

MODULATING BRAIN FUNCTION: THE DIFFERENCE BETWEEN TRADITIONAL EEG NEUROFEEDBACK AND BELLABEE

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What is an easy way to explain the difference between traditional NFB and Bellabee in terms of how they modulate brain function?

Bellabee:

Bellabee simply directs your brain oscillations in the desired direction without training, effort, or supervision. You just put the Bellabee headband on, connect it to your mobile device and select the desired mode then Bellabee will start working in the background, leaving you free to continue your daily activities. That's right! Bellabee can be used at home or on the go (that is why it is called "Your Daily Assistant") and does not require specialist supervision or appointments. Most people start switching to the desired frequency within 3-5 minutes.

Over time, with continued use, your brain will begin to resonate with the frequency generated by Bellabee so you won't need to use the device as often. Think of it like riding an autonomous self-driving bicycle that trains you to ride the correct way right from the start. Soon you will be able to ride on your own due to the frequency following response, neuroplasticity and neuromodulation principles of neuroscience. And when you feel the need, you can restart using Bellabee.

NFB:

On the other hand, NFB specialists try to teach you how to push your brain in the desired direction using audio-visual games and other tools. A specialist needs to be present to provide the training. EEG electrodes are connected to your brain in order to monitor the brainwave frequency and try to move it to the right frequency with the help of audio-video programs that reward you for producing the desired frequency and penalize you for producing the incorrect brainwave frequency (operant conditioning).

Ultimately Bellabee is more affordable, convenient, and easier to use.

Bellabee Vs Traditional EEG NFB

BELLABEE

Uses electromagnetic waves to modulate brain

Passive method, individual is not involved in intensive training.

TRADITIONAL EEG NFB

Train person to modulate brain through audio-visual and tactile feedback.

Active and concentrated effort required for certain protocols (activation training) while relaxation training is passive (though the client must be still with their eyes closed).

BELLABEE

- Can be performed anywhere, anytime.
- Non-intrusive, can perform other tasks while using.
- It is portable, a headband connected to a mobile device.
- Easy customization.
- Can be used at home without professional supervision.
- Can be used as a stand-alone therapeutic tool and can also be combined with other modalities, like NFB, pharmaceutical treatment, psychological treatment.
- Totally wearable, a headband connected to your mobile. You can jog, read, or do other chores.
- Validated by NASA.
- Can be used on your own, without supervision.
- Compact, can be carried anywhere.
- Bellabee app can be downloaded from Google play store or Apple store to your mobile device.
- Silent, no audio, video, light, or vibration signals.
- NASA used it for well-being of astronauts in space.
- Change in brainwave to the desired frequency can be seen even during the first session, in some cases.

TRADITIONAL EEG NFB

- While it does require expensive hardware and software, people can train at home with a remote or home training system. A clinical setup is preferred.
- Tasks like academic bridge and other activities can be performed together, and with wireless devices, movement tasks can be performed. However, these are not as "free" as with Bellabee.
- Not portable, needs an elaborate setup.
- Time consuming Customization is true for previous generations of equipment. Modern systems allow for "point and click" changing of protocols.
- Needs professional input for every session. Lately, however, several systems are automated and allow laypersons to train themselves using pre-made protocols.
- Many systems include biofeedback (GSR, HRV, respiration, temperature, etc.) with neurofeedback, such as the BrainMaster and Nexus (BioTrace) systems. Others use HRV with every session via programs like emWave. Most practitioners use at least one other biofeedback method when training neurofeedback.
- Wearable but usually used in a clinical setting. There are a number of wireless devices that communicate with the computer via Bluetooth (Cognionics and Wearable Sensing for example), but they are **VERY expensive**, costing between **\$16,000 and \$24,000 each**.
- NASA, the US Navy and the Air Force have all endorsed neurofeedback. In fact, some developers of neurofeedback systems worked for NASA before going work on his own after having used neurofeedback while at NASA. The studies were with pilots and the work that they validated was the concentration – relaxation cycle.
- Needs supervision and interaction with a professional trained in NFB.
- Cannot carry it around easily. The newer systems are portable, and some are even app based.
- Not an option.
- Accompanied audio, visual, and tactile signals.
- There have been dozens of EEG studies in space by both NASA and Russia.
- Usually takes some number of sessions to see this change. sLORETA and swLORETA neurofeedback elicit changes within minutes and these are visible in the EEG during the session, often in the first few minutes.

