



Andrew Newton

music  
and the mind

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# Music and the mind

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I have a lot of experience in music. From 1975 to 1979 I attended the Royal Northern College of Music (RNCM) in Manchester and graduated with a diploma and a BA (hons) degree. A lot of the time I was supposed to be in college, I was actually bunking out of college – playing with professional orchestras, something that most music students do *after* they leave college.

The Royal Liverpool Philharmonic and Hallé Orchestras regularly booked me as an extra player where fate dictated I usually ended up playing the triangle while the full-time members got the most exciting parts – such is the word of classical music! You have to work your way up the hierarchy before you get to play the bass drum!

Quite often, I would make a mad dash from college to perform in the evenings with various freelance orchestras such as the Manchester Sinfonia and the Manchester Mozart Orchestra. I even got to do the odd gig with the BBC Scottish Symphony Orchestra and in 1978 / 79 I became conductor of the semi-professional Manchester Concert Orchestra before turned fully pro.

For four summers I played at the Spa Grand Hall in Scarborough with the then famous Max Jaffa Orchestra – a forerunner of André Rieu, but without the frocks and the schmaltz. Those four month-long summer seasons were some of the happiest times of my life. Max is long gone of course, but the orchestra is still there, albeit with a much reduced number of players and sadly, rather smaller audiences.

Classical musicians are a special and unusual breed. Rank and file orchestral musicians are not very well paid – even though most are brilliant and outstanding musicians. What they all have in common is that they love music and they love playing it. I left because I wanted to see the world, and seeing the world requires a considerable investment of time and money. At a time when I was one of only a handful of stage hypnotists in the world, I got the money – too much of it for my own good probably – and I did see the world – several times over.

Classical musicians' brains are astonishingly highly organised – not only when they're making music, but in other areas of their lives too.

Musicians are extremely good at recognising patterns (which is why they spend so much time practicing scales and arpeggios) and they are fastidious in their attention to detail. Most have few interests outside the world of classical music – instead, they practise for hours every day. Classical musicians are trained to a fantastically high standard and music – that is the written music on the page – is a highly complex language of pitch, rhythm, tempo, phrasing and instructions given in the form of geometric shapes, arcs, various squiggly lines, and letters and words not usually in English.

Learning to sight-read music fluently and perfectly is as difficult as learning to read and speak Chinese to the same high standard. To be a professional classical musician involves a considerable sacrifice of time and mental energy, and years of practice and uninterrupted dedication.

At the same time, psychologists are attempting to explore the link between musical preferences and personality. Leading the search for this link is David Greenberg, a

psychologist and researcher at the University of Cambridge. Mr Greenberg is working on a project called the Musical Universe and has formulated an experiment to test the link between musical taste and personality.

Anyone can contribute to Mr Greenberg's research by taking part in a simple quiz – all you have to do to take part is go to [MusicalUniverse.org](http://MusicalUniverse.org) and select the Musical Taste option.

So far, thousands of people have taken part in the project, filling in questionnaires designed to pigeonhole their personalities and find out what kind of music they prefer. According to Mr Greenberg, musical preferences may be linked to three different types of brain.

The Empathising/Systemising Theory was first developed by Professor Simon Baron-Cohen of Cambridge University. Professor Baron-Cohen is a renowned researcher and expert on autism, and also, believe it or not, Ali G's brother.

The Empathising/Systemising Theory proposes that on a level below normal personality there are individual differences in the wiring of the brain that result in two different ways a person may process information - empathising and systemising, hence the name.

Empathisers tend to be good listeners and can put themselves in someone else's shoes.

Systemisers can have an average or even high ability to do this too – it's not that they necessarily lack empathy, but their systemising abilities are greater. They possess a well-developed ability to understand thoughts and feelings in themselves and others. They also prefer the kind of music that evokes deep emotion. This preference would surely include both classical and popular music – think Tchaikovsky and Whitney Houston.

Systemisers are more easily able to identify patterns in music and, according to Greenberg, prefer more intense music that forms complex sounds. This would certainly apply to all the musicians I knew. We were trained to deconstruct symphonic scores, isolating themes, counterpoint, instrumentation, as well as the complex structures that create the emotional response in musical works.

[The complex sounds and colours of the musical spectrum are far more wide-ranging when they're coming from a seventy-piece symphony orchestra than when emanating from three guitars and a drum kit. Think *Star Wars* as opposed to '*We're all going on a summer holiday*'].

So... empathisers are interested more in music's emotional qualities and how it makes them feel, whereas systemisers are more intrigued by the complexity of its structural qualities.

No big surprise then, that people who liked both emotional music and intense music tend to have similar scores in empathising and systemising tests, which apparently, also indicate an ability to think in a balanced way.

It is important to understand the difference between [unfairly] discriminating between classical and popular music in terms of good and bad, and the ability to distinguish between well composed and arranged music and badly written or arranged music, regardless of genre. '*Hit me with your rhythm stick*' is just as musically mature and complex as Beethoven; *I did it my way* just as emotive as Rachmaninov. *The Blue Danube* sounds great when played by a full orchestra, with its variation in colours and differences between strings woodwind and brass, but positively dire when played on a Hammond organ.

The study found that people who prefer reflective and complex music such as classical and jazz, scored highly when tested for openness to experience and saw themselves as politically liberal, intelligent, but not very athletic. So just like all my classical music friends. Those who preferred heavy metal and heavy rock music were similar to jazz-lovers, but more likely to think of themselves as athletic, very much *unlike* my classical music friends.

Greenberg believes that the converse may also be true – that openness to experience could be an indicator of musical ability, even in those who have never picked up a musical instrument.

The study also found that fans of upbeat music like country, western, country & western, mainstream pop and movie theme tunes, tended to have low scores for openness to experience and overall intelligence, although they were more likely to be agreeable, extroverted, conscientious and think of themselves as attractive, wealthy, athletic and politically conservative.

The third type are people who prefer energetic and rhythmic music. Those people were also extroverted, agreeable, attractive and athletic, but they did not share the political inclination, wealth or intelligence scores as lovers of emotive and more complex music.

It doesn't take a genius to work out that our preferences in music reflect who we are – and that includes personality and the way we think. It may even reflect the way our brains are wired at birth. Musical appreciation might also be hereditary – all my family were musical, although not professional, as were many of the parents and siblings of many at the RNCM, so I think that probably supports the point.

