Music, art and the brain

Professor Keith Kendrick
Music, art and the brain

Are musical and artistic skills adaptive?

What makes the brain responsive to music and art?

Are the brains of highly artistic individuals different in some way?

Is listening to music, or learning how to play it or sing, beneficial to mental functioning?

Are music and art unique to humans?
The influence of music in the modern world

The music industry is bigger than the pharmaceutical one
The influence of music in the modern world

The music industry is bigger than the pharmaceutical one.

The largest USA export is not high technology but entertainment.
The influence of music in the modern world

The roads of almost every country are music super highways
The influence of music in the modern world

The roads of almost every country are music super highways

The world is full of CD players, MP3 players, instrumental music and songs
The influence of music in the modern world

Music is used to evoke and control our emotions
The influence of music in the modern world

Music is used to evoke and control our emotions

Best selling songs are part of our everyday lives
The influence of music in the modern world

Music is used to evoke and control our emotions

Best selling songs are part of our everyday lives

The number one best-known and performed song is......

'Happy Birthday' composed in 1893 by Mildred and Patti Hill
The influence of music in the modern world

Anthropologists claim all human cultures have used music
The influence of other forms of art

Visual and performing arts have a major impact on the lives of most of us
The influence of other forms of art

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Art is representative of but independent of reality, or a distortion of it.
The influence of other forms of art

Visual and performing arts have a major impact on the lives of most of us

Art is representative of but independent of reality, or a distortion of it

'Art is a lie that makes us realise the truth'

Pablo Picasso
Art evokes ideas, thoughts and emotions
The influence of other forms of art

Art evokes ideas, thoughts and emotions

Artists find novel and unexpected ways to do this
The influence of other forms of art

Art evokes ideas, thoughts and emotions

Artists find novel and unexpected ways to do this

Art that has no meaning is simply a transient sensory experience
The influence of other forms of art

What we define as art is highly subjective
What we define as art is highly subjective.
The influence of other forms of art

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What we define as art is highly subjective
'As neither the enjoyment nor the capacity of producing musical notes are faculties of the least use to man in reference to his daily habits of life, they must rank among the most mysterious with which he is endowed'

Darwin – The Descent of Man
The evolution of artistic brains in humans

Do artistic skills aid survival? – i.e. are they adaptive?
The evolution of artistic brains in humans

Do artistic skills aid survival? – i.e. are they adaptive?

The oldest musical instruments are bone flutes (43,000 - 82,000 years old)
The evolution of artistic brains in humans

Older than cave paintings
The evolution of artistic brains in humans

Older than cave paintings

...and probably language
The evolution of artistic brains in humans

Music may have evolved as far back as 250,000 years ago!
The evolution of artistic brains in humans

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Time for it to be selected as an evolutionary trait with a genetic basis.
The evolution of artistic brains in humans

Music may have evolved as far back as 250,000 years ago!

Time for it to be selected as an evolutionary trait with a genetic basis

Not everyone agrees:

'Music is auditory cheesecake'
Stephen Pinker
The evolution of artistic brains in humans

Non-adaptive pleasure seeking theory (NAPS)
The evolution of artistic brains in humans

Non-adaptive pleasure seeking theory (NAPS)

Music as an evolutionary vestige
Evolutionary theories of music and art

Mate selection - is it all down to serenading a prospective partner?
Evolutionary theories of music and art

Birds, bats, whales, dolphins, gibbons and humans?
Evolutionary theories of music and art

Birds, bats, whales, dolphins, gibbons and humans?
Evolutionary theories of music and art

Even male mice may be unexpected crooners!
Evolutionary theories of music and art

In most species one sex sings and the other listens
Evolutionary theories of music and art

Evidence for musicality and sexual selection is not strong

However...
Evolutionary theories of music and art

Evidence for musicality and sexual selection is not strong

However...

Dylan Thomas

Pablo Picasso

...poets and artists have more sexual partners
Nettle and Clegg, 2005
Grooming, gossip, and social cohesion

Group sizes and bonding behaviours
Grooming, gossip, and social cohesion

Group sizes and bonding behaviours

Bonding using gossip is more efficient
Grooming, gossip, and social cohesion

Group sizes and bonding behaviours

Bonding using gossip is more efficient

Bonding using singing and music is even better!
Music and war
Grooming, gossip, and social cohesion

Music and war

Music and peace
Grooming, gossip, and social cohesion

Music, and Williams and Asperger’s syndromes
Grooming, gossip, and social cohesion

Does music release bonding hormones?

Cys-Tyr-Ile-Gln-Asn-Cys-Pro-Leu-Gly-NH₂

Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Arg-Gly-NH₂
What is it about successful works of art that appeal to the brain?
The left, right and centre...

What is it about successful works of art that appeal to the brain?

