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Using individual EEG peculiarities increase neurofeedback efficiency

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Background

The "alpha rhythm" had large sinusoidal waveforms at a rate around 10 cycles per second against a background of smaller waves, "waves of the second order" (i.e., beta). Alpha waves were pronounced in posterior regions during eyes closed resting states, and diminished markedly upon opening the eyes.

This is how the alpha rhythm was defined 70 years ago. Today we have a superior definition: Alpha activity occurs between 8 and 13 Hz, or is it between 8 and 12 Hz, or perhaps 7 and 13 Hz, or 7.81 and 14.06 Hz, or 8 and 15 Hz (Etevenon *et al.*, 1990, Ray and Cole, 1985). What is more disturbing than the different intervals are their boundaries, which are artificial, a product of ease of communication and the limits of one's analytical technique. The alpha rhythm is defined as the dominant frequency rhythm in the resting state, the frequency band that dominates the spectral density distribution. At this scale the brain rarely uses integers. Perhaps we would do better to keep the names simple but not its designation.

Klimesh (1999) developed a simple designation strategy; he identifies an individual alpha frequency (IAF) from each subject, then defines bands relative to this peak. Lower alpha is from 2.5 Hz below IAF up to IAF, and higher alpha runs from IAF to IAF plus 2.5 Hz. The theta band is also defined relative to IAF. Obviously the plus or minus 2.5 Hz is artificial and is one of those compromises plentiful to psychophysiology, based on empirical data and ease. Some subjects will have a narrow dominant frequency, others might hit the mark exactly. Perhaps a refinement of the formula is needed, a mixture of percent attenuation and topography. This might produce a truly customized dominant frequency bandwidth. From there we build towards the otherbandwidths of interest. Eventually we may find out that restricting our analysis to such unique ranges can improve the reliability and validity of our conclusions.

Materials and methods

The hypothesis was tested of whether neurofeedback training applied in order to increase or decrease power of individual EEG frequency ranges is more efficient than neurofeedback training of standard EEG frequency ranges. The sessions of theta/beta decreasing and alpha stimulating trainings were carried out on two outpatients with attention deficit disorder (the schoolboy) and functional pain contraction (professional musician).

Results

The neurofeedback with standard frequency ranges was inefficient and even resulted in aggravation of symptoms of disorders in both cases. The neurofeedback training with individual frequency ranges resulted in substantial clinical improvement.

Discussion

The large variance in peak and width begs the question: why do we use a large band to assess dominant frequency activity? Would it not be simple to calculate an IAF, even with a one-channel EEG system? These three properties align to produce the most regular and consistent recording possible in human EEG. We are all aware of frontal slowing in ADHD children. Some argue convincingly that high theta activity in such a population is actually misnamed; it is merely an immature manifestation of the alpha rhythm (the child's dominant frequency). So 4–7 Hz may be theta for some and alpha for others. Analogy can be noted for persons with IAF more then 11 Hz. Sta-

tistical descriptions may be powerful and accurate tools, but rarely as powerful as individual data (Kaiser, 2001).

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