There is something else of interest here that deserves at least a mention. Great composers stamp *their* personality, *their* beliefs – including their political beliefs – and *their* emotional state of being on their music. Beethoven speaks to the audience and is often political; Mahler addresses the whole world with his expansive symphonies, his belief in fate and resurrection of the soul; and Tchaikovsky speaks directly to the individual – Tchaikovsky reaches into your chest and rips out your heart.

I would say that listening and creating are two sides of the same coin. You could take this one step further and apply the same rule to soloists and conductors, who routinely impress their own interpretations on music. My orchestral experience is proof of this – same piece, different meaning, depending on the soloist or the conductor.

We already know that sad music can make us feel down and uplifting music can lighten our mood. It could be our brains release a pleasure hormone in response to the music in order to calm or excite us. Empathisers may get a bigger dose, since the region of their brains responsible for regulating the chemical's release is larger. Systemiser's brains are bigger in regions responsible for recognising patterns, so when they hear intense or highly structured music, that could be the reason they prefer it for its complexity.

According to the Musical Universe Project and the Short Test of Musical Preferences, musical taste falls into distinctive groups, each indicative of the listener's personality.

**Mellow** music can be romantic, quiet, relaxing, slow, sad, soft, and usually evokes a deep emotional response. This kind of music is unpretentious, uncomplicated and often includes 'easy-listening,' country & western, folk, and singer/songwriter genres.

People who have a preference for mellow music have a well-developed ability to understand the feelings of others as well as themselves. People who enjoy both mellow

and intense music score equally in empathy and systemic tests, indicating balanced thinking.

**Upbeat** music can be defined as music that is er... well, upbeat. Obvious really. *Eye of the Tiger, Tie a yellow ribbon round the old oak tree, Agadoo*, that sort of thing.

People who like this sort of musical drivel, including some country music (Hank Williams for example) and mainstream pop tend to achieve low scores for openness to new experiences and intelligence.

However, they are more likely to be agreeable (especially when they have had a few drinks) extroverted (especially when they have had a few drinks) and, perhaps surprisingly, conscientious. They also see themselves as attractive (especially when they've had a few drinks) wealthy (they have a penchant for ostentatious displays of 'bling') athletic (they love going to the gym and talking about going to the gym) and are in the main politically conservative (Sun reader.)

**Sophisticated** music is more inspiring, soaring, intelligent, complex and dynamic, sometimes percussive with strident themes and orchestration. Includes classical, operatic, traditional jazz.

People who like sophisticated, more complex music score highly on openness to experience and see themselves as politically liberal (some of them may read The Guardian) intelligent and not at all athletic. They can identify patterns (and not just in music).

**Intense** music is loud, sometimes even aggressive and definitely not meant for relaxation or easy listening. Neither is it inspiring. It includes the simplicity of heavy rock, punk, heavy metal, heavy 'pop,' and sometimes 'classic rock' genres.

**Contemporary** music is usually percussive, electric and definitely not sappy or sad. It includes Electronica, Latin, Acid house, Jazz funk, Garage and other loud and obnoxious shit music generally played by people who look as if they haven't had a wash for a week.

People who like energetic, punchy music and rhythmic music are agreeable, also extroverted, attractive and athletic. However, they do not display the political inclinations, wealth or lower intelligence scores of lovers of upbeat music.

So, in conclusion, the systemisers (the ones who prefer intense music that forms complex sounds) possess the drive to analyse and explore systems in order to understand the underlying rules that govern a system's behaviour. Like the composers, they also have the drive to construct systems. They also tend to be male. These people intuitively figure out how things work and what the rules are. Tell tale signs include repetitive behaviour, an obsession with arranging things and an eye for detail. They are also more likely to be less sociable. In fact their general traits are similar to those of autism.

Conversely, Empathisers tend to be female. They are the ones who prefer more mellow music that elicits emotional response. They are able to identify other's feelings and emotions and respond to those proportionately. Unlike the systemisers who can spot patterns and rules, they have the intuition and empathy to understand how other people are feeling and can treat others with care and sensitivity. They are relaxed about details and are socially communicative.

So now we have something of a dichotomy – because trained musicians are all these things combined. They have the intelligence (both emotional and technical) to interpret a musical score – they also have the intuition to recognise the feelings and emotions

reflected in the music. In fact classical musicians can recognise, interpret and enjoy all these things just by looking at the score – they don't actually have to *hear* the music to appreciate it!

Herein lies the danger in trying to pigeonhole humanity. I am always deeply suspicious of attempts to describe the human condition in terms of tables and graphs because we are all more than just the sum of our parts and to reduce humanity to a series of pie charts runs the risk of discrimination and possibly racism.

We are all both empathisers *and* systemisers, just with different emphases on balance. Musical preference, I suspect, is just the tip of a very large iceberg. Studying the links between the behaviours, as interesting as it is (and I do find it very interesting) will of course lead to a better understanding of humanity and its predictable and unpredictable behaviour. But there are too many other blanks in the equation left to consider.

It will take a lot more persistence and effort, including bringing in other disciplines and discoveries to get closer. [This is no criticism of David Greenberg and Simon Baron-Cohen and other researchers, for whose work I have tremendous respect.]

Music is one of my great loves. But we could be taking a closer look at the connection between music, emotion and spirituality... and the link between music and the visual arts and personality.

This research touched a nerve because music is a subject very close to my heart. The temptation is to listen ever more closely...

We connect through music because music synchronises the brains of performers with their audience, allowing both to share emotions. The greater the synchronisation between musicians and listeners, the more enjoyable the performance is.

Researchers have been able to track changes in brain activity by monitoring changes in levels of oxygenated blood in certain parts of the brain where a greater supply of oxygen is allocated to neurons that are more active, and in the case of music, particularly to those in the left temporal cortex. They found that listening to music triggered increased blood flow to areas of the brain known to be associated with the interpretation of the rhythm of sounds, as well as interpersonal intentions and expression.

This connection appeared to be stronger after around 50 seconds, suggesting it may take a little time the brain to develop appreciation of a piece of music. The same happens in both musician and listener, suggesting a neural synchronisation between audience and performer.

The full findings of the study were published in the journal *NeuroImage*

People who prefer Bach and Mozart might even be more intelligent than people who prefer words in their music. Some scientists believe there may be a link between brain power and instrumental music.

Researchers from Oxford Brookes University studied more than 467 teenage students in Croatia and results showed that people with lower intellect preferred music with lyrics, rather than complex orchestrations. This reaffirms the popular theory by Satoshi Kanazawa, known as the Savanna-IQ hypothesis, which links intellect with novel or uncommon stimuli.