Ten laws of Art?
Reith Lectures 2003 by Vilayanur Ramachandran
The ten laws of Art

Peak shift
The ten laws of Art

Peak shift

Grouping
The ten laws of Art

Peak shift

Grouping

Contrast
The ten laws of Art

Peak shift

Grouping

Contrast

Isolation (understatement)
The ten laws of Art

Peak shift

Grouping

Contrast

Isolation (understatement)

Perception problem solving
The ten laws of Art

Symmetry and balance
The ten laws of Art

Symmetry and balance

Abhorrence of coincidence/generic viewpoint
The ten laws of Art

Symmetry and balance

Abhorrence of coincidence/generic viewpoint

Repetition, rhythm and orderliness
The ten laws of Art

Symmetry and balance

Abhorrence of coincidence/generic viewpoint

Repetition, rhythm and orderliness

Balance
The ten laws of Art

Symmetry and balance

Abhorrence of coincidence/generic viewpoint

Repetition, rhythm and orderliness

Balance

Metaphor
The musical brain

Language on the left, music and vocal tones on the right?
The musical brain

Language on the left, music and vocal tones on the right?

No sex differences in musical ability
The musical brain

Left side involved in both grammatical and musical syntax
The musical brain

Left side involved in both grammatical and musical syntax

Hum it with the left and beat it with the right
The musical brain

The auditory system is organised tonotopically
The musical brain

The auditory system is organised tonotopically

Right auditory cortex is more organised than left
Dissonance is experienced with similar sound frequencies
Dissonance is experienced with similar sound frequencies

- Major triads (Diss0)
- Flatted 13th triads (Diss5)

Pleasant/Unpleasant and Sad/Happy ratings graphs.
Memory for songs and music is remarkable
Music and memory

Memory for songs and music is remarkable

Words in songs and poems are highly memorable

If you can keep your head when all about you
Are losing theirs and blaming it on you...

Kipling
Music and memory

The frontal cortex is important for music memory

Memory for melodies is distinct from words or objects
Music and imitation

Brain regions involved in language and imitation also help interpret music.
Music and emotion

Musical 'chills' activate the same brain areas as sex and drugs.
Music and emotion

Are these the same or unique?
Musical dissonance activates negative emotion regions
Music and emotion

Musical dissonance activates negative emotion regions

Right brain hemisphere is involved in intense emotions
There was an old fellow of Sheen whose musical sense was not keen
He said: It is odd,
I can never tell ‘God save the Weasel’ from ‘Pop goes the Queen’
Congenital amusia

Famous tone deaf individuals

Ulysses Grant
Theodore Roosevelt
Che Guevara
Famous tone deaf individuals

'I only know two tunes. One of them is Yankee Doodle and the other isn’t'

Ulysses Grant
Congenital amusia is distinct from language problems.
Congenital amusia

Congenital amusia is distinct from language problems

Probably the result of impaired organisation of the auditory cortex
Congenital amusia

Amusia runs in families
Congenital amusia

Amusia runs in families

70 - 80% concordance in monozygotic twins – indicating a strong genetic link
Are music and art just for human brains?

As with language, we don’t really know

NEVER TRY TO TEACH A PIG TO SING
(IT WASTES YOUR TIME AND ANNOYS THE PIG)
Are music and art just for human brains?

As with language, we don’t really know

Birds and some mammals produce and respond to songs and some imitate human music

May also show similar emotional responses to us

Perhaps generic brain design is optimised to respond to music
Are music and art just for human brains?

Octave generalisation in monkeys
Hauser and McDermott, 2003
Are music and art just for human brains?

Animal artists?
Mozart, music and memory

A classic case of wishful thinking and exploitation?

The Mozart Effect Resource Center

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Mozart, music and memory

A classic case of wishful thinking and exploitation?

The origins of the Mozart effect
Rauscher et al 1993 Nature
Mozart, music and memory

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The origins of the Mozart effect

Rauscher et al 1993 Nature

![Graph showing spatial IQ scores for Mozart, relaxation tape, and silence](chart.png)
Mozart, music and memory

A classic case of wishful thinking and exploitation?

The origins of the Mozart effect
Rauscher et al 1993 Nature

The effect lasted only 15 minutes
Mozart, music and memory

A classic case of wishful thinking and exploitation?

The origins of the Mozart effect
Rauscher et al 1993 Nature

The effect lasted only 15 minutes

There is no benefit for verbal or object memory
Mozart, music and memory

It has never been tested on babies!
Mozart, music and memory

It has never been tested on babies!

...and not everyone has replicated the effect

Prelude or requiem for the 'Mozart effect'?

