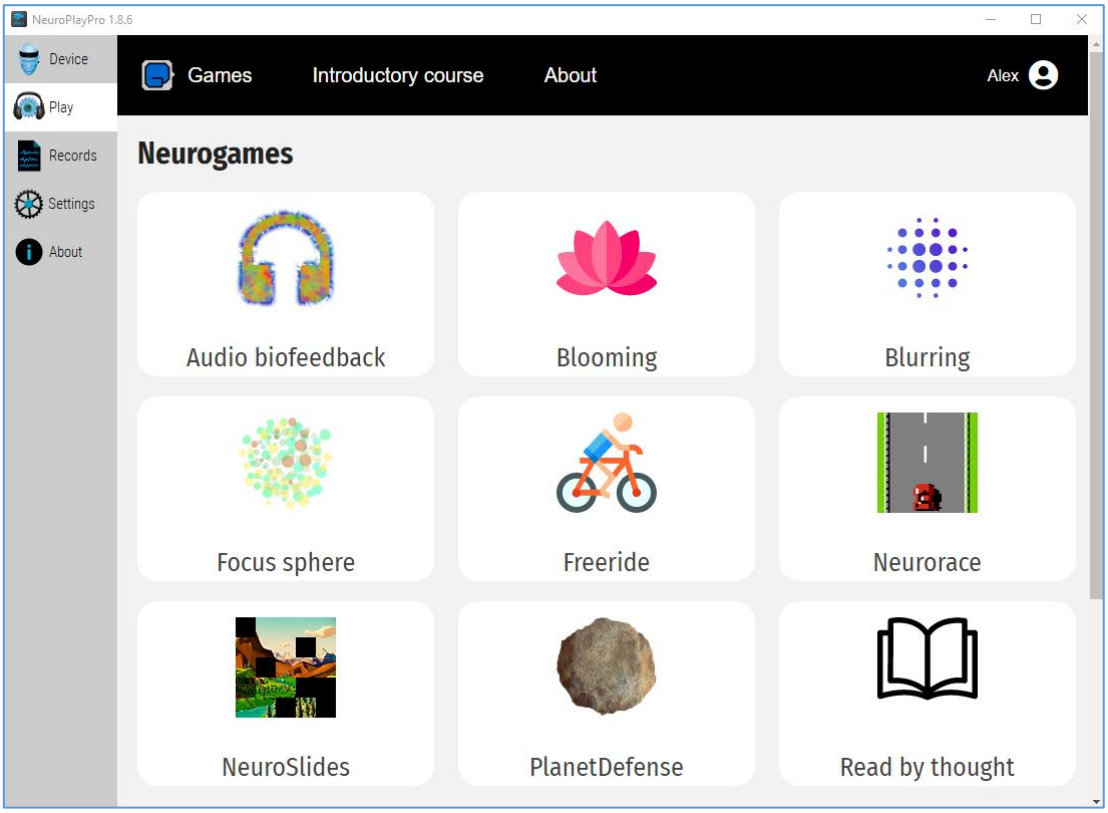


Fig. 5. Games section

The "About" section provides information regarding the purpose and features of the software (Fig. 6):

