

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?



Should auld ac- quain- tance be for- got and ne- ver brought to mind? Should auld ac- quain- tance

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

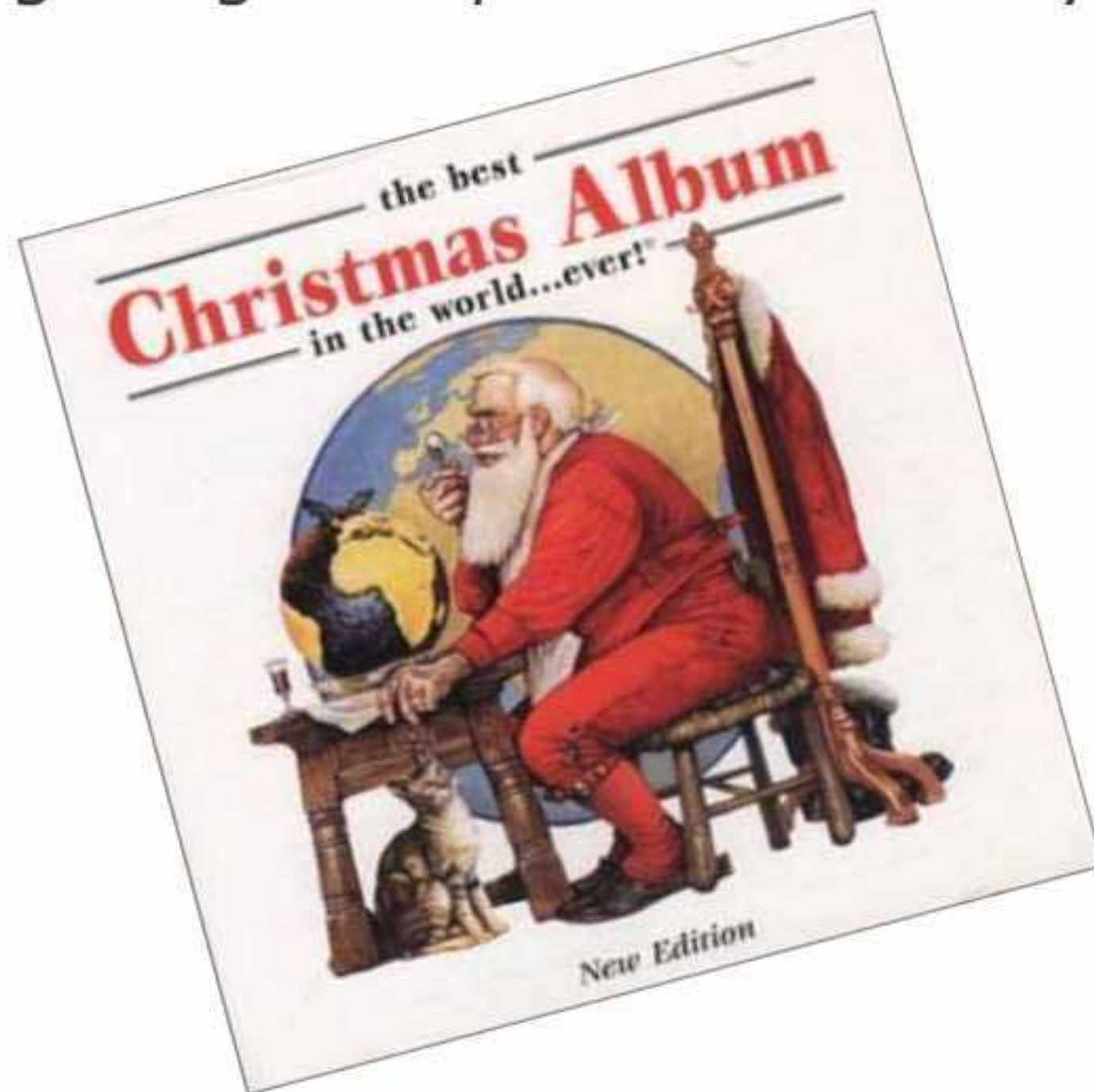
Music is used to evoke and control our emotions



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



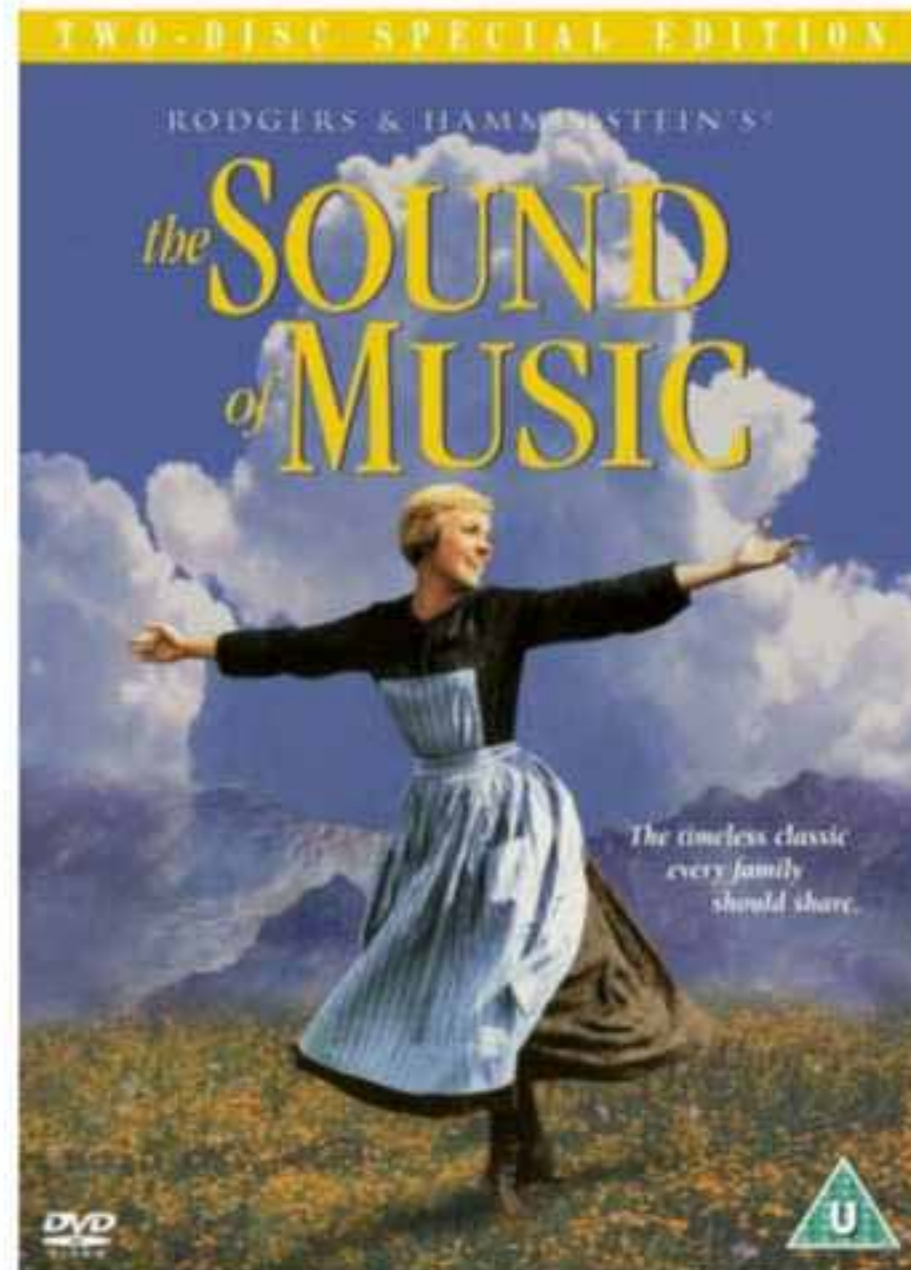
The influence of music in the modern world

Anthropologists claim all human cultures have used music



The influence of other forms of art

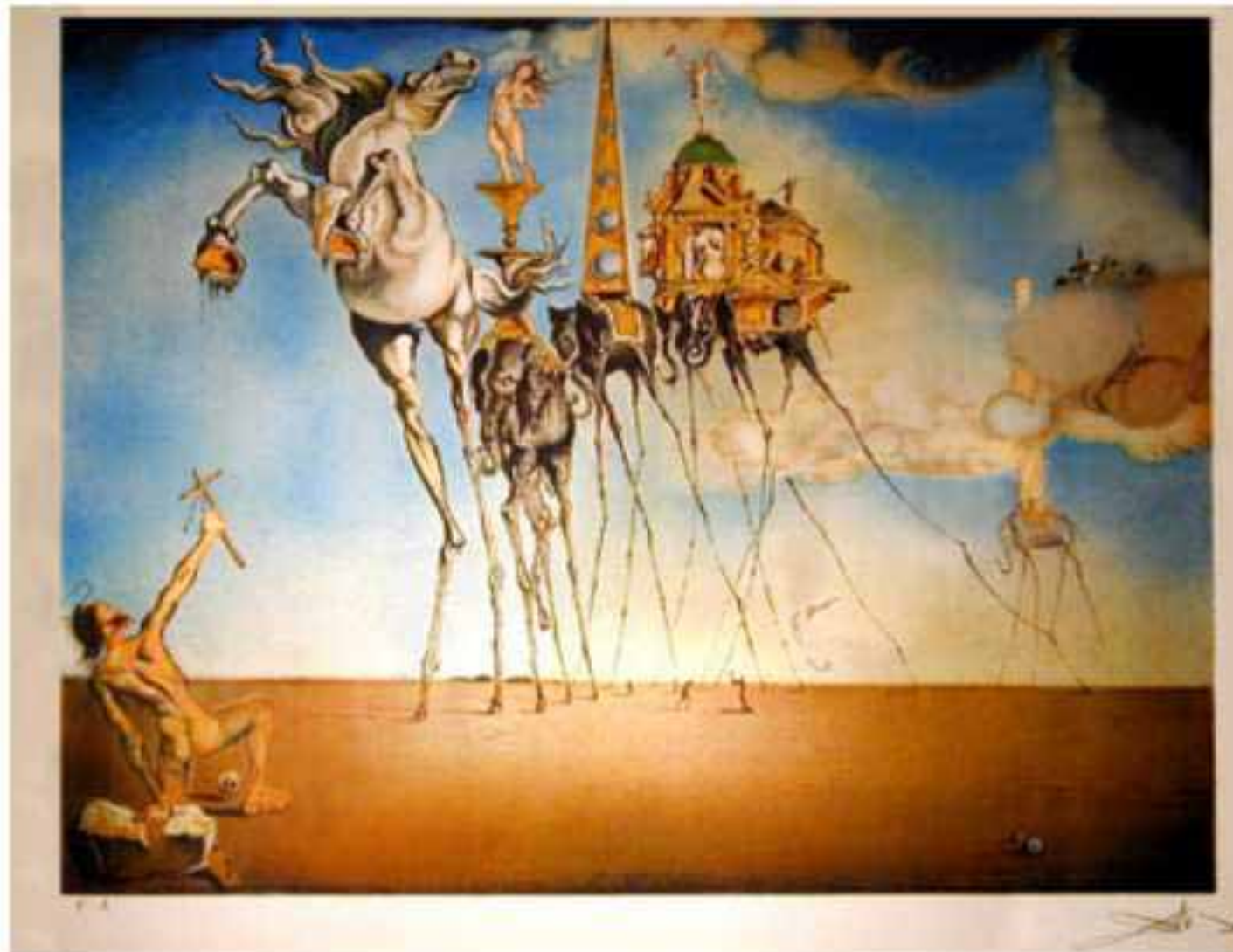
Visual and performing arts have a major impact on the lives of most of us



The influence of other forms of art

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

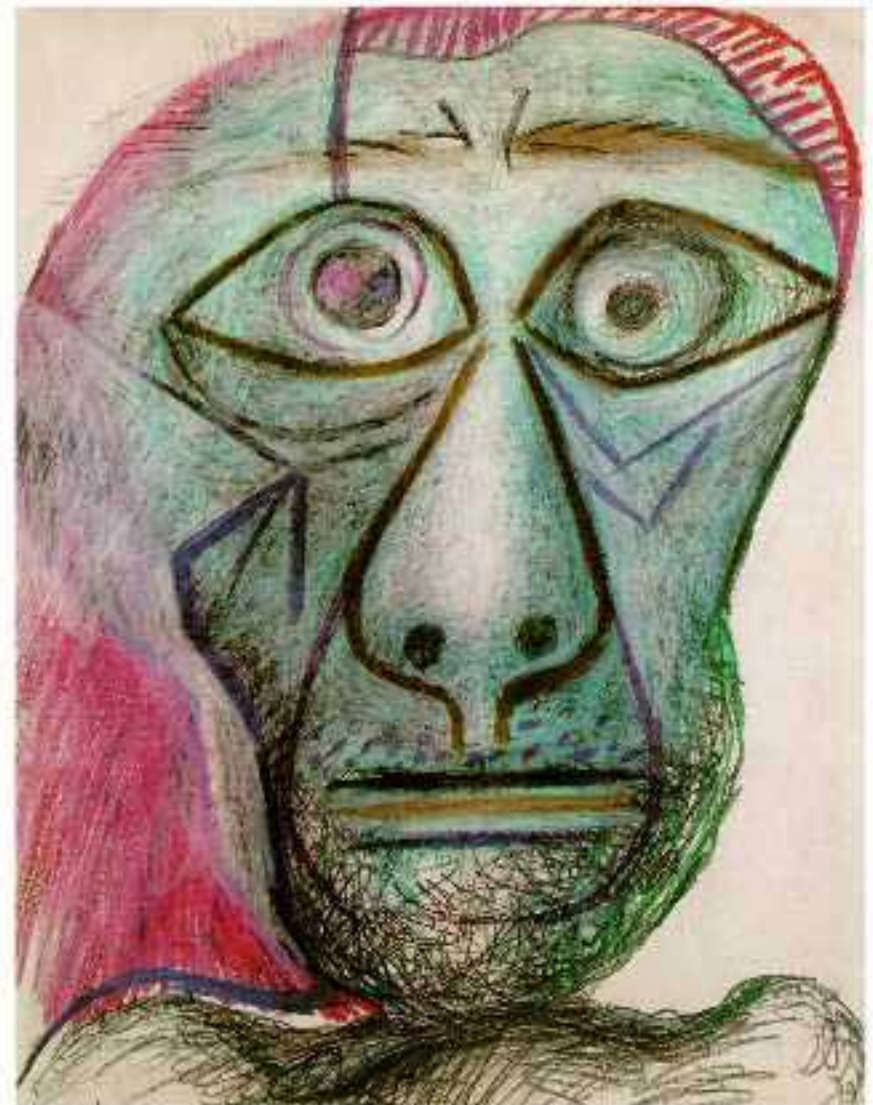


The influence of other forms of art

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



The influence of other forms of art

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



The influence of other forms of art

What we define as art is highly subjective



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What we define as art is highly subjective



The influence of other forms of art

What we define as art is highly subjective

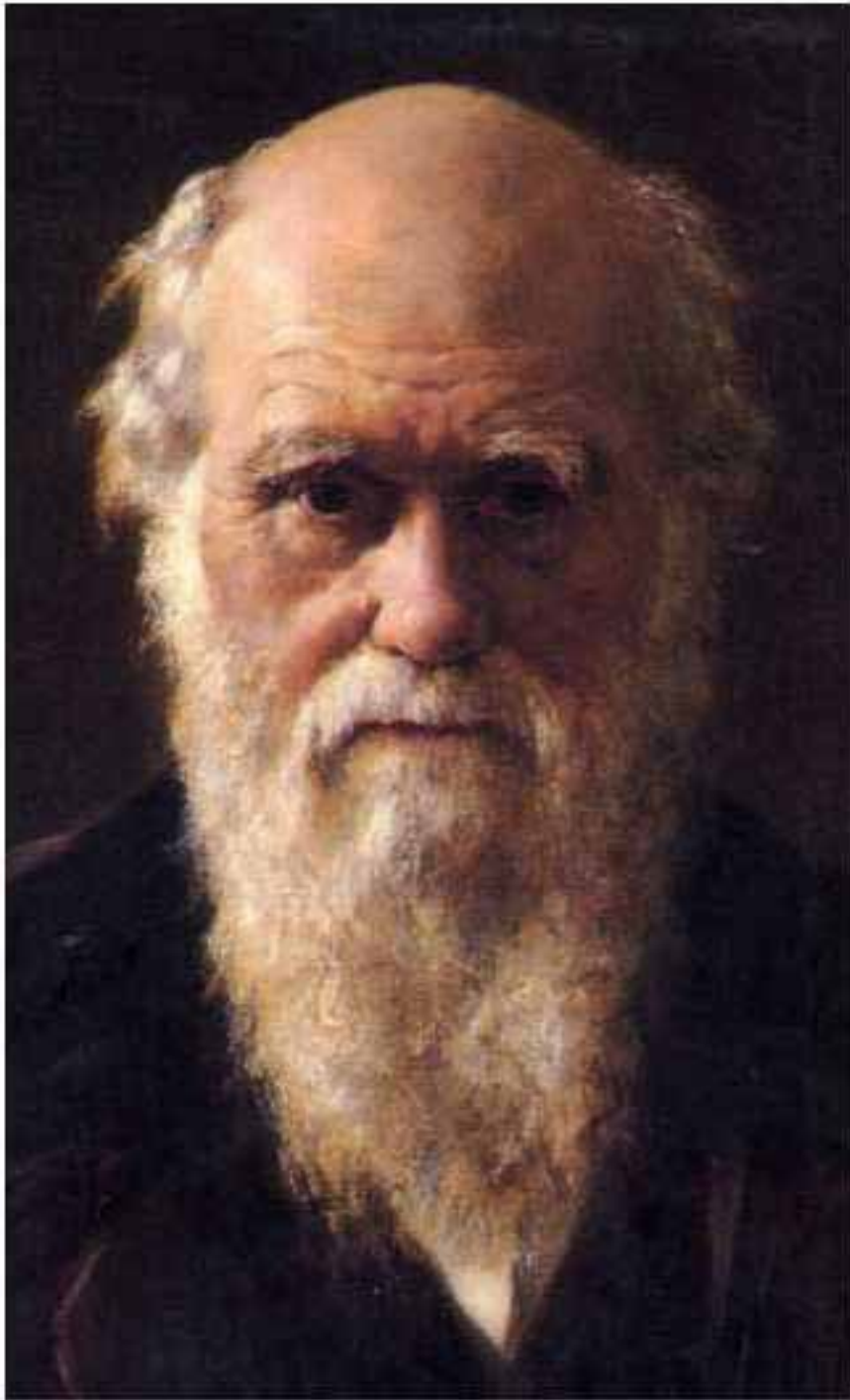


The influence of other forms of art

What we define as art is highly subjective



The evolution of artistic brains in humans



'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?



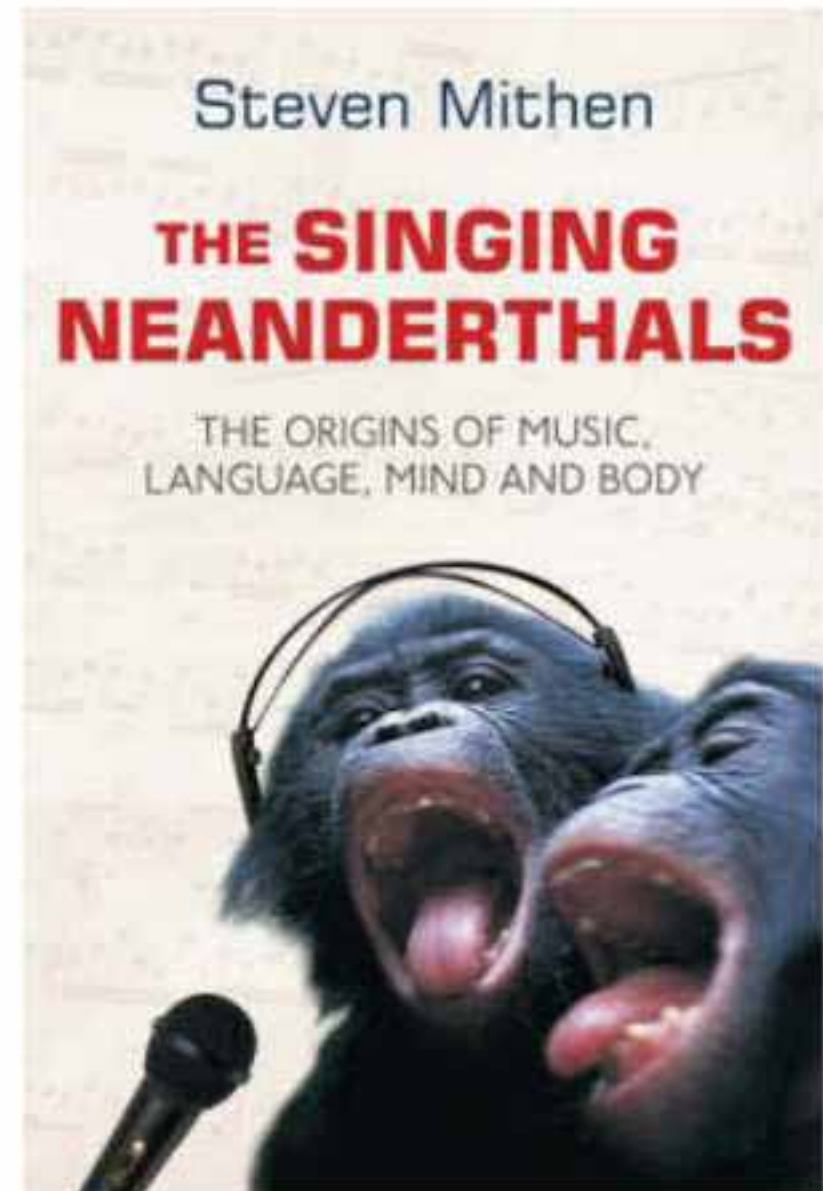
The evolution of artistic brains in humans

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

The oldest musical instruments are bone flutes (43,000 - 82,000 years old)



Srdjan Zivulovic / Reuters



The evolution of artistic brains in humans

Older than cave paintings



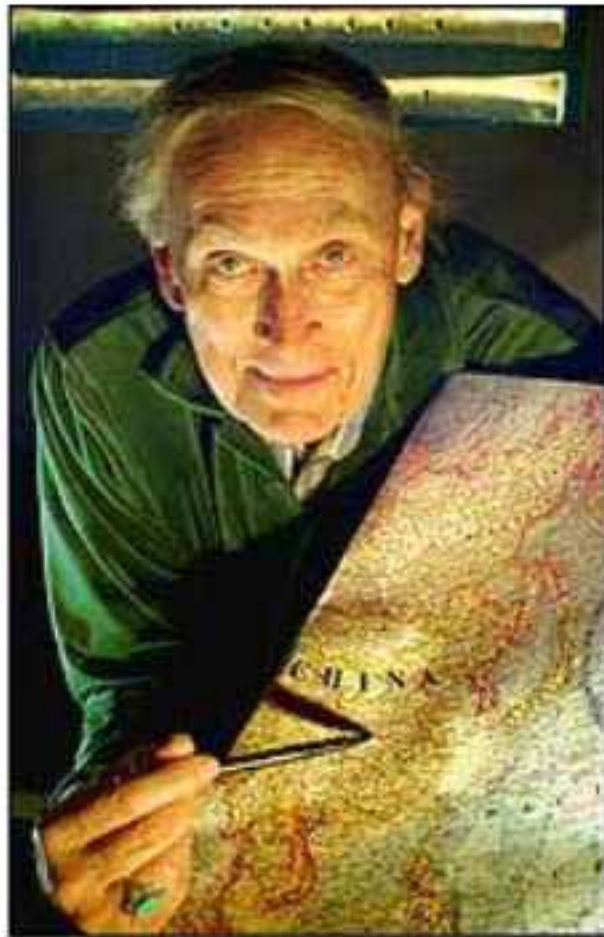
The evolution of artistic brains in humans

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!