When the students took an intelligence test, and then asked to rank musical genres in order of preference, those with the highest IQ scores displayed a clear preference for instrumental music.

The Savanna-IQ hypothesis was first presented by evolutionary psychologist, Satoshi Kanazawa in 2004. The hypothesis claims that human behaviour will always be somehow anchored in the environment in which their ancestors evolved and developed on the 'savanna'. Making music by banging sticks together or beating primitive drums and singing, all things which would aid social interaction would have their roots in primitive societies.

One application of the theory is that our ancestors craved fatty and sugary foods vital for sustenance, which are now responsible for many health concerns, including diabetes. The theory has been expanded to link intellect with novel or uncommon stimuli, for example people who prefer more complex music with less explicit content, such as lyrics.

The Croatia study employed a non-verbal type of intelligence test which included a music questionnaire which measured a number of variables likely to have an effect in this relationship, such as taking part in extra-curricular music education, its type and duration.

However, study was limited because it didn't account for other factors, such as age, level of education and social class.

The results were published in the journal *Evolutionary Biological Sciences*.

Neuroscientists at the Montreal Neurological Institute, McGill University, Canada, studied music's ability to induce feelings of pleasure on the brain. Stimulating nerve cells in the brain's reward pathways led to enhanced music induced pleasure in test participants. Communication between the brain's auditory and reward circuits is the reason why humans find playing and listening to music so rewarding.

The brain's reward pathway is stimulated by all types of reinforcing stimuli, which also includes food, sex, alcohol, drugs... and music. It also regulates emotion and motivation. We know there is a correlation – a link – between such stimuli, but that does not necessarily prove that one causes the other.

Participants who preferred pop music were asked to listen to pop songs while the research team measured their brain activity with fMRI, which measures brain activity by detecting changes associated with blood flow. Before each scan, the research team indirectly excited or inhibited the brain's reward circuit with trans-cranial magnetic stimulation (TMS). TMS is a noninvasive way of delivering stimulation to the brain to stimulate neurons using an electromagnetic coil placed against the scalp.

Participants pressed one of four different buttons on a response pad to indicate their degree of pleasure as they listened. Exciting the reward circuit prior to hearing music increased the pleasure that participants felt when listening to the songs, while inhibiting it decreased pleasure. These induced pleasure changes were linked to changes in activity in the nucleus accumbens, which is a key region of the reward circuit. The nucleus accumbens is also directly involved in reinforcing and addictive behaviours in response to drug use.

In the tests, changes in activity in the nucleus accumbens predicted variations in responses, indicating interaction between auditory and reward regions that drive the pleasure we feel when we're listening to music.

A series of sounds heard in no particular order have no inherent value, but when arranged in patterns they can stimulate a sense of reward. The integrated activity of brain circuits involved in pattern recognition, prediction, and emotion allow us to experience music as an aesthetic or intellectual reward.

Even if you listen to a piece of music you have never heard before, activity in one brain region can reliably and consistently predict whether you will like it. The nucleus accumbens is also involved in forming expectations that may turn out to be rewarding.

Our brains are able to synchronise with music's rhythm. Mood can reflect what we listen to – fast or energetic music can make us feel alert and excited, while slow music can calm us down. [Is this why they play Mantovani in mental hospitals?]

Slower tunes have been observed to slow people's heart rates, which in turn slows breathing, lowers blood pressure and relaxes the muscles. A faster heart rate has the opposite effect and can even make people feel tense or uncomfortable.

Researchers at Stanford University in the US found music could have the same effect on the brain as meditation and that slow, regular tunes are the most relaxing.

In line with meditative purposes, often the most relaxing music seems to be songs which don't have any lyrics – possibly because thinking about words requires active effort from the brain.

# Music makes smarter children

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Children tinkling away on the piano or tapping away on a drum kit may not seem as important as studying English or maths, but time spent learning a musical instrument actually boosts exam scores in maths physics, chemistry and biology! Overall, students who master instruments are around one year ahead of their non-musical peers.

Music boosts learning. Learning to play an instrument means gaining unique skills. Playing in a small ensemble or a large orchestra can be very demanding. Children have to learn to read music notation, develop eye-hand-mind coordination, develop keen listening skills, and most important, learn the discipline needed to practice in order to succeed as part of a creative team. All those learning experiences play a role in enhancing children's cognitive capacities.

Time spent practising should not be seen as a distraction from 'more important' subjects. The discipline of mastering instruments and reading musical notation increases concentration and a host of other useful study skills. Music boosts learning because working out how to play an instrument bestows transferable skills. The more children study music, the better they do in other subjects.

Canadian researchers at the University of British Columbia carried out a study of 112,000 students. Approximately 13% of the students had taken at least one music course. Most notable was that playing an instrument for just six months improved children's linguistic skills. Compared to children who just read books, those who learned to play the piano were far superior in their detection and repetition of linguistic sounds.

After just one month, children who played the piano outperformed others in a language test based on the sound of consonants and were better at distinguishing between different words and also showed better detection of pitch.

Although playing an instrument is not a shortcut to improved intelligence, no matter how irritating those screeching violin scales may seem, those music lessons are not a waste of time – your children's memory and vocabulary will improve from playing an instrument. Music is, after all, a universal language.

Another study, from VU University Amsterdam and ArtEZ Institute of the Arts at Zwolle in the Netherlands, of primary school children found that those learning music benefit from a boost in brainpower. Regardless of ability, they do better in language and memory tests and are also better at planning and controlling their behaviour.

A child learning to read music is believed to use parts of their brain involved in memory and attention, which 'trains' them to improve other life skills.

In the Dutch study, 147 children with an average age of six were split into four groups. One was given school music lessons, another school and private music lessons, a third had no music lessons and a fourth attended art lessons only.

The children given music lessons, regardless of whether they had private tuition, and regardless of their level of ability, all saw improvements. They were tested on memory by remembering dots in a grid on a screen and on vocabulary by naming the similarities between a cat and dog. Those who had music lessons did better than children with no musical training, and were also better at controlling their behaviour.

The study, published in the journal *Frontiers in Neuroscience*, also found art lessons significantly improved children's visual and spatial memory.

Learning to play an instrument can also help children concentrate longer and remember more.

Neuroscientists at the Pontifical Catholic University of Chile conducted tests with children who had been taught to play an instrument and discovered they had increased brain activity in regions related to hearing and attention. This confirms what already know about the advantages of learning to play a musical instrument.