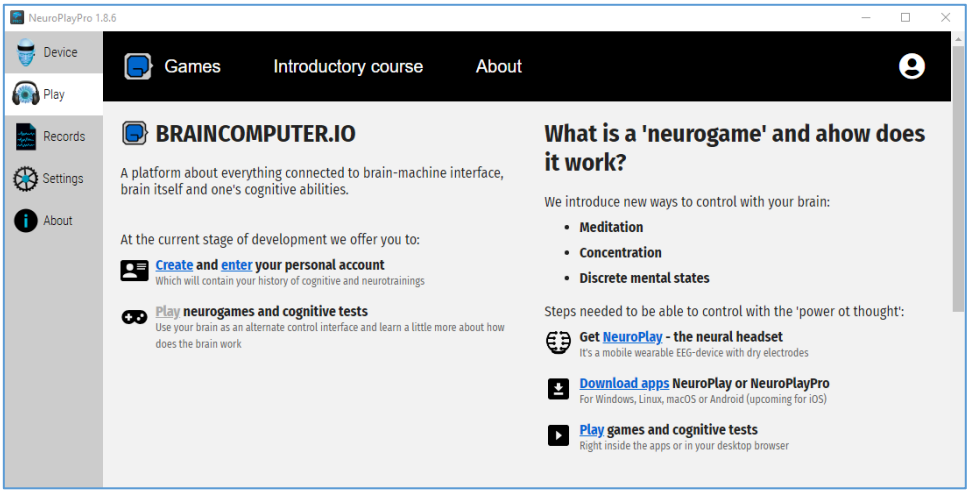


Fig. 5. “About” section

You must have a braincomputer.io account to play the games. Go to braincomputer.io to register or log in. Registration is free.

Once the game is selected you will be prompted to set its key parameters.

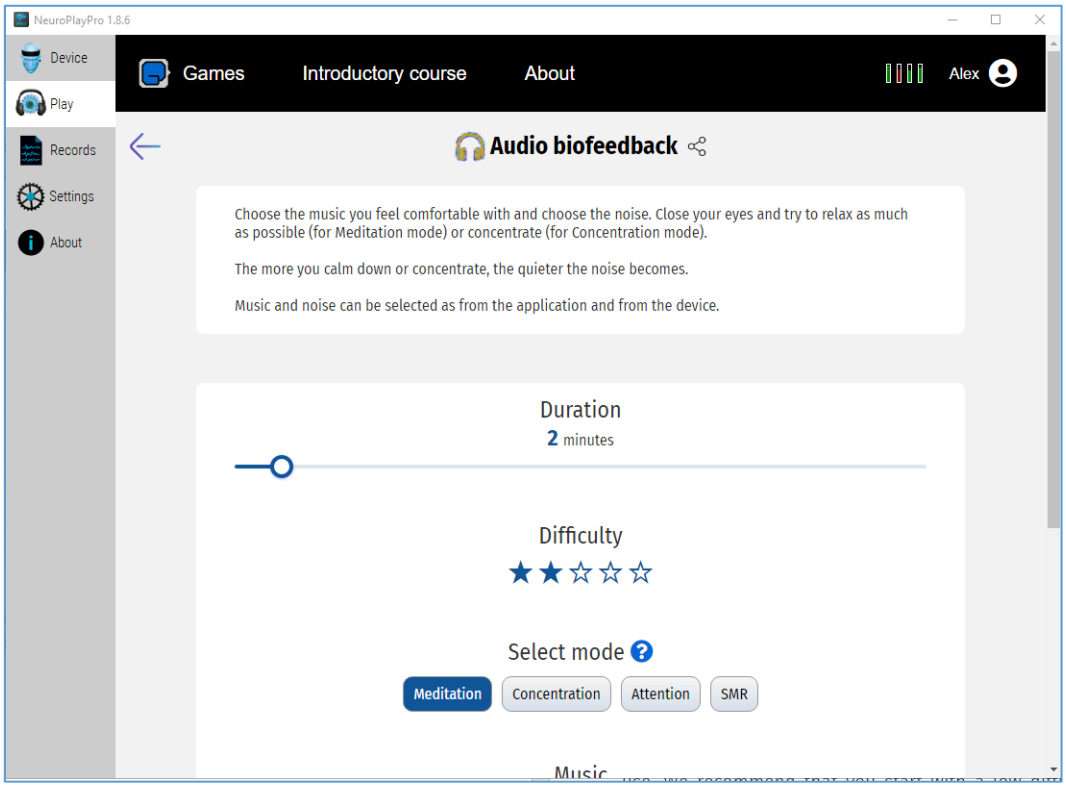


Fig. 6. Setting up the game's parameters

Use the "Duration" slider to set the game duration. Set the difficulty level via "Difficulty" selection bar from 1 (one star selected) to 5 (all stars selected). Increase the duration and difficulty gradually for comfortable use. We recommend that you start with a low difficulty level, gradually increasing it.

