

## Opinion Article

# Psychotropic Medications and the EEG: Reflections on Psychotherapy

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## Abstract

The mainstay of treatment for psychological disorders is a combination of psychotropic drugs and psychotherapy. A major effect of the psychotropic medications is modulation of the autonomic nervous system. In a previous publication, the author argued that different approaches and techniques of psychotherapy are equally effective, probably because they have a final common pathway, the autonomic nervous system. Similarly, in this opinion paper, it is proposed that pharmacotherapy (psychotropic medication) and psychotherapy, share the autonomic nervous system as a final common pathway. The psychological disorders, which psychotropic medications and psychotherapy treat, have EEG profiles which are increasingly being clarified. The second proposal in this paper is that like psychotropic medication, psychotherapy also produces changes in the EEG. Possible EEG changes associated with psychotherapy are proposed. The paper ends with the suggestion that the efficacy of both pharmacotherapy and psychotherapy would be enhanced by incorporation of EEG assessments and treatments.

## Treatment of Psychological Disorders Pharmacotherapy

The mainstay of treatment for psychological disorders is a combination of pharmacotherapy and psychotherapy. Pharmacological treatments include anti-depressants, antipsychotics (neuroleptics), anxiolytics, sedatives, mood stabilizers, stimulants, and others. The mechanisms of action of the psychotropic medications importantly include action on the autonomic nervous system, where they modulate the levels of monoamine transmitters (epinephrine, norepinephrine, dopamine, serotonin) and other neurotransmitters, such as acetylcholine and serotonin. The

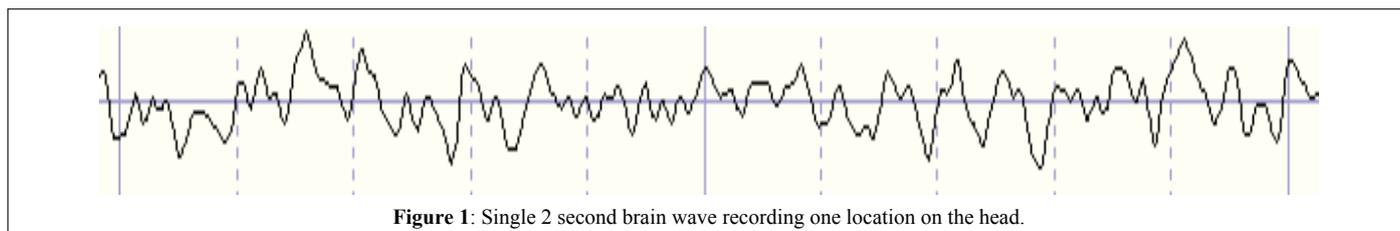
autonomic nervous system appears to be a final common pathway for psychotropic medications.