The neuroscientists go so far as to suggest that children who learn to play instruments may enjoy enhanced reading skills, resilience, creativity and quality of life thanks to the cognitive benefits.

They tested the attention and working memories of 40 children aged between 10 to 13 years old, twenty of whom had been learning to play an instrument for at least two years, who had practiced for at least two hours a week, and played regularly in an orchestra or ensemble. The remaining children – the control group – were recruited from public schools in the Chilean capital of Santiago. They had no musical training beyond what they had been taught as part of the regular curriculum.

The children took a series of audio-visual and memory tests to assess their attention and working memory and were simultaneously presented with both an abstract visual image and a short melody. For a period of four seconds, each child was asked to focus on either one, both, or neither stimuli, and were then asked to recall both stimuli two seconds later.

To determine activity associated with paying attention, the team took MRI data from passive tests – where children passively observed the stimuli – and from active tests, when children paid attention to the images and sounds. The scientists also measured response accuracy and reaction time.

They found that although reaction times between the musically-trained children and the control group were similar, the musicians did significantly better on the memory task.

The study was published in the journal *Frontiers in Neuroscience*.

It seems that people who start learning an instrument at a young age really do have better connected brains.

Researchers from Stanford University School of Medicine compared the brains of 153 volunteers – including professional musicians, non-musicians and those with perfect pitch (the ability to recognise a tone without a reference). They found that those that began training at a younger age have stronger brain connections than those who picked up their instrument later in life.

The discovery shows that whether it's the piano, the violin or the trumpet, musicians have stronger structural and functional connections in the brain compared to non musicians. In addition, time also makes the connections stronger, regardless of whether musicians have absolute pitch or not.

Years of musical training shape the brain in dramatic ways – the longer people train, the bigger the benefit to their brain. Musicians who began their training at a younger age had stronger structural connections than musicians who started at a later age.

The findings were published in the journal *JNeurosci*

# Live music concerts can reduce stress

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## ***'Music hath charms to soothe a savage breast'* – from William Congreve's *The Mourning Bride***

Listening to live music and watching it being performed can lead to reduced levels of stress... which means going to concerts could be good for your mental health and wellbeing.

A live music performance of just an hour can significantly reduce the body's levels of stress hormones. There have been lots of studies that examined this in a laboratory setting, but the most recent is the first to explore the relationship in a cultural space, that is, in a concert hall.

Recently conducted research carried out by scientists at Imperial College London, University College London, and the Royal College of Music, has established that singing can have a profound impact on the immune system. In fact, singing for just one hour significantly increases levels of the immune proteins the body uses to fight serious illnesses – including cancer.

Singing, and enjoying it, has also been found to significantly reduce amounts of stress hormones (such as cortisol) and increase immune proteins (such as cytokines) that boost the body's ability to fight serious illness. The current thinking is that singing reduces stress and anxiety, taking the strain off the immune system, allowing it better to use valuable resources to fight infection and disease.

Researchers conducted two separate experiments at different venues to measure the effect of live music on stress. With a total of 117 participants between the two performances, the researchers collected saliva samples from each person just before the concerts. They then collected another sample 60 minutes into the performance.

To replicate the concert experience for both experiments, all parts of the performance were kept the same – the same players and conductor, the same performance length, the same musical genre, and the same key pieces.

When they tested the saliva samples taken during the interval, the researchers found a significant drop in cortisol and cortisone, both of which are involved in stress. They also found a drop in the cortisol/cortisone ratio, which is indicative of heightened stress when found at high levels. This suggests there is a universal response to concert attendance among audience members.

Audience participants were recruited from mixed musical backgrounds and experience, including both regular and infrequent concertgoers and musicians and non-musicians, and the findings were the same across the two experiments. The results of this study go further than more than 20 previous laboratory studies, and suggests that attending a live performance leads to lower biological stress.

However, the results could be skewed because of the social setting of a live performance, with its expectations and excitement... and of course because music is always better when heard live, and the music played at the [classical] concerts was of a particularly calm

nature. However, none of the biological changes were because of age, musical experience or familiarity with the music being performed.

More studies are in the pipeline and scientists hope soon to understand how other musical genres affect hormone levels. It would be interesting for instance, to carry out the same tests on audience members at a heavy metal concert, or at say, a recital of Stockhausen's greatest hits.\*

However, the researchers hope to explore the idea that cultural activities can help to reduce stress over time to improve a person's overall wellbeing – a worthy goal if ever there was one.

\* Karlheinz Stockhausen: an early 20<sup>th</sup> century German composer of dubious merit and unlistenable-to music – utter crap, all of it. Just my opinion of course - but to find out for yourself, try listening to some. If you can't be bothered doing that, try sticking a red-hot poker in your ear while beating yourself with an industrial strength wire brush. If you enjoy that, you'll enjoy Stockhausen – guaranteed to increase stress when everything else has failed.

# Music and exercise

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Scientists have discovered that listening to music while you're exercising not only helps keep you motivated but can also improve your mood, and there are also clear benefits to mental health and general wellbeing

People often wear headphones at the gym, or while running or cycling [very dangerous] to set their pace to the beat of the music. Music playing in your ears while you push your body to burn calories can improve mood and cognitive function.

Researchers assessed the mood of 33 young adult volunteers immediately after they finished exercising. The volunteers had either listened to music or a series of beeps.

As well as being graded on a 'mood scale' they also carried out cognitive tests to see how the period of exertion impacted their cognitive performance. Those who listened to music were in a better mood and performed better in the cognitive test. Exercising while listening to music elicited greater enhancement of a positive mood described as vitality, than exercise with the beeps.

Previous research has found exercise increases activity in a specific part of the brain called the. It is known that when this region of the brain is activated, executive performance was also improved. In fact there were significant associations between a positive mood induced by exercise with music as well as improved executive performance and increased activation in the dorsolateral part of the prefrontal cortex.

# How music can help battle dementia

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Dementia sufferers, deprived of so many precious memories, are still able to remember the songs they love.

Music can evoke emotions even in the most advanced Alzheimer's patients. With emotions come associated memories, so music can make life worth living again.

When I joined the Max Jaffa Orchestra in 1977, one of the first things I noticed was the large number of elderly ladies in the audience, both at the evening concerts in the 2,000 seat Grand Hall and at the morning concerts, held outdoors in the Spa Sun Court in beautiful Scarborough. It's fair to say those concerts provided these nice old biddies with a structure to their lives and vital social contact with others.