Choose an integral indicator of biorhythms to be used for the game controls - select "Meditation" or "Concentration" button. For more information on the training method, click on the question mark icon.

Advanced settings may be available depending on the game.

Use checkboxes to choose the following options to display:

- information panel (infobar), which displays current control level
- elapsed time counter
- the pre-game countdown option

These settings are enabled by default. To turn them off, deselect the appropriate checkboxes. Press the Play button to start the game.

Training results

Game completion results are shown automatically (Fig. 7):

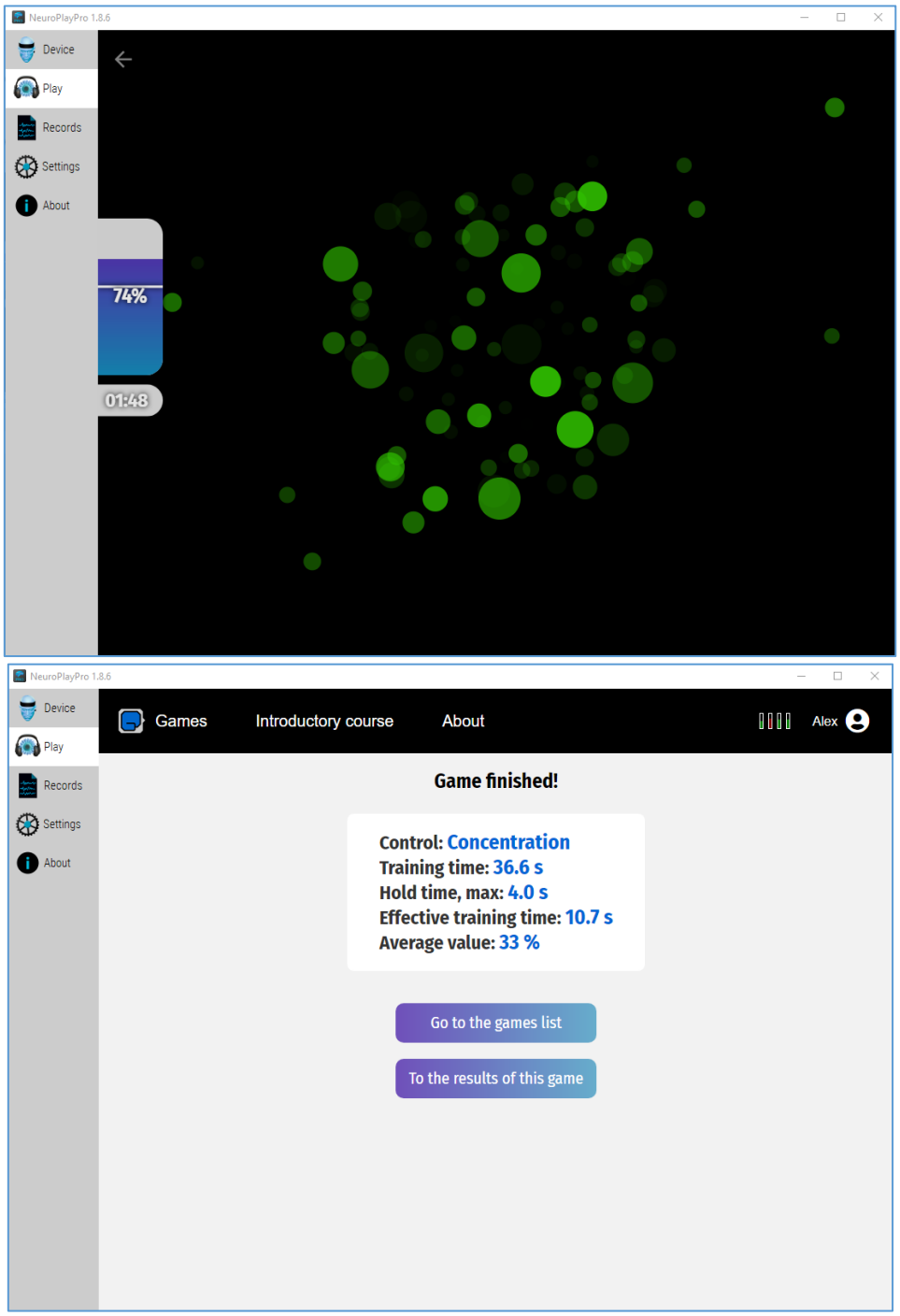


Fig. 7. Game results window

Results contain the difficulty level, the type of target state used for control and the overall training time, the time that the target state was held, the

average value of target state, the efficiency and the effective training time. You can view the training dynamics in more detail by clicking on the "To the results of this game" button (Fig. 8):