Garman Harbottle



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



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

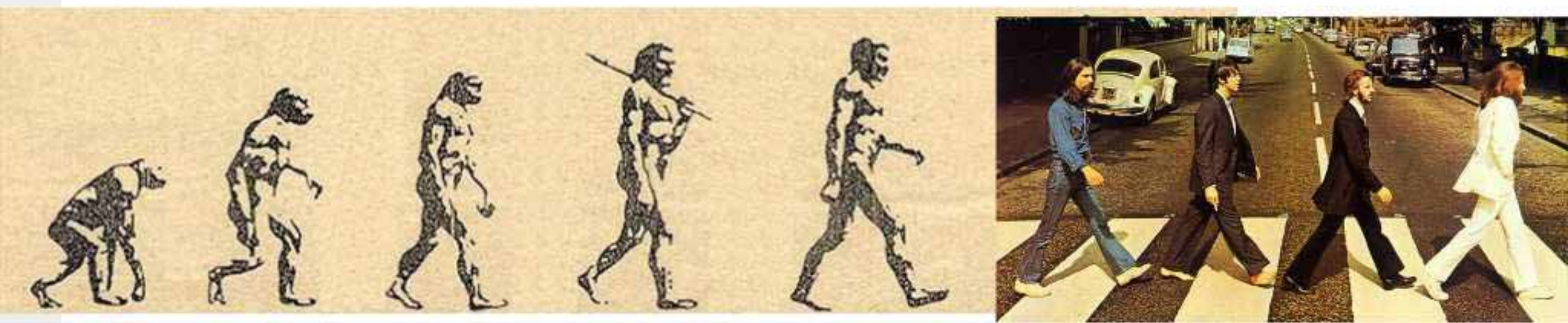
Non-adaptive pleasure seeking theory (NAPS)



The evolution of artistic brains in humans

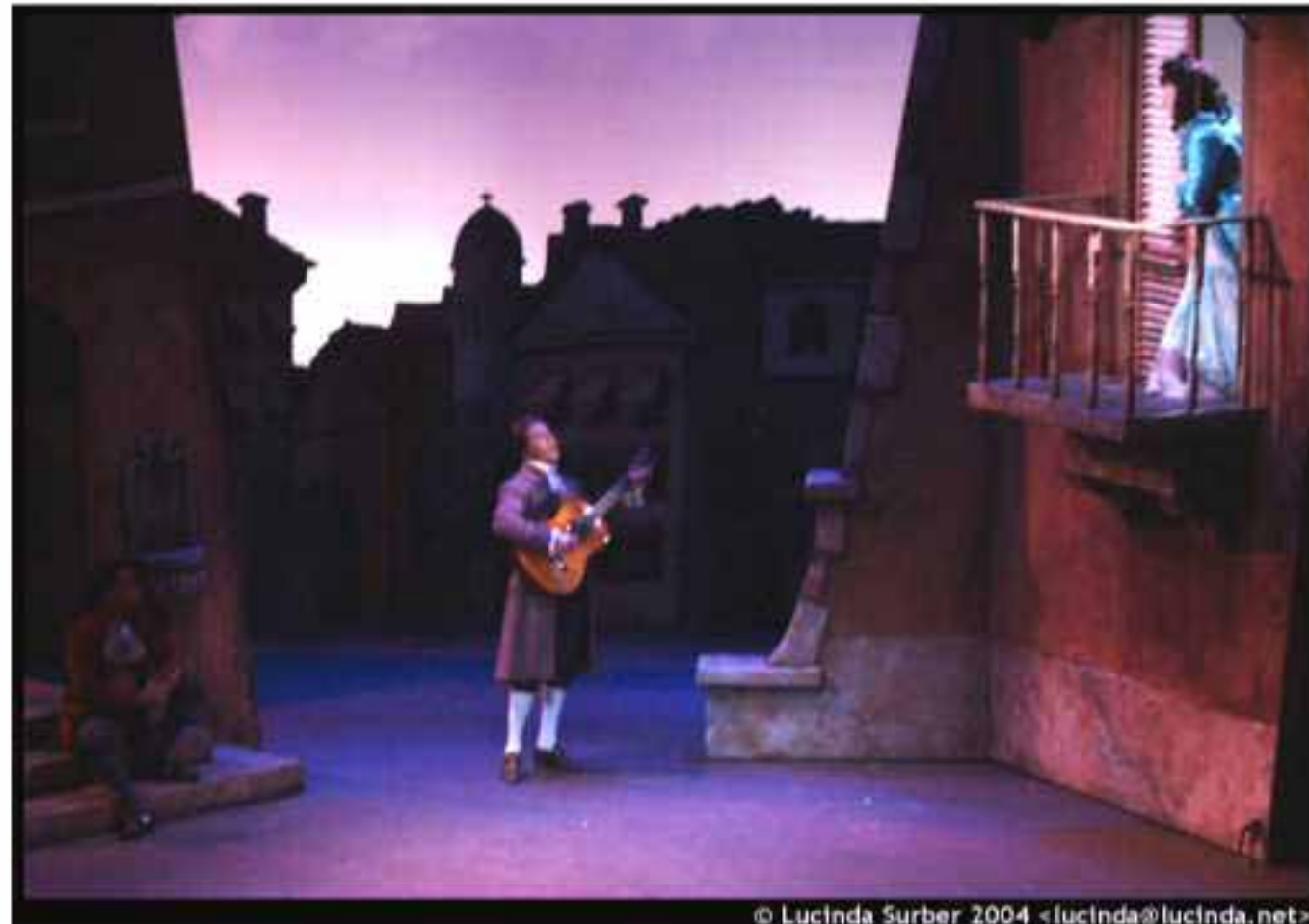
Non-adaptive pleasure seeking theory (NAPS)

Music as an evolutionary vestige



Evolutionary theories of music and art

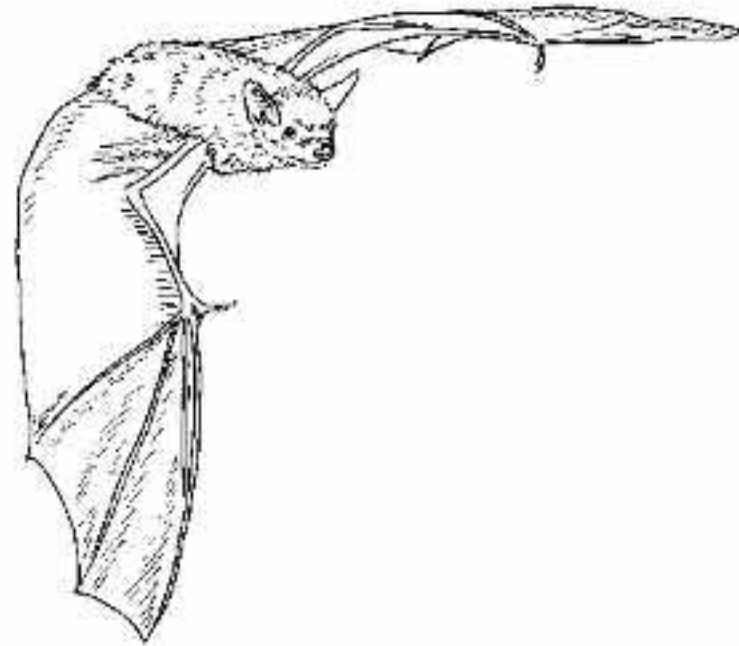
Mate selection - is it all down to serenading a prospective partner?



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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

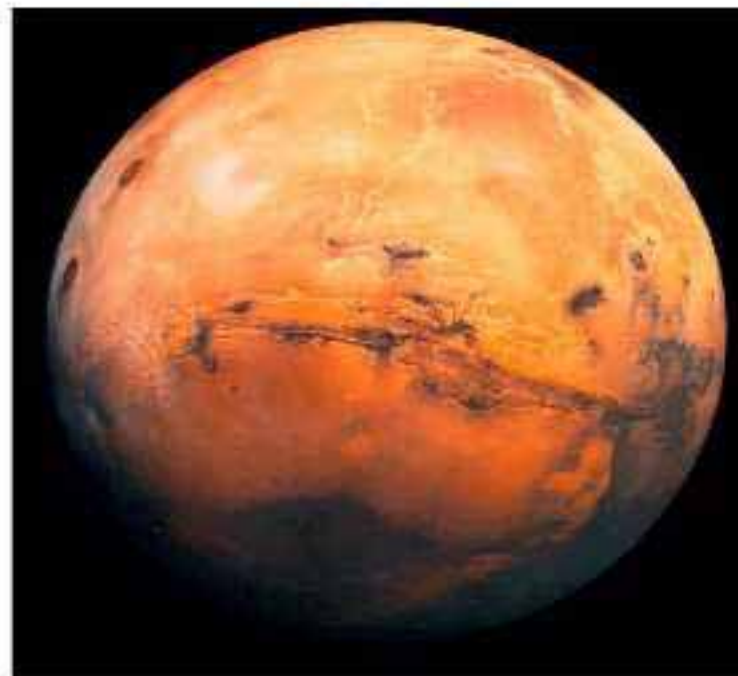
Bonding using gossip is more efficient

Bonding using singing and music is even better!



Grooming, gossip, and social cohesion

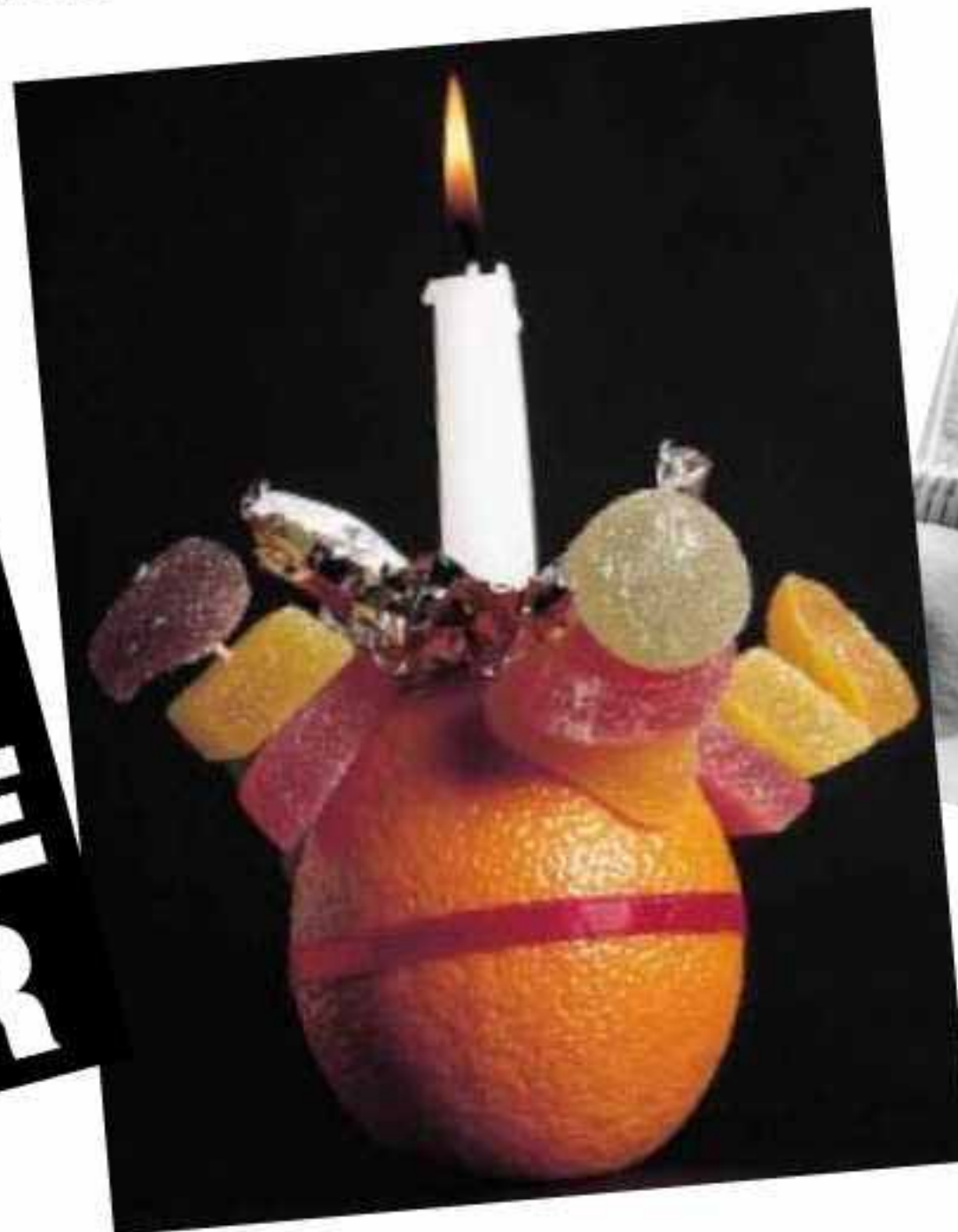
Music and war



Grooming, gossip, and social cohesion

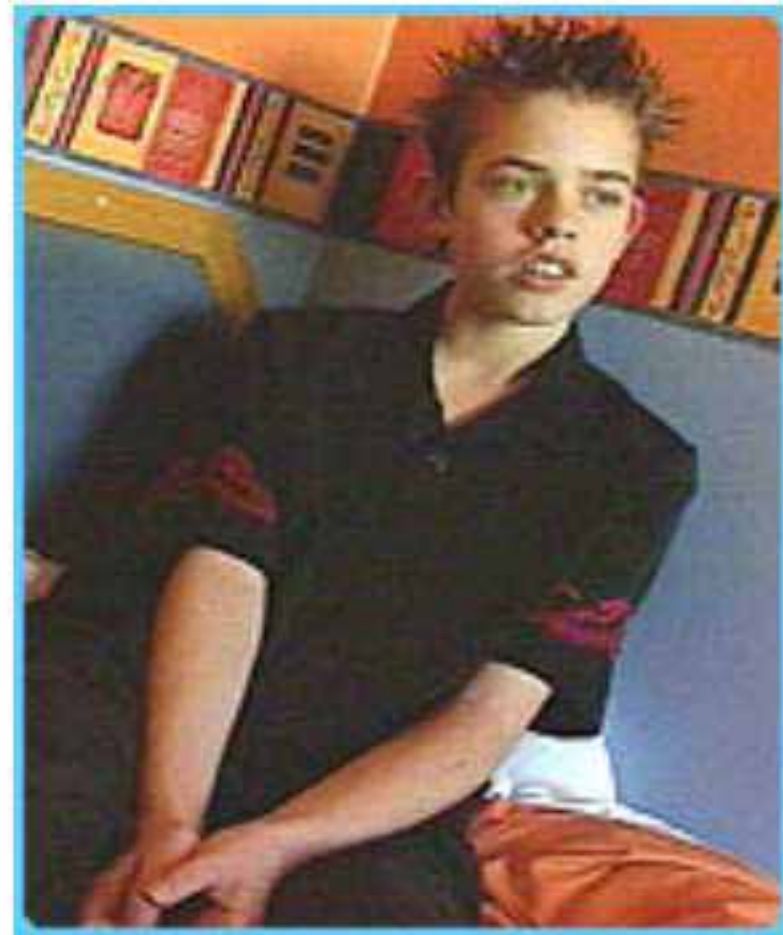
Music and war

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

S S

Adagio

Vlns. I
Vlns. II
Vles.
Cellos
Basses

Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Arg-Gly-NH₂

S S

The left, right and centre...

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

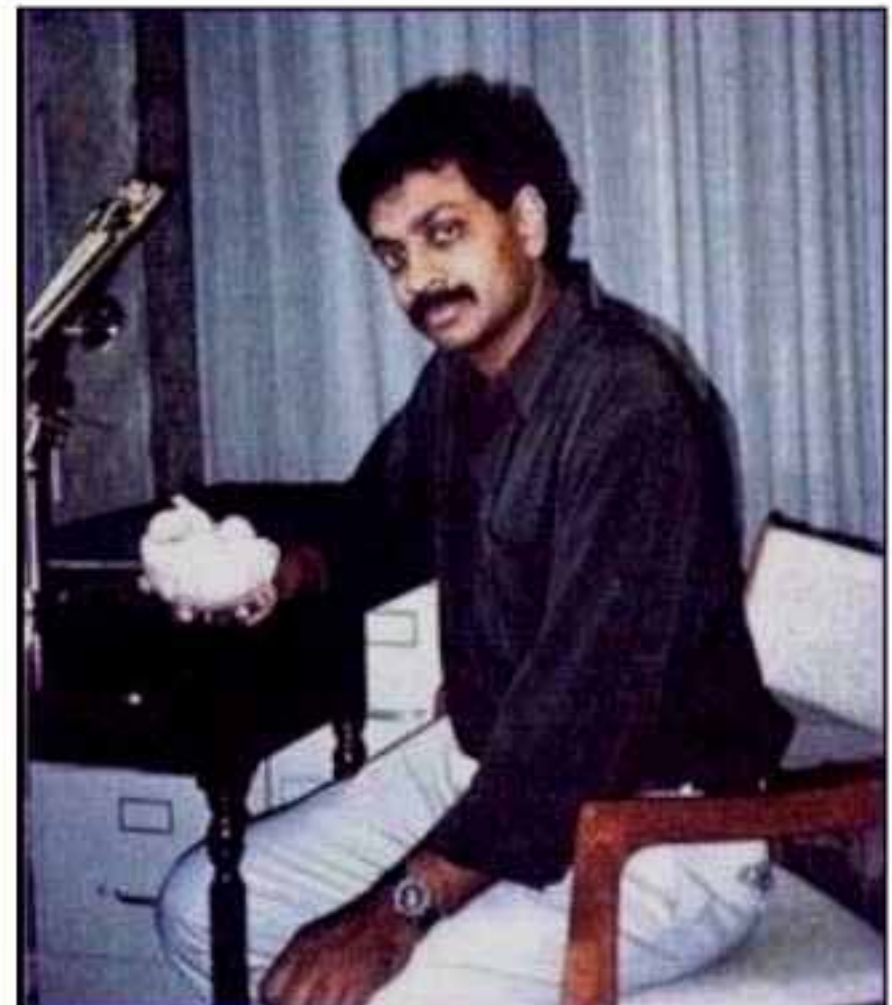


The left, right and centre...

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

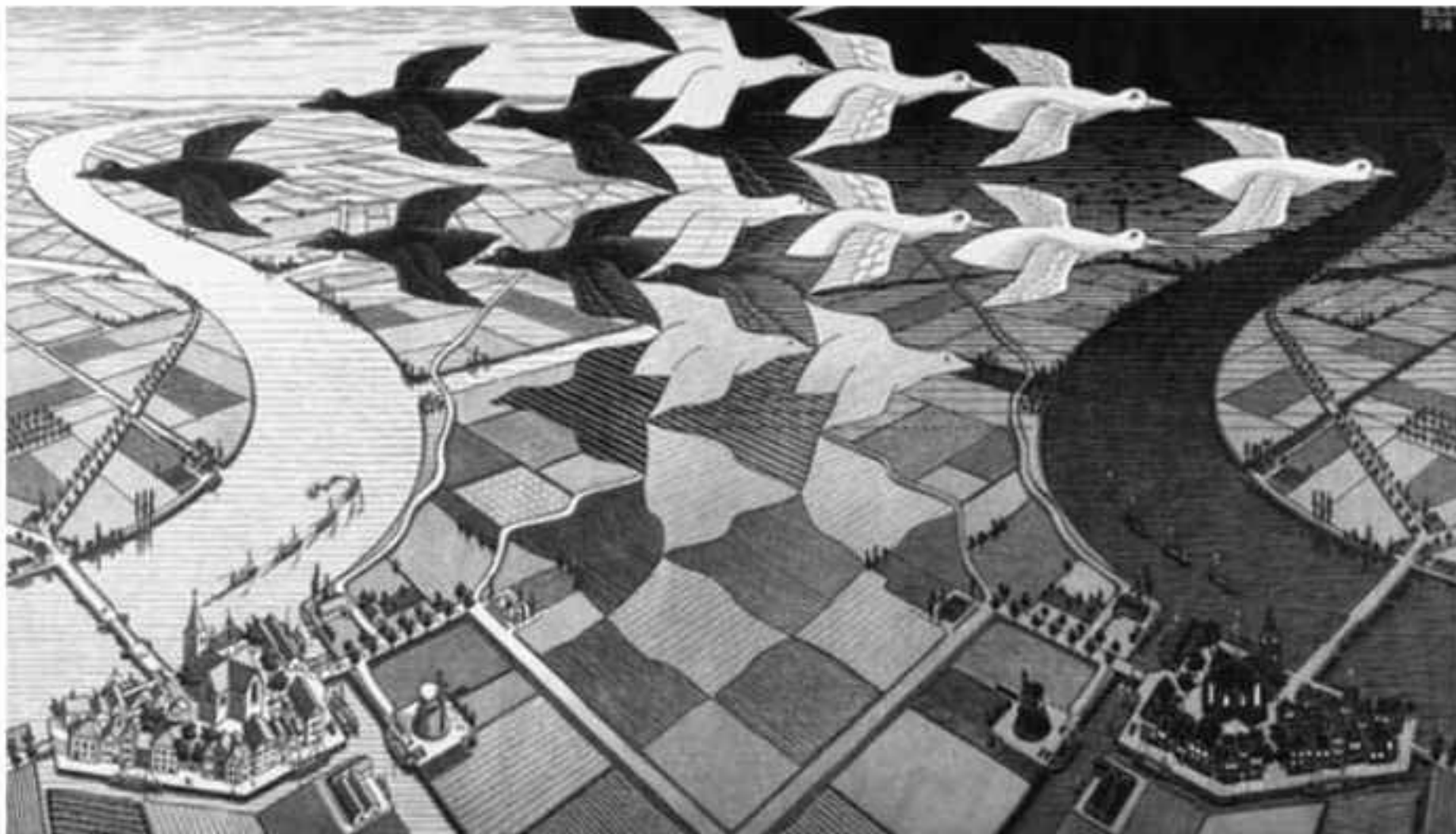


The ten laws of Art

Peak shift

Grouping

Contrast



The ten laws of Art

Peak shift

Grouping

Contrast

Isolation (understatement)