## Psychotherapy

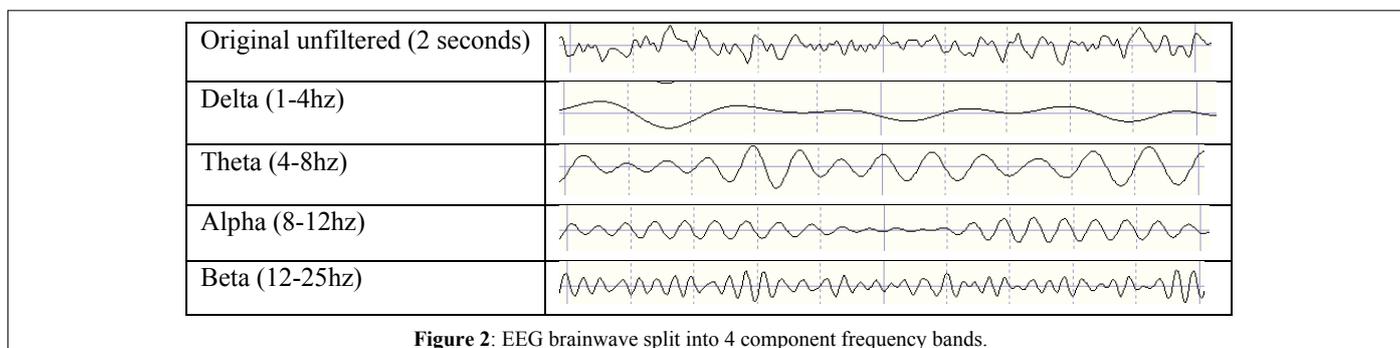
There are hundreds of individual psychotherapy techniques, classified under a small number of approaches or schools of thought, namely humanistic therapies, cognitive behaviour therapies (CBT), behaviour therapies, psychodynamic therapies, integrative/holistic therapies, and a few others. Some of these approaches are conceptually opposed to each other. For example, psychodynamic approaches emphasize the importance of subconscious mental processes as a source of psychological problems, whereas behaviour therapies de-emphasize mental processes, and focusses instead on learning and conditioning. Despite the differences in therapy approaches however, meta-analytic studies have repeatedly shown that different psychotherapy techniques are equally effective [1]. This equality is probably partly due to the autonomic nervous system acting as a common final common pathway for the different treatment techniques [2].

## Common Final Common Pathway for Pharmacotherapy and Psychotherapy?

Pharmacotherapy and psychotherapy are generally assumed to be different, in that pharmacotherapy is a biological intervention, whilst psychotherapy is not. The two forms of treatment however, share the autonomic nervous system as a final common pathway for their beneficial effects. This means that contrary to popular assumptions, pharmacotherapy and psychotherapy are both biological treatments [3]. Sharing in the final common pathway does not necessarily imply that the two treatments have identical mechanisms of action in every respect. It simply means



**Figure 1:** Single 2 second brain wave recording one location on the head.



**Figure 2:** EEG brainwave split into 4 component frequency bands.

that they act on the same neurophysiological systems, where their effects may be identical or complimentary in some instances. Meta-analytic studies have shown that psychotropic medications and psychotherapy are both effective in the treatment of depression, and that they are more effective when used in combination [4]. A meta-analytic study by Leichsenring et al. [5] found that for depression, pharmacotherapy and psychotherapy are equally effective in the short-term, but psychotherapy is more effective in the long term.

## The EEG

The readers of this journal are probably either familiar with, or experts on the EEG. Definitions and basic descriptions of the EEG will therefore be skipped. The following items need to be mentioned however, because of their direct bearing on the discussion to follow.

### The Brain Waves

Using an EEG amplifier, brainwaves (EEG waves) are systematically recorded from various locations of the head, usually 19 locations.

A brainwave, from one location may look like this (A two-seconds sample) (Figure 1)

The EEG amplifier can split this single wave into its many component waves. The most frequently analysed frequency bands, from slowest frequencies to fastest frequencies, are delta (1-4hz), theta (4-8hz), alpha (8-12hz), and beta (13-25hz). For illustrative purposes, the original 2 second sample above is shown again below, with its filtered components delta to beta. *Hz* means cycles per second.

EEG waves are classified according to their frequencies and their amplitudes. The frequency is simply the number of times the wave recurs in a second. Amplitudes are measured in microvolts (mV), and reflect, broadly speaking, the electrical energy represented by the wave.

In figure 2, the brainwaves are grouped into frequency bands, from the slowest frequencies to the fastest, i.e. delta (1-4Hz), theta (4-8Hz), alpha (8-12Hz), and beta (12-30Hz).

## Brainwaves and Behavioural (Psychological) Functions

**Delta & Theta:** These are the slowest frequency bands and reflect low arousal states such as sleep and drowsiness. Theta is involved in memory processes and relaxation.

**Alpha:** Alpha is the idling rhythm of the brain. It is maximally located in the posterior (especially occipital). Alpha is produced when a person is awake but not actively processing information; and it reflects calmness and relaxation.