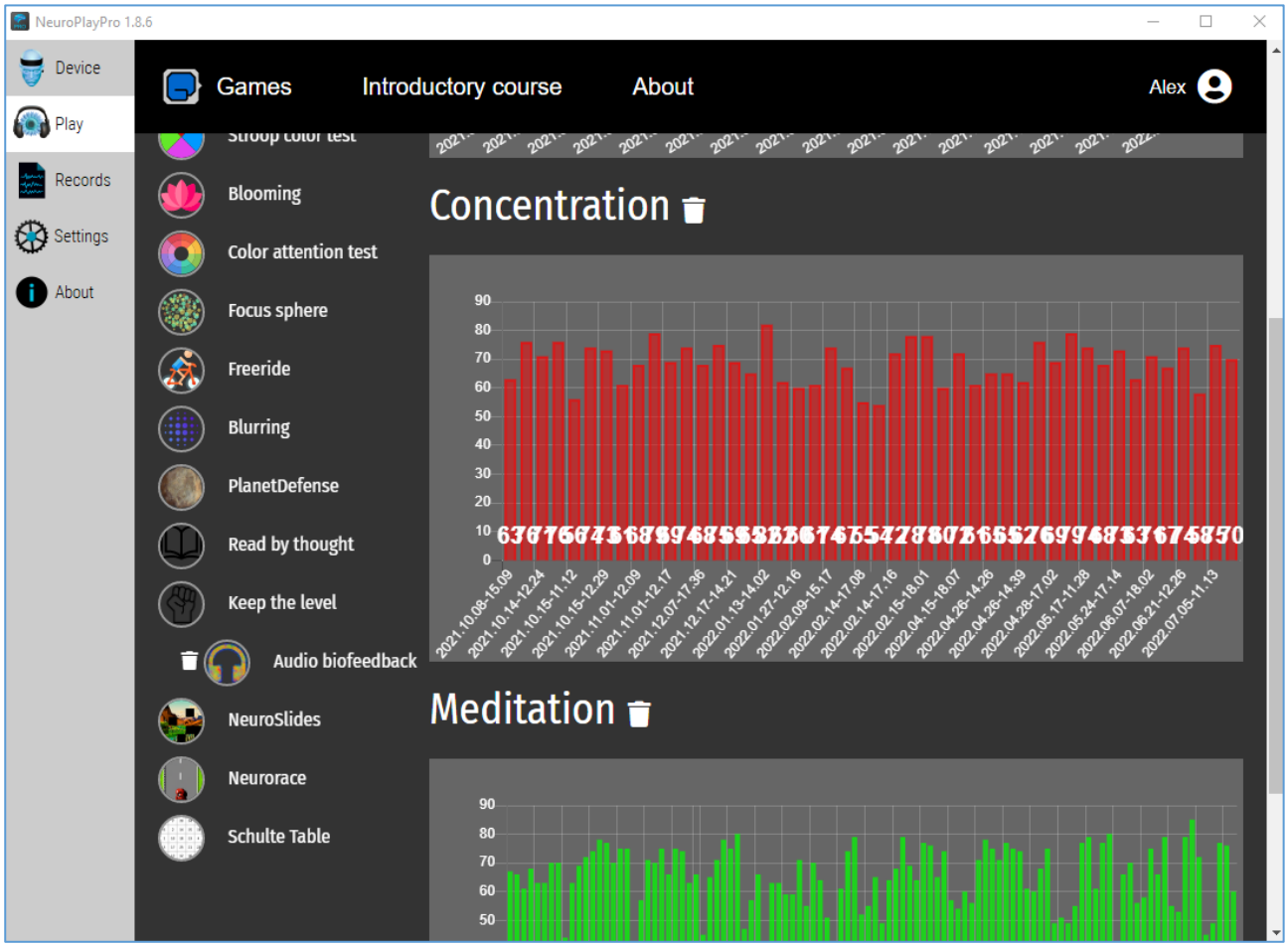


Fig. 8. Statistics for “Meditation” target state and “Attention” integral index

Review the detailed results as an NPD graph by clicking on the relevant bar in the charts.

