OUR MUSICAL BRAIN

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Music and treatment in cultural perspective

The use of music in connection with the treatment of illness has been known in a number of classical cultures for millennia. Music has been used in India, Greece and China, and perhaps most effectively and beautifully, in the Arabic culture, where music played on string instruments combined with the sound of water from fountains was a significant element of the environment at hospitals and healing centres. What is new is that, in a number of clinically reliable studies, science has demonstrated that music influences our hormone system, the involuntary nervous system which controls breathing and heart rate, the body's hormone regulation in stress situations, and also has an effect on the immune system. Furthermore, music alleviates anxiety and improves sleep quality. These effects have been reported for both awake and anaesthetised patients. The sense of hearing is the only sense which is not blocked out when a person sleeps, and even under deep anaesthetic, the ear registers sounds.

The traditional perception of music as medicine

Music has traditionally been used to treat mental disorders, and has shown an effect in the treatment of anxiety and depression. In recent years, interest in documentation and in scientific studies into the effects of music has increased. The focus has been on stress and pain relief in combination with traditional treatments. There is a good basis for concluding that music can be used as a support therapy and to relieve symptoms in relation to a number of conditions such as dementia, Alzheimer's disease, and depression. Even though music has specific and significant effects and negligible side-effects, it cannot be considered as an equal to the classical treatments such as medication and surgery. However, music still has a moderate but definite effect on pain levels after surgery, rheumatic complaints, and in palliative care during the last phases of life. Music can therefore enhance the effects of classical treatments without expense or side-effects.

Music and its effect on the body

Music has an effect on everyone. Some forms of music speak particularly to the body. We cannot help but move to the beat when we hear it. Other forms of music speak mostly to the emotions and influence our mental state. But it is the elements of music which effect us psychologically that we wish to focus on.
All the studies show that patients who listen to music generally feel better and more relaxed, and experience less anxiety and stress. Some heart patients were able to completely do without sedative medication when they were given music to listen to instead. The nurses in hospitals are also affected by music played for the patients. The staff began to move around and speak more quietly and experienced a more comfortable atmosphere in their workplace.

Music science or biomusic – a new discipline

Biomusic science is a new scientific discipline which focuses on the relationship between music, brain function and biology. We know that music influences our body, but in what ways can sound produce changes in our mental state? in the brain's electrical oscillations (EEG)? in the hormonal status? On closer consideration the connection is not clear – how music can manifest itself bodily. Biomusic is therefore an exciting interdisciplinary

scientific activity which draws together a number of interesting aspects of music's effect on the body and its functions.
The body constantly strives for balance, homeostasis, precisely as we are familiar with the way music strives after harmony. This has given rise to a number of popular observations, such as the "Mozart effect". Lately, criticism has been directed at the "Mozart effect", which is the enhancing effect on our memory and ability to solve complex tasks when stimulated by music. But is there any basis whatsoever for this apparently easily-attainable and attractive effect? A number of studies of the electrical oscillations of the brain under the influence of music have now been done which appear to confirm the "Mozart effect". From a neurophysiological perspective, one could say that the brain's electrical oscillations have an acoustic structure which swings like a pendulum around a point of equilibrium, from chaos to order, from disharmony to harmony. Such structures usually influence us unconsciously. It has been shown that music causes better synchronisation, resonance and coordination between the two halves of the brain (left and right), by stimulating the corpus callosum, the electrical and nervous connection between the two halves of the brain. It has also been shown that the distribution of oscillations between the two brain hemispheres can be influenced using music, especially in patients with depression, where the electrical activity moves to the opposite brain hemisphere as a result of music.

The brain and music – or the "musical brain"
The brain consists of three parts: the primitive part of the brain/brain stem, the so-called "reptilian brain", the middle brain or mammalian brain and the new brain which developed last, consisting of two brain hemispheres connected by a bridge (the corpus callosum). The problem is, how does music affect the brain and where does it have an impact?