**Beta:** It has a general distribution on the brain, but is maximally present in the frontal lobes. Beta is associated with focus, concentration, problem solving.

Excesses and deficits of all frequency bands create psychological problems. For example, excesses of delta and theta are associated with slower than normal speed of information processing and attention problems. On the other hand, excesses of high alpha (11-12hz) and beta may be associated with over-arousal, agitation, and anxiety. Engelbregt et al. [6] for example, documented increase in frontal beta (13-26hz) as a panic reaction commenced, and a relatively sudden decrease of frontal-central theta (3-6hz) at the end of panic. In a study monitoring resting state EEG and connectivity, Keeser et al. [7] found that depression was associated with increase in slow wave activity in the sensor and source space in pre-frontal cortical networks.

**Brainwaves and Neurotransmitters:** Vakalopoulos [8] noted that alpha rhythms reflect the predominance of acetylcholine, whilst the other waves reflect the predominance of the mono-amines (epinephrine, norepinephrine, dopamine, serotonin).

## Effects of Psychotropic Medications on the EEG

There is a growing body of knowledge about the effects of psychotropic medications on the EEG [7,9,10]. Blume et al. [11] observed that excess beta activity and a mild theta increase may be the most common EEG alterations associated with medication. For the purpose of illustration, the table 1 is a small selection of medications and their impact on the EEG, extracted from a paper by Gunkelman [10].

In table 1, the term “coherence” refers to the degree of correlation in activity between one brain area and another or others. It reflects the extent of information sharing, or functional connection between brain areas. This sharing of information may be too little (hypo-coherence) or too much (hyper-coherence) for optimal function.

The use of the EEG to choose appropriate medication is called individualized medicine, also called pharmaco-EEG [12]. For psychotherapy, a similar approach could perhaps be called “Psychotherapeutico-EEG”

## Is it Feasible to Match Psychotherapy Techniques to EEG Changes?

Table 1 matches a few pharmacotherapy interventions to EEG changes. The question posed here is whether psychotherapy techniques can similarly be matched to changes in the EEG.

If such EEG profile/ psychotherapy matches could be identified, this would facilitate the choice of psychotherapy techniques appropriate to the patient’s neurophysiological profile. It is hoped that such EEG-guided psychological interventions will bring about quicker resolution of psychological problems.

Neuropsychotherapy is an attempt by some researchers and clinicians to identify the biological changes brought about by psychotherapy [13-15]. Allison and Rossouw et al. [13] for example, suggested that the sense of safety engendered by the therapeutic alliance down-regulates distress in the primitive regions of the brain (including amygdala). They considered this as a bottom-up process for emotional regulation. Anti-depressants also have bottom-up effects, from limbic structures to the frontal cortex. On the other hand, talk therapies, including cognitive therapy, are a top-down process, whereby the frontal lobes inhibit activity in the limbic system<sup>13</sup>.

Below are some preliminary suggestions about the psychotherapy techniques which could be chosen, based on EEG evaluations.

## Individual Psychotherapy based on the EEG: Some Suggestions

Because pharmacotherapy and psychotherapy share a final common neurophysiological pathway, it is reasonable to assume that they share at least some of the EEG changes

in common. The EEG profiles documented for psychotropic medication, e.g. increase beta/decrease alpha, can thus be used as a template against which psychotherapy techniques can be chosen or developed in order to effect beneficial EEG changes.

It is notable from table 1, that of the 4 frequency bands cited there, the increase in beta is the most common feature, followed by decrease in alpha. This suggests that increasing arousal is a more effective intervention than increasing relaxation for a sizable number of patients, but this still has to be confirmed by research.

The challenge for psychotherapists is to classify therapy techniques on a continuum from most arousing to least arousing. Furthermore, this highlights the need for psychotherapists to determine the patient’s neurophysiological status, that is, the relative distribution and locations of delta, theta, alpha and beta, before choosing the intervention. Treatment will then be tailored, not exclusively to a DSM diagnosis, but to the current neurophysiological status of the patient as revealed by the EEG.

