Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

Neurofeedback as a Science

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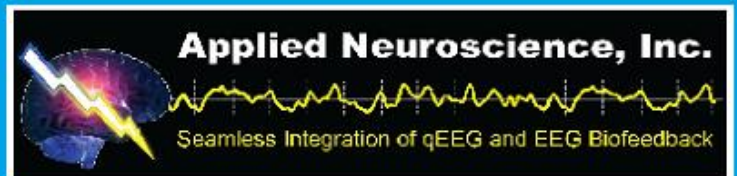
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EDITORIAL

NEUROFEEDBACK AS A SCIENCE

When the undersigned was an undergraduate psychology student, there seemed to be too many scientific articles out there to read. Still, there was hope that, in due time, one would manage to cover a significant percentage of one's reading wish list. Today, it is impossible to keep up. Scientific publications have been logarithmically accelerating during the past decade. There is news to read in neurophysiology, neuroimaging, neuropsychology, applied neuroscience, and in so many other fields directly related to the undersigned's practice and research.

There are new technologies producing data, and there are new ways to analyze data from existing technologies. Electroencephalography (EEG) with 19 channels was outdated by 32 channels, then 64, 128, 256, and this goes on. Comprehending spectral analysis of the EEG with the Fast Fourier Transformation was already overwhelming, when wavelet analysis came along.

Neurofeedback (NF) was a matter of one or two active electrodes, when it was already difficult to decide where to put these electrodes, and what frequencies to train. Now 19-channel NF is used by many, combined with inverse solutions (Congedo, Lubar, & Joffe, 2004), or with normative databases (Collura, Guan, Tarrant, Bailey, & Starr, 2010), promising better and faster clinical outcomes. Then came new ways of neuromodulation, including transcranial magnetic stimulation (TMS; Pape, Rosenow, & Lewis, 2006) and transcranial current stimulation (tCS; Angelakis & Liouta, 2011).

It all sounds exciting. The field of improving mental function and quality of life, using noninvasive (or minimally invasive) technology instead of drugs, is expanding. Yet, how do we choose what to use? Single-channel or 19-channel NF? TMS or tCS? To some, the answer is easy: Use all of these as per manufacturer's instructions. But how can one trust the use of any technique on one's clients unless one understands how it works, and has some unbiased scientific evidence it does what it is supposed to do? The undersigned is often asked by authorities or individuals about the claims that some professionals have about NF. He tells them what he knows about replicated research by independent controlled studies. Anything below that level may be interesting but not a scientific fact.

There are three ethical problems here, two relating to the client and one relating to the clinician's field—in our case, neurotherapy. The first problem is the risk of causing unpredictable side effects to the client, and the second problem is spending a client's money, time, and hope for something that may not help them. The third problem is the outcome of the other two: clients who see no benefit for their money and time or, even get worse, may discourage others from getting such services. Therefore, we need to understand how new techniques work, if and when they work, before using them in providing services. For example, in this issue, Arns claims that hemoencephalography is not near infrared spectroscopy and that there is no evidence that hemoencephalography can penetrate the skull. Does a clinician have the background to judge such claims on technical matters?

So, how much does a clinician need to understand before using a technique with his or her clients? The answer is, as much as possible, and even more. And, for what a clinician is not trained to understand, he or she should

ask for supervision from those who are. Brain-mapping needs understanding of problems when recording EEG, skills in interpreting raw EEG, a grasp of the limitations of normative databases, and continuing education on the interpretation of EEG patterns into behavioral or cognitive correlates. A lack of any of these may result in recording or mapping artifacts instead of brain signals, under- or overestimating the results of z scores, or erroneously translating z scores into pathology. Just because 8–12 Hz activity is related to inactivation of the visual cortex when eyes are closed doesn't necessarily mean that this rhythm shows inactivity of the precuneus or the hippocampus, if localized there by an inverse solution.

In this issue, Arns claims that individual alpha peak frequency is "highly stable across time" and "hence . . . a true endophenotype." But as Arns correctly mentions, individual alpha peak frequency is affected by chemical substances or situational factors, which makes it state dependent, too. Alpha peak frequency has been shown to be affected by state cognitive preparedness for an expected cognitive task (Angelakis, Lubar, Stathopoulou, & Kounios, 2004), and to be self-regulated with NF (Angelakis et al., 2006). Therefore, one should be careful to interpret EEG brain maps as solid traits, when an EEG measure as stable as alpha peak frequency is state dependent.

With NF, one needs to be as careful. If one knows that a certain cortical region is related to a particular function—let's say Broca's area to speech production—one may be tempted to hypothesize that putting an electrode (or set of electrodes) over that area is enough to guarantee training of the particular function. In the example of Broca's area, one may assume that reducing 8–12 Hz power at F7 will improve speech in specific language disorder (or developmental dysphasia). This is, at best, an educated hypothesis that needs several steps to be proven right or wrong. First, in the previous example, one needs to show that at least one person with specific language disorder improved his or her speech after NF training at F7 (a case study). Then, one needs to show that more persons show similar benefit

(a feasibility study). Last, one should control for nonspecific effects, including practice or placebo, by conducting a double-blind randomized controlled study. And still, one should be careful to trust these effects before an independent researcher replicates these findings. If any of these steps are missing, clinicians should be cautious to promise such effects to their clients.

In this issue, Hong and Lee report on a randomized controlled study, showing cognitive improvement in children with mental retardation who received NF, but not in two control groups. This is the proper next step, adding significant control, on a case series published in 2010, showing significant cognitive improvement in 19 of 23 children with mental retardation who received NF (Surmeli & Ertem, 2010).

At a different level, in this issue Balconi and Pozzoli show a parietal focus of event-related potentials for perception of facial emotions in healthy volunteers. This is basic science that may lead to a possible hypothesis for an NF application. Because people with autism show difficulty in perception of facial emotions (Celani, Battacchi, & Arcidiacono, 1999), a series of studies can be designed to test (a) whether people with autism show abnormal parietal event-related potentials for facial emotions, and (b) whether NF at parietal areas may improve perception of facial emotions in people with autism. The first of those steps was undertaken by Gross et al., who in this issue show that, compared with normal children or those with ADHD, children with autism show different event-related gamma activity at parietal areas during a perception task of facial emotions.

The key to differentiating our field from phrenology is educated rational thought and well-designed experimental evidence. The International Society for Neurofeedback and Research's Research Foundation can provide guidance to those who want to try any of these steps by providing guidelines and experienced supervision on how to do a proper case study, a feasibility study, or a controlled study. The *Journal of Neurotherapy* can and should be

the front line for such published research. Clinicians as well as researchers should read carefully its research articles and be able to criticize its claims, for even a peer-reviewed publication has room for biases and errors. We are all responsible for this field, and to the best of our ability we should keep it scientifically rigorous.

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