



# Binaural beats

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**Binaural beats** or [binaural](#) tones are [auditory](#) processing artifacts, or apparent sounds, the [perception](#) of which arises in the brain independent of physical [stimuli](#). This effect was discovered in 1839 by [Heinrich Wilhelm Dove](#).

The brain produces a phenomenon resulting in low-frequency pulsations in the [loudness](#) of a perceived sound when two tones at slightly different frequencies are presented separately, one to each of a subject's ears, using stereo [headphones](#). A beating tone will be perceived, as if the two tones mixed naturally, out of the brain. The frequency of the tones must be below about 1,000 to 1,500 [hertz](#) for the beating to be heard. The difference between the two frequencies must be small (below about 30 Hz) for the effect to occur; otherwise, the two tones will be heard separately and no beat will be perceived.

Interest in binaural beats can be classified into two categories. Firstly, they are of interest to

[neurophysiologists](#) investigating the [sense of hearing](#). Secondary (and more controversially), binaural beats reportedly influence the brain in more subtle ways through the [entrainment](#) of [brainwaves](#)<sup>[1][2]</sup> and can be used to produce relaxation and other health benefits such as pain relief.<sup>[3]</sup>

#### Contents [\[hide\]](#)

- [1 History](#)
- [2 Physiology](#)
- [3 Hypothetical effects on brain function](#)
  - [3.1 Overview](#)
  - [3.2 Brain waves](#)
  - [3.3 Other uses](#)
- [4 Example](#)
- [5 See also](#)
- [6 References](#)
- [7 External links](#)

## History [\[edit\]](#)

Heinrich Wilhelm Dove discovered binaural beats in 1839. While research about them continued after that, the subject remained somewhat of a scientific curiosity until 134 years later, with the publishing of Gerald Oster's article "Auditory Beats in the Brain" (Scientific American, 1973). Oster's article identified and assembled the scattered islands of relevant research since Dove, offering tremendous fresh insight (and new laboratory findings) to research on binaural beats.

In particular, Oster saw binaural beats as a powerful tool for [cognitive and neurological research](#), addressing questions such as how animals [locate sounds](#) in their three-dimensional environment,

and also the remarkable ability of animals to pick out and focus on specific sounds in a sea of noise (what is known as the "[cocktail party effect](#)").

Oster also considered binaural beats to be a potentially useful medical [diagnostic](#) tool, not merely for finding and assessing auditory impairments, but also for more general neurological conditions. (Binaural beats involve different neurological pathways than ordinary auditory processing.) For example, Oster found that a number of his subjects that could not perceive binaural beats suffered from [Parkinson's disease](#). In one particular case, Oster was able to follow the subject through a week-long treatment of Parkinson's disease; at the outset the patient could not perceive binaural beats; but by the end of the week of treatment, the patient was able to hear them.

In corroborating an earlier study, Oster also reported gender differences in the perception of beats. Specifically, women seemed to experience two separate peaks in their ability to perceive binaural beats- peaks possibly correlating with specific points in the [menstrual cycle](#) (onset of menstruation and approx. 15 after). This data led Oster to wonder if binaural beats could be used as a tool for measuring relative levels of [estrogen](#).<sup>[1]</sup>

## Physiology

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The sensation of binaural beats is believed to originate in the [superior olivary nucleus](#), a part of the [brain stem](#). They appear to be related to the brain's ability to locate the sources of sounds in three dimensions and to track moving sounds, which also involves inferior colliculus (IC)

neurons.<sup>[4]</sup> Regarding entrainment, the study of rhythmicity provides insights into the understanding of temporal information processing in the human brain. Auditory rhythms rapidly entrain motor responses into stable steady synchronization states below and above conscious perception thresholds. Activated regions include primary sensorimotor and cingulate areas,

bilateral opercular premotor areas, bilateral SII, ventral prefrontal cortex, and, subcortically, anterior insula, putamen, and thalamus. Within the cerebellum, vermal regions and anterior hemispheres ipsilateral to the movement became significantly activated. Tracking temporal modulations additionally activated predominantly right prefrontal, anterior cingulate, and intraparietal regions as well as posterior cerebellar hemispheres.<sup>[5]</sup> A study of aphasic subjects who had a severe stroke versus normal subjects showed that the aphasic subject could not hear the binaural beats whereas the normal subjects could.<sup>[6]</sup>