BELLABEE

No electrode attachment with messy gels, and wires going to and from the equipment.

Works at different parts of brain like cerebrum and cerebellum.

Works at multiple levels:

- a. Brain, cerebrum and cerebellum.
- b. Neural pathways going to and from the brain.
- c. Body, particularly the heart, through the neural pathways.
- d. At cellular level.

1. Bellabee is like autopilot used in planes, and now available in other vehicles too. You just put Bellabee on, connect to the mobile device, click on the desired mode and it starts working.

Electromagnetic therapy has been in use for many centuries in one form or another.

Magnetic waves are a natural phenomenon, like in:

- a. Earth magnetic field, used by birds for navigation during migration.
- b. Schumann Resonance (If we are out of sync with Earth's Frequency (Schumann Resonance) we begin to exhibit signs of discomfort that can range from anxiety, insomnia, illness, suppressed immune etc.)

Inexpensive, less than US\$ 200.

TRADITIONAL EEG NFB

Electrode attachment needs with gel/ paste and wires connect it to a machine. There are dry systems that do not use past or gel.

Usually aims at a specific portion of brain. Some NFB devices and software can train the cerebrum, cerebellum, red nucleus, vermis, habenula, amygdala, hippocampus, and thalamus.

Neurofeedback works through synaptogenesis, neurogenesis, increased regional cerebral blood flow, and improvements in connectivity metrics in the cerebrum, cerebellum, red nucleus, vermis, habenula, amygdala, hippocampus, and thalamus. Thus, NFB works on populations of pyramidal neurons (population dynamics) and the surrounding support cells (glia) and can influence the microglia as well.

In the 1950s – 1980s this is how amplitude training was done: you connect EEG electrodes to the scalp, see the existing brainwave frequency and tries to move it to the right frequency with the help of an audio-video program that awards for the right frequency and penalizes when not moving towards the desired brainwave frequency.

However, since the 1990s and even more so in this century, NFB has moved away from amplitude training in favor of Brodmann Area training in multiple metrics (amplitude, relative power, power asymmetry, power ratios, coherence, phase, phase shift, phase lock, phase lock duration). Since the early 2000s, the focus has been on normalizing the EEG via Z score training, and in the past 10 years, normalization of the Z scores within a given brain region or networks has become common. There is no penalizing the brain in operant conditioning – only rewards for movement toward the thresholds.

It is a new concept originating in the last century.

No such equivalent. nevertheless, there is nothing more natural than the EEG and the operant conditioning training method in which NFB predicates how the brain learns best.

Expensive, costs in thousands. **Good equipment cost starts from US\$ 5,000** and goes up.

BELLABEE

It is very simple to set up and use:

- a. Download Bellabee apps from google play or apple store.
- b. Connect headband to mobile device earphone jack.
- c. Put on Bellabee band around your head as instructed.
- d. Run the desire app program from the mobile device.

Bellabee uses PEMF, that is also used to treat non-union of fractures, other musculoskeletal problems/ associated pain syndromes, and even cancer.

Acts through cerebellum, (which is now scientifically proven to act as a moderator of brain cognitive and higher executive functions, in addition to motor functions).

Cerebellum has abundant connections to cerebrum, other parts of brain and through them to the body, particularly the heart. That is why that Bellabee, placed against cerebellum can have far-reaching effects, beyond its area of placement on the brain.

The mechanism of action is based upon Frequency Following Response (FFR). Through this the brainwave frequency starts resonating with the frequency produced by Bellabee.

It is a futuristic neuro-wearable device. Neuroscience equipment is advancing in the direction of AI (artificial intelligence) and BMI (brain machine interface). Bellabee is exactly on this path.

Bellabee future is optimistic. It is moving in the right direction, is based on latest technology and is under process of constant improvement and addition of features to treat more and more brain disorders.

Bellabee simply directs your brain oscillations in the desired direction. No questions asked, no training, no effort to come to the desired level, even you do not have to come to practice, rather can do it at your home, or anywhere else.

Autonomous in nature. It is akin to, teaching a student how to drive a bike, only that with Bellabee it is like riding an 'autonomous self-driving bike', which trains the person to start riding the bike right from the start with its help.

No active supervision, teaching required.

TRADITIONAL EEG NFB

Elaborate arrangement and professional setting required.

No such musculoskeletal or cancer treatment possibilities.