Below are described some putative suggestions about how one can use psychotherapy techniques to effect EEG changes similar to those achieved by psychotropic medications. The techniques are not neurofeedback, whereby the therapist uses devices to directly train a patient’s EEG waves. Rather, the techniques described below are the conventional psychotherapy interventions, viewed from the perspective of what changes they produce on the EEG.

## Beta Increase

These are fast-frequency waves, associated with increased alertness, focus, concentration, and mood. What psychotherapeutic interventions could bring about such beneficial increases in beta rhythm activity? Below are some

**Table 1:** Effects of Selected Psychotropics on the EEG.

Medication	Effect on the EEG
Neuroleptics	- Increase coherence - Decrease beta
Anxiolytics (Benzodiazepines)	- Decrease alpha - Increase beta (20-30hz) - Sinusoidal, hyper-rhythmic spindling wave form. - Reduces paroxysmal and epileptiform discharges
Anti-depressant (Imipramine)	- Increases slow activity - Decrease in alpha and high alpha - Increase in faster beta frequencies (mid to upper 20s and up).
Antidepressants (SSRIs)	- Mild fronto-central beta increase in the 18-25 hz. - Decrease in alpha anteriorly.
Antidepressant (MAOI) Isocarboxazide	- Increase 20-30hz - Decrease lower and higher frequencies.
Stimulant (Methyphenidate)	- Decrease in delta and theta. - Increase in posterior alpha and low beta
Anti-manics (Lithium Carbonate)	- Increase in theta - Mild decrease in alpha - Increase in faster activity - Strong potentiation of epileptiform activity.

**Table 2:** Psychotherapy Models/ Techniques Which May Increase Beta Rhythms.

Psychotherapy Model/ Technique	Beta Rhythm Promoting Factors
Humanistic therapies (Person-centred Psychotherapy)	The optimal therapeutic relationship provides a “safe” environment. This reduces predominance of sympathetic nervous system activity and allows beta rhythm activity-related activities of focus, concentration, and problem-solving to take ascendance. The impact is probably similar to what benzodiazepines and anti-depressants do.
Cognitive-Behaviour Therapy	By training the client to systematically questions dysfunctional thoughts, the therapist is encouraging beta-rhythm related activities. This is promoting action by the frontal lobes (where beta is maximal) to engage in supervisory or executive action over thoughts, emotions (limbic system), and behaviour. It helps persons to arrive at more rational decisions. The author proposes that this is a top-down approach
Behaviour Therapy (Relaxation therapy, systematic desensitization and others)	Relaxation therapy is a direct attempt to reduce predominance of sympathetic nervous system activity in the presence of anxiety-provoking stimuli. The effect is probably similar to benzodiazepines and anti-depressants. Beta rhythms are allowed to take predominance. This is perhaps a bottom-up approach.
Psychodynamic Therapies	The highly charged emotional state of “catharsis” seems to represent fast frequency activity in the beta range, associated with high arousal. The development of insight in the course of psychoanalytic therapy probably reflects a top-down process, in which the frontal lobes exert inhibition on the emotional and memory centres of the brain (limbic system).
Integrative/Holistic Therapies	This is likely to promote optimal levels of one of more of the brainwave rhythms, delta, theta, alpha, and beta. It probably contributes to increased coherence. It is expected that integrative therapies include both bottom-up processes (slow EEG waves- theta and/or alpha), and bottom-down processes (beta).

psychotherapy models/ techniques, with comments about potential relationships to the EEG (Table 2).

### Alpha Decrease

Alpha is the brain’s restful, idling rhythm. It is thus counter-intuitive that the effectiveness of several medications involves a reduction of alpha. A tentative explanation is that reduced alpha indicates shift from idling state to active required action in the beta and/ or the slower frequencies (delta & theta). Low alpha (8-10hz) as opposed to high alpha (11-12hz) is associated with slow information processing and lethargy. Medicines which inhibit low alpha whilst enhancing high alpha/ beta are thus beneficial.