## Hypothetical effects on brain function

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*For more details on this*

*topic, see*

*[brainwave](#)*

*[synchronization](#)*

## Overview

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Binaural beats may influence functions of the brain besides those related to hearing. This phenomenon is called *frequency following response*. The concept is that if one receives a stimulus with a frequency in the range of brain waves, the predominant brain wave frequency is said to be likely to move towards the frequency of the stimulus (a process called [entrainment](#)).<sup>[7]</sup> In addition, binaural beats have been credibly documented to relate to both spatial perception & stereo auditory recognition, and, according to the frequency following response, activation of various sites in the brain.<sup>[8][9][10][11][12]</sup>

The stimulus does not have to be aural; it can also be visual<sup>[13]</sup> or a combination of aural and visual.<sup>[14]</sup> (One such example would be [Dreamachine](#).) However, using alpha frequencies with

Such stimuli can trigger [photosensitive epilepsy](#).

Perceived human hearing is limited to the range of frequencies from 20 Hz to 20,000 Hz, though [Infrasound](#) - sound below 20Hz - still have scientifically observable effects on humans, however, it is not readily audible, especially at low volume levels. While the frequencies of human brain waves are below about 40 Hz. To account for this lack of perception, binaural beat frequencies are used. Beat frequencies of 40 Hz have been produced in the brain with binaural sound and measured experimentally.<sup>[15]</sup>

When the perceived [beat frequency](#) corresponds to the [delta](#), [theta](#), [alpha](#), [beta](#), or [gamma](#) range of [brainwave](#) frequencies, the brainwaves entrain to or move towards the beat frequency.<sup>[16]</sup> For example, if a 315 Hz sine wave is played into the right ear and a 325 Hz one into the left ear, the brain is entrained towards the beat frequency (10 Hz, in the alpha range). Since alpha range is associated with relaxation, this has a relaxing effect or if in the beta range, more alertness. An experiment with binaural sound stimulation using beat frequencies in the Beta range on some participants and Delta/Theta range in other participants, found better vigilance performance and mood in those on the awake alert state of Beta range stimulation.<sup>[17][18]</sup>

Binaural beat stimulation has been used fairly extensively to induce a variety of states of consciousness, and there has been some work done in regards to the effects of these stimuli on relaxation, focus, attention, and states of consciousness.<sup>[19]</sup> Studies have shown that with repeated training to close frequency sounds that a plastic reorganization of the brain occurs for the trained frequencies<sup>[20]</sup> and is capable of asymmetric hemispheric balancing.<sup>[21]</sup>

## Brain waves

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*Main article:*

[Electroencephalography](#)

Frequency range	Name	Usually associated with:
> 40 Hz	Gamma waves	Higher mental activity, including perception, problem solving, fear, and consciousness
13–40 Hz	Beta waves	Active, busy or anxious thinking and active concentration, arousal, cognition
7–13 Hz	Alpha waves	Relaxation (while awake), pre-sleep and pre-wake drowsiness
4–7 Hz	Theta waves	<a href="#">Dreams</a> , deep <a href="#">meditation</a> , REM sleep
< 4 Hz	Delta waves	Deep dreamless <a href="#">sleep</a> , loss of body awareness

(The precise boundaries between ranges vary among definitions, and there is no universally accepted standard.)

The dominant frequency determines your current state. For example, if in someone's brain alpha waves are dominating, they are in the alpha state (this happens when one is relaxed but awake). However, also other frequencies will be present, albeit with smaller amplitudes.

The brain entraining is more effective if the entraining frequency is close to the user's starting dominant frequency. Therefore, it is suggested to start with a frequency near to one's current dominant frequency (likely to be about 20 Hz or less for a waking person), and then slowly decreasing it towards the desired frequency.

Some people find pure [sine waves](#) unpleasant, so a [pink noise](#) or another background (e.g. natural sounds such as river noises) can also be mixed with them. In addition to that, as long as the beat is audible, increasing the volume should not necessarily improve the effectiveness, therefore using a low volume is usually suggested. One theory is to reduce the volume so low

that the beating should not even be clearly audible, but this does not seem to be the case (see the next paragraph).