They would often sing along to the melodies that had been popular in their youth. The enjoyment they derived was not just from the music – their faces gave away the happy memories of their youth, their romances, their own voyages of discovery. Songs from the war years and selections from Ivor Novello musicals were particularly popular. More interesting, they could remember all the words! All the members of the orchestra understood that for many of them, it was access to the type of music they loved that helped them keep a grip on life.

When I hear any of the music I grew up with and still enjoy, a host of memories come flooding back. I can remember where I was, the time of year, what the weather was like, who I was with and what I was doing when I first heard it. *Supertramp Live in Paris* instantly reminds me of driving home from Newcastle in such a heavy snowstorm I wondered if I would make it all the way home! Memories from 40 years ago are clear... thanks to the music.

Listening to and enjoying music requires very little mental processing, although learning music takes time and some effort. But musical memories, particularly of songs learned in youth and music first encountered in early adolescence remain strong and robust and accessible. Most people can instantly recognise a song they know after hearing just a few notes. Music can also remain evocative.

Scientists from the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, the University of Amsterdam and INSERM Caen, succeeded in pinpointing the location of musical memory. They have found that the ability to hold and remember a tune activates specific parts of the brain and that these memories reside in areas responsible for association and memory. These areas seem to be particularly resistant to the effects of dementia and remain largely intact – despite the effects of progressive degeneration.

So musical memory seems able to withstand the effects of neurodegenerative decline. Musical aptitude and appreciation are two of the last remaining abilities that remain almost unaffected in dementia sufferers, and it's thought that music can restore memories when everything else fails.

The idea that people with dementia may benefit from singing and other musical activities has grown increasingly popular in recent years, with initiatives such as *Singing for the Brain* being offered by the Alzheimer's Society.

Music has three advantages for the elderly, and particularly for those suffering dementia.

First, dancing to music helps coordinate motor movements in Parkinson's sufferers as well as those with dementia.

Second, singing does not require the cognitive functionality absent in most dementia patients. Singing sessions activate the left side of the brain and listening to music sparks activity in the right side of the brain, while simply watching rehearsal activates the visual cortex. With so much of the brain being stimulated at once, patients exercise more mind power than usual, as well as enjoy themselves!

Third, by pairing music with everyday activities such as having lunch, the scientists hope to make life easier for patients. They can learn to associate songs and pieces of music with corresponding activities, thereby improving not only the memory of that activity but also the necessity of performing it. For example, one song could remind a patient that it's time to make a cup of tea, whilst another could act as a reminder that it's time to go for a walk.

There have been several detailed case studies that offer support for the idea that musical memory might be disproportionately preserved in dementia patients. One key finding is that music is a particularly good cue for autobiographical memories – the memories that reinforce our sense of identity and play a hugely significant role in how we connect socially and emotionally with those that are close to us.

Jaak Panksepp, author of *Affective Neuroscience: The Foundations of Human and Animal Emotions* argues that music is a core ingredient of emotional communication – and so it is! Much of our interaction with pre-linguistic infants depends primarily on changes in voice tone. Most parents would agree that a lullaby is a very effective way of getting babies to sleep. Music is also an integral part of spoken language – without its melodic nuances, our words would sound robotic and devoid of feeling. Shouting, screaming, laughing, crying are all just distinctive changes in pitch, rhythm and volume.

The essential communicative qualities of music may be at least in part why singing gives us a way to connect with people with severe cognitive impairments like dementia.

Music is so much more than a collection of toe-tappin' tunes – there is a wealth of evidence that it can significantly improve health and wellbeing. Apart from the obvious physical benefit of singing as cardiovascular activity, musical engagement also reduces levels of the stress hormone cortisol, increases immunity, lowers perception of pain and reduces symptoms of depression. Music can improve mood, memory and overall quality of life in people with dementia. It certainly improved quality of life for the old dears in the audience in Scarborough.

Music therapy can help treat conditions such as anxiety depression, autism, and dementia – especially if classical music is played while patients discuss their illnesses.

Music therapists work toward 'moments of change' where they make a meaningful connection with their patient. Researchers wired a therapist and her client to a ECG machine and noted that at certain points in the consultation the patient's brain activity shifted suddenly from deep negative feelings to a positive peak. Not only that, but the therapist's scan also showed similar results, as she realised the session was working.

Both participants were listening to the same music, and thus any similarity in emotional processing could be in principle due to the common factor of music-evoked emotions in both participants.

In subsequent interviews, both were able to identify the moment when they felt the therapy was really working.

By analysing hyper-scanning data alongside video footage and a transcript of the session, researchers were able to demonstrate that brain synchronisation between therapist and client occurs. They were also able to show what a patient's and therapist's 'moment of change' looks like inside the brain.

Jorg Fachner, professor of music, health and the brain at Anglia Ruskin University says the study is a milestone in music therapy research. Music therapists report experiencing emotional changes and connections during therapy, and that has been confirmed using the data recorded directly from the brain.

Music therapists have always had to rely on the patient's response to judge whether the therapy is working, but using hyper-scanning, therapists can now see exactly what is happening in the patient's brain. By highlighting exactly where the sessions have worked, it could be particularly useful when treating patients who struggle with verbal communication.

The full study was published in the journal *Frontiers In Psychology*.

# How music can help battle Parkinson's disease

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Singing may reduce stress and improve mood for people with Parkinson's disease. Scientists from Iowa State University, say therapeutic singing could be a more accessible and affordable treatment option for Parkinson's patients.

The Iowa team studied 17 Parkinson's patients who joined a therapeutic singing group, measuring their heart rate, blood pressure and levels of the stress hormone, cortisol. The patients were also asked to report on feelings of anger, anxiety, happiness and sadness. Data was collected both before and straight after a one-hour singing session.

Although there were no significant changes in feelings of happiness or anger, the group members did report feeling less anxious and sad after the singing session.

The scientists at Iowa State say they see the improvement in patients every week when they leave the singing group and that it's almost like they 'have a little pep in their step' and also that they're feeling better and their mood is elevated.

The improvement in the patients mirrored the benefits of medication and some symptoms, such as finger tapping and the gait that don't always readily respond to medication did improve after 'choir practice'.

The scientists are encouraged by the results, but they still have to find the mechanism steering the behavioural changes. For instance part of the reason cortisol levels reduced could be because the singing participants feel positive and less stressed in the act of singing with others in the group.

