

Brain.fm's Science FAQ

Compiled by

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Does Brain.fm have any peer- reviewed papers published?

Brain.fm is currently in the process of scientifically validating its concepts, but no study is currently published.

In collaboration with Dr. Psyche Loui from Wesleyan University (USA) and Dr. Benjamin Morillon from Aix-Marseille University (France), Brain.fm is currently investigating the impact of its music at both the behavioral and neurophysiological level – thanks to Electroencephalography (EEG) and functional MRI (fMRI). Some pilot data can be found at: www.brain.fm

What is the definition of 'Dynamic Attending Theory' (DAT)?

The dynamic attending theory was developed by Dr. Mari Riess Jones^{1,2}. The idea is that during perception attention is modulated dynamically to optimize sensory processing at expected points in time. Crucially, this framework capitalizes on the fact that many stimuli and actions are rhythmically organized (e.g. speech, music, walking, among others). By extracting such temporal regularities, the brain is able to predict the occurrence of subsequent events of interest and optimize their processing³. In other words, attending itself is an oscillatory process that entrains to environmental rhythms, thus improving perceptual discriminative performance⁴.

How exactly does DAT work from a neurological perspective?

Neuronal (or oscillatory, brainwave) **entrainment** is the likely physiological substrate, mechanism, by which DAT operates. Neuronal oscillations correspond to regular variations of electric activity in the brain. They regulate the occurrence of action potentials, hence the communication between neurons. Neuronal oscillations have an important role in brain

operations to the extent that understanding of neuronal oscillation ‘rhythms’ now seems to be essential to our understanding of brain function⁵.

When a temporal regularity is present in the environment, neuronal oscillations can synchronize (i.e. entrain) to this external rhythmic stream. This is operationalized by appropriately biasing the high excitability phases of ongoing neuronal oscillations so that they align with the events in the stream⁶.

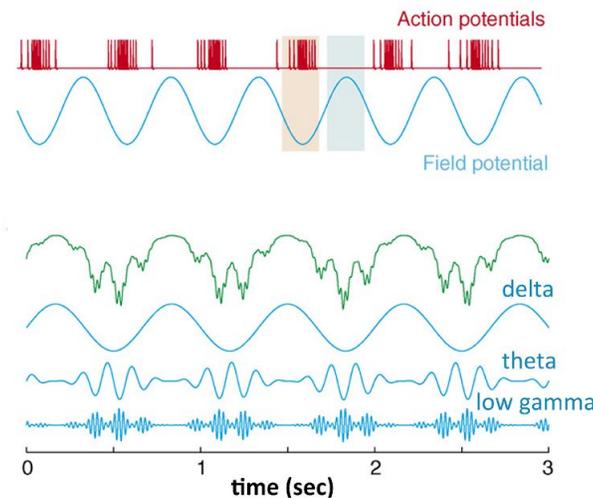


Figure 1: (top) Relationship between action potentials (red) and oscillations, as indexed by a local field potential (blue); neuronal oscillations have optimal (high excitability) and non-optimal (low excitability) phases; (bottom) Schematic highlighting the complex nature of oscillations. The (top) green trace illustrates a typical recording of oscillations. The traces below illustrate the individual oscillatory components in the delta (1.5 Hz), theta (7 Hz) and low gamma (35 Hz) bands that comprise the composite waveform. Adapted from⁷.

What is the literature on DAT and entrainment? How well accepted is it?

The literature on DAT and neuronal entrainment is plenty and pretty well accepted. The field is rapidly expanding, principally through neurophysiological experiments. For comprehensive reviews, please read Drs. Schroeder and Lakatos⁴ or Dr. Nobre⁸.

See also: www.brain.fm/pdfs/ResearchLibrary.pdf

How long do the effects last? Are there long-term effects?

Currently, there is no consensus on these questions. In the past decades, researchers investigated and described entrainment during the stimulation period. Currently, different

laboratories start to explore the short-term after-effects of neuronal entrainment induced by rhythmic auditory stimulation^{9,10}. Their results suggest that entrainment continues even after stimulus offset. However, it is currently unknown whether long-term effects exist, *i.e.* whether such stimulation induces either marginal or significant reorganization of the brain.

Does altering brainwaves really mean we are altering mental state?

It is now admitted that neuronal oscillations play an important role in brain operations⁵. Cognition – the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses – results from interactions among functionally specialized but widely distributed brain regions, organized as sets of neuronal networks. Cognitive processes can be associated with specific neuronal networks (such as the dorsal attention network, the default mode network, the alertness network, and so on*); and the multiple brain regions composing a neuronal network communicate through neuronal oscillations. Thus, neuronal oscillations correspond to the critical ‘middle ground’ linking single-neuron activity to behavior. The emerging new field of ‘neuronal oscillations’ has created an interdisciplinary platform that cuts across psychophysics, cognitive psychology, neuroscience, biophysics, computational modeling, physics, mathematics, and philosophy. And specific patterns of neuronal oscillations now start to be seen as fingerprints of cognitive processes¹¹. Mental states can thus be altered via neuronal oscillations, but such an alteration has to reach a critical level to be consciously perceived. Indeed, neuronal oscillations are in a constantly fluctuating, while we have a subjective impression of mental stability and continuity.

* See also: www.brain.fm/pdfs/ResearchLibrary.pdf

Is there a relation between Brain.fm and binaural beats?

Brain.fm technology is completely unrelated to binaural beats. Binaural beats relate to auditory beat stimulation (ABS) methods¹². The binaural beat percept seems to be caused by the major neural mechanism that enables sound localization, which occurs at the subcortical level. The impact of binaural beats on cognition is moreover not well established: Findings for most putative applications up to now are either solitary or contradictory, and the underlying neural mechanisms are still yet to be unraveled¹².

On contrary, Brain.fm technology exploits auditory rhythms and is backed-up by plenty of neurophysiological experiments¹³ (see also above).

Why do you use music?

The trend in all research is to isolate a single phenomenon, to reduce it to its key constituents and to study each constituent individually. However, simplicity is not what the brain expects to hear or has been evolved to process. This is probably why music is enjoyable to listen to, while clicks or pure tones are not!

Research indicates that behavioral performance and neuronal entrainment are more efficient when complex auditory stimuli are used^{14,15}, and musical preference has been shown to play a part in the effectiveness and enjoyment of music therapies¹⁶. In a recent experiment, Bolger and colleagues concluded that “[The] use of [musical] stimuli is not only possible, but also advisable, insofar as it seems to magnify the level of entrainment”¹⁵.

Since 2003, Adam Hewett (co-founder of Brain.fm) has been working on methods of embedding brainwave entrainment into music, and holds a patent on the process. The AI built for Brain.fm now assembles music for this purpose.

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