Klimt



The ten laws of Art

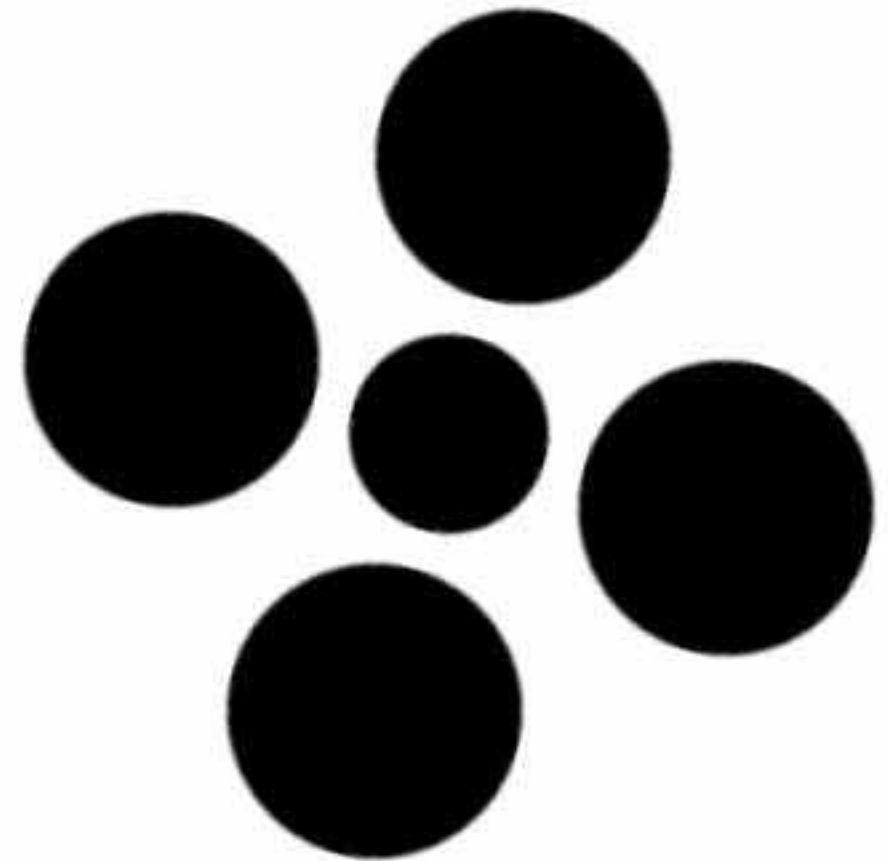
Peak shift

Grouping

Contrast

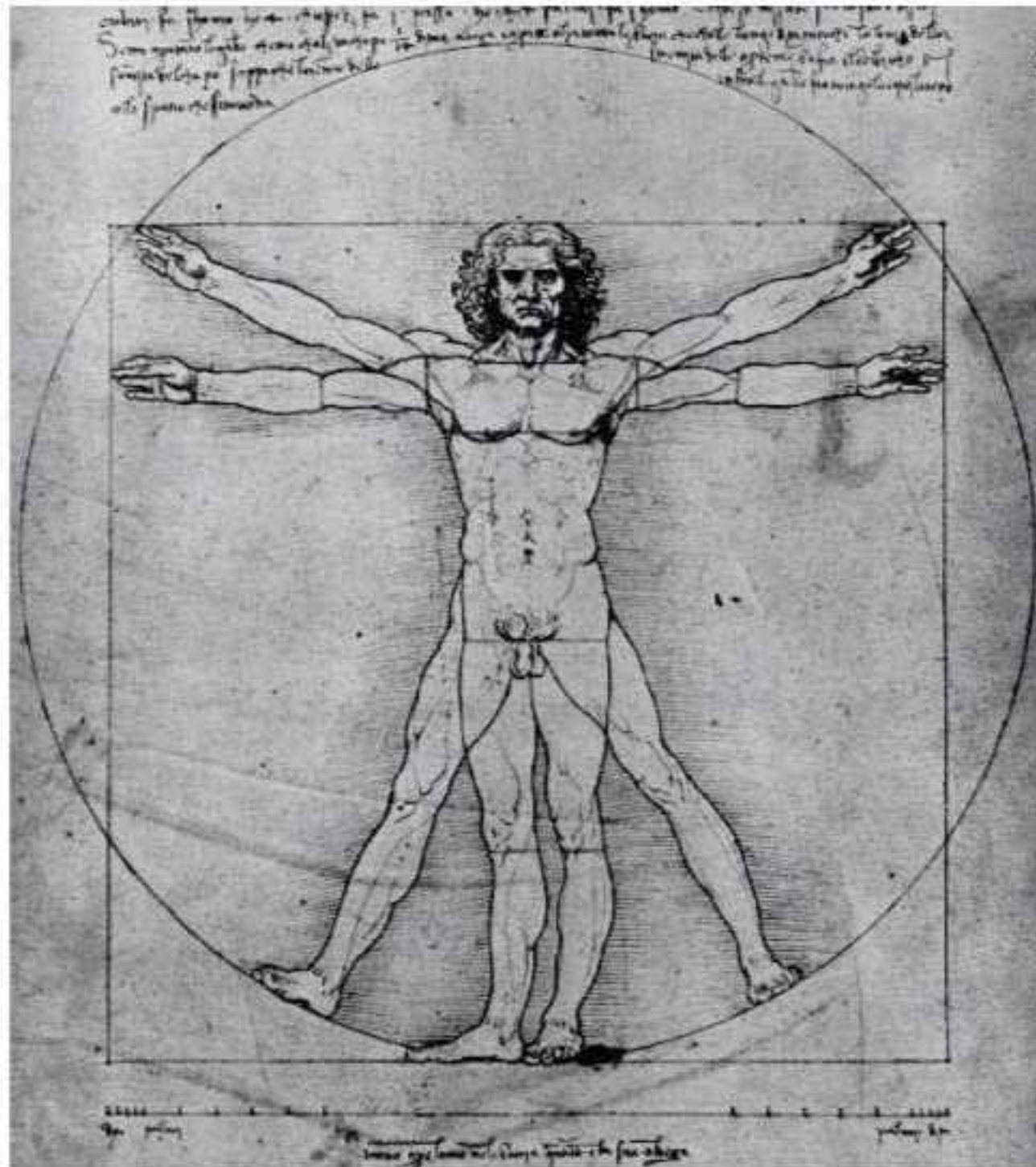
Isolation (understatement)

Perception problem solving



The ten laws of Art

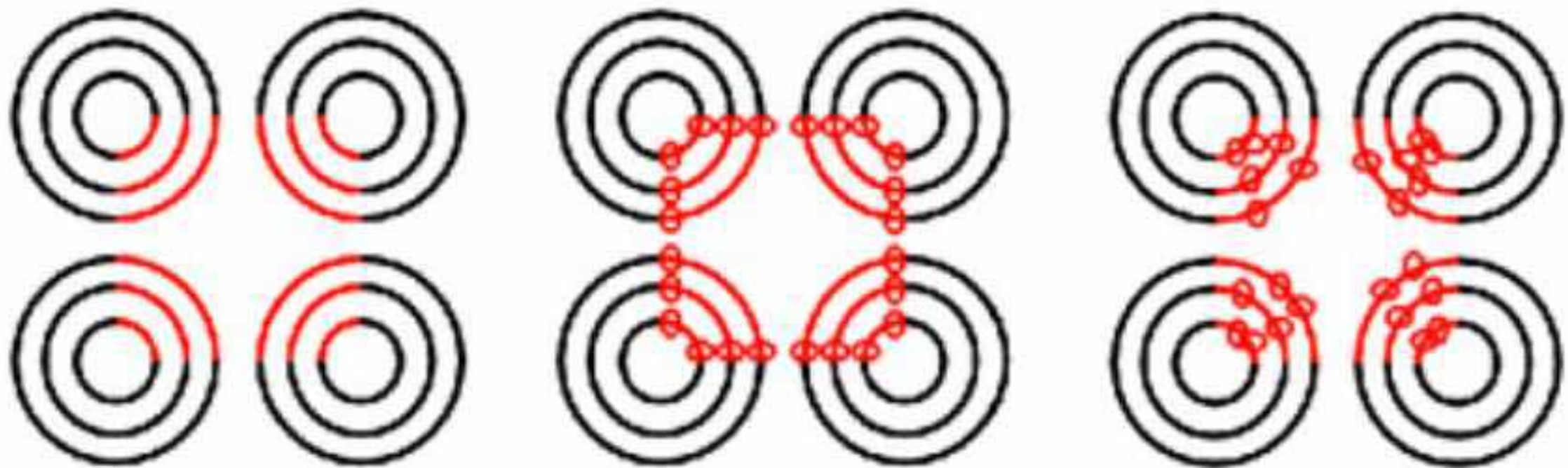
Symmetry and balance



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

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Balance



The ten laws of Art

Symmetry and balance

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Repetition, rhythm and orderliness

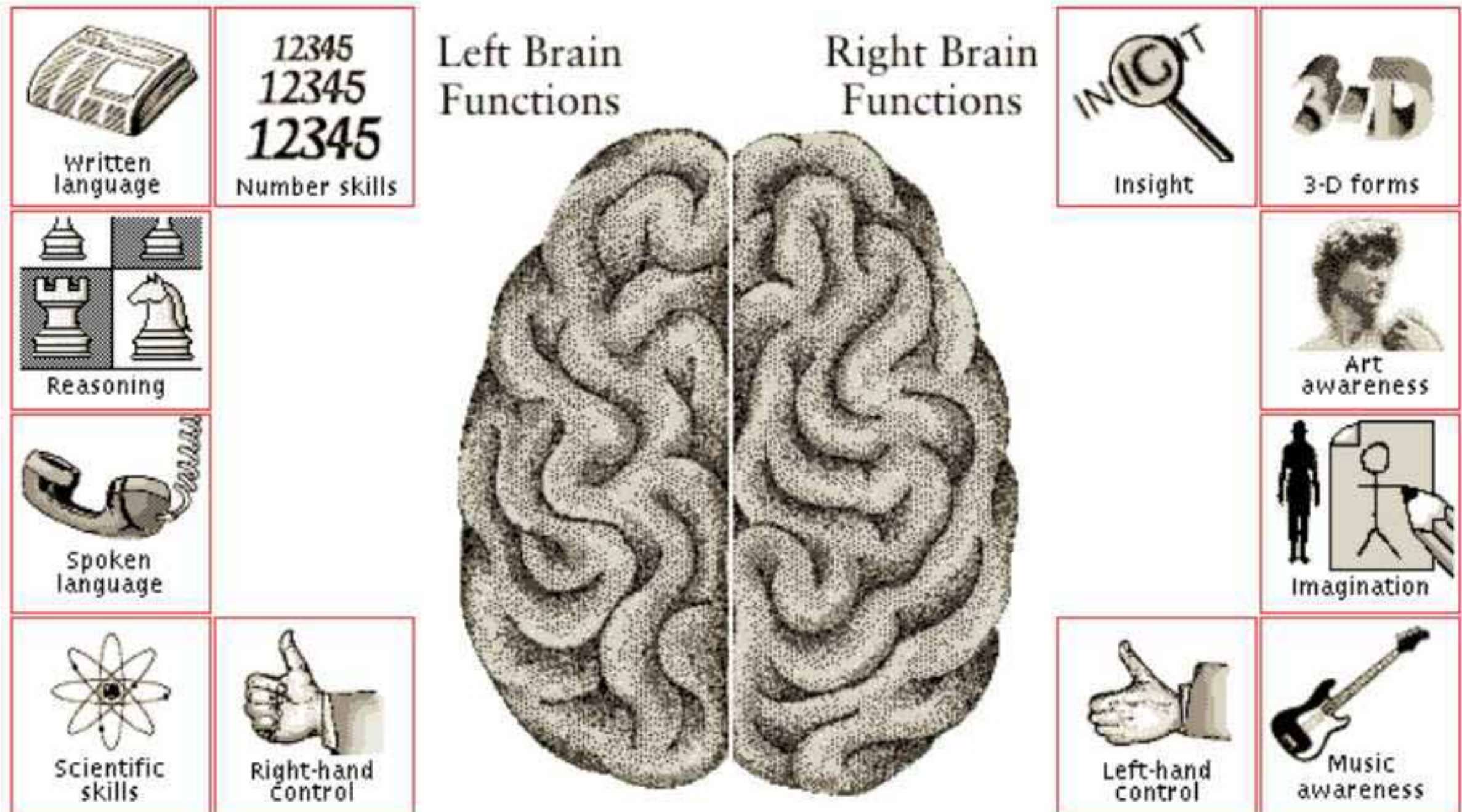
Balance

Metaphor



The musical brain

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



The musical brain

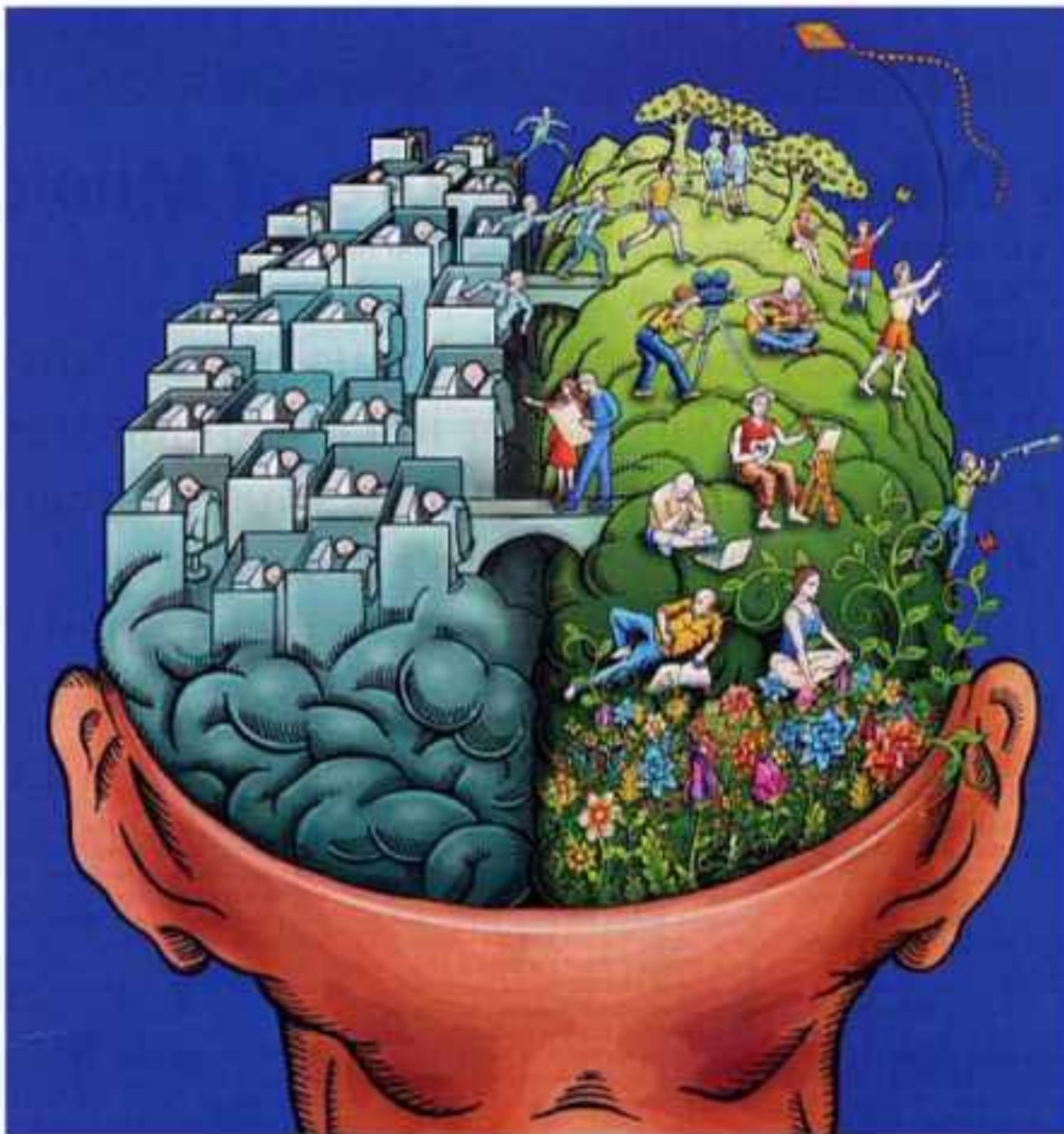
Language on the left, music and vocal tones on the right?

No sex differences in musical ability



The musical brain

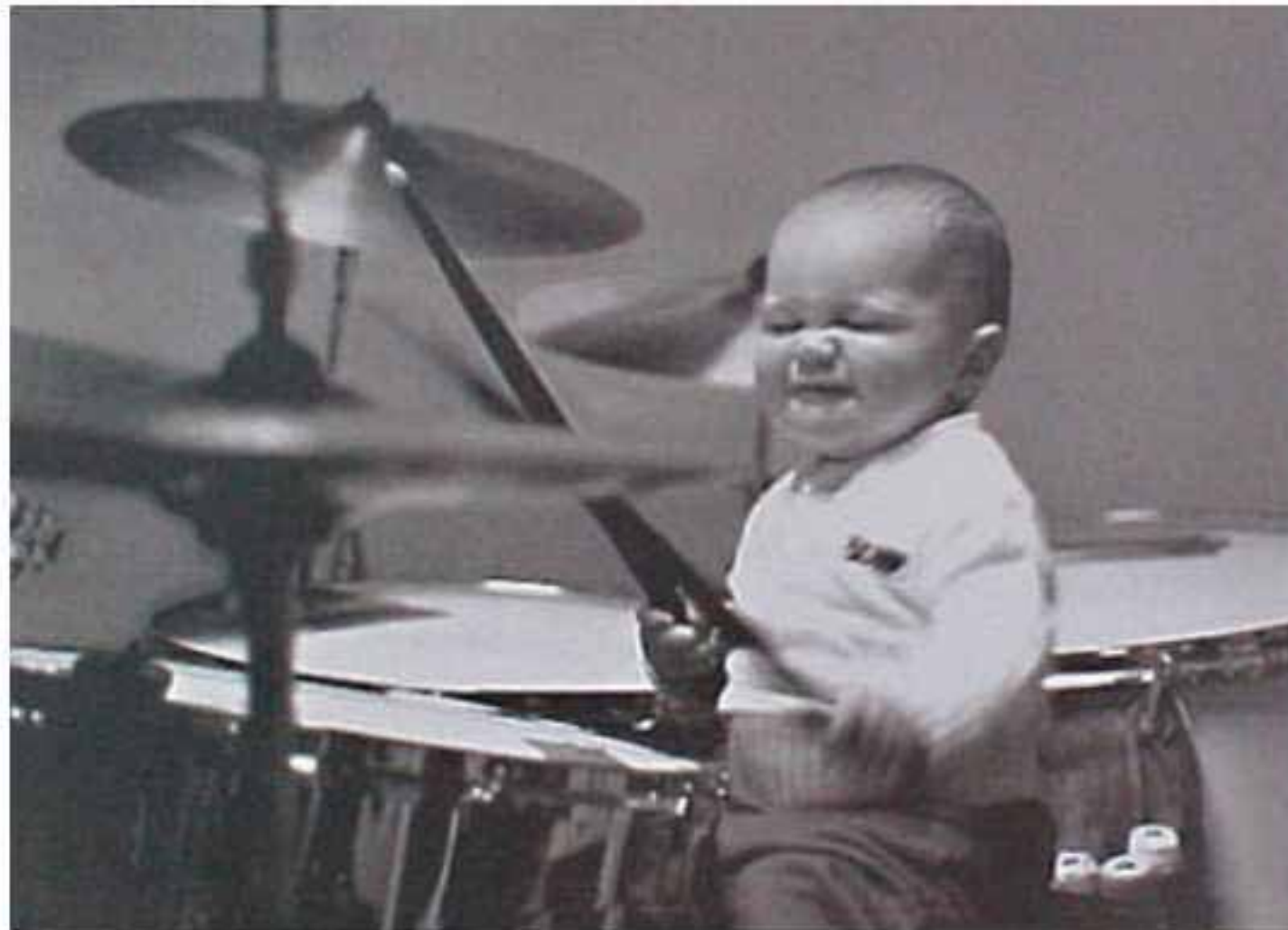
Left side involved in both grammatical and musical syntax