Next, the team plans to analyse patients' blood samples to measure levels of oxytocin, a hormone that plays a role in social bonding. They will also be looking at changes in inflammation, which is an indicator of the progression of Parkinson's disease, and neuroplasticity – the ability of the brain to change – to see if singing benefits these factors.

It might be that heart rate and heart rate variability – an indication of how calm and physiologically relaxed the individual is after singing – is also a factor.

The research builds on the team's previous research, which found that singing also improved respiratory control and muscles used for swallowing in Parkinson's patients.

Currently in the US, between 50,000 and 60,000 cases of Parkinson's are diagnosed every year. However, the prevalence of the disease is expected to double over the next 20 years as result of an increasing ageing population.

According to the Parkinson's Foundation, that means there will more people living with Parkinson's disease in the US than the combined number of people diagnosed with multiple sclerosis, muscular dystrophy and Lou Gehrig's disease.

Actor Alan Alda, who played Dr Benjamin 'Hawkeye' Franklin Pierce in the anti-war series M.A.S.H, has been diagnosed with Parkinson's... he said his advice was to 'keep moving... I'm taking boxing lessons three times a week, I do singles tennis a couple of times a week. I march to Sousa music because marching to music is good for Parkinson's.'

# Operations normal

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Listening to soothing music and words while you're unconscious on the operating table could mean you wake up in less pain.

According to research published in the *British Medical Journal*, playing relaxing music and recordings of positive comments, such as 'you are safe now and in good care' to patients under general anaesthetic had a positive impact on their recovery. Previous studies have also shown that listening to music before, during and after surgery reduces people's pain, anxiety and need for painkillers.

Patients who listened to the sounds via headphones during their operations reported 25% less pain than those who had surgery in silence. Patients were also 17% less likely to need painkillers such as morphine in the first 24 hours after the operation.

The theory is that even while we are unconscious, we are still in a state of 'connected consciousness'. This means that although we're not awake during general anaesthetic, because the consciousness centre in the brain – the reticular activating system – is turned off, the pathways to the brain remain working, so the body can still hear and process information.

With general anaesthesia making up 80% of the 3.5 million anaesthetics given by the NHS each year, these findings have implications for millions of patients who suffer with post-operative pain. Some 80% of patients experience this, and the pain persists for around one in ten people.

This new approach could help reduce the number of patients prescribed powerful opioid drugs which can be highly addictive. Instead, the discovery could provide a safe and inexpensive way of reducing post-operative pain.

Drugs are commonly used to treat acute pain after surgery, but they can also have side-effects, such as breathing difficulties, constipation, itching and drug dependency.

Music is known to have a profound effect on our emotions and mental state while we are awake, releasing 'feel-good' endorphins which can help relieve pain, stress and anxiety. If endorphins are released during surgery, the patient is primed to feel less post-operative pain. In addition to the music, positive suggestions could have a similar effect.

This latest study involved 385 patients, aged 18 to 70. All underwent routine surgery under general anaesthesia. All were fitted with earphones once unconscious. Half were played a mix of relaxing background music and positive phrases while the rest heard nothing.

During the first 24 hours after surgery, pain scores were 25% lower in the group who listened to soothing sounds.

However, the researchers behind the study also issued a warning to medics that if patients can process and benefit from positive sounds during operations, the opposite might also be true. This means surgeons and anaesthetists should be careful about background noise and conversations during surgery in case patients wake with an unexplained desire to play a round of golf!

# If music be the food of love...

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If you find yourself ordering a greasy cheeseburger in a restaurant instead of a low-calorie salad, the background music might be to blame. Music not only sets the mood of an evening, it can also influence what you order.

Louder music encourages customers to order unhealthy food, such as burgers, chips and cheesecake, although hopefully not all on the same plate. But if the same music is playing softly in the background, it exerts a more calming effect and is more likely to make you mindful of what you order and choose a more healthy alternative.

Listening to slow and steady music while eating also slows down food intake because humans tend to unconsciously 'eat to the beat' of the music. When music is played is soft and slow, it amplifies the effect and further reduces food consumption. Could music perhaps be the solution to eating less?

It is well known that the tempo – the speed of the music – is linked to levels of excitement. A quicker beat raises the heart rate while a slower beat induces relaxation.

Volume also directly impacts heart rate and arousal in the same way uptempo songs and louder music increases stimulation and stress – and inspire diners to crave junk food.

'Retail atmospherics' is becoming an increasingly important strategic tool, and restaurants and supermarkets use ambient music to influence consumer buying behaviour.

In a café in Stockholm, various genres of music were played in a loop at 55 decibels (somewhere between gentle background chatter and the hum created by a refrigerator) and 70 decibels (closer to that of a vacuum cleaner).

The experiment was conducted over several hours on multiple days and the foods available on the menu were divided into three categories – healthy, non-healthy and neutral. The number of customers who ordered something unhealthy when louder ambient music was played compared to those who dined when quieter music was played increased by 20%.

Carefully selected music can increase sales and also influence how much customers spend. Major restaurant chains, including McDonalds and TGI Fridays are installing specially-designed sound systems that make customers spend as much as 10% more.

The system, called Soundtrack Your Brand, plays music that reflects a brand's values, evoking a range of positive emotions in customers and designed to increase customer satisfaction. HUI Research – a consulting firm in Stockholm – conducted the largest ever academic study of background music, to design the system.

While most restaurants play music in an attempt to shape their customers' experience, they tend to choose songs casually and without much thought – often songs chosen randomly by staff members.

HUI researchers analysed nearly two million unique transactions in 16 McDonalds restaurants in Sweden over the course of five months. They compared the sales impact of playing a carefully selected choice of music that fitted the chain's brand, with playing random popular music, and the results showed a 9.1% difference. Music that fitted McDonalds 'values' made customers more likely to buy additional items than if the

restaurant played random popular music. The formula for success was a mixture of both popular and less known songs – but all reflected the McDonalds brand.

Music can have a major effect on sales, mainly from guests purchasing more items such as desserts and side orders. In particular, sales of desserts and sides rose by more than 11%, while the sales of smoothies and milkshakes increased by 15%. But playing the wrong music runs the risk of alienating that same customer – and selling significantly less.

The research also into account factors such as the time of day and the type of people likely to be in a certain location. Ambient music was carefully chosen to create a tailored atmosphere for both the brand and consumer.