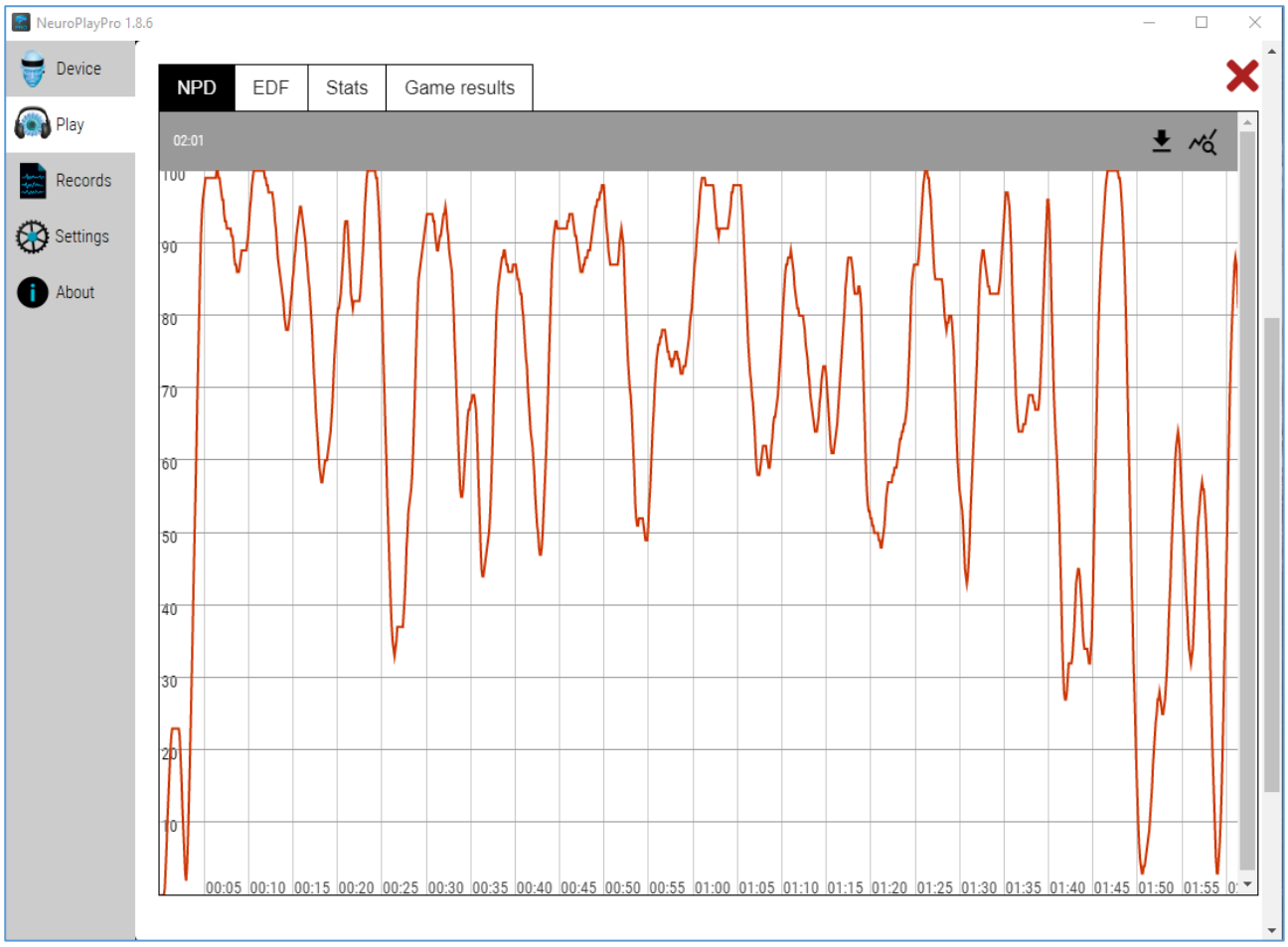


Fig. 9. Detailed "Concentration" graphic

The "Game Results" tab contains information on key game results (Fig. 10):