The musical brain

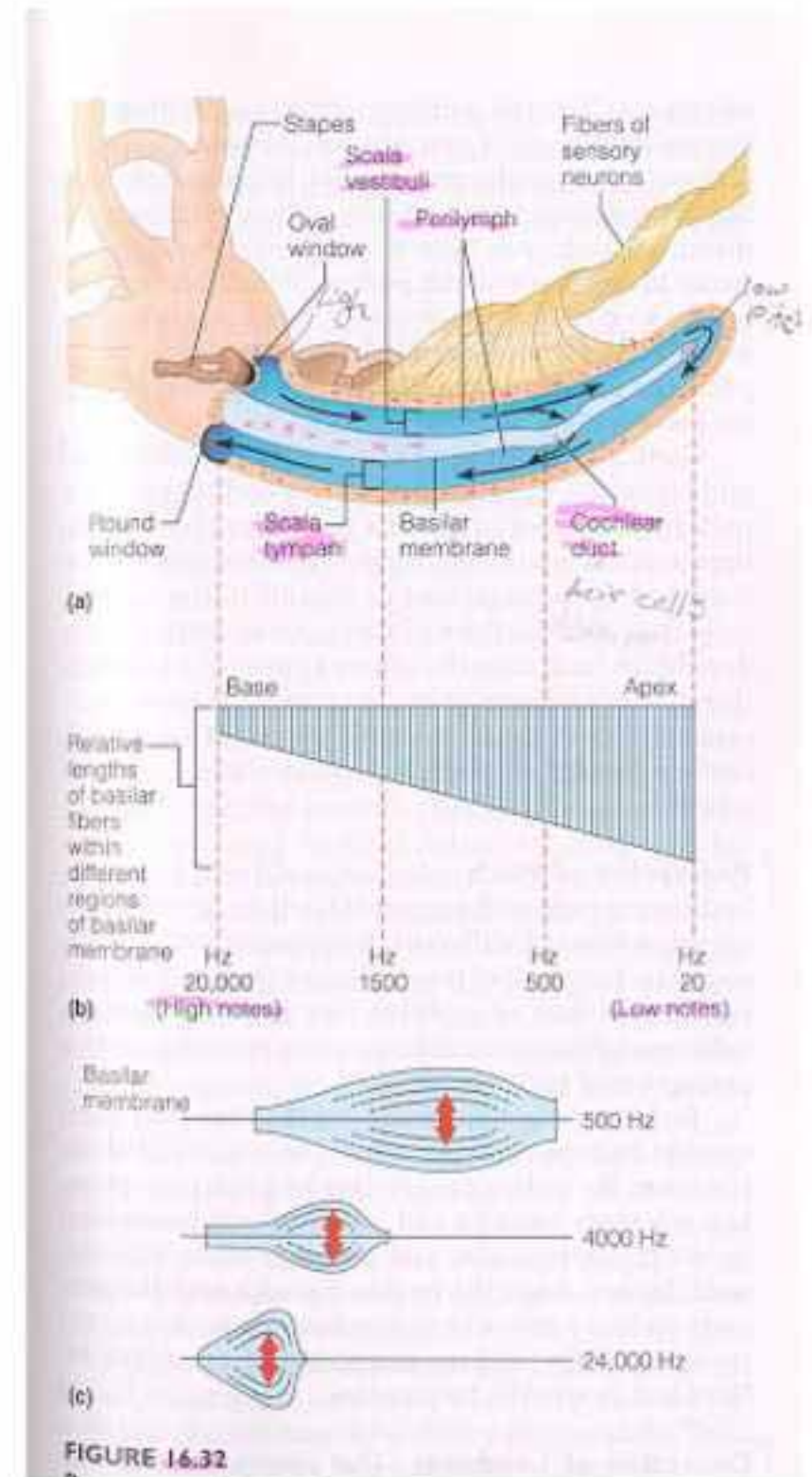
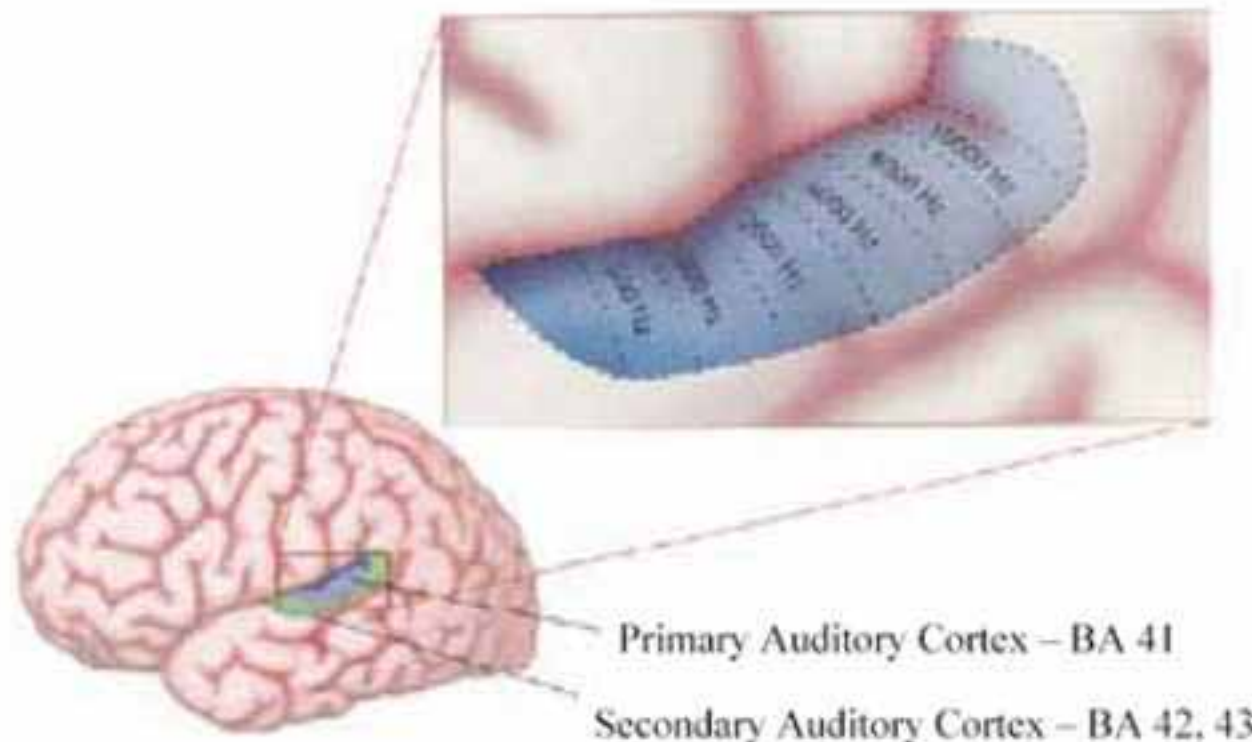
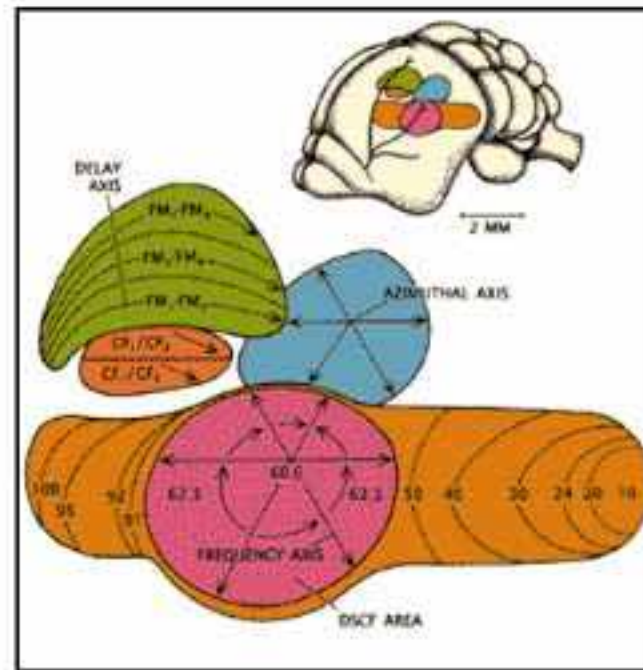
Left side involved in both grammatical and musical syntax

Hum it with the left and beat it with the right



The musical brain

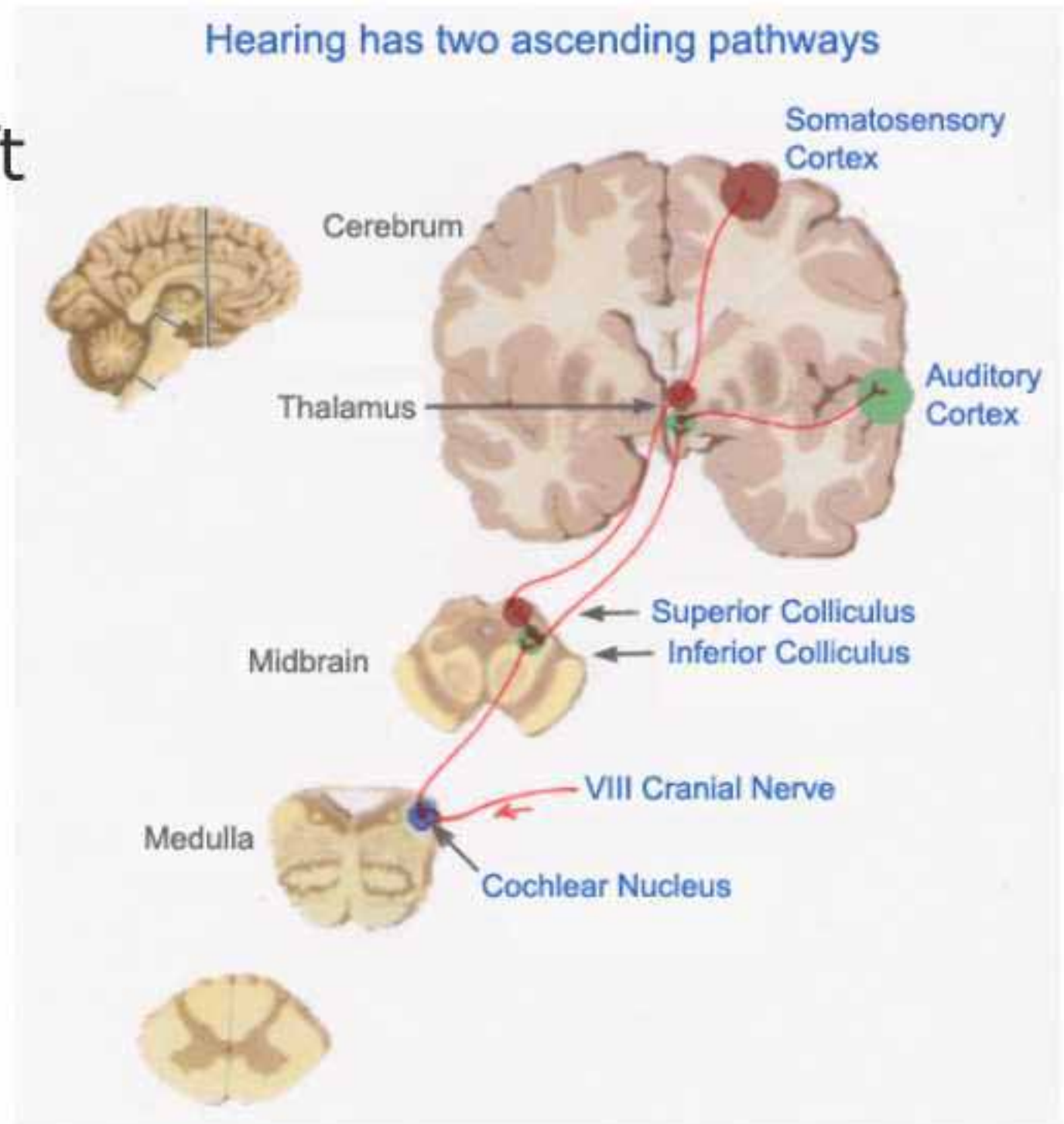
The auditory system is organised tonotopically



The musical brain

The auditory system is organised tonotopically

Right auditory cortex is more organised than left



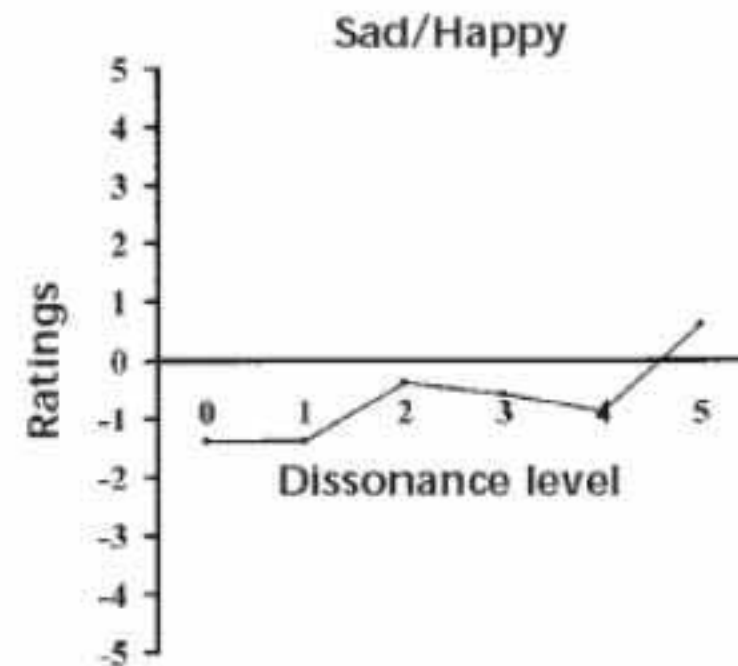
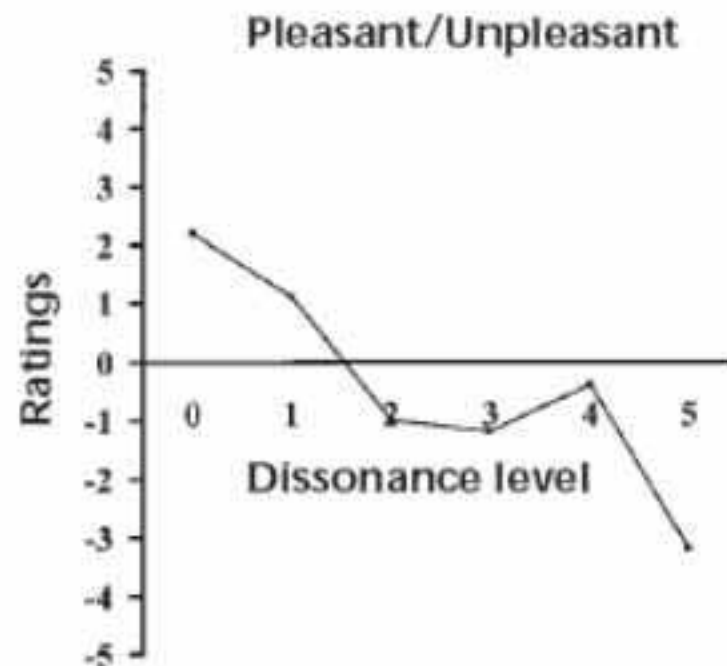
The musical brain

Dissonance is experienced with similar sound frequencies

Major triads (Diss0)



Flatted 13th triads (Diss5)



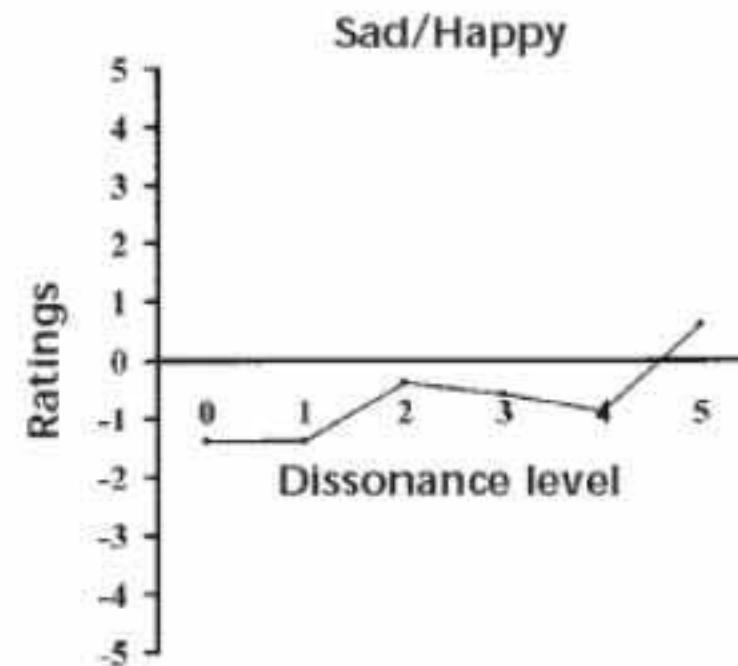
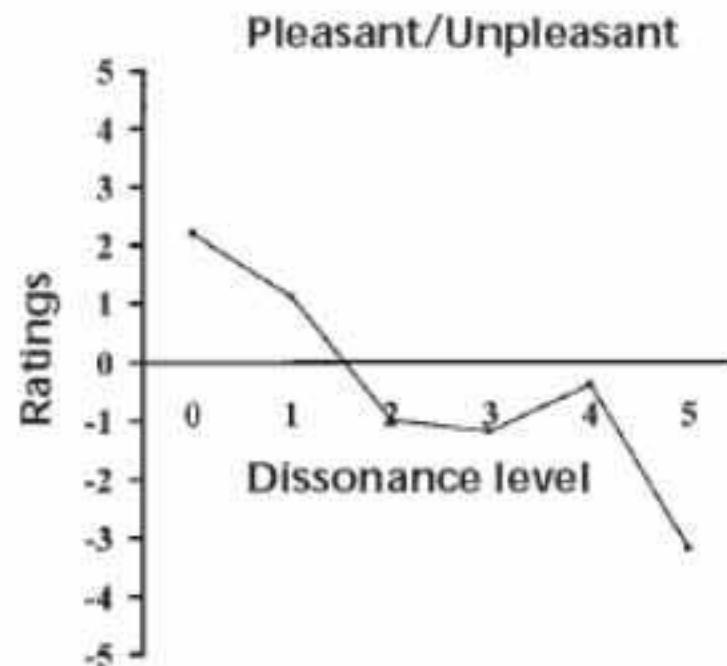
The musical brain

Dissonance is experienced with similar sound frequencies

Major triads (Diss0)

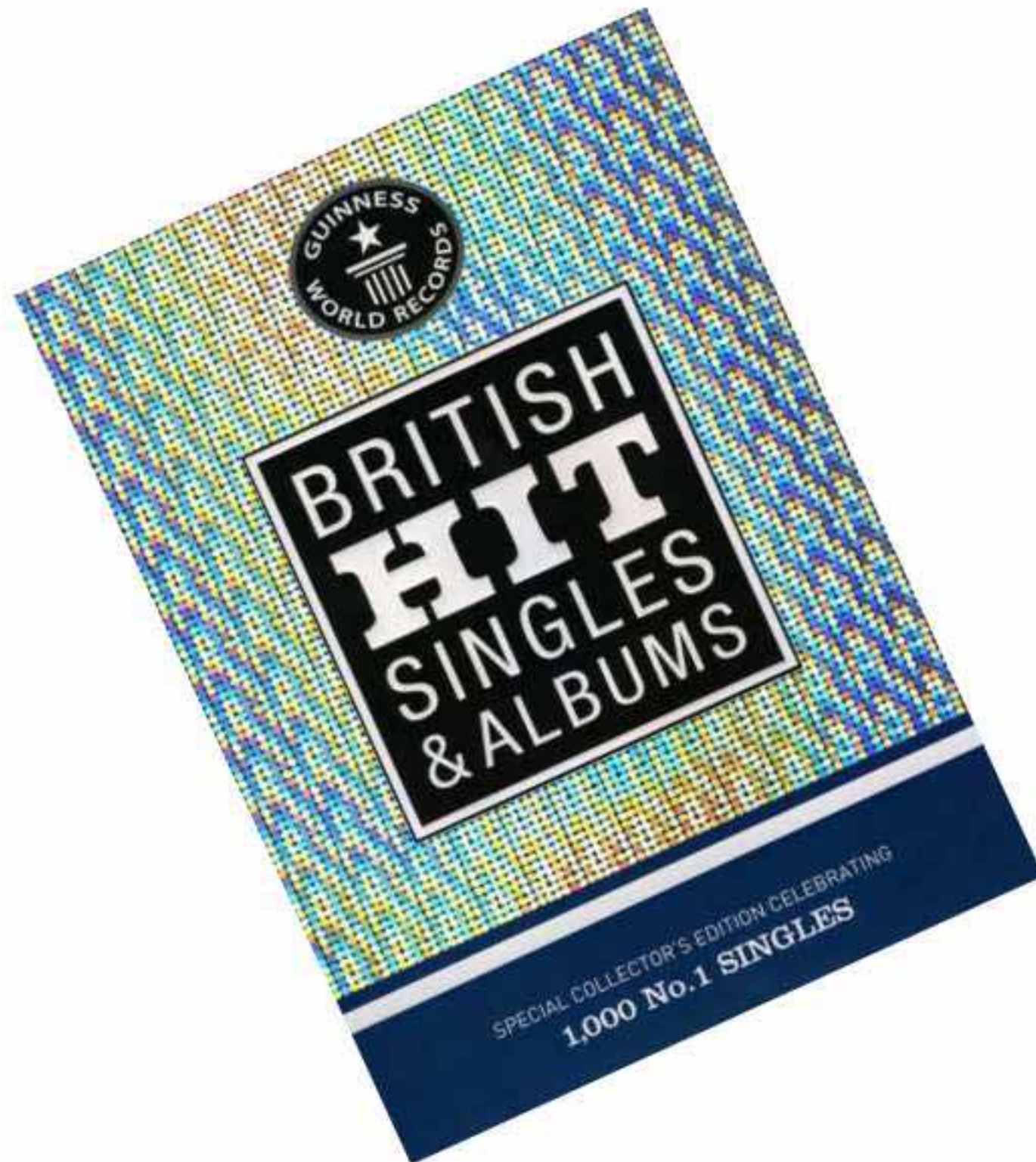


Flatted 13th triads (Diss5)



Music and memory

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



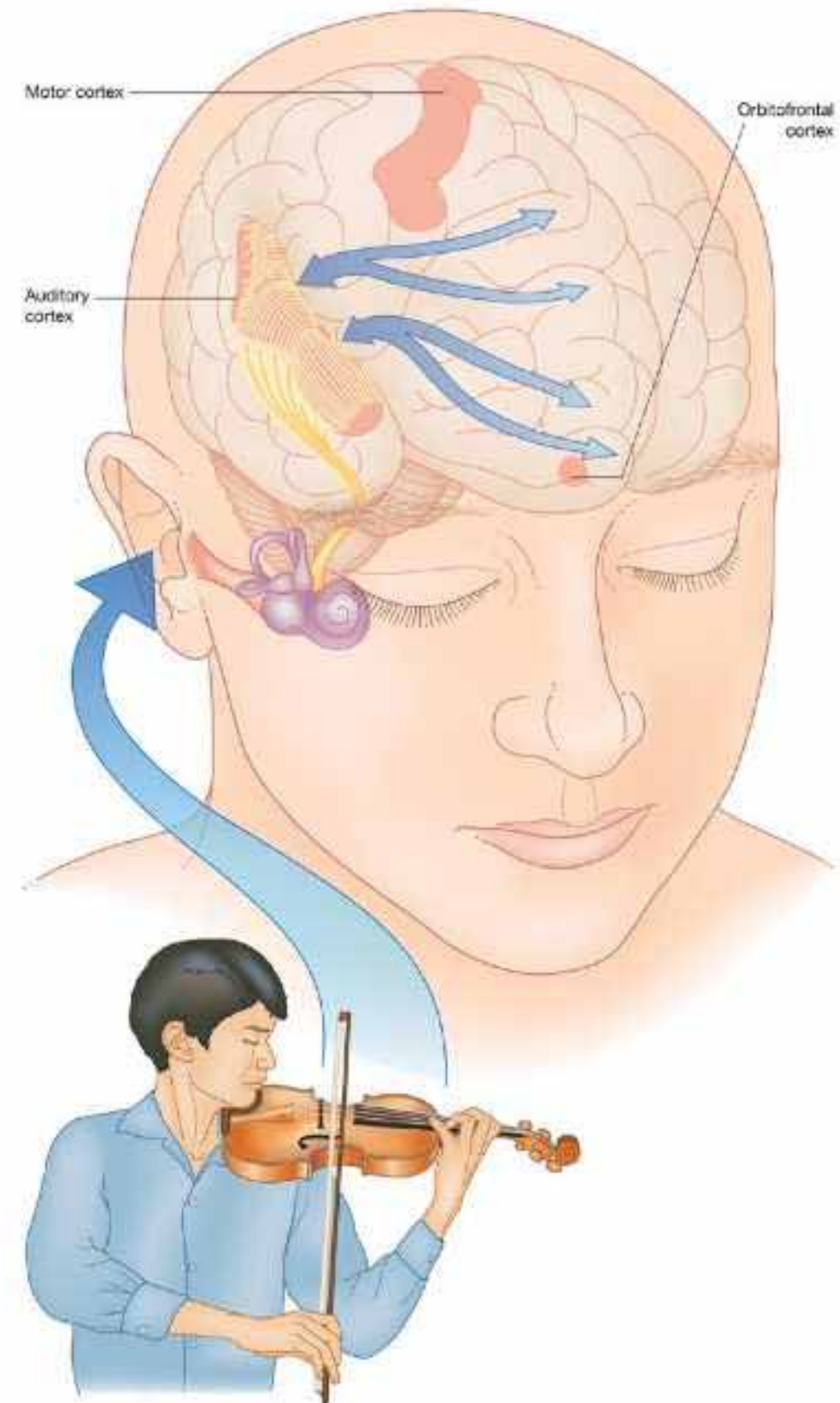
If you can keep your head when all about you
Are losing theirs and blaming it on you...

