

## Brain Maps

Lincoln Stoller, PhD., 2012

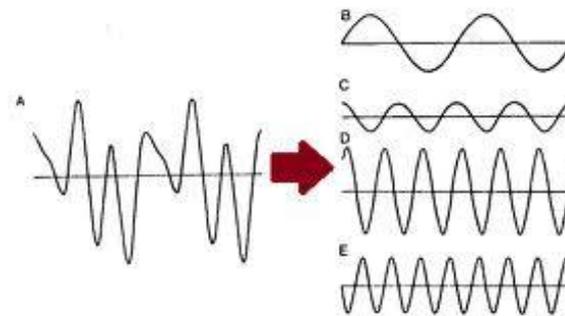
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Due to the generosity of [Dr. Richard Soutar](#) and the folks at NewMindMaps.com, I can offer anyone an EEG-based analysis of their brain at half the usual price up until the end of 2012. Half-price is \$45, and if you're interested in coming in for a map contact me at LZS [at] tengerresearch.com, or call me at 845-657-6411 to make an appointment.

This newsletter explains what a brain map is, how it's used now, and how we might use it in the future. It's all based on *frequency*, so that's where we begin.

Breaking a noisy signal into frequencies means that we can take any signal, no matter how irregular, and equate it to a series of regular, sinusoidal waves of various frequencies. There are some restrictions to this breakdown – such as the possibility of adding separate waves without having one interfere with another – but ordinarily breaking noisy signals into separate frequencies is general.



*frequency decomposition*

In the picture above there is a wiggly wave on the left, and a set of four pure sine waves on the right. If you graphically add these four waves – meaning that you measure the position of each wave above zero and add these values together for each point from left to right – you'll recover the wiggly wave. This is what we mean when we say that the wiggly wave has been decomposed into four frequency components.

Abrairwave is just a wiggly wave. It's a measure of the voltage difference between two points. It's recorded by simply attaching two metal contacts to your scalp using a dab of salt paste. The voltage differences are small but they can be amplified and then broken into components.

When you do this for brainwaves you find that the components range in frequency from 1/10 of a cycle to 30 cycles per second. Actually, there are other important frequencies but we can't distinguish them from the noise created by our muscles, skin, and blood flow. Also, much of what goes on in the brain stays in the brain, so we're limited to working with those electrical emanations that make it out through the brain tissue, skull, and skin.

The 1/10 to 30 cycles-per-second range is a convenient window, and much of the brainwave analysis that we do is a matter of convention and convenience. New explorations are attempting to extend this range to both higher and lower frequencies; but in either direction new problems arise, so our analysis will focus on this region.

The contributions of frequencies are grouped into frequency ranges. We don't look at every single different frequency but at how much contribution to the "wiggly wave" comes from slow, medium, and fast components. Actually we look at six areas, not just three, and these frequency ranges have been given the arbitrary names delta, theta, alpha, low-beta, high-beta, and gamma. These areas were named because it appears that people's brainwaves are composed of contributions that center in these areas. In other words, your brainwaves appear to be much simpler than they could be.

An overly simple description of brainwaves identifies certain states of mind with certain waves. That is, when your wiggly wave is predominantly composed of alpha waves, then your mind is in a state of conscious perception. When it's dominated by beta waves, then your mind is in the process of thinking. Here's a breakdown of this simple description.

### Brainwaves, Frequencies and Functions

Unconscious		Conscious		
Delta	Theta	Alpha	Beta	Gamma
0.5 – 4 Hz	4 – 8 Hz	8 – 13 Hz	13 – 30 Hz	30-42 Hz
<b>Instinct</b>	<b>Emotion</b>	<b>Consciousness</b>	<b>Thought</b>	<b>Will</b>
Survival Deep sleep Coma	Drives Feelings Trance Dreams	Awareness of the body Integration of feelings	Perception Concentration Mental activity	Extreme focus Energy Ecstasy

When most people hear of brainwaves this chart is usually floating around. This breakdown has literary value but not much more. Not only are these categories too simple, but the correlations of these waves with mental states depend upon where on the scalp they're measured, what other waves are present at other sites, and how the waves at one location interact with and reflect off the waves coming from other areas.

These frequency band names are supposed to make things simpler, but every person is slightly different. When you look closely the general rules show small violations, which themselves show regular patterns. The simple patterns give way to more complex brainwave patterns which, in turn, give way to further distinctions.

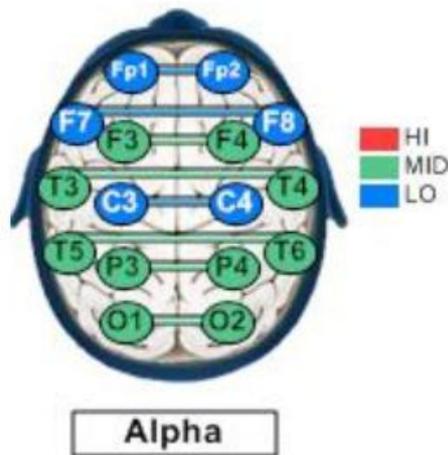
You have to decide what you want to talk about when you're looking at brainwaves. For our purposes we are concerned with the "amount" of each brainwave component at each of 19 sites over your scalp. By "amount" we mean "more or less than average for a person of your age and gender." We measure this by saying that you've got a lot more, some more, the same as, a bit less, or a lot less of some frequency at some scalp location.

For example, you might have a lot more alpha waves at the Cz location on the crown of your head or an average amount of theta waves over your right temple. Each location is given a code, like Cz, and the relative amount is given a color. Using what I've said so far, here is what a brain map looks like.