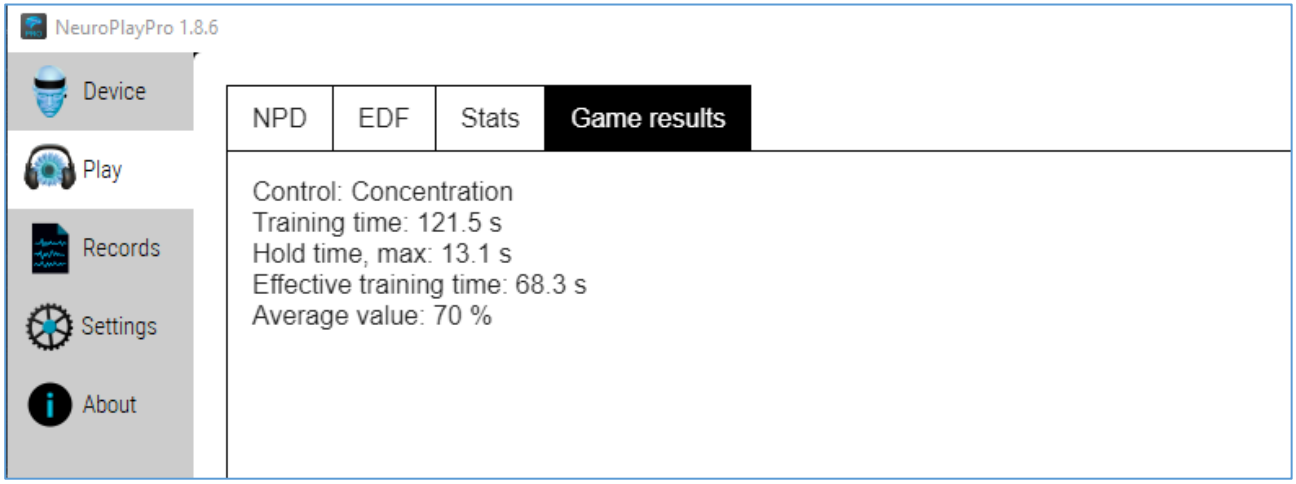


Fig. 10. Game results tab

Recorded files viewing (EDF)

The “Record” tab provides (Fig. 11):

- view original EEG signals
- calculate rhythms’ characteristics:
    - relative power index
    - power
    - amplitude
- filter signal in rhythm frequency range
- perform spectral analysis
- export original and derived data in spreadsheet format