KENNETH M. STEELE*, SIMONE DALLA BELLA†, ISABELLE PERETZ†, TRACEY DUNLOP†, LLOYD A. DAWE†, G. KEITH HUMPHREY‡, ROBERTA A. SHANNON*, JOHNNY L. KIRBY JR* & C. G. OLMSTEAD*

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Rauscher et al. reported that brief exposure to a Mozart piano sonata produces a temporary increase in spatial reasoning scores, amounting to the equivalent of 8-9 IQ points on the Stanford-Binet IQ scale. Early attempts to confirm this 'Mozart effect' were unsuccessful. Rauscher et al. subsequently restricted their account to an improvement in spatial-temporal reasoning, as measured by the Paper Folding and Cutting task. We use procedures modelled on the original report to show that there is little evidence for a direct effect of music exposure on reasoning ability.
Mozart, music and memory

The idea is that Mozart’s music was in tune with his brain.
The idea is that Mozart’s music was in tune with his brain.

'Perhaps the cortex’s response to music is the Rosetta Stone for the code or internal language of higher brain function.'

Rauscher (1995)
Mozart, music and memory

All positive mood music can work – from classical to pop
Mozart, music and memory

All positive mood music can work – from classical to pop

Sad music is not effective
Mozart, music and memory

All positive mood music can work – from classical to pop

Sad music is not effective
Mozart, music and memory

All positive mood music can work – from classical to pop

Sad music is not effective

Release of dopamine in the right brain hemisphere?
Mozart, music and memory

The moral of the story is...

Listen to Mozart because you enjoy his music

It will not make you smarter
The advantages of playing an instrument

Spatial-temporal ability:

Improved by music instruction, playing the piano and singing and rhythm training

No advantage on verbal and object memory tasks

Only when training starts before 7 years old

Needs to have been for at least 2 years
The advantages of playing an instrument

Mathematical ability:

Piano keyboard instruction in 7-9 year olds improves proportional reasoning
Graziano et al, 1999

2 years of piano instruction in at-risk children associated with higher scores on standardized arithmetic tests
Rauscher 2001
Mathematical ability:

Children receiving singing instruction are better at mathematical reasoning
The advantages of playing an instrument

Mathematical ability:

Children receiving singing instruction are better at mathematical reasoning

Music training is associated with altered brain activity during maths tasks

Schmithorst and Holland, 2004
The advantages of playing an instrument

Reading:

Should auld acquaintance be forgot and never brought to mind? Should auld acquaintance...
The advantages of playing an instrument

Reading:

A meta-analysis of studies on 500,000 students showed music training is associated with better reading test scores.
The advantages of playing an instrument

Reading:

A meta-analysis of studies on 500,000 students showed music training is associated with better reading test scores.

No direct causative link has been shown experimentally.
Very little work has been carried out on this.

Arousing music increases frequencies and calming music decreases frequencies.
Music and the gestalt

- **Figure-Ground:** The ground is always seen as farther than the figure.
- **Proximity:** Objects that are physically close together are grouped together.
- **Continuity:** Objects that continue a pattern are grouped together.
- **Closure:** The tendency to see a finished unit.
- **Similarity:** Similar objects are grouped together.
Correlation shifts and pattern changes in global networks?
Do artists have special brains?

Changes in brain motor control centres
Do artists have special brains?

Changes in brain motor control centres

Better communication within and between brain hemispheres

Bengtsson et al
Nature Neuroscience 2005
Do artists have special brains?

Changes in brain motor control centres

Better communication within and between brain hemispheres

Maybe musicians are more in touch with their feminine side!
Do artists have special brains?

Experiencing the world in a different way?
Do artists have special brains?

Synaesthesia:
syn = together + aesthesis = perception

Galton
Do artists have special brains?

Seeing or hearing specific words, letters or numbers as colours

"I've chosen and dumped girlfriends because of how their names tasted. The name Tracy tastes of flaky pastry. "

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Do artists have special brains?

Seeing or hearing specific words, letters or numbers as colours

Tasting shapes

Cytowic
Do artists have special brains?

Seeing or hearing specific words, letters or numbers as colours

Tasting shapes

Feeling musical instruments as touch in different body regions
Do artists have special brains?

Seeing or hearing specific words, letters or numbers as colours

Tasting shapes

Feeling musical instruments as touch in different body regions

Affects between 1 in 200 and 1 in 20,000 people
Do artists have special brains?

Prevalent in artists
(23% of 358 fine-arts students)

Nabokov  Scriabin  Messiaen
Do artists have special brains?

Prevalent in artists
(23% of 358 fine-arts students)

Probably caused by cross wiring between adjacent sensory maps

- Somatosensory cortex
- Angular gyrus
- Visual cortex
- Auditory cortex
Music sells more than drugs – more Happy Birthday than Prozac

Art is a lie that makes us realise the truth

Music could have evolved 250,000 years ago

It could just be auditory cheesecake

But it could help mate selection and bonding
Poets have greater pulling power

Artists may use their right hemisphere more

But both sides get in on the act
Music processing structures in the brain may be distinct

Musical sense is not always keen
...and finally

The brain is designed to respond to representational art.

Other species may respond to music as well.

Listening to Mozart does not make you smarter.

But music instruction early in life might help.

If you see sounds and taste shapes you may have an advantage.
...and finally

But...very few artists make money!