Our perception of music is complex, because it is the sum of essentially different musical elements. These basic elements: pitch, intensity, duration, rhythm, and memory for what has just been played, are spread across many different parts of the brain – the basic primordial brain or reptilian brain, the middle brain where emotions are located, and the most recently developed neocortex, where the intellect resides. The neocortex consists of the two brain hemispheres connected by the corpus callosum. It is just too simplistic to claim that music is localised in the right brain hemisphere alone, as one might otherwise be tempted to believe. The truth is that when it comes to music, the brain has "delegated" the important, specialised foundational music elements.
The right brain hemisphere is specialised in the perception of spatial musical elements that is the sense of harmony and pitch, whereas the left hemisphere perceives the progress of the melody, which requires musical memory. In order to attain a complete musical perception, the connection and integration between the two brain hemispheres (via the corpus callosum) is necessary. This interaction via the corpus callosum can be enhanced by music. In reality, this agreement or harmony is only experienced via interaction between the two brain hemispheres and the various regions of the brain, mediated by the corpus callosum. This important new documentation of the perception of music is confirmed in a study published in the recognised scientific journal, Nature. In this study, researchers found that integration between various individual centres and global brain function only occurred for series of notes, that is, was only promoted by melody sequences.

Thus it appears that music is able to coordinate the two brain hemispheres and hence the division of work which exists between the right hemisphere which primarily perceives notes, melodies, pattern recognition, imagination, and image formation, and the left hemisphere which handles the more logical processes. Concentration in the left

hemisphere gives us the ability to concentrate on one thing at a time. The left hemisphere relates to time, while the right hemisphere relates to space. It has therefore been said that the Mozart effect, that is, the ability to coordinate the perception of time and space, corresponds to this coordination between the two brain hemispheres.

Music and emotions

The acoustic nerve runs to the middle brain and is located very close to the centre which regulates hunger, satiety, metabolism, and level of consciousness, as well as the centre which controls overall hormone regulation. One can therefore easily imagine that stimulation of the middle brain, which is directly connected to the ear, could affect our degree of alertness and our hormonal status.
The middle brain is our emotional brain. It plays a central role in the regulation and mediation of the effect of music on our basic mood. One could imagine that the activation of codes located in the middle brain's emotion region, the "limbic system", triggers positive feelings. A basis for the belief that this part of the brain is receptive to harmony and consonance, and that harmonic musical stimulation can provide a foundation for the integration of sensory perceptions. The most consistent clinical effect of music therapy on conditions such as schizophrenia and depression is improved communication ability and social interaction.

The brain's electrical activity

The electrical waves in the brain – EEG registrations – can be influenced by music. Brain function is coordinated by patterns of brainwaves which can be measured using electrodes to plot an EEG. EEG waves are divided into high and low frequencies. The high frequencies: Beta waves are associated with activation of the brain, a high degree of alertness, agitation, intellectual activity, tension, activity directed towards the outside world. Stress is often linked to an over activation of these Beta waves, corresponding to an inadequate ability to relax. Relaxation appears to be directly linked to the extent to which brainwaves move from a Beta pattern to the lower frequency Alpha wave pattern.

Alpha waves are particularly associated with relaxation, imagination, and states in which we let our minds wander and forget thoughts of the outside world. The Alpha pattern can be effectively disrupted by sensory stimulation, reasoning, and strong emotions. Alpha waves are most easily triggered by preventing sensory stimulation, for example, with the eyes closed. Dreams, day dreams and states of meditation produce alpha waves, especially in connection with internal images, for example, induced by music.
The even slower Theta waves accompany deeper meditation and sleep-like states. A large proportion of sleep provides EEG readings at this level. Creative skills might flow out of this frequency pattern. The lowest frequency Delta waves correspond to brainwaves during deep, dreamless sleep and are also present in unconscious patients.

The effect of music on brainwaves

Many trials have been carried out which show that the slow rhythms in classical music cause the brain to change from Beta to Alpha activity, and rhythmic music can produce the lowest frequency waves. The brain processes music at several levels, and much of the research taking place is focussed on the interplay between music and the brain, the "musical brain". Brainwave activity can be reduced, from dominance by Beta-level electrical oscillations, to lower frequencies – to waves at the alpha and theta level. Recent studies have shown that musical stimuli can increase activity in the new brain (neocortex) which is associated with learning and coordination, and strengthen the connection between the two brain hemispheres. Studies suggest that music can enhance the ability

to solve problems which demand higher mental functions. It is important to point out here that the effect of music is of short duration.

Chronic stress and music

Music therapy has a well-known, relaxing effect. It has been shown in a number of patients that the signal chemicals in the brain can be affected by music. Research among Alzheimer patients has shown that the effect of music is a subsequent increase in the amount of melatonin, which can help contribute to a more relaxed and calm state of mind (2). Melatonin is the hormone which signals sleep.