Kipling

Music and memory

The frontal cortex is important for music memory

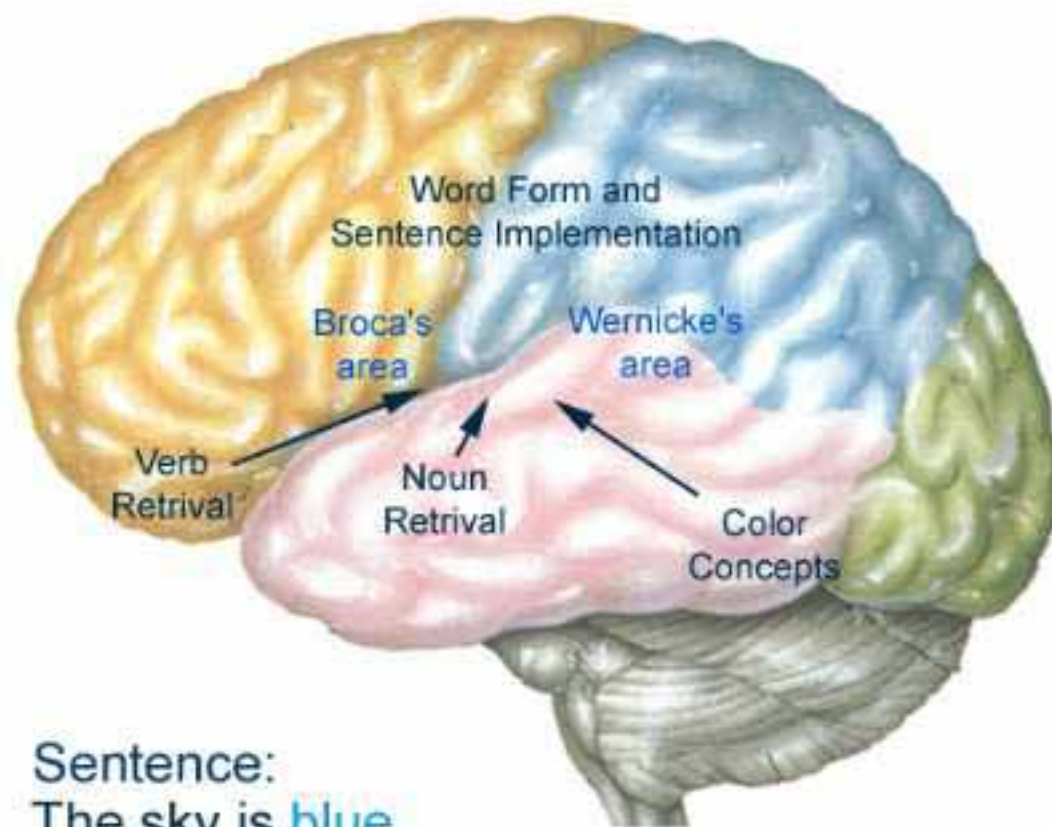
Memory for melodies is distinct from words or objects



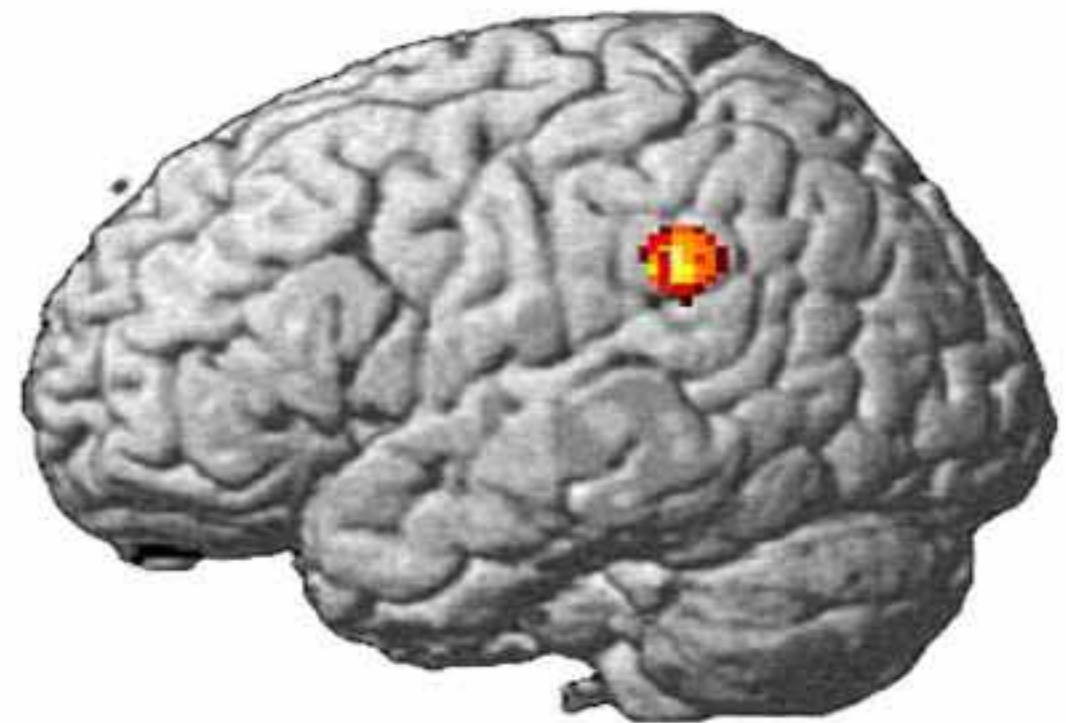
Music and imitation

Brain regions involved in language and imitation also help interpret music

Language involves retrieval of information from many brain areas.



Sentence:
The sky is blue.

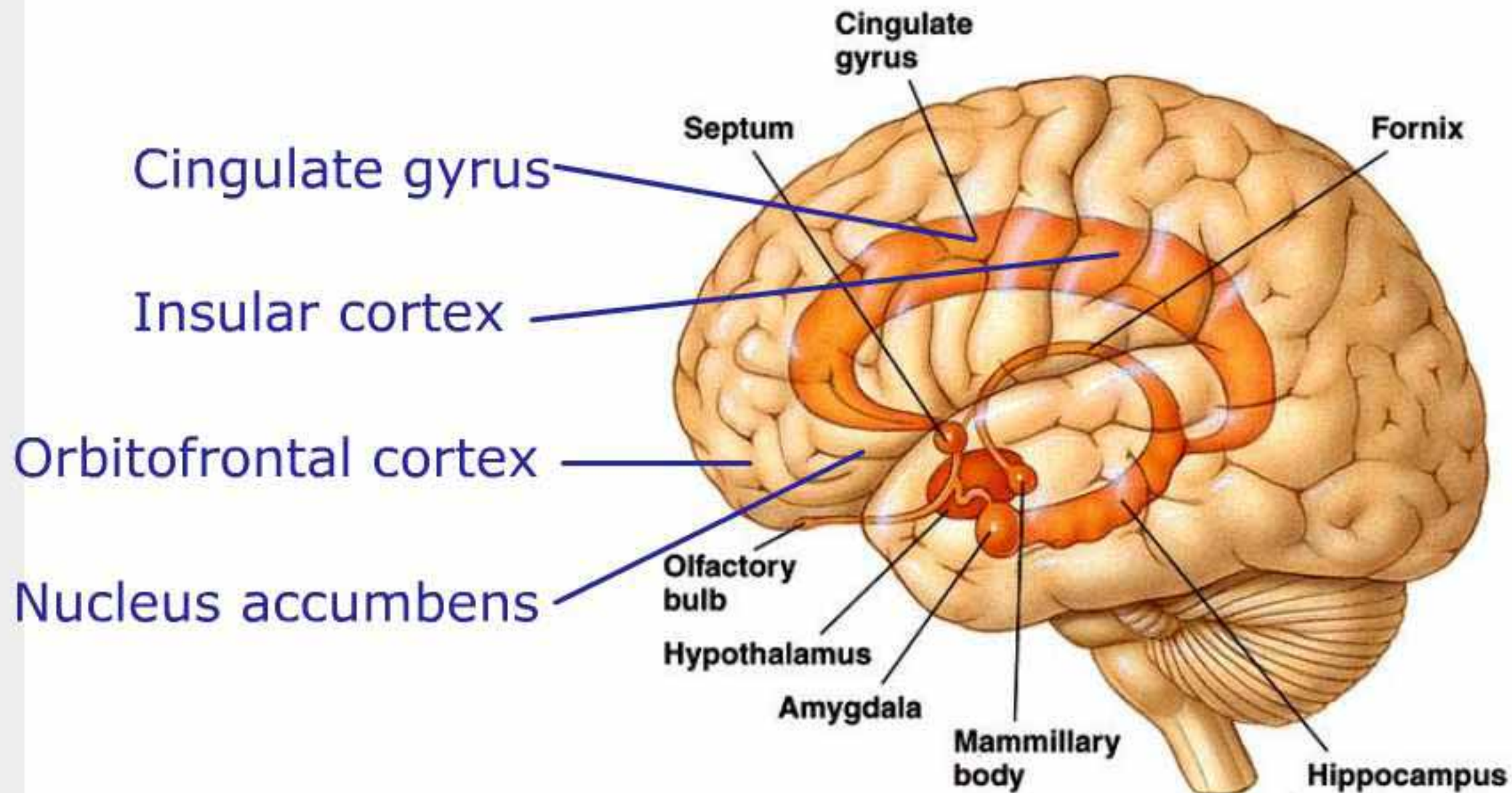


LEFT
IMITATING

Music and emotion

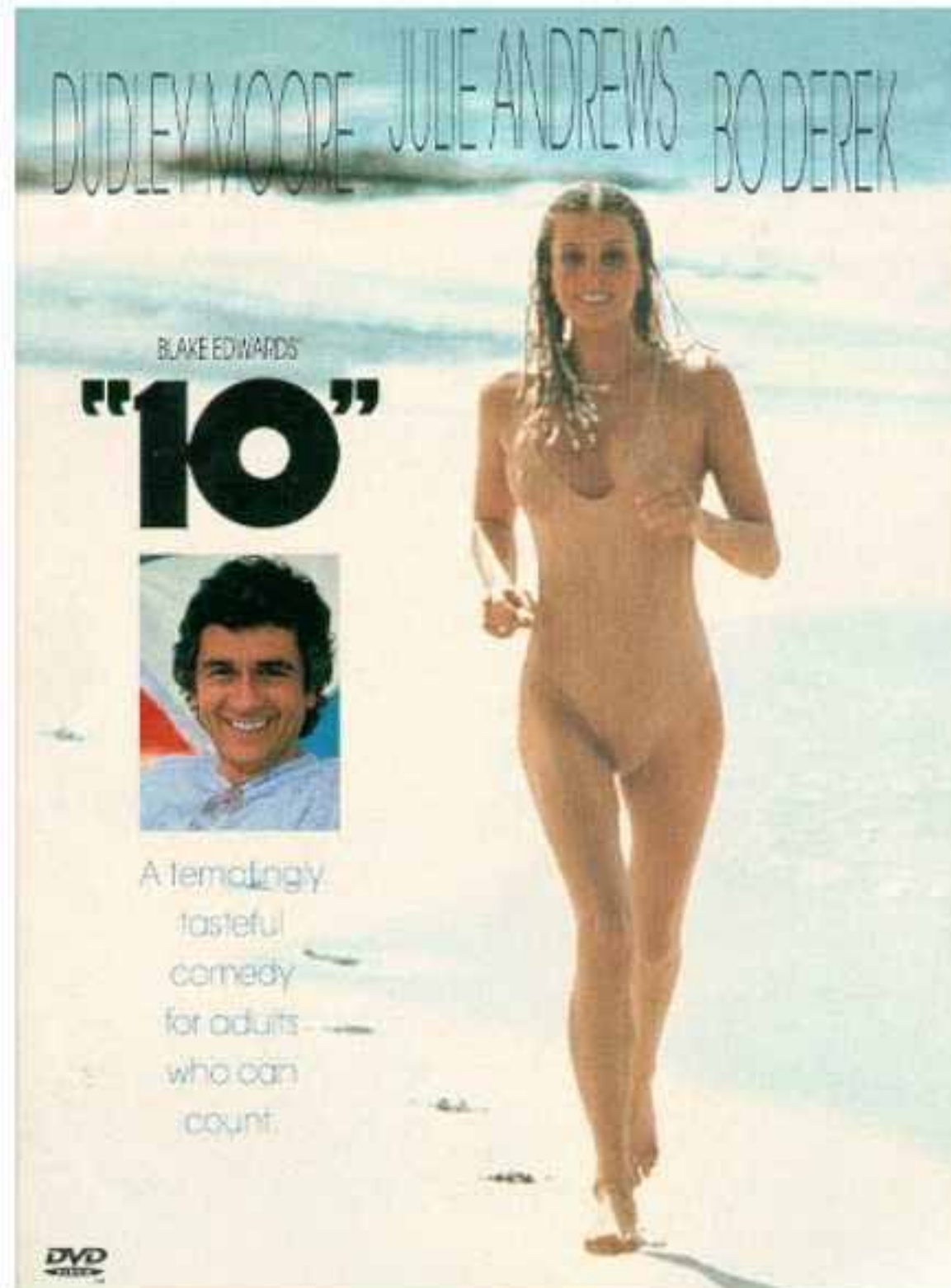
Musical 'chills' activate the same brain areas as sex and drugs

► Location of Major Limbic System Structures



Music and emotion

Are these the same or unique?



Music and emotion

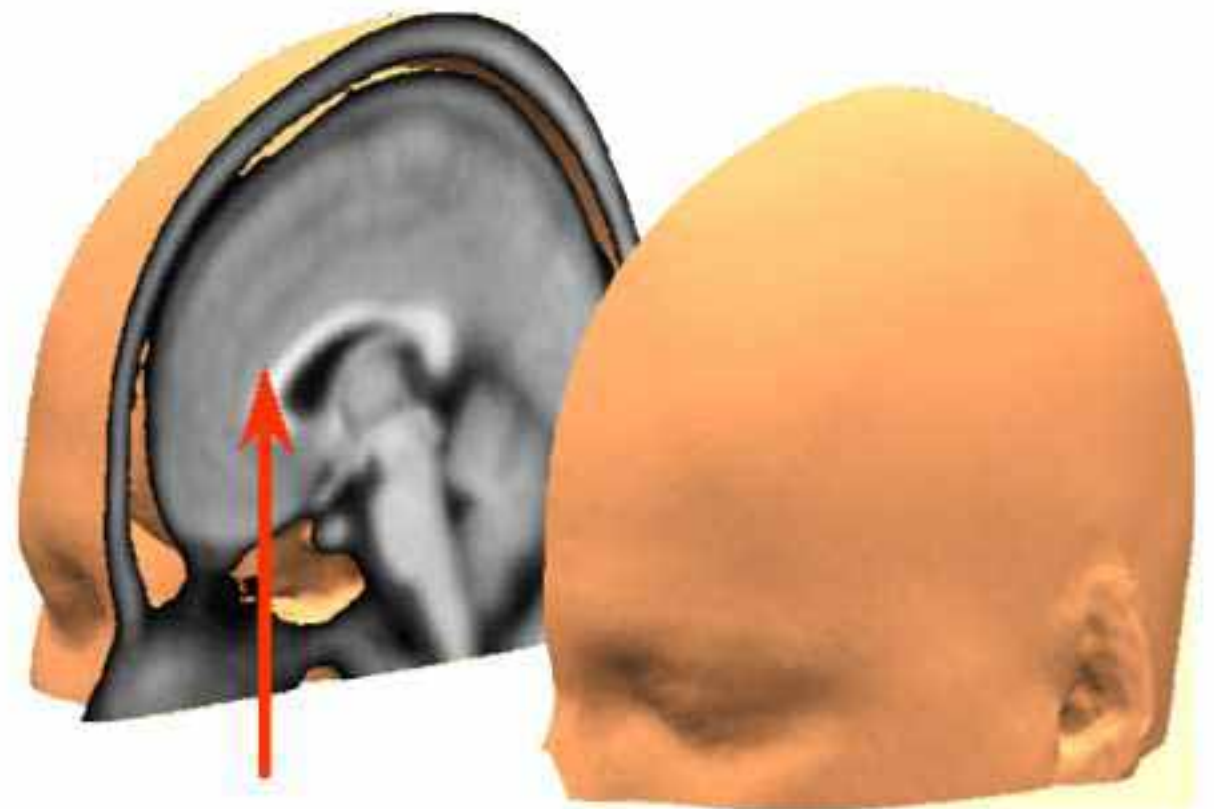
Musical dissonance activates negative emotion regions



Music and emotion

Musical dissonance activates negative emotion regions

Right brain hemisphere is involved in intense emotions



Congenital amusia

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

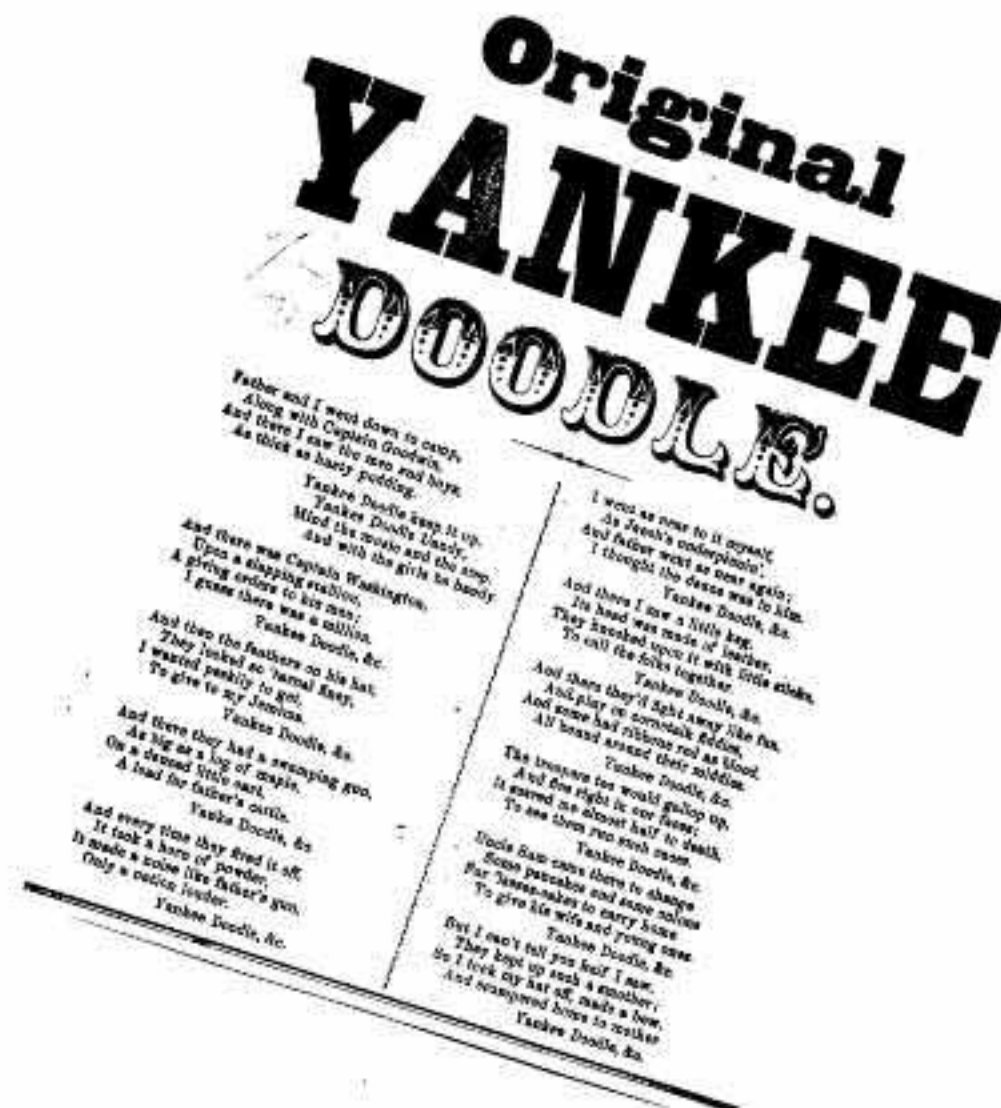
Congenital amusia

Famous tone deaf individuals



Ulysses
Grant

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



Congenital amusia

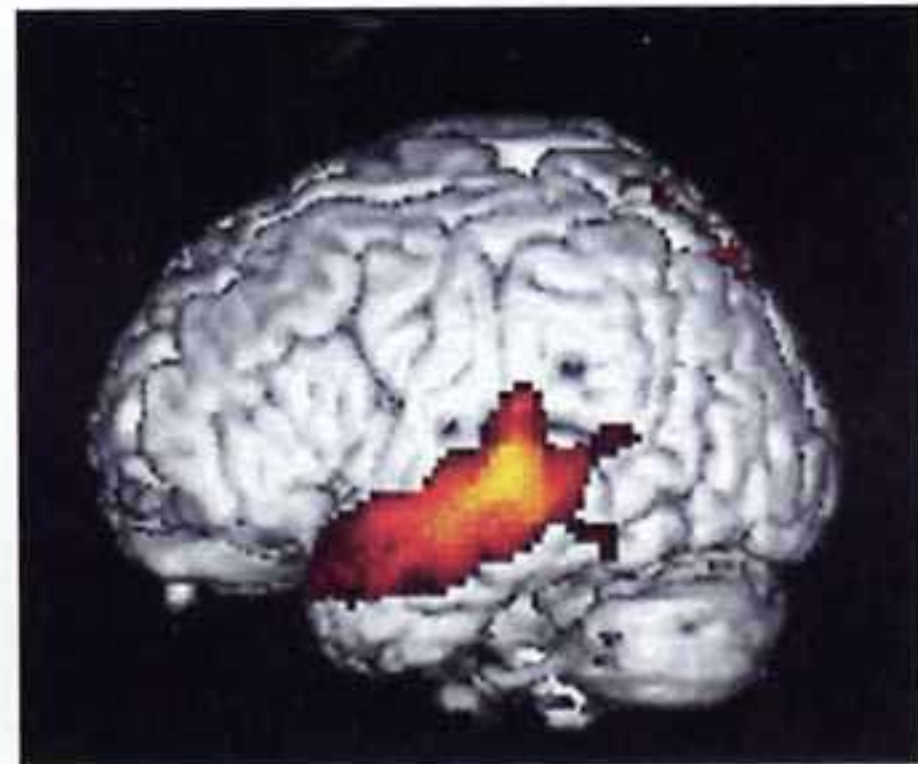
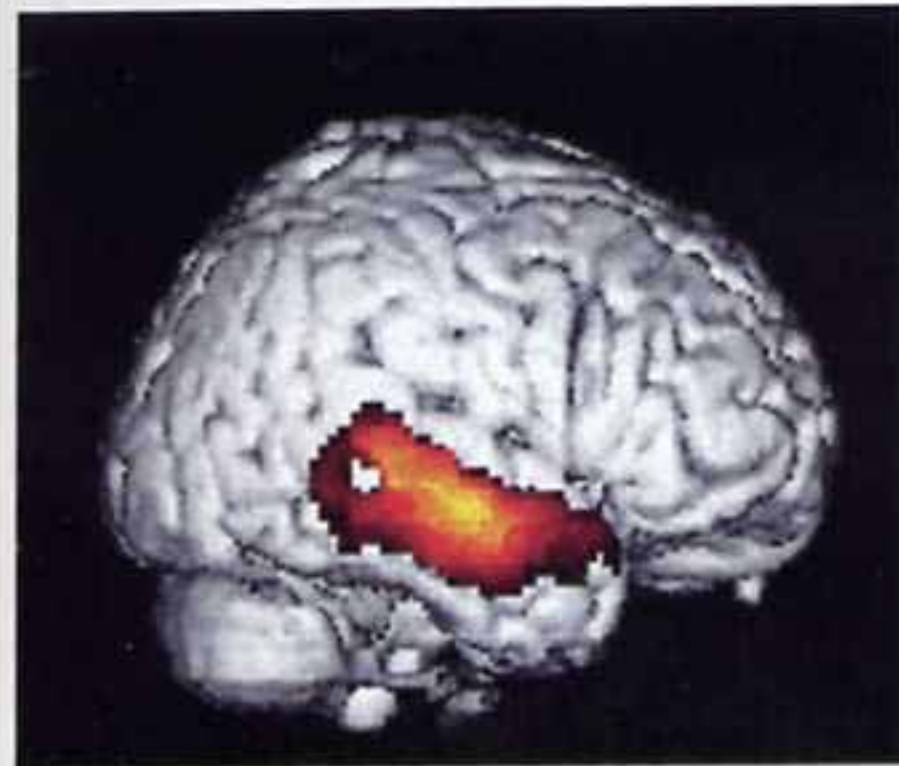
Congenital amusia is distinct from language problems