## Other uses

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In addition to lowering the brain frequency to relax the listener (or to raise it to help focusing), there are other controversial, alleged uses for binaural beats. For example, that by using specific frequencies an individual can stimulate certain [glands](#) to produce desired [hormones](#). Beta-

endorphin has been modulated in studies using alpha-theta brain wave training,<sup>[22]</sup> and dopamine with binaural beats.<sup>[23]</sup> Among other alleged uses, there are reducing learning time and sleeping needs (theta waves are thought to improve learning, since children, who have stronger theta waves, and remain in this state for a longer period of time than adults, usually

learn faster than adults;<sup>[*citation needed*]</sup> and some people find that half an hour in the theta state can reduce sleeping needs up to four

hours;<sup>[*citation needed*]</sup> however, this is supposed to happen with *any* way to get into theta state, e.g.

[meditation](#);<sup>[*citation needed*]</sup> some use them for [lucid dreaming](#) and even for attempting [out-of-body experiences](#), [astral projection](#), [telepathy](#) and [psychokinesis](#).

However, the role of alpha-wave activity in lucid dreaming is subject to ongoing research.)<sup>[24][25][26]</sup>

Alpha-theta brainwave training has also been used successfully for the treatment of [addictions](#),<sup>[22][27][28]</sup> for the recovery of [repressed memories](#), but as with other techniques this can lead to [false memories](#).<sup>[29]</sup>

A trial of Delta binaural beat technology over 60 days has shown positive effect on self-reported psychologic measures, especially anxiety. There was significant decrease in trait anxiety, an


increase in quality of life, and a decrease in insulin-like growth factor-1 and dopamine<sup>[23]</sup> and has been successfully shown to decrease mild anxiety<sup>[30]</sup> and lessen hospital acute pre-operative anxiety.<sup>[31]</sup>

Another claimed effect for sound induced brain synchronization is enhanced learning ability. It was proposed in the 1970s that induced alpha brain waves enabled students to assimilate more information with greater long term retention.<sup>[32]</sup> In more recent times has come more understanding of the role of theta brain waves in behavioural learning<sup>[33]</sup> The presence of theta patterns in the brain has been associated with increased receptivity for learning and decreased filtering by the left hemisphere.<sup>[32][34][35]</sup> Based on the association between theta activity (4-7 Hz) and working memory performance, biofeedback training suggests that normal healthy individuals can learn to increase a specific component of their EEG activity, and that such enhanced activity may facilitate a working memory task and to a lesser extent focused attention.<sup>[36]</sup>


## Example

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For these examples to be effective, it is required that the listener use headphones.



**Binbeat Sample**



30 seconds of steady 10 Hz binaural beats with background [pink noise](#).

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Direct downloads of the above files:

[Media:Binbeat sample.ogg](#) [Media:](#)

[Binbeats2.ogg](#)

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- [Electroencephalography](#)
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- [Evoked potential](#)
- [Gnaural](#)
- [Hemi-Sync](#)
- [Human enhancement](#)
- [Induced activity](#)
- [Intelligence amplification](#)
- [Lucid dream](#)
- [Mind machine](#)
- [Neural oscillations](#)
- [Neurofeedback](#)
- [Ongoing brain activity](#)
- [Schumann resonances](#)

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[Binbeat Sample 2](#)



Frequency starts at 20 Hz, falls to 7.83 Hz in 10 minutes, stays constant for 15 minutes and rises back to 16 Hz in 5 minutes.

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## External links

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- Stanford University thesis, review of literature on brainwave entrainment; Chapter 4 binaural sound source Stanford
- Gnaur - GNU General Public License binaural beat generator for Win/Linux ([Java version](#))
- SBaGen - GNU General Public License binaural beat generator for Win/Mac/Linux

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- [MultiFree](#)  - A free and versatile program for creating binaural beats
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- [Main page](#)
- [Contents](#)
- [Featured content](#)
- [Current events](#)
- [Random article](#)

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- [About Wikipedia](#)
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