Next time you're dining out, note the time of day and listen to the music – you'll find that breakfast music in a city centre is very different to that played over a romantic evening in the countryside.

In fast food restaurants in particular, chains target a millennial audience and are therefore looking for music that reflects a brand identity that is welcoming, modern, expressive. Ed Sheeran's *Shape of You* is like a warm hug as you walk into a restaurant.

A separate survey of over 2,000 diners showed the impact of brand-fit music versus random popular music on emotion and satisfaction, confirming that guests' well-being and mood dramatically improved when listening to brand-fit music.

Research reported in the *Journal of the Academy of Marketing Science*.

Music can also change the way your food tastes.

Scientists have found that listening to fast-paced, energetic music can increase the perceived spiciness of food by up to 10%. Researchers at Oxford University have even christened the phenomenon 'sonic seasoning'.

Perhaps unsurprisingly, traditional Indian music has one of the strongest sonic seasoning effects. But uptempo songs from bands such as the Spice Girls and the Red Hot Chili Peppers can also affected the taste buds.

The researchers asked 180 volunteers to pick music they thought would be associated with spicy food. The volunteers were split into three groups. The groups listened to either short clips of the music, white noise, or silence while they ate spicy food.

The group that listened to the music with a faster tempo, higher pitch and distorted sounds said the food tasted spicier and had more intense flavours.

If ever there was a perfect example of indirect suggestion, then this is it.

So far, we have only looked at the effect of music in 'family' Restaurants such as McDonalds, and other cheap and cheerful high turnover outlets. At the other end of the scale are the high-end eateries, where the food and fine wine is expensive and diners are likely to spend the entire evening. Here, the music is designed to accompany and enhance the food and create a specific ambience and atmosphere.

These restaurants even employ their own musicians, sometimes a pianist, or a string trio or quartet. With the exception of the War years, London's top hotels employed small orchestras to play in their dining rooms. The great violinist Max Jaffa and the Palm Court Orchestra and trio, with Jack Byfield and Reginald Kilbey, broadcast weekly for the BBC in a programme called *Grand Hotel*.

Different types of restaurant will play different kinds of music, but the very best play discreet instrumental music that doesn't distract from the food or is too loud for quiet conversation.

There is clear evidence that music strongly influences our perception of food and wine. According to research from the *Crossmodal Research Laboratory* at the University of Oxford, people associate higher notes, flutes, and tinkling piano with sweetness, and deeper, more resonant notes with bitterness. The finest restaurants do not play any music at all, reasoning – correctly – that if the food is truly great, any kind of distraction will only detract from it.

The right music can affect how food tastes. Punchy, energetic and fast paced background music can increase the perceived spiciness of food, again by up to 10%. Experts at the Oxford University have called the effect 'sonic seasoning.'

Indian music, featuring sitar and rhythmical tabla drumming, in Indian restaurants definitely affects the way we perceive food. Italian crooner Julio Iglesias enhances the dining experience over a romantic dinner in a quiet Italian restaurant.

Researchers got 180 volunteers to eat spicy food while listening to short sections of music they thought would be associated with the food, or white noise, or silence. When music with a faster tempo, a higher pitch and distorted sounds was played, the diners reported that the food tasted spicier and had more intense flavours.

Loud, fast music activates the sympathetic nervous system – the 'fight-or-flight' response. This opposes the parasympathetic system and diminishes appetite, which is why you don't suddenly feel a tinge of hunger while being chased up a tree by a lion.

Music can detract from conversation if it's too loud and music with lyrics imposes the singer's thoughts and emotions on diners. Lyrics are either banal or incongruous, and can easily clash with diner's moods. Why should diners care about a stranger's love life? And then there are people who have nothing or little to say to each other, in which case music can cover the silence and relieve the pressure of having to make conversation. Some restaurants have silent areas or privates rooms.

Incidentally, McDonalds also install hard plastic seating in all their restaurants – it's easier to keep clean, but it's mainly there to discourage customers from sitting there too long! McDonalds is a volume business and they need to free up the space as quickly as possible for other customers.

Even the quality of cutlery can affect the taste of food. This is because of a phenomenon known as 'sensation transference,' which converts negative visual sensations into less pleasant flavours, sometimes by as much as 10%. Heavy cutlery screams quality, and that persuades you to appreciate the food more – and consequently makes you willing to pay more. The same goes for the quality of the tablecloths, the furniture, the lighting... and so on.

There are high street shops, almost always aimed at young people that blare loud rock n' roll music to attract those customers into the shop. They are almost all darkly lit and sell mainly dark coloured clothes. No one over the age of 25 goes in there. But the music in these shops is very definitely tailored to the brands inside and shoppers' expectations of

how they're going to look when they step out, wearing their new ripped jeans and chain belts, and ridiculously impractical footwear.

Atmospheric sounds matter. The pop of the champagne cork, the gurgle and hiss of the coffee machine, the grind of the pepper mill... Crisps taste fresher when they *sound* crispy and crunchy, and even more so when the packet also makes a crackling sound.

In terms of product preservation, there is no reason for noisy packets – but noisy food must have the right packaging because it reinforces the expectation of crisp fresh food. Manufacturers know this, which is why lettuce and salad is wrapped in cellophane. The packaging – as well as the food itself – is made as noisy as possible to make it taste better.

The influence of background music in restaurants is far more subtle however, and that may account for the secret of its success – it's less 'in your face.' However, you seldom hear 'muzak' played in supermarkets any more, or in hotel lifts, because people found it irritating. It seems that sometimes, silence is golden!

When it comes to wine, we are far more easily fooled! Our brains are often tricked into thinking a bottle of wine tastes better just because it's expensive. In one research project, a group of volunteer wine tasters believed that the same wine tasted better when they thought it had a higher price tag.

This is the placebo effect in action, well known to psychologists and hypnotherapists everywhere. With wine, the effect is employed as a marketing tactic to coerce people into buying more expensive bottles.

As a lover of wine, I can confirm that I am not fooled by this tactic for one moment! I can also confirm that the cost of a bottle of wine is largely dependent on the cost of harvesting the grapes. For instance, grapes from a vineyard on a hillside will be more expensive to harvest than those from a vineyard on the flat. The other thing to bear in mind is that most people drink wine with food, and different foods can change the way a wine tastes. Most people choose a medium priced bottle in a restaurant to avoid the embarrassment of appearing mean. The truth is, the cheapest bottles on the wine list are often just as good as the medium priced ones – often the reason is because the restaurant has bought a large supply at a discounted rate. However, the marketing placebo does have its limits. You would notice a poor quality wine offered at an outrageous price.