This is a map of the amplitude of alpha band contributions to the wiggly wave measured at each of 19 sites. The occipital sites at the back of your head are labeled O1 and O2. The temporal sites over your ears are T3 and T4, and so on. The five colors indicate whether the amplitudes of the alpha contributions are Very High, High, Normal (OK), Low, or Very Low relative to a collection of normal, healthy people of your age and gender.

The picture on the masthead of this newsletter shows the same kind of map for delta, theta, and beta frequency ranges. There is an almost endless amount of detail in these EEG maps. We'll only consider one other aspect. *Connectivity* refers to how much the waves at one location move together with the waves at another. The most important connections are those between sites on the left and right sides of your head.



The connectivity map shown here highlights the low connectivity between frontal sites compared to an average level of connectivity at most other sites.

The punch line for brain mapping is that you can learn to change your brain map by focusing on one or more of these relationships while being cued as to whether you're generating more or less of a particular pattern. There are questions about how you accomplish this, and there are different schemes to help you learn this skill. The general requirement is that you can focus and become attuned. Being flexible and sensitive also helps, but it's something that anyone can do to varying degrees.

## All About Patterns

The Brainwaves, Frequencies and Functions chart shown above is inadequate. Your mental state correlates poorly with overall brainwave levels. What are more important, and more useful, are the strength and correlation patterns of different wave groups at and between different sites. That is to say simply generating more of one class of brainwave versus another not only fails to enable what this chart associates with that frequency, but will likely disrupt your normal function and potentially irritate or disable you in some regard.

The functions listed on this chart can be useful as mnemonics, but they're not of practical use. The kinds of patterns that are both predictive and trainable are based on larger patterns that exist not only on the brainwave map, but also correlate with behavior and personal experience. Here are some examples.

- Weak generation of alpha frequencies in your right frontal area – and weak correlation of low frequencies at the left and right frontal areas – is associated with weak emotional control leading to symptoms such as depression and obsession. Weak alpha generation in the left frontal areas can relate to difficulties in executive focus on such issues as planning and ordering.
- Excess high frequencies in those areas running over your crown from left to right sides of your head – and a weak correlation in the low frequency waves between these areas – reflect poor muscular regulation, resulting in issues of digestion, movement, and tension. These issues can translate into physical tremors, gastro-intestinal or sleep problems.
- Irregularities at the far back of your head are usually associated with vision problems such as vision stability, situational awareness, and the recognition of faces and places. This is quite different from simple visual acuity as measured on an eye chart, but it remains an essential component in your ability to process visual information.

Each of these patterns, and many more involving different frequencies and areas, suggests specific neurofeedback training to remedy dysfunction, aid in recovery, or enhance existing function. It is the neurofeedback practitioner's expertise, coupled with the trainee's sensitivity and attention, that makes it possible to train the brain to change itself.



For the last few years the folks at NewMndMaps have been collecting EEG maps and answers to a psychological profile that aims to measure aspects of one's memory, reasoning skills, attention, social behavior, sense of self, self-expression, emotional control, and resilience. They've compared 10,000 profiles and EEG maps to deduce aspects of personality that might be caused by potentially altering the trainable EEG patterns.

A close match between one's self-report and the predictions of your EEG, as shown for this report, suggests that you may alter your state of mind by retraining your EEG. Note that this table shows the degree of the match between issues and patterns and is not a measure of the pattern or the issue. It simply says that neurofeedback training may alter your experience in these areas. Based on this analysis they

suggest which frequencies should be trained at specific sites.

After 5 or 10 training sessions you should start to see results either through a change in how you feel, or a change in what the EEG shows. The NewMindMaps website allows you to track your progress and, after you record subsequent EEG maps, they will compare pairs of maps and report the changes that have occurred.

The key is not that neurofeedback enables you to do what you could not otherwise do. The key is that it breaks a complicated problem down into focus areas, and it facilitates the process of change. This is the same process that can proceed on its own when you're ready and the path to change is clear.



The problem is that our mental state is both sticky and complex. When we're stuck it's usually because we're bogged down by inertia, distraction, and our general habitual nature.

Neurofeedback simplifies a complex problem and lubricates the process of change.



## From Ill-Being to Well-Being and Beyond

Richard Davidson and colleagues wrote a 2006 article titled "[Psychological well-being and ill-being: Do they have distinct or mirrored biological correlates?](#)" in which they wondered:

*"... whether psychological well-being and ill-being comprise opposite ends of a bipolar continuum, or are best construed as separate, independent dimensions of mental health... Is well-being merely the flip-side of ... psychological maladjustment, or do well-being and ill-being constitute separate, independent dimensions of mental functioning?"*

Most of psychiatry, psychology, neurofeedback and therapy focus on sick care, or the remediation of ill-being. In contrast, the pursuit of well-being is curiously considered a luxury, something for health-conscious dieters, doting mothers, and exercise junkies.

In the 2002 article "[The Mental Health Continuum, from Languishing to Flourishing in Life](#)" Corey Keyes says:

*"Mental illness and mental health are highly correlated but belong to separate continua, and therefore the prevention and treatment of mental illnesses will not necessarily result in more mentally healthy individuals"*

This is not a small matter. We have a Diagnostic and Statistical Manual of Mental Disorders, but there is nothing like a manual of states of mental well-being. Other than "being well" we don't even have a word for it, and most people understand the phrase to mean the same as "not sick". Not only that, but health care, and health insurance are actually sick care, and sick insurance neither of which aims to achieve, pay for, or advocate anything beyond normal health. For most of this culture well-being is the state of being not ill.

I suggest that we might start moving in the direction of enhanced well-being by looking at the brain map and asking ourselves, "How can I become exceptional?" I suggest that this is not simply a question of doing a little more, but actually doing something quite different. What do you think?



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