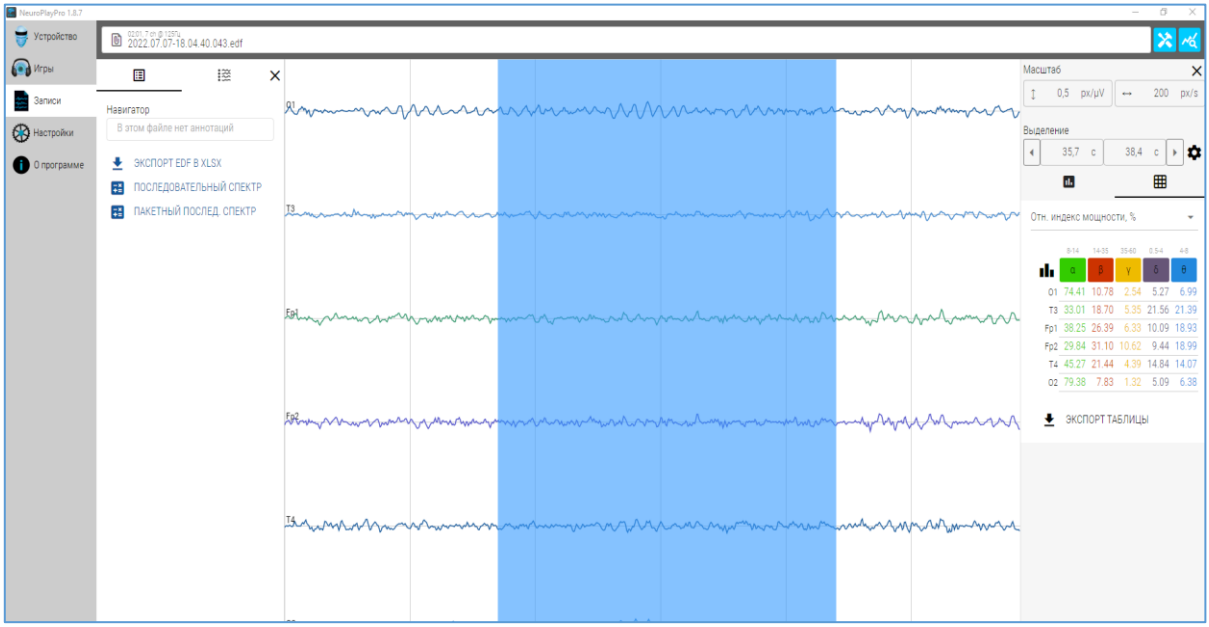


Fig. 11. Record view

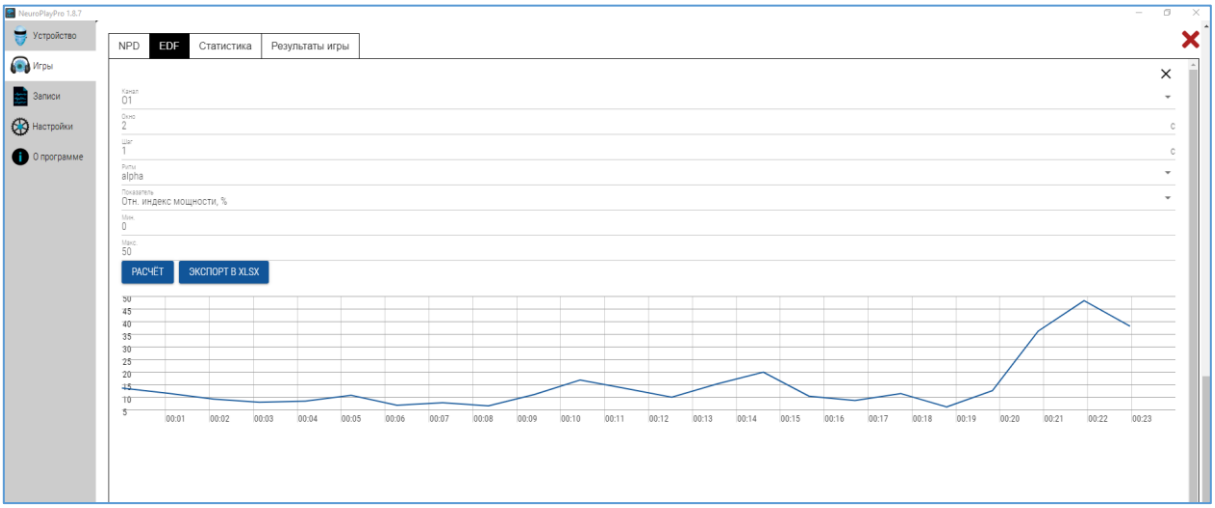


Fig. 12. Continuous spectral analysis

Developer features

In case of ticking the “Advanced settings” checkbox and enabling the use of "Virtual Devices" there will be shown 2 virtual devices - signal generator "GeneratorDevice" and EEG emulator "EDFVirtualDevice". Typically, the generator is used in the absence of devices while studying the program or for demonstration purposes. The EEG emulator allows you to simulate EEG by reading EDF file. This can be useful when creating and debugging your own neurogames.