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

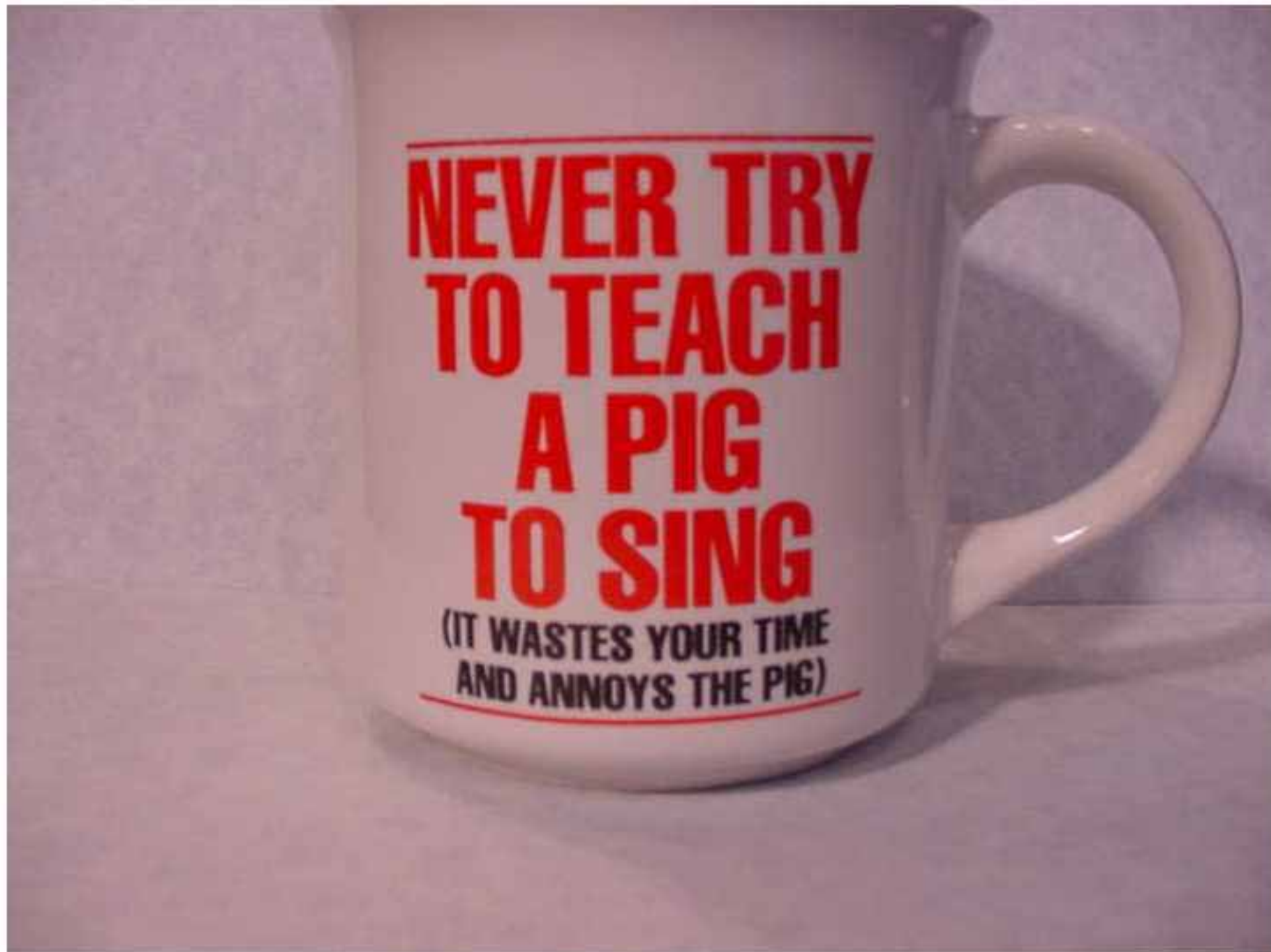
Amusia runs in families

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



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

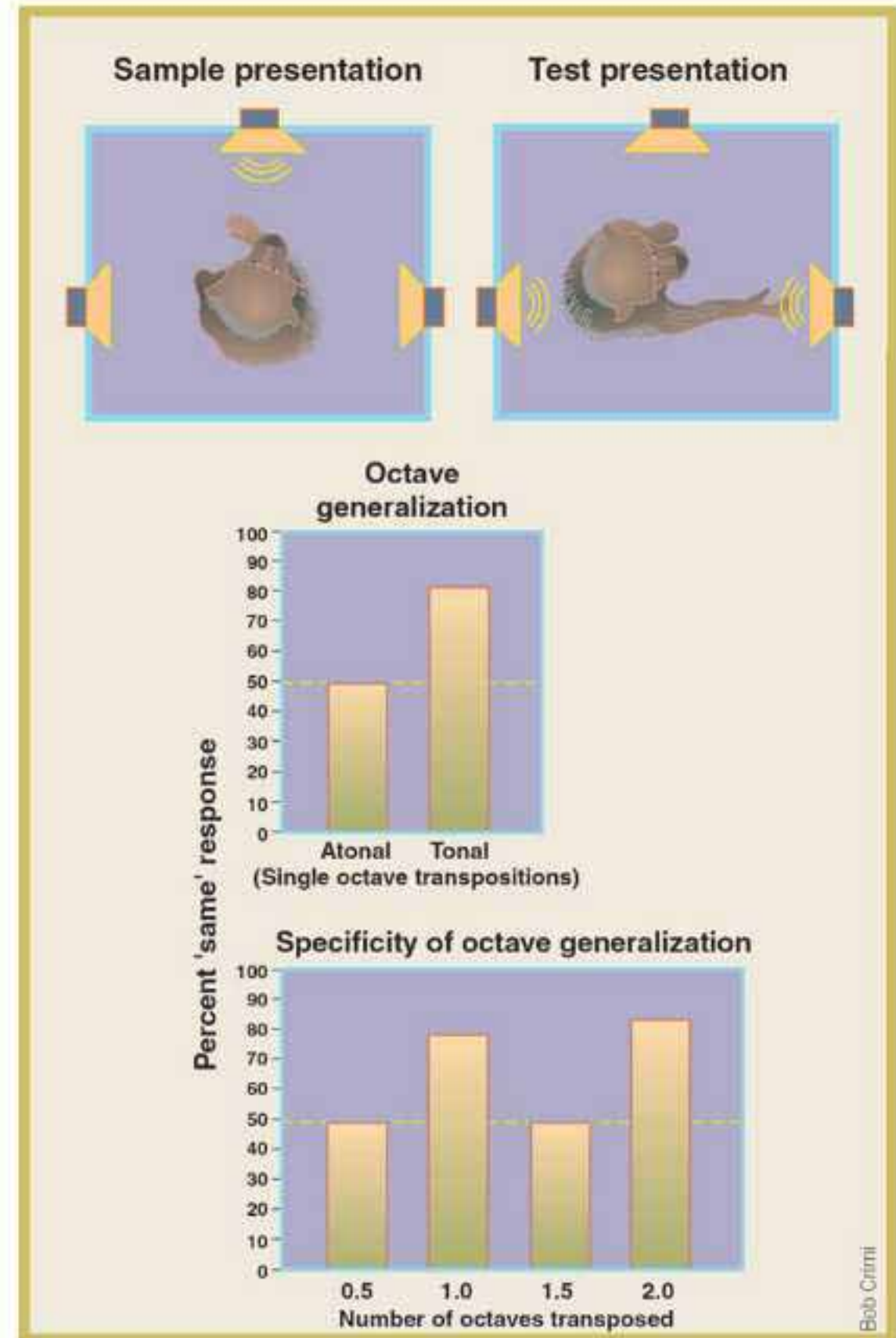
Perhaps generic brain design is optimised to respond to music



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?

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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

A classic case of wishful thinking and exploitation?

The origins of the Mozart effect

Rauscher et al 1993 Nature

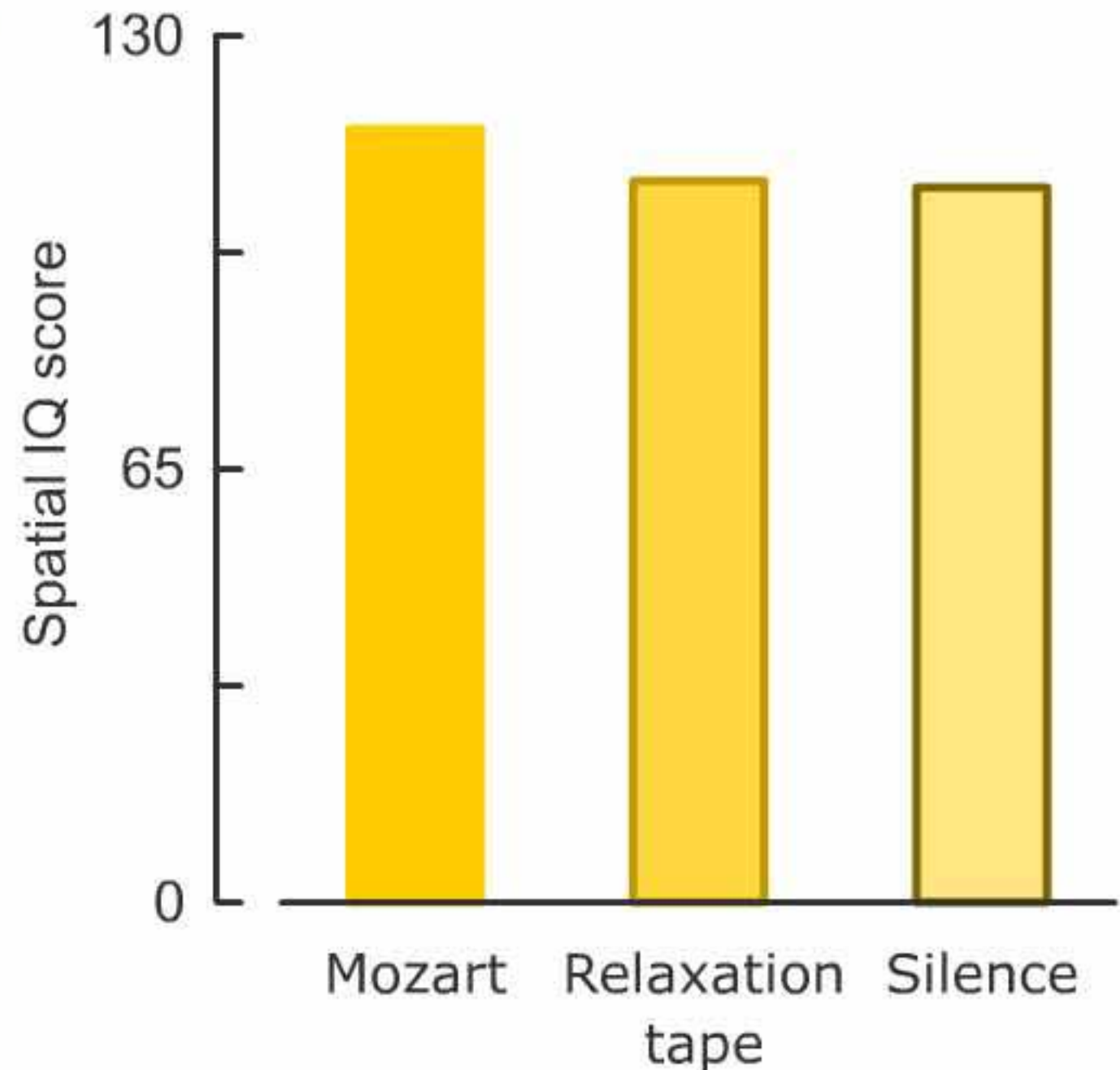


Mozart, music and memory

A classic case of wishful thinking and exploitation?

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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

The effect lasted only 15 minutes



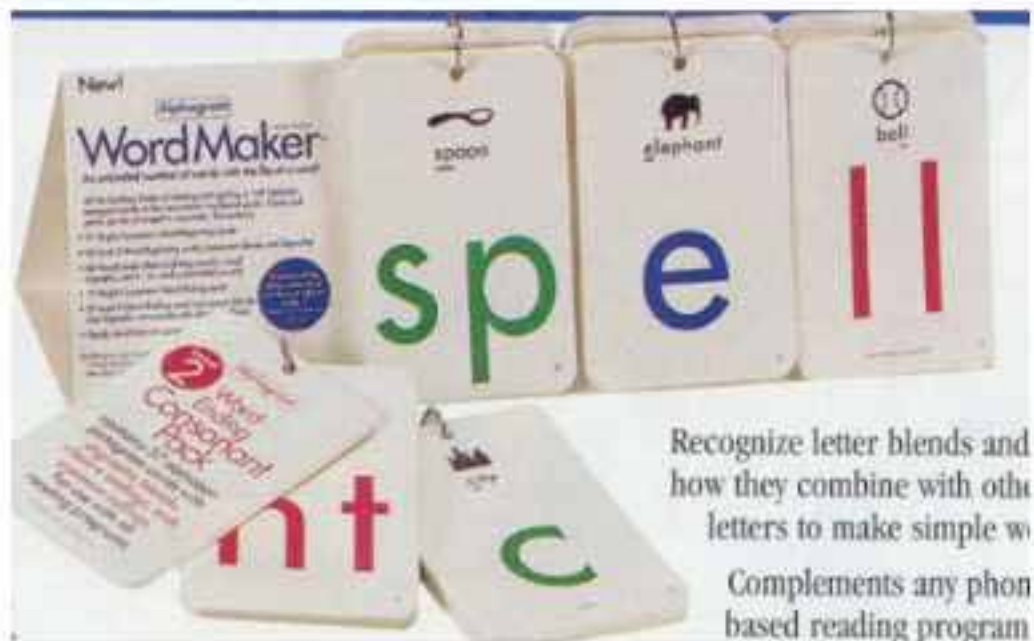
Mozart, music and memory

A classic case of wishful thinking and exploitation?

The origins of the Mozart effect
Rauscher et al 1993 Nature

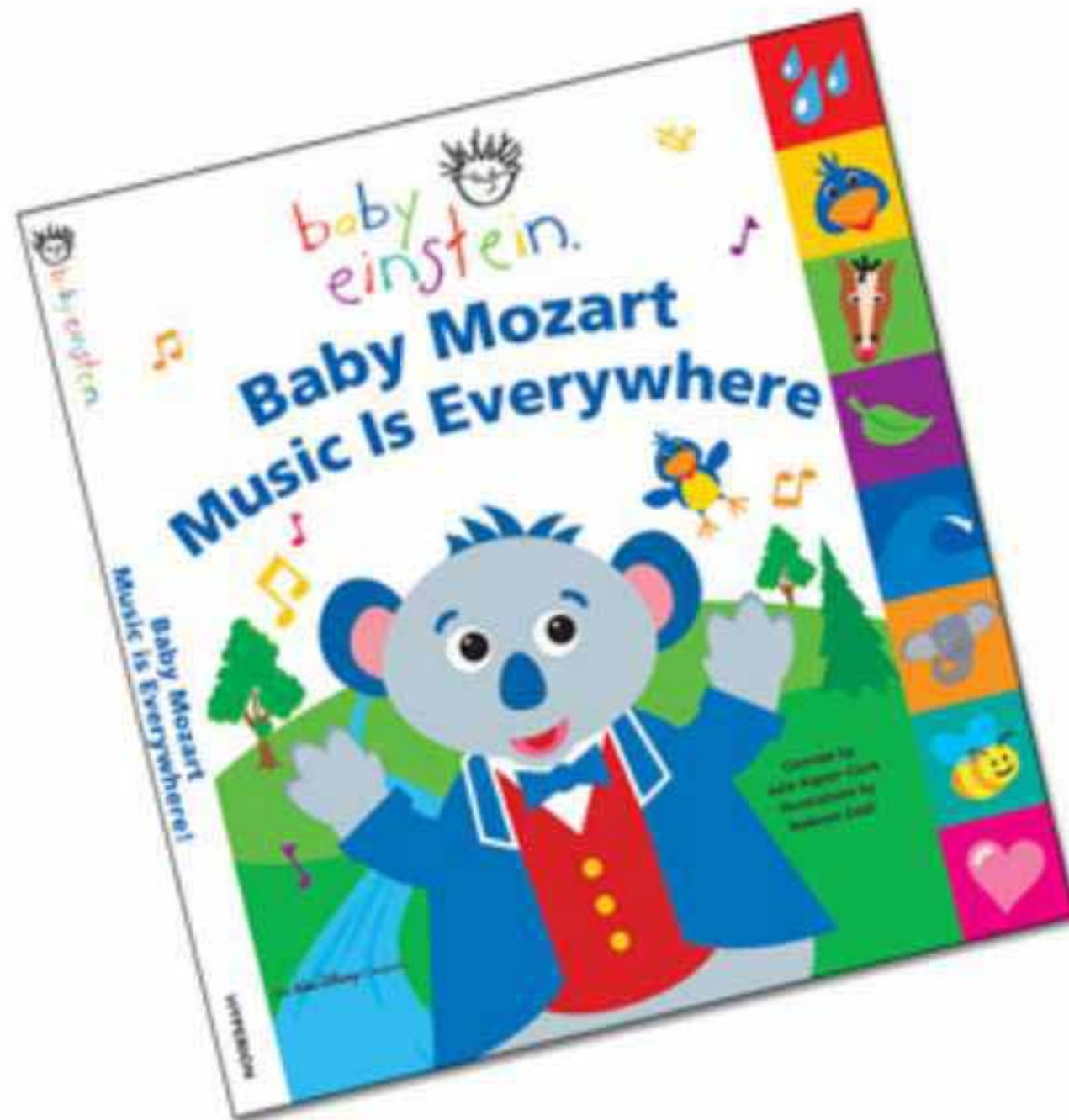
The effect lasted only 15 minutes

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

nature

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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*

* Department of Psychology, Appalachian State University, Boone, North Carolina 28608, USA

† Département de Psychologie, Université de Montréal, CP 6128, succ. centre-ville, Montréal, Québec H3C 3J7, Canada

‡ Department of Psychology, University of Western Ontario, Social Science Centre, London, Ontario N6A 5C2, Canada

[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



Mozart, music and memory

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

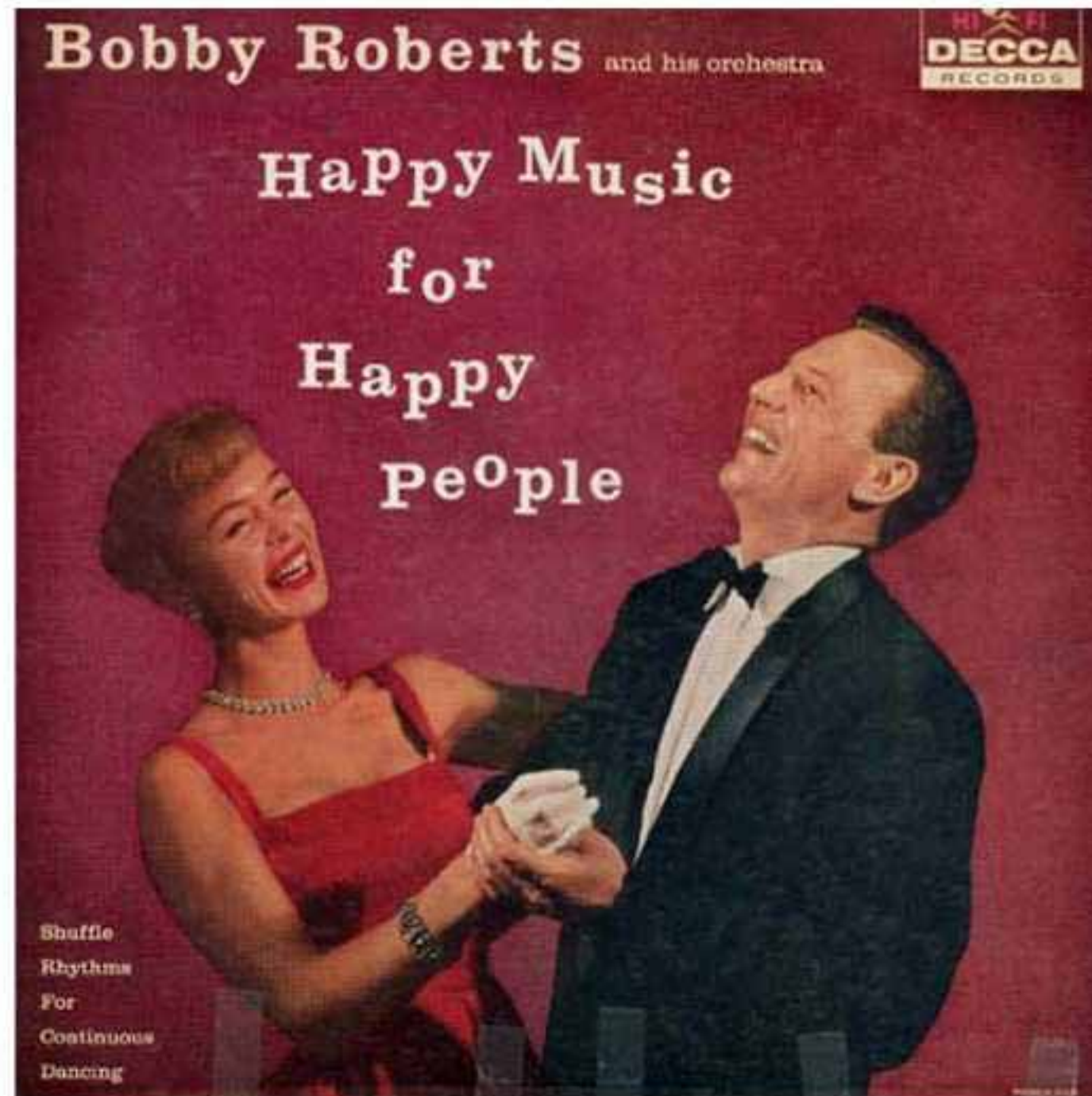
'Perhaps the cortex's response to music is the Rosetta Stone for the code or internal language of higher brain function'