Neurofeedback works through synaptogenesis, neurogenesis, increased regional cerebral blood flow, and improvements in connectivity metrics in the cerebrum, cerebellum, red nucleus, vermis, habenula, amygdala, hippocampus, and thalamus. NFB works on populations of pyramidal neurons (population dynamics) and the surrounding support cells (glia) and can influence the microglia as well.

It is based on operant conditioning principle.
(Both have been in use to modulate the frequencies of the brainwaves.)

Usually it is not wearable, though there *are* wearable systems. The greatest advances in neuroimaging in the past five years have been in qEEG and neurofeedback. qEEG (which is also used for Bellabee) is superior in the time domain and is getting very accurate in the spatial domain (5 mm³)

Latest technical advancement are being incorporated at the desired pace.

Training and effort required from the person undergoing NFB therapy.

The individual learns to push his brain in desired direction, using audio-visual and tactile feedback. The purpose of NFB is to teach the brain options, thereby improving flexibility and increased self-regulation. These are the enabling objectives for personal autonomy.

It requires some sort of guidance/ training to work.

How does Bellabee accomplish similar results as NFB without targeting a specific frequency for a specific brain site or side?

Though the brain has different areas and parts, they are all connected through networks and work in synchronization to achieve a goal or execute a task. For example, when you look at an object the Occipital lobe gets involved. When you compare it to another object the Temporal lobe gets involved since this is where memory is stored. If you reach for the object the Sensory-Motor cortex gets involved since it controls your motor functions. If you touch the object the sensory perception activates to fine-tune your movement and associated senses to help you reach the goal at hand. Meanwhile, the Cerebellum regulates the entire process.

Since the cerebellum fine tunes every action of the brain (higher mental functions, cognitive, emotions, sensory, motor) to accomplish a task in the most efficient manner, a device placed against the cerebellum, while emitting electromagnetic pulses within the natural frequency range of brainwaves, will help the cerebellum modulate the brain towards the correct frequency. As the cerebellum is connected to all other parts of the brain through nerve tracts, it can send and receive signals to and from (those parts) and influence the required part/s of the brain. It can even influence the body using the same neural pathways.

Bellabee uses a neuroscience phenomenon called "Brain Entrainment (BWE)" in this regard. Also known as "Brainwave Synchronization" and "Neural Entrainment", it refers to the capacity of the brain to naturally synchronize its brainwave frequencies with the rhythm of periodic external stimuli. Brainwave Entrainment causes brainwave frequencies to synchronize with a periodic stimulus such as the frequency produced by Bellabee corresponding to the intended brain-state. The brainwave entrainment effectively "pushes the entire brain into a certain state". Brainwave entrainment works for almost everyone. It is a great way to guide your mind into states that you might usually have difficulty achieving.

By focusing the pulse at back of head where cerebellum is located, Bellabee conveys the modulated frequencies to reach other parts of the brain. This generated pulse acts maximally where the said frequency correction is required, just like when we take medicine, it absorbs through the blood and reaches every part of the body but works at the place where it is needed.

How does Bellabee achieve long-lasting results with PEMF technology?

The brain, like any other organ, requires a state of ideal equilibrium to function at an optimal level. This equilibrium is what our internal regulatory mechanisms work to maintain. When any system in the brain or body is out of equilibrium to the point where internal regulatory mechanisms fail, symptoms appear and you need to give external input to correct it.

As you apply an external input, (electromagnetic, chemical or otherwise), the mind and body naturally moves toward the equilibrium state. Over time this (minimal amount of) outside help is all that is required for the internal balancing mechanisms to take up the job and start functioning on their own without external help.

Bellabee uses "Frequency Following Response (FFR)" to help the brain move towards the specific state and, after time, start working on its own, decreasing dependency on the device. This is possible because of the characteristic properties of FFR and Neuromodulation (NM), as well as the regenerative and new connectivity features of the brain's neuroplasticity (NP) capability. This can happen at a swift pace and can be verified by recording the EEG.

Once the brain is in equilibrium state, it tends to remain in this state as it is natural. As symptoms decrease or disappear entirely, it becomes a reward for the brain since the symptoms become an undesirable feature to avoid.

One study at Harvard Medical School found that a PEMF device could improve the mood by over %10 after just one 20-minute treatment in patients with bipolar disorder and in patients with major depressive disorder (Rohan, et al).

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