There are several options for developers of new applications based on the NeuroPlay headset:

- Communication **directly** with the device via Bluetooth protocol to retrieve raw data
- A high-level API/SDK that allows you to control the NeuroPlayPro application via HTTP or WebSockets. Features include device selection and connection, raw and filtered data, spectral characteristics, rhythms and meta-indicators ("meditation", "concentration", etc.). Available for Windows, Linux, macOS, Android and iOS alike.

To display the auto-assembling API guide, start NeuroPlayPro and go to http://127.0.0.1:2336/api (http://localhost:2336/api) in your browser.

The latest versions of the software and SDK are available at https://neuroplay.ru/en/.

Transportation and storage

It is allowed to transport the product by any means of transportation, except for non-heated compartments of aircraft and sea transport.

Store indoors in the transportation package of the manufacturer at the warehouses of the supplier and the consumer, except for warehouses of railway stations, at temperatures between +5 °C to +40 °C and relative humidity of no more than 80%.

Do not store in conditions of precipitation, condensation, salt spray and

ozone, in direct sunlight, in explosive environments, in environments with conductive dust, corrosive gases and vapors, and other conditions that do not provide adequate protection against adverse effects.

Troubleshooting

Do not try to repair the device on your own. Improper repair attempts do not fall under the warranty protection.

If you experience any of the problems below while using the product, please check the following. There may be no problem with the product.

Missing or unstable connection

Problems:

- Device is not being discovered by the application
- The device is visible in OS, but failed to connect via application
- The device is visible in application, but inaccessible to work with
- Data transfer has been established, but the signal rate is low

Cause 1. Battery is low

Shake the device to wake it up from sleep mode. Check the status LED: red light indicates that the battery is running out. No light indication means an insufficient battery: be sure to charge it.

Cause 2. The device is already connected

Other devices (desktops and smartphones) might be already paired with the headset. Check the status LED: blinking or flashing LED means that the connection has been already established.

Manually disconnect from other devices or reboot the headset by charging it for 3 seconds.

Cause 3. The antennas of the headset and the pairing device are far way from each other or shielded

Though the stated Bluetooth transmission range is 10m, the location and orientation of the device antenna may significantly affect the connection

quality. Try to move the devices closer to each other or change their angles.

Cause 4. Improper operation of the Bluetooth adapter (for Windows)

The pairing device must support the Bluetooth 4 BLE protocol.

The pairing device is required to run the x64 version of Windows 10.

Built-in (laptop) or external (USB) Bluetooth adapters may be incompatible with Bluetooth 4 BLE protocol.

1. Install the latest Windows 10 updates
2. Install the latest Bluetooth adapter updates
3. For built-in Bluetooth adapter, disable it in Task Manager and insert the USB adapter included in the package
4. In case the included Bluetooth adapter doesn't work, replace it with another model.

If nothing helps and the device is still unable to work properly, please contact the manufacturer's technical support service.

Manufacturer’s guarantee conditions

The acquirer is granted a guarantee for a period of 12 months. The guarantee starts with the initial new product purchase from a dealer.

The guarantee lapses if changes or repairs are made to the products or components by people who are not qualified to do so.

Warranty and post-warranty service is provided by the manufacturer.

Costs and expenses such as postage or others associated with transportation of defective, repaired or new product will not be covered by the guarantee.

The specified lifespan of the product is not less than 3 years.

The guarantee period is prolonged by the performance of work which falls under this guarantee service. In case of product replacement with a new one, the guarantee period restarts from the day of replacement.

Guarantee claims are excluded insofar as the notified defect is attributable to the following circumstances (improper use, misuse or improper treatment, abnormal use conditions, etc.).

The post-warranty service is provided by the manufacturer at the acquirer’s expense.

1. Replaceable electrode parts and neoprene headband or helmet material are not covered by the guarantee
2. The electrode surface is made of composite Ag/AgCl and provides 350 cycles of use

Manufacturer

Neuroassistive Technology LLC

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