### Decrease Delta/ Theta

Stimulants decrease delta and theta and increase beta. This is beneficial for a person who is depressed and producing slow-waves. Decreased delta/theta is probably one of the effects of cognitive behaviour therapy and humanistic therapies.

### Increased Delta/theta

Anti-depressant imipramine, and anti-manic lithium carbonate increase slow activity. The slowing probably partly compensates for excess fast activity, notably high beta. The medicines thus have a calming effect, so do psychotherapies which promote relaxation, restfulness, and normal sleep.

Some studies have found that the hypnotic state (psychodynamic therapy) occurs in the theta rhythm [16].

Neurotherapists typically do not train patients to increase delta or theta in order to avoid the risk of slowing the brain beyond acceptable limits. This concern is justified, given the indication, for example, that theta increase (lithium carbonate), potentiates epileptiform activity.

### Decreased Beta

Neuroleptics decrease beta. This suggests that by reducing dopamine, they reduce arousal. Dickerson and Lehman et al. [17] reviewed studies and concluded that cognitive behaviour therapy is the most effective form of psychotherapy for schizophrenia. The effectiveness is likely related to the impact of neuroleptics on the autonomic nervous system [18]. Psychotherapies can reduce arousal, but not to the same extent as medication does. The use of the EEG would help to confirm arousal levels so that the therapy can aim to increase or decrease beta and/ or other EEG rhythms to optimal levels.

### Coherence

All the psychotherapies probably lead to optimal coherence. The study by Keeser et al. [2] for example, suggests that alterations in functional connectivity may contribute to the pathophysiology of major depression. EEG evaluations can confirm whether or not there are functional brain connectivity abnormalities, thus providing a rational basis for choosing medications or psychotherapeutic techniques, for treating the depression.

### Suggestions for Psychotherapy Practice

The preliminary recommendations below are based on assumption and evidence that psychotherapy, like psychotropic medications, can induce EEG changes. These changes reflect neurobiological changes associated with therapy.

### Consideration of Neurobiological Factors (EEG) in Case Problem Formulation.

Assessment of persons prior to psychotherapy requires comprehensive evaluation of factors contributing to the

diagnosis. These include genetic vulnerability, personality factors, concomitant medical conditions, stressful life events, and stress modifiers (such as social support). The recommendation is that EEG assessments should be routine. The diagnosis/ problem formulation before therapy would then take into account the electrophysiological status of the patient.

### **EEG-Guided Choice of Psychotherapy Models or Techniques**

The EEG cannot be the only factor taken into account when deciding on the psychotherapy strategy. However, taking into account what was discussed in this paper, choices based on the EEG, when feasible, should be considered for implementation. An accurate matching of psychotherapy techniques to changes in the EEG, is yet to be accomplished. This fact should however, not hinder immediate application of the approach, based on the current state of knowledge.

### **Special Role for EEG Biofeedback (Neurofeedback).**

The most direct method for using EEG to modulate psychological states is EEG biofeedback, also called neurofeedback. This treatment method is accessible to both psychiatrists and psychologists, and is worth mastering. EEG biofeedback assesses EEG changes in real time. It provides the facility to directly and more rapidly change EEG rhythms than conventional psychotherapy.

### **Training in Psychopharmacology for Psychologists**

Psychotherapy and pharmacotherapy overlap in their neurophysiological effects, detectable by the EEG. For this reason, it makes sense that psychologists should have more than just a passing knowledge of psychopharmacology. Psychiatrists generally have more training in psychotherapy than psychologists have in psychopharmacology. As knowledge about the neurobiological changes brought about by psychotherapy increases, competence in both psychotherapy and pharmacology will become essential for clinical psychologists.

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