Rauscher (1995)



Mozart, music and memory

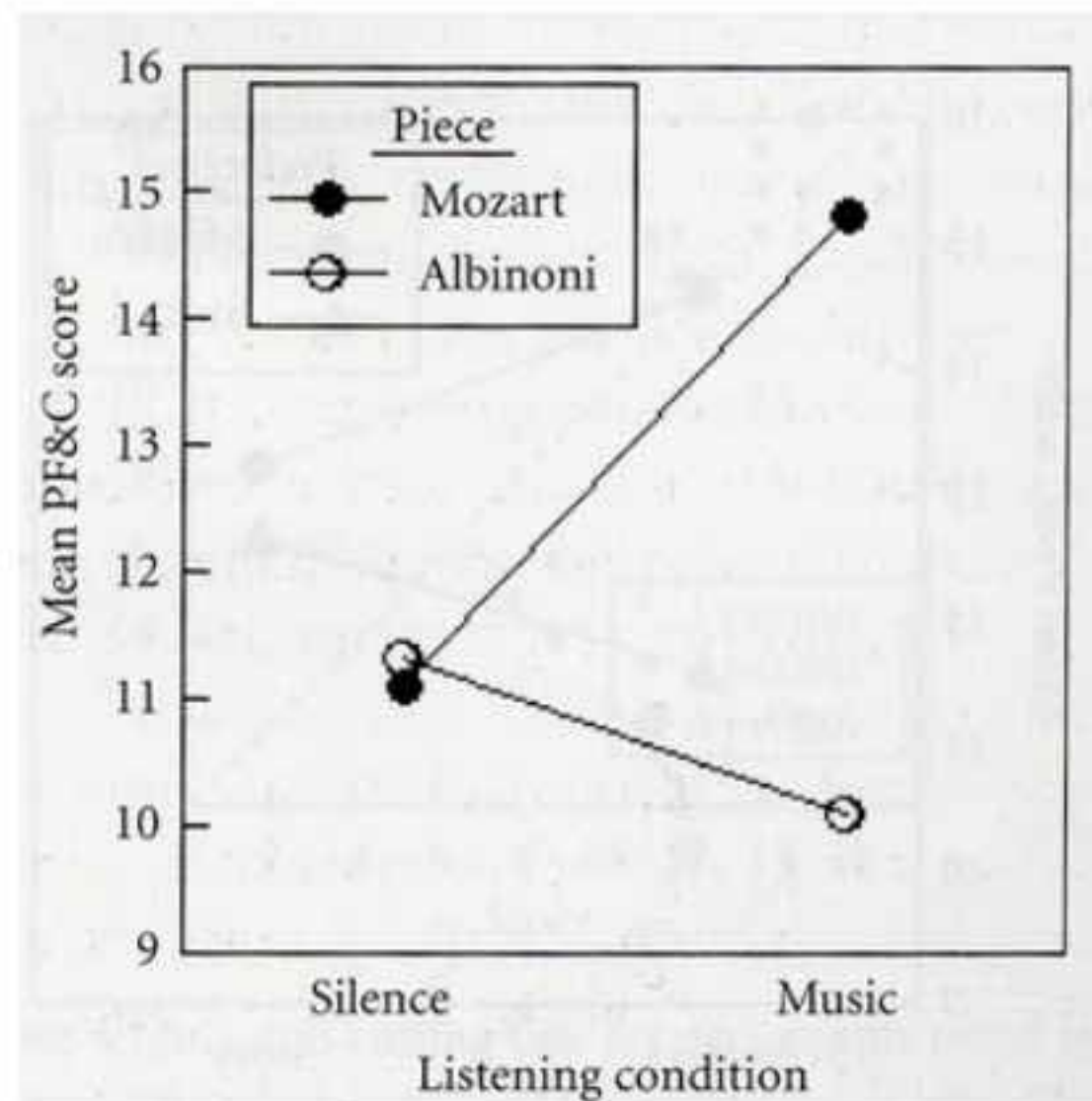
All positive mood music can work – from classical to pop



Mozart, music and memory

All positive mood music can work – from classical to pop

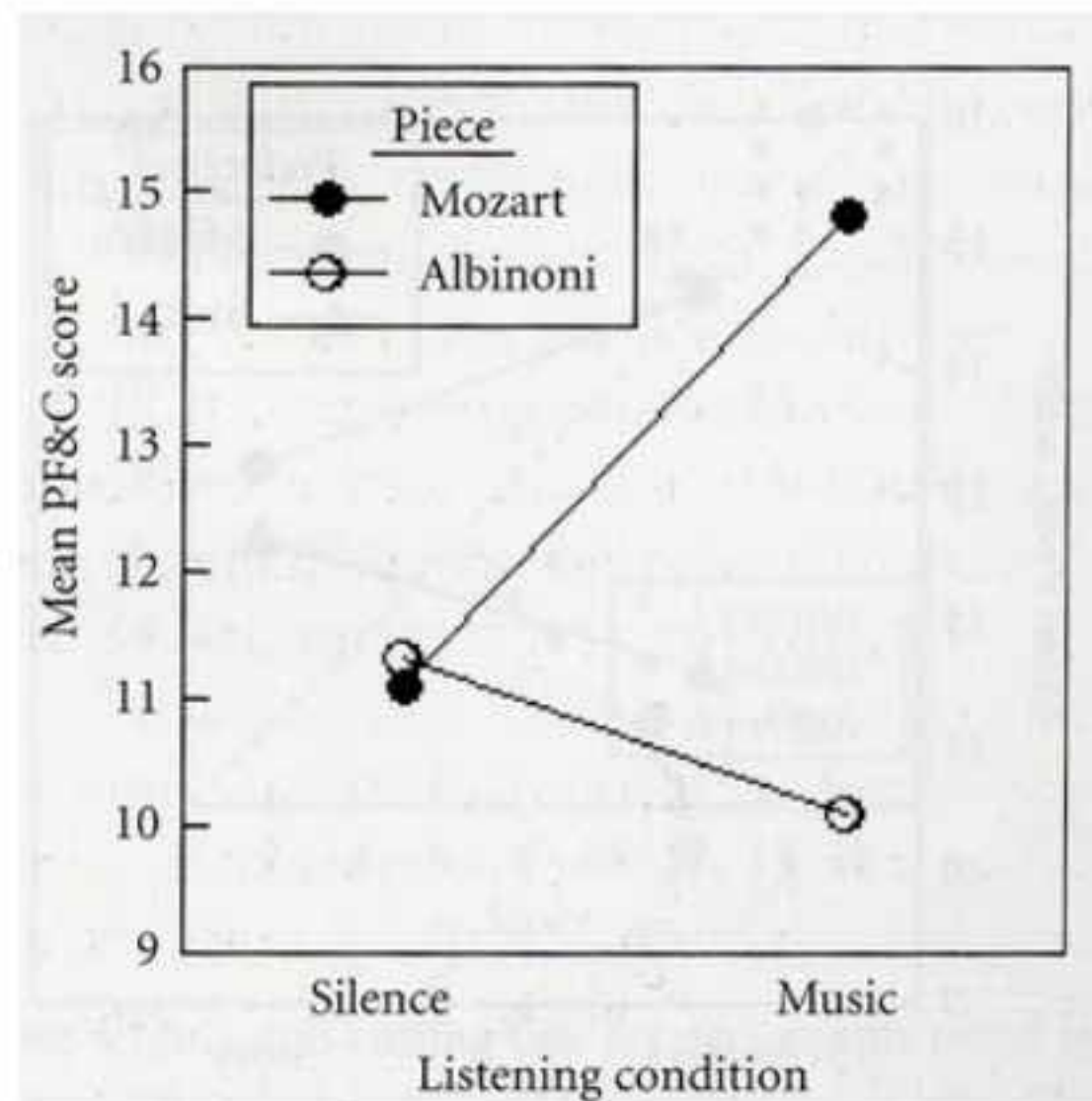
Sad music is not effective



Mozart, music and memory

All positive mood music can work – from classical to pop

Sad music is not effective

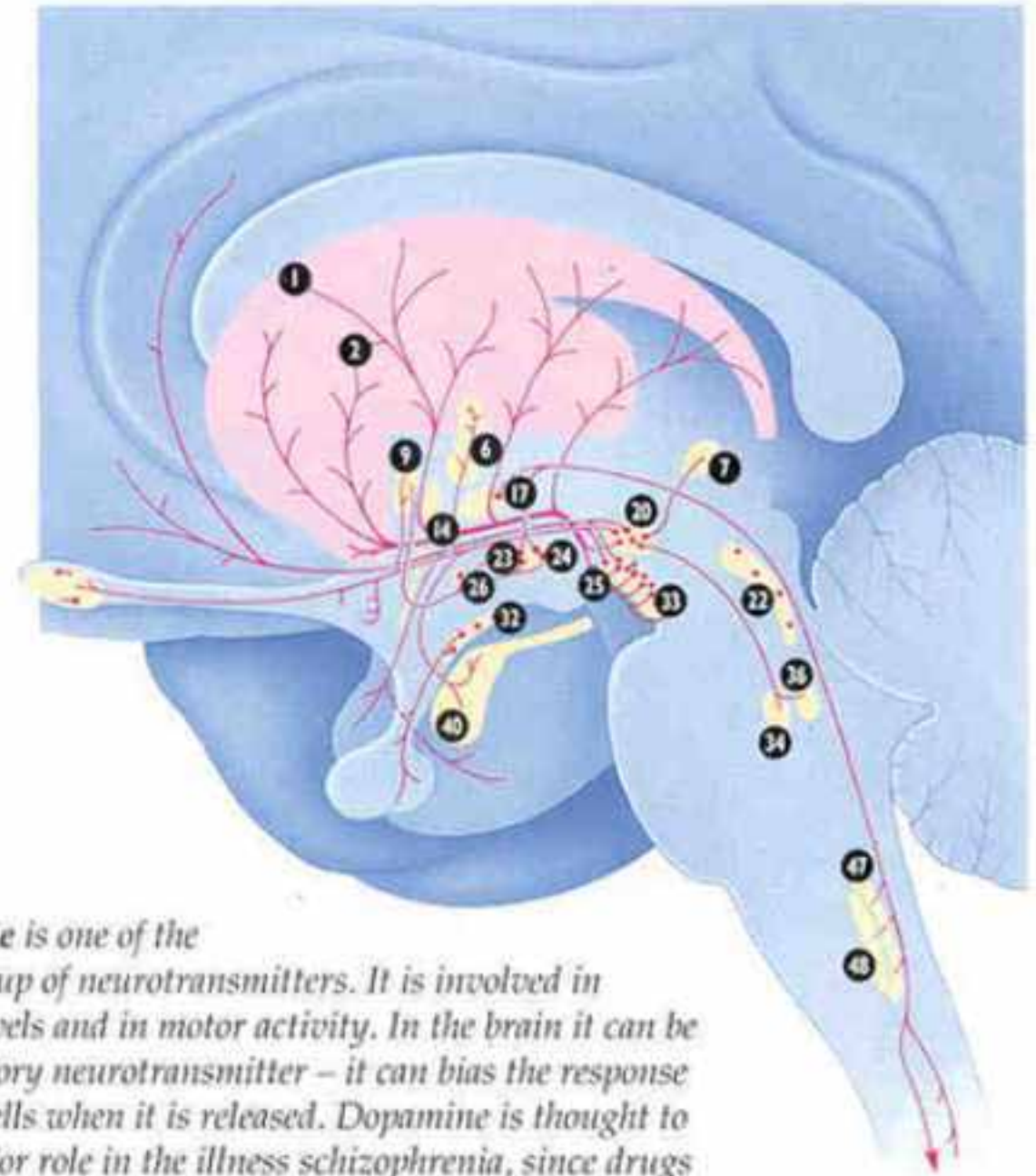


Mozart, music and memory

All positive mood music can work – from classical to pop

Sad music is not effective

Release of dopamine in the right brain hemisphere?



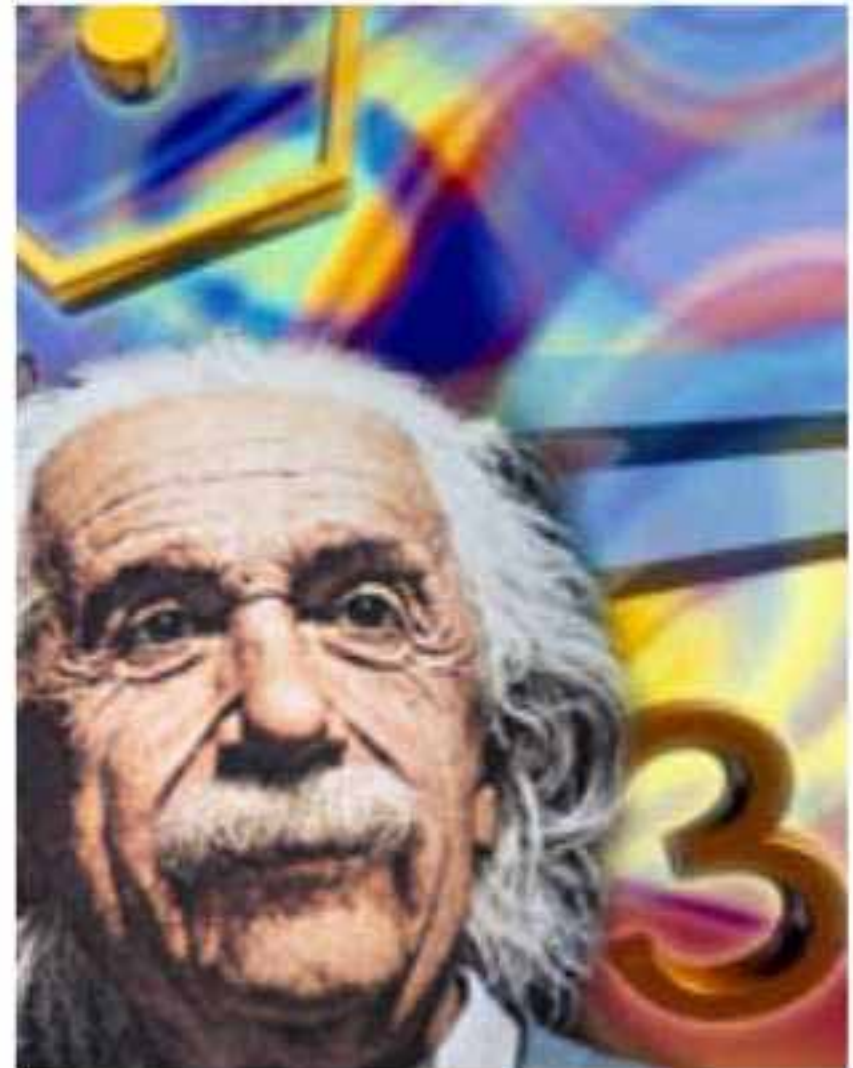
Dopamine is one of the amine group of neurotransmitters. It is involved in arousal levels and in motor activity. In the brain it can be a modulatory neurotransmitter – it can bias the response of nerve cells when it is released. Dopamine is thought to play a major role in the illness schizophrenia, since drugs that block the action of dopamine reduce the symptoms of the illness, and drugs that enhance its action can induce symptoms similar to those of schizophrenia.

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



The advantages of playing an instrument

Mathematical ability:

Children receiving singing instruction are better at mathematical reasoning



The advantages of playing an instrument

Mathematical ability:

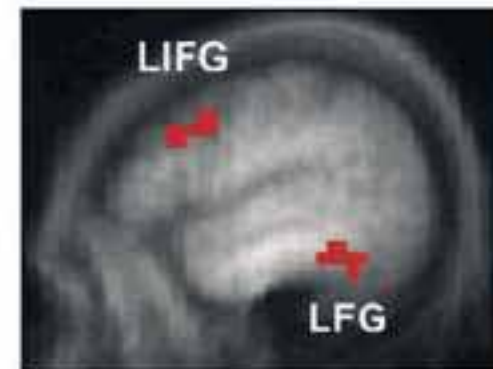
Children receiving singing instruction are better at mathematical reasoning

Music training is associated with altered brain activity during maths tasks

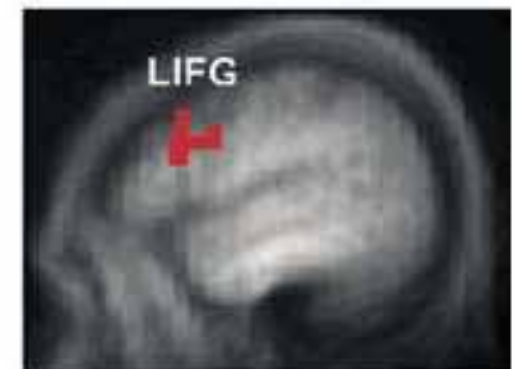
Schmithorst and Holland, 2004

X = -50

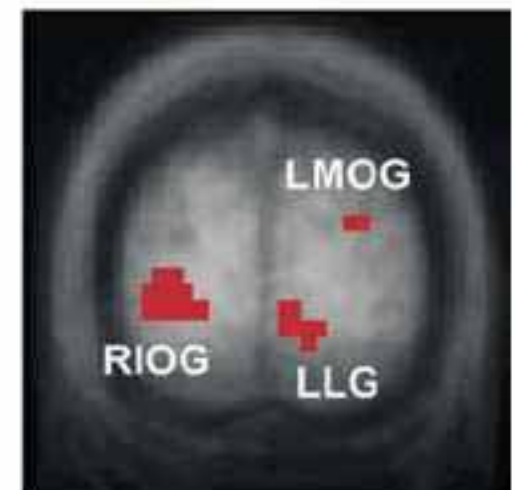
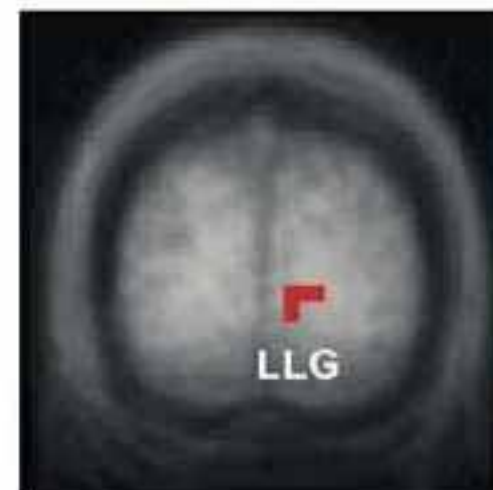
Musicians



Non-Musicians



Y = -83



The advantages of playing an instrument

Reading:



Should auld ac- quain- tance be for- got and ne- ver brought to mind? Should auld ac- quain- tance

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



Should auld ac- quain- tance be for- got and ne- ver brought to mind? Should auld ac- quain- tance

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

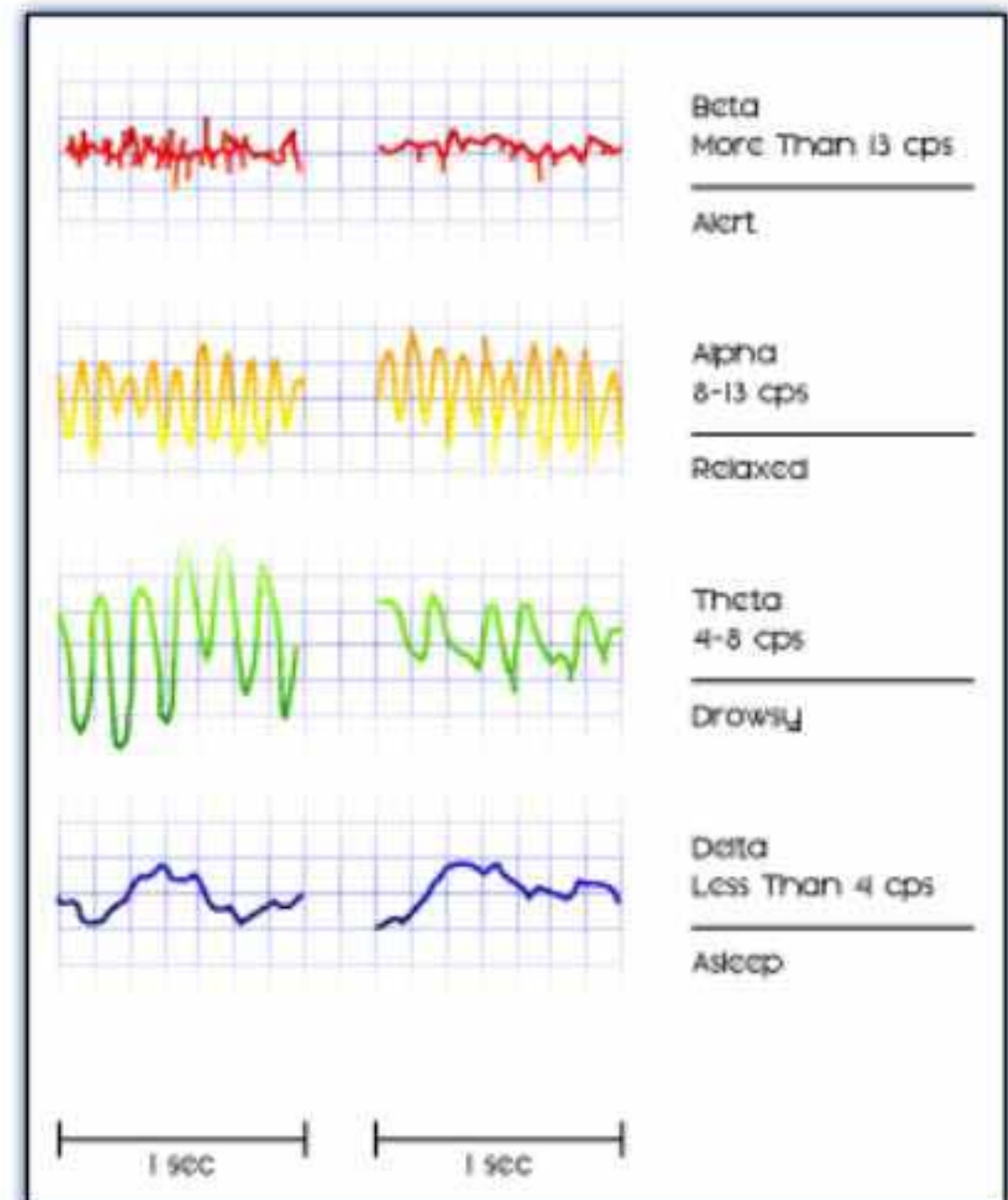


Should auld ac- quain- tance be for- got and ne- ver brought to mind? Should auld ac- quain- tance