Nonetheless, researchers from the INSEAD Business School and the University of Bonn looked at how different prices are translated into taste experiences in the brain, even if the wine is from the same bottle. The study involved 30 participants – 15 women and 15 men, average age, 30.

The participants lay in an MRI scanner while tasting various wines, allowing brain activity to be recorded. A price for a wine was shown, before just one millilitre – enough to taste – was given to them. They were then asked to rate how good the wine tasted on a nine-point scale. They rinsed their mouths with a neutral liquid between samples, which although priced differently were in reality from the same bottle.

The researchers carried out the tests using an average to good quality red wine with a retail price per bottle of €12 (£11/\$14). The price of the wines shown randomly to the volunteers varied between €3 (£2.70/\$3.50), €6 (£5.45/\$7) and €18 (£16.30/\$21.20.)

As predicted, participants stated that higher priced sample tasted better than the ostensibly cheaper one. In addition, it made no difference whether participants had to pay for the wine or were given it for free. And the brain scans from the MRI confirmed that identical wine tasted better when the participants believed it was more expensive. It's all about perceived value – when prices were higher, the researchers found that the brain's reward and motivation systems was activated more significantly when prices were higher, thus enhancing the taste. Ultimately, it is the reward and motivation system that tricks our brain into thinking wine tastes better.

Research also suggests that the language used on the label of a bottle could be as important as the flavour of the wine itself. Elaborate and emotional descriptions act as a placebo, tricking our brains into a false sense of quality. Study participants rated the same wine higher if its description included information regarding winery history and positive wine quality statements, while the wine was not rated as highly when it had no description.

# 'The Mozart effect'

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Wolfgang Amadeus Mozart, one of history's most famous composers, born in Salzburg in 1756 and died in Vienna in 1791 aged 35, composed more than 600 musical works, including piano sonatas, concertos, symphonies, operas, and his own requiem.

We know that listening to classical music can help focus the mind and significantly improve intelligence. But the 'Mozart effect' – a theory first promoted in 1991 by French researcher Alfred A. Tomatis – argues that Mozart's music promotes better brain *development*.

The theory is supported by some leading scientists, including Frances H. Rauscher et al, who published a study in *Nature* on the benefits of listening to Mozart on spatial reasoning – particularly in children.

After listening for 10 minutes to Mozart's sonata for two pianos, test subjects showed significantly better spatial reasoning skills than after periods of listening to relaxation instructions designed to lower blood pressure, or silence.

However, while Rauscher et al showed an increase in spatial intelligence, the results were popularly misinterpreted as an increase in general IQ – which is inaccurate.

Subsequent tests of the Mozart effect were not able to replicate the original results. Instead, it was found that boosts in performance were simply due to increased arousal when listening to energetic music.

As an ex professional classical musician, I would argue that listening to music by other great composers would have the same effect. True, Mozart's music is very mathematical and ordered, but I am still skeptical of 'The Mozart effect'. I believe that classical music does help the brain and does assist intelligence, but so would the music of composers Bach, Vivaldi, Wagner, Shostakovich, and John Williams to name but a few.

In short, the Mozart effect is now generally considered a myth. But proper science depends on proper rigorous research, and so researchers at Harvard University took 25 boys aged between 8 and 9 and 25 older people aged between 65 to 75, and made them complete a version of a Stroop task – a test used to investigate an individual's mental performance by asking them to identify the correct colour when the word spells out a different colour.

Both age groups were able to identify the correct colours quicker and with less errors when listening to the original Mozart music. But when dissonant music was played, reaction times became significantly slower and there was a much higher rate of mistakes.

Scientists say that the brain's natural dislike of dissonant music and the high success rate of the flowing, harmonious music of Mozart, with its neat phrasing, its flowing melodies and harmonic resolutions, indicates the important effect of music on cognitive function.

It also showed that consonant (as opposed to dissonant) music could help some people ignore distractions.

It has been claimed that listening to Mozart could be a way to reduce epileptic fits. Affected children aged 2 to 18 who listened to the composer's music saw a significant drop in

epileptic activity in the brain. But again, what about the music of other composers? What effect would the sweeping melodies of Tchaikovsky and Rachmaninov have? And what of the possibility that calming music might just help children to think and reason without stress or distraction.

Doctors at the Royal Hospital for Sick Children, Edinburgh, who carried out the research, say Mozart may offer a low-cost anti-epileptic therapy for children, some of whom do not respond to current treatments. [The annual cost of anti-epileptic drugs to the NHS is around £165 million.]

In the Edinburgh study, 45 children listened to the first 15 minutes of the Sonata For Two Pianos In D Major or to control music. The results showed a significant reduction in the frequency of electrical epileptic discharges in their brains while listening to Mozart, but no change when they listened to control music.

Just how listening to a few minutes the Sonata For Two Pianos In D Major could have such an effect is something of a mystery. One theory is that Mozart's music has a unique pattern of rhythms and melodic lines that affects electrical activity. As a former musician, my own theory is that truly great music catches the attention and distracts the mind away from less pleasant things, such as thoughts and feelings of stress and anxiety – well known precursors of fits.

But still, we are left with the fact that listening to Mozart's Sonata for Two Pianos in D major once a day does appear to reduce the number of seizures in patients with epilepsy. Researchers in Canada found that the beneficial effect of the Sonata is not conferred by a similar – but not the same – version of the piece.

It cannot be ignored that Mozart was almost certainly autistic and displayed many of the symptoms of autism, including a fanatical attention to musical detail. His music is indeed, perfect – even his early works display a simple mathematical perfection.

Subsequent studies have also suggested that the Sonata – along with another of Mozart's compositions – the Piano Concerto No. 23 – can help reduce the frequency of seizures in patients with epilepsy.

Only one other piece of music has been found to have a similar effect – '*Acroyali / Standing in Motion*' by the modern Greek composer Yiannis Chryssomallis – known as 'Yanni'.

*Acroyali / Standing in Motion* is a very different musical genre than Mozart's Sonata. *Acroyali* is repetitive, percussive, and has none of the melodic subtlety of Mozart. It is also performed on an impressive array of electronic keyboard instruments and an equally impressive array of drums percussion. No two pieces of music could be so different.

I'm also wondering how many other Mozart compositions have been tried, or is it just the Sonata?

The Canadian study was published in the journal *Epilepsia Open*.

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