In connection with stress, the adrenalin glands are involved. Increased levels of adrenal cortex hormone – cortisol – are observed under chronic stress. Music has an effect on chronic stress, judged by measuring cortisol levels in saliva. A stressful situation produced a significant rise in cortisol levels in saliva within 15 minutes. Listening to music led to a significant reduction in the cortisol concentration in saliva, which after just one hour was back down to the normal level (3). One might ask whether there might be a difference between the effect of music on the two sexes. It has been found that both men and women experience a reduction in stress level (judged by a fall in cortisol levels) during and after music (4). Stress can arise in connection with thoughts about hospital procedures, and it has been shown that music reduces stress and anxiety and causes blood pressure and heart rate to drop in connection with surgery under local anaesthetic. Soothing music negated the stress associated with surgery under local anaesthetic, an effect which has also been shown under general anaesthetic after anaesthetised patients heard music while unconscious. In a random trial involving music and an absence of music, blood pressure patterns were studied. When the anaesthetic wore off, there was less increase in heart rate and blood pressure in the group which had been exposed to music, compared to those who had not. Patients in the music group preferred this form of anaesthetic, even though they did not know whether music had been played. These findings indicate that music has an effect on blood pressure and heart rate during awakening from anaesthetic, but also increase patients' acceptance and positive experience of being anaesthetised (5).

Studies have also been done on the effect of music on pain after an operation. The study involved patients who had had an operation. The patients were exposed to music either while anaesthetised or immediately afterwards, and were compared with a control group which did not hear any music. Each patient's need for morphine or other pain relieving medications after their operation was noted. The impact on fatigue and anxiety was also recorded. The results showed that patients exposed to music either while under anaesthetic or immediately after their operation had significantly less pain in the first hours after the operation, required less morphine, and experienced less fatigue, compared to the control group (6).

In addition, the many stressful sounds, alarms and noises which occur in our hospitals provoke anxiety. One might logically assume that music played together with hospital noise would increase the sound level. On the contrary, it has been found that random noise in the surroundings is subdued by the music. In other words, the mind focuses on the music. This causes other sounds to recede into the background, so despite a lot of activity and noise in a hospital ward, music has a stress-relieving and calming effect. Many patients have said that it speaks to their imagination and provokes images.

The use of music outside hospitals

It is surprising that many people use music as part of their daily routine, for stress relief and relaxation. It is very important to realise that in the complex society we live in,

everyone needs breaks or periods of greater reflection, without too much sensory stimulation. Music is able to create this break, in a similar way to yoga and meditation. The effects noted on our musical brains correspond closely to the meditation effect, whether or not people have musical talent. Television is not able to provide such deep relaxation, it simply creates more confusion.

MusiCure and Musica Humana

To summarise, it is clear that the global interest in music in relation to health and treatment is very great. In Denmark, we have taken a great step forward within this field with Musica Humana's research and the creation of the MusiCure programme, which is the first and most comprehensive scientifically documented original music programme of its kind in the world. The interdisciplinary cooperation between the composer, Niels Eje, and the research group, Musica Humana, has resulted in the accumulation of unique documentation, which along with the CD releases in the MusiCure series, is being used in the daily work of music treatment in many countries. (Please also refer to the articles: "Impact of the sound environment on healing" and "The Musica Humana Project Organisation" in the book which accompanies *MusiCure 1. The Journey*).

Conclusion

Our perception of music is complex because it consists of a number of musical elements which are spread across various parts of the brain. Music can, in itself, integrate our combined music perception into a whole. Music has a number of quite specific biological effects which can be used in relation to a number of normal conditions, but also in connection with a number of clinical medical conditions. Music has only a moderate and relatively short-lived effect. Music therefore supplements conventional treatment brilliantly.

Both in the hospital and at home, music reduces stress, anxiety, sleep problems and apparent pain sensitivity. Music has a harmonising effect on the mind, making it well-suited for a daily, regulated, "musical break", with effects comparable to meditation. Music coordinates the function of the new brain and gets the best from the two brain hemispheres because it has an effect on the corpus callosum, and also influences the emotional brain, hence promoting harmony. Music also has an effect on the subconscious. It reduces breathing frequency, chronic stress, and blood pressure after an operation.

The MusiCure releases attempt to concentrate these positive effects of the power of music, and *MusiCure 2. Equator*, is the second release in a total series of 10.

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