Music, brain waves and gestalt processing

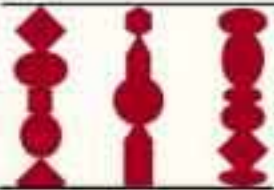







Very little work has been carried out on this

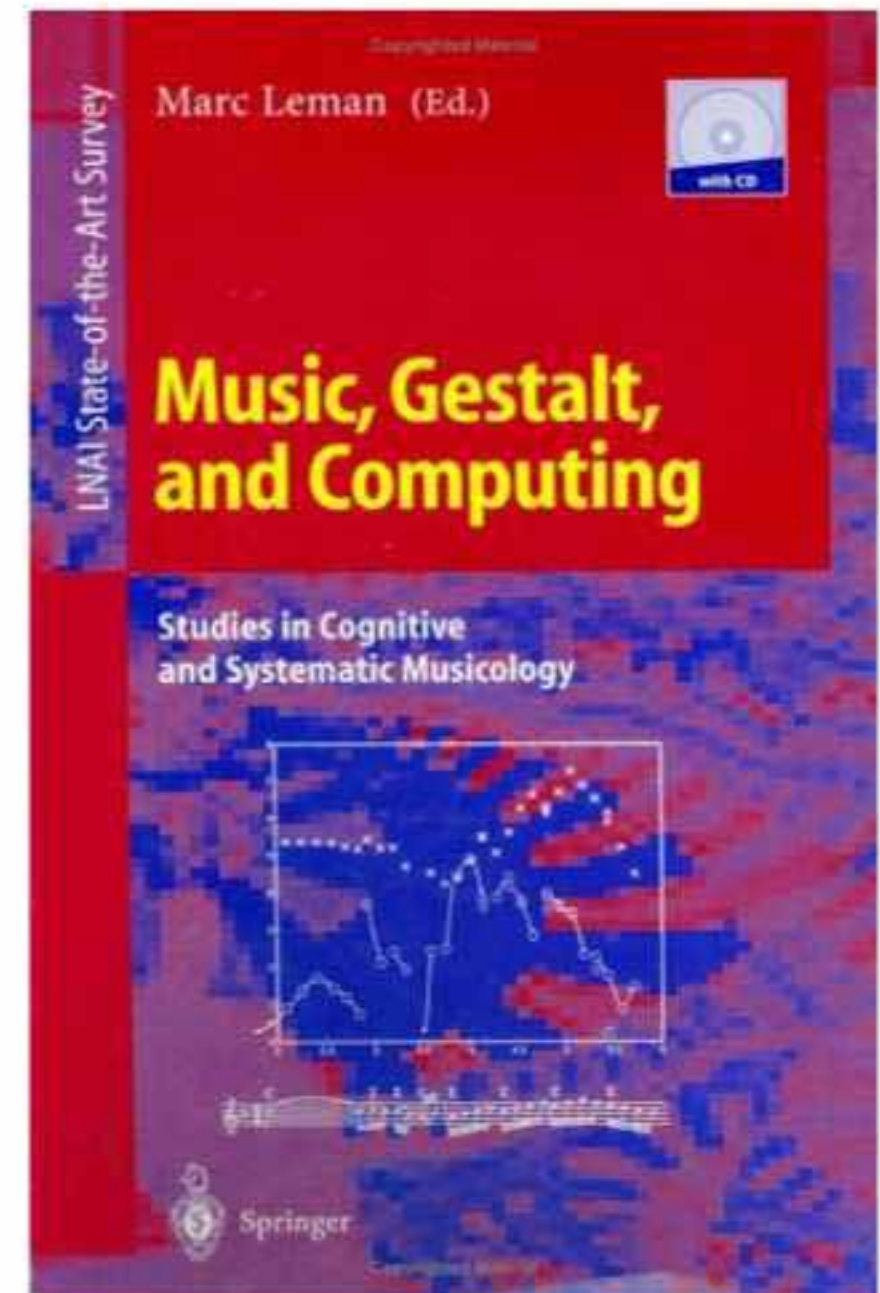
Arousing music increases frequencies and calming music decreases frequencies



Music, brain waves and gestalt processing

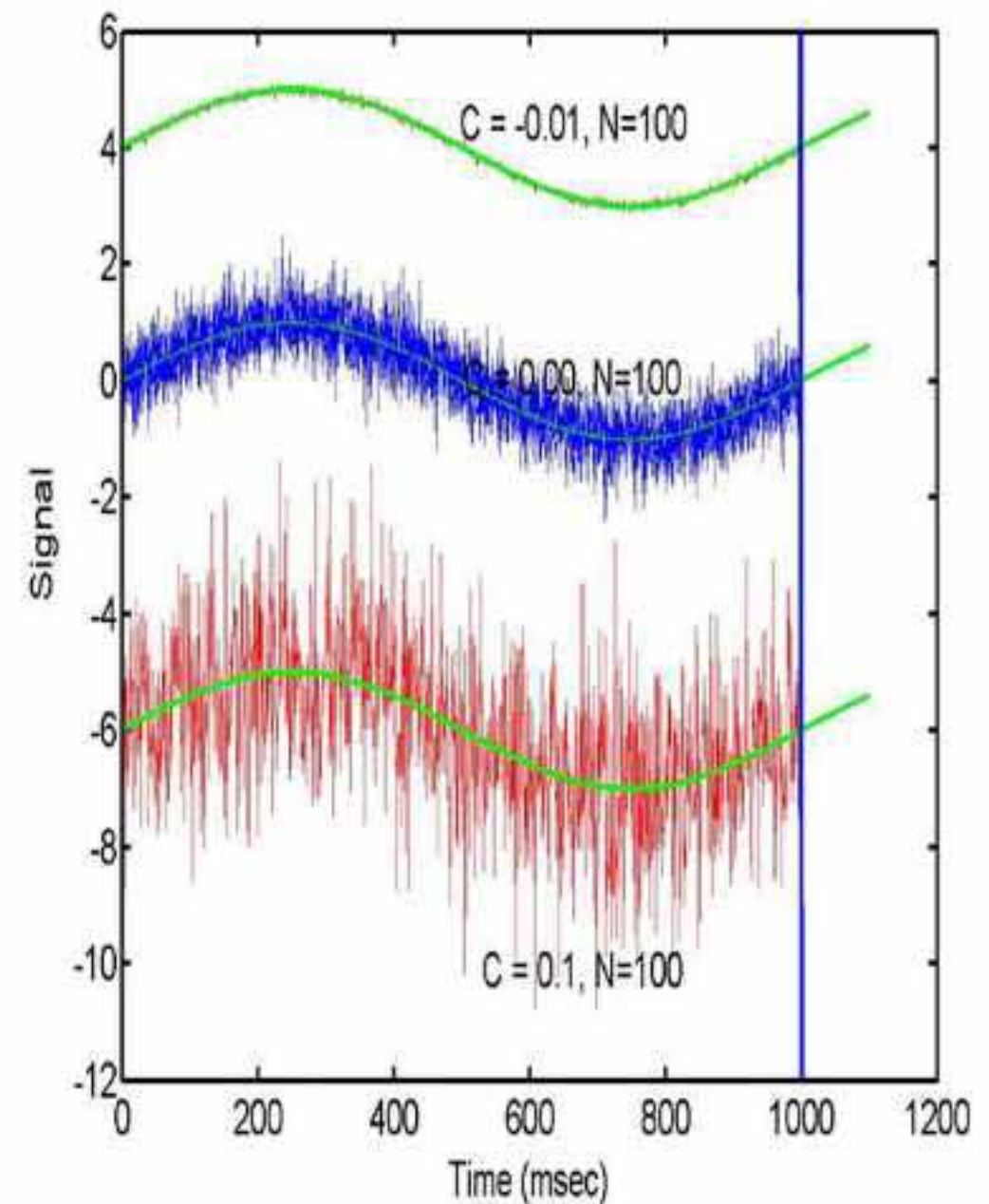
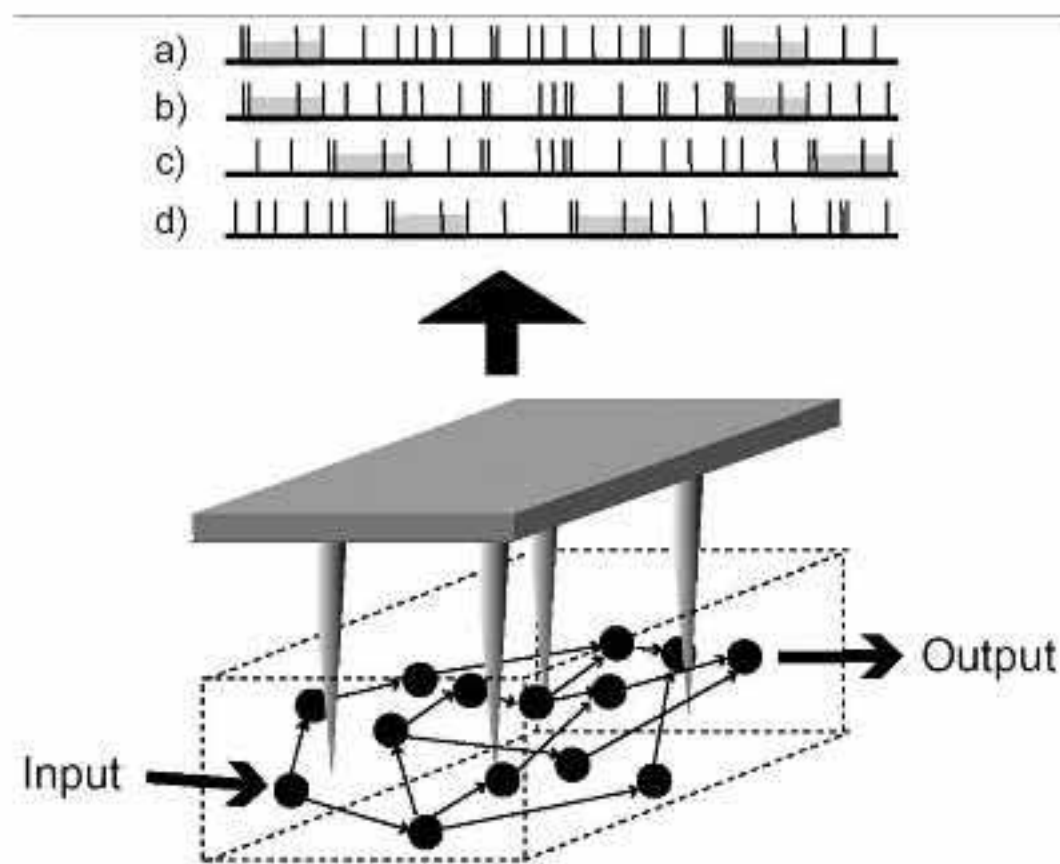
Music and the gestalt

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	<p>When you see this</p>  <p>do you see this?</p>  <p>plus this?</p>  <p>or this?</p> 
Closure: The tendency to see a finished unit	
Similarity: Similar objects are grouped together	



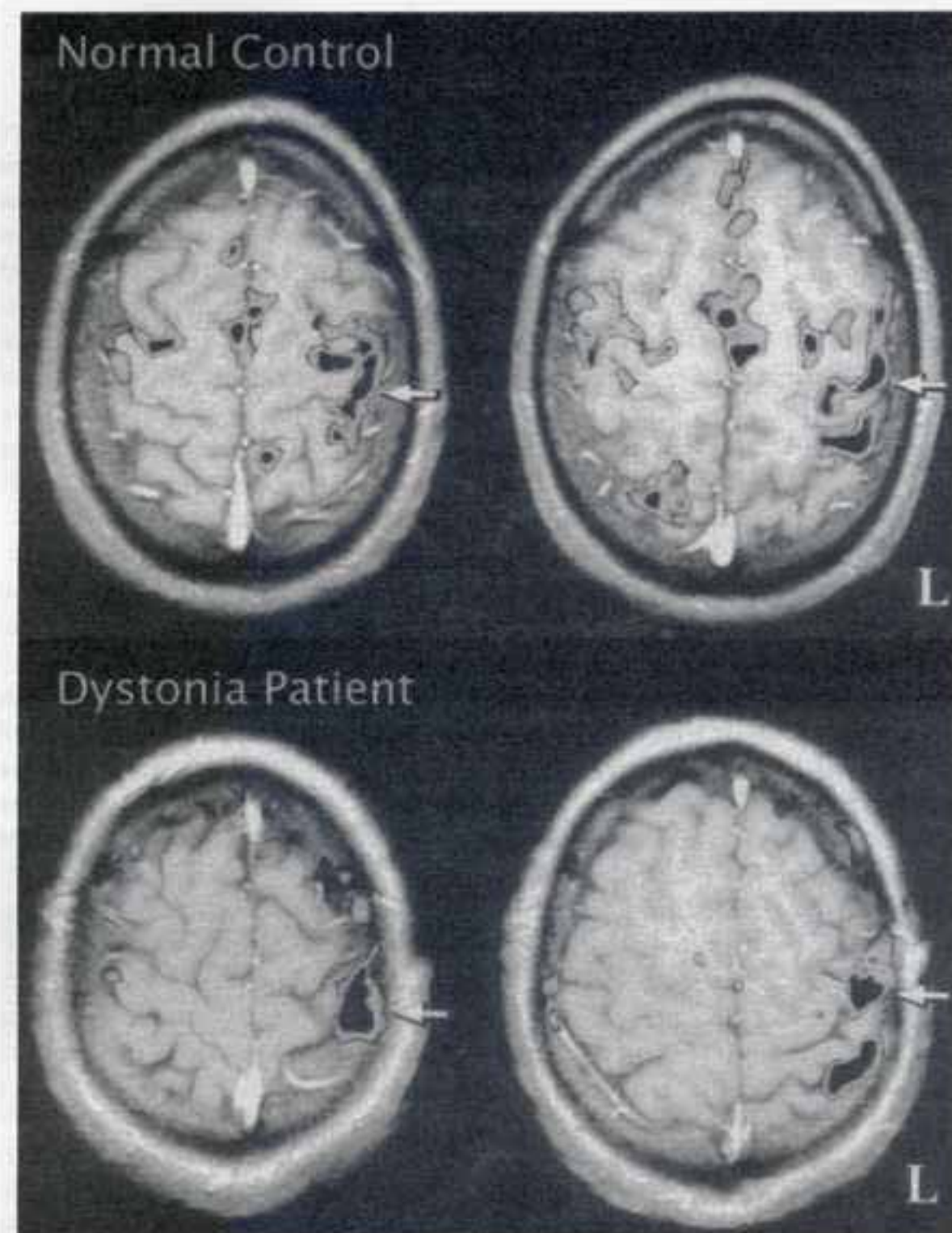
Music, brain waves and gestalt processing

Correlation shifts and pattern changes in global networks?



Do artists have special brains?

Changes in brain motor control centres

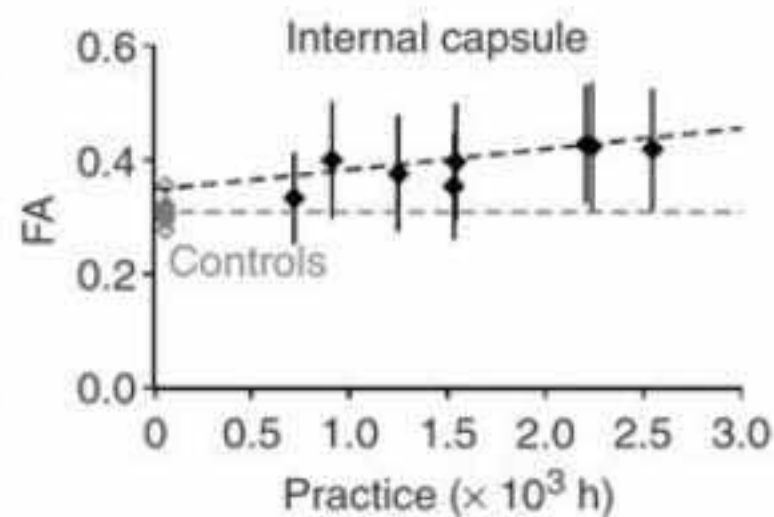
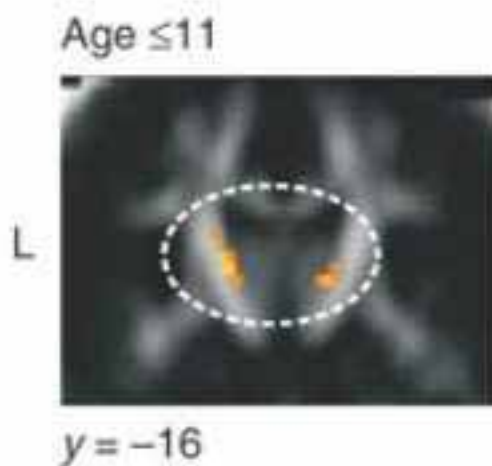


Do artists have special brains?

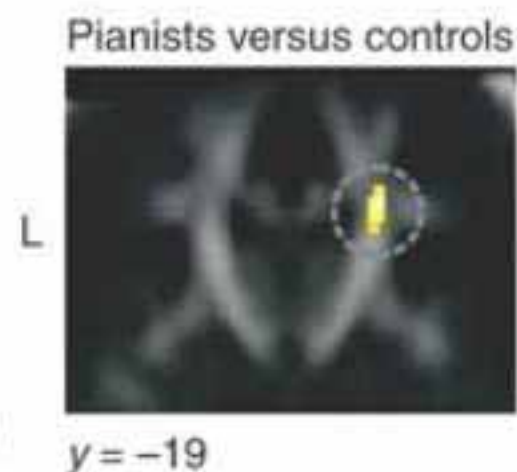
Changes in brain motor control centres

Better communication within and between brain hemispheres

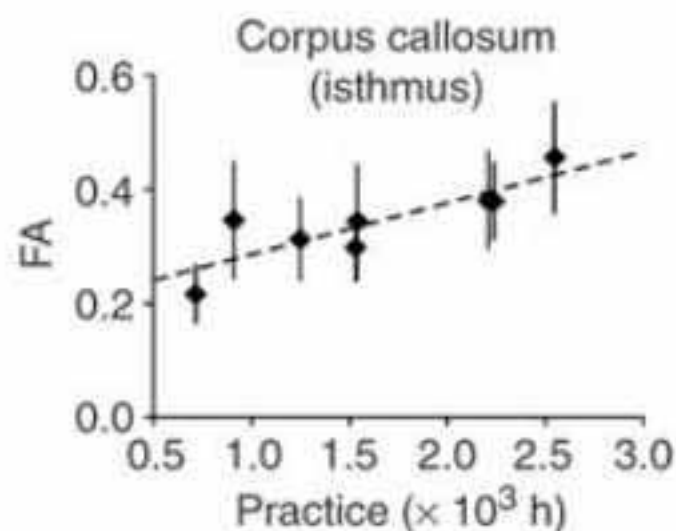
a



b



c



Bengtsson *et al*
Nature Neuroscience 2005

Do artists have special brains?

Changes in brain motor control centres

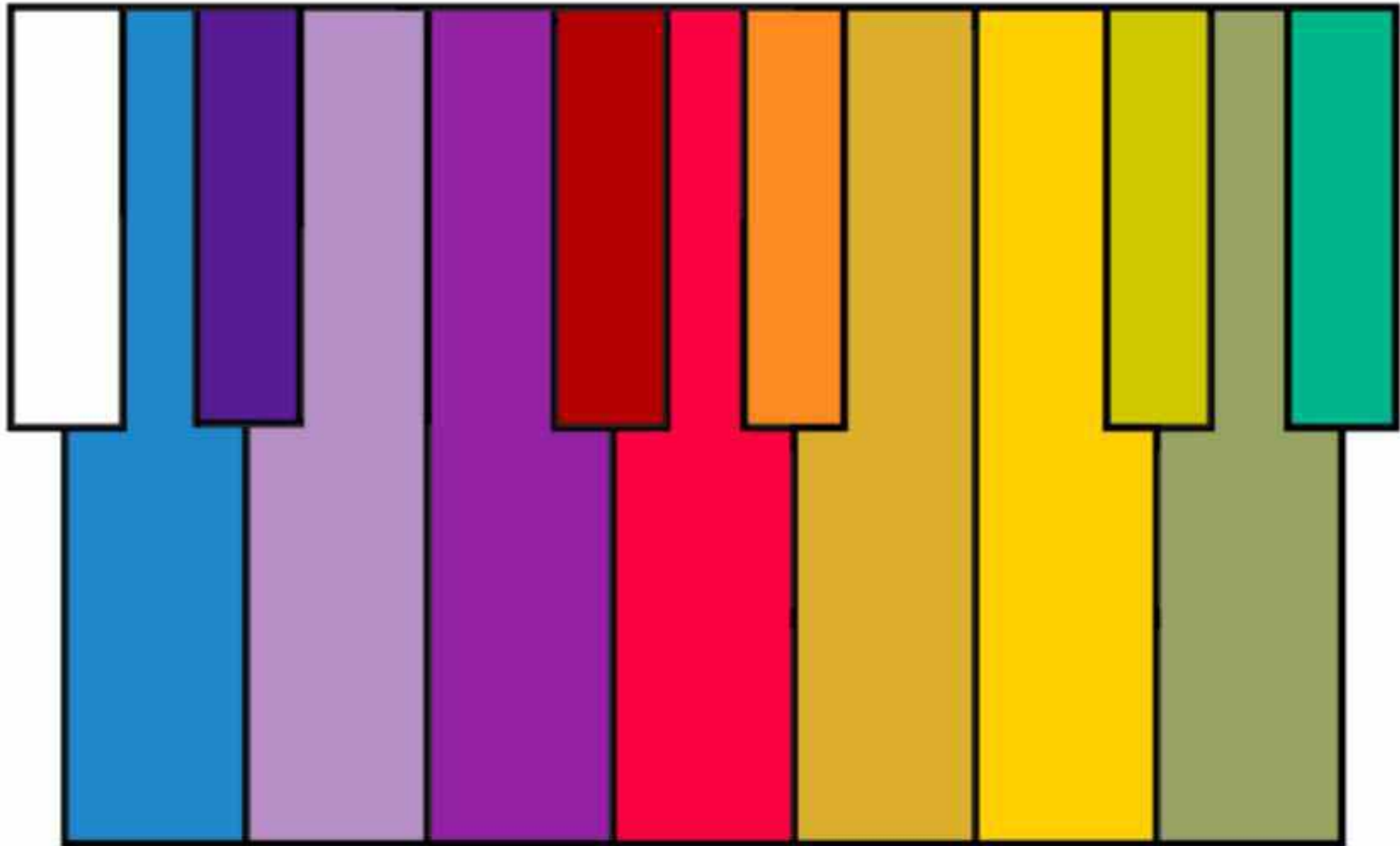
Better communication within and between brain hemispheres

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."



