

HRV: THE MANUFACTURERS AND VENDORS SPEAK

Instrumentation for Heart Rate Variability Biofeedback: The NeXus™ System

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Keywords: heart rate variability, biofeedback, Bluetooth/wireless, NeXus

The author speaks as an experienced biofeedback trainer and introduces a multimodal computer-interfaced biofeedback system, the NeXus™. He emphasizes the effectiveness of heart rate variability biofeedback in conjunction with other autonomic measures for many stress-related disorders. He highlights the technical features of the NeXus system, including 24-bit resolution, Bluetooth wireless technology and carbon-coated cables to reduce noise.

A Trainer’s Story

I was first introduced to heart rate variability (HRV) biofeedback in 1989, and intuitively knew that it was going to be the next big approach to autonomic self-regulation and stress management. I do not understand why I felt that so strongly. I had found respiration training extremely important, and this new approach combined respiration rhythm with heart rhythm. For whatever reason, I am glad I trusted that hunch because HRV biofeedback training has become an important part of my work across all the stress-related disorders.

Over the years, as a biofeedback clinician and instructor, I have had the opportunity to use nearly every HRV instrument on the market, and most are very good. The NeXus™ systems by Mind Media B.V. (Roermond-Herten, The Netherlands), however, with gorgeous screens and easy-to-use software, are the only ones that remind me of that very positive first hunch about HRV in 1989. But before I go any further with this “right brain” description of this system, let me start with some good old “left brain” stuff.

Technical Features of the NeXus-10

The NeXus-10 (now there are three others—the 4, 16, and 32, with the number designating the number of channels) was introduced in early 2004 and is the first fully functional Bluetooth-based wireless biofeedback/neurofeedback platform with 24-bit resolution (the NeXus-32 also does quantitative electroencephalography). At that time, Bluetooth was popular in Europe but had not caught on

yet in the United States. Now Bluetooth is everywhere, and it provides the portability and freedom for the client to move about within the clinic without being tethered to a computer. It took me awhile to appreciate the value of 24-bit resolution, but it can best be seen with thermal biofeedback. Have you ever noticed during training that the temperature trace line appears to have leveled off? Temperature is always changing; it just appears as a flat line due to limitations of most systems in showing these small changes—limitations in resolution. With the NeXus, I can present changes in temperature as small as .0001 of a degree. With 24-bit resolution, even the smallest change of temperature can be seen and recorded.

One of the things that makes NeXus unique is that it uses special carbon-coated cables with an active noise cancellation technique. There is another pleasurable aspect of this system, separate from the technology. Most biofeedback systems, regardless of the quality, force the clinician to buy sensors individually. For example, five separate sensors would be required to record dual-channel electromyogram (EMG) or dual-channel electroencephalogram (EEG) or electrocardiogram (ECG). With the NeXus system, one carbon-coated cable can be used for any of these. For the price of one cable, you have the ability to record up to five different measures.

OK, I am trying to keep a grip here on the technical stuff, and what we were talking about was the benefit of using carbon-coated cables. Bottom line: It means that the NeXus does not show visible artifacts in the EEG, EMG, or ECG data—even if you swing the cables. Clean signal, high resolution, and high sampling rates make the NeXus an ideal platform for researchers who want to study HRV with greater precision. ECG signals sampled at up to 2 kHz mean that interbeat intervals can be recorded with up to 1 millisecond precision.

The NeXus is fully multimodal and supports a wide range of sensors that can be used for simultaneously acquiring heart rate data. Additionally, heart rate can be taken from any of three separate sensors: an EKG sensor placed wrist to wrist

or over the heart, a blood-volume-pulse (BVP) finger sensor, or a BVP sensor mounted in a headband and used around the head. I have gotten into the habit of always recording heart rate, respiration, temperature, and skin conductance. Although I haven't as yet used the other modalities, the NeXus systems can also do oximetry, slow cortical potentials, force, and (by year's end) capnography. When I see that all these autonomic nervous systems measurements move in the direction of self-regulation, I know that the client's performance is flowing perfectly. Furthermore, you can see the client's review screen with just one key stroke. You do not have to leave the recording session to look at what has been recorded, because you can toggle back and forth at any time with no loss of data.

Training Screens and Protocols

Although all NeXus systems come with a generous number of screens that can be presented individually on one monitor or separately on two separate monitors, the time will come when the clinician user wants to build his or her own screens and protocols. Here is the good news: You will not have to take a course to learn how to build screens and protocols. Developing screens and protocols is no more difficult than working with PowerPoint. When the user is ready, the sky is the limit. The first protocol I built was a simple stress profile. Then, after reading "Characteristics of Resonance in Heart Rate Variability Stimulated by Biofeedback," by Vaschillo, Vaschillo, and Lehrer (2006), I was motivated to build my own resonance frequency assessment protocol.

Using the respiration pacer that is built into the NeXus software, I created a protocol consisting of five 2-minute respiration periods breathing at 6.5, 6.0, 5.5, 5.0, and 4.5. Each period is divided by a 1-minute screen during which the client is asked to breathe normally. Heart rate data, along with respiration rate and temperature, are recorded and graphed in the record for the 2-minute segments only. Then the segments are analyzed individually by the NeXus's HRV analysis report, which produces a beautifully crafted spectral analysis of the data. The segment that produces the greatest height on the power spectrum is the resonance frequency for that individual. In addition to the spectral report, the software also offers extensive HRV frequency and statistical analysis reporting, HRV artifact rejection algorithms, and data export of interbeat-interval tables.

Conclusion: Personal Impressions

Everyone who studies the technical side of the NeXus is impressed, but here is what I love.

It is a classy system with beautiful screens, and it is easy to use. It does not cause user frustration or stress—now there is a novel product from a manufacturer! I feel like I am more creative as a therapist. Smoothing is accomplished with a single keystroke, on the fly. Likewise, scaling is accomplished either automatically at the end of a screen sweep or by a single keystroke at any time. I program my favorite screens on the 12 function keys at the top of the keyboard. Should I forget what key evokes what screen, I can use a hot key ("K") to see what is on each function key. There are so many small quality touches like this—it makes operating the system simple.

There is an active NeXus User's Group where questions are posted and answers provided. Although rarely needed once the system is set up, tech support is available by phone. The NeXus BioTrace software is constantly being updated and improved with suggestions from various reputable users like Dick Gevirtz, Barry Serman, Cory Hammond, John Anderson, and many more. Upgrades to the software are free, just download them from the Web site.

After having introduced and taught more than 9,000 students in biofeedback for more than 30 years and having used well over 35 different systems during my courses in that time, I can honestly say that there has never been as impressive a system as the NeXus line of wireless products. If you haven't taken a spin yet, don't deprive yourself any longer!

Reference

Vaschillo, E., Vaschillo, B., & Lehrer, P. M. (2006). Characteristics of resonance in heart rate variability stimulated by biofeedback. *Applied Psychophysiology & Biofeedback, 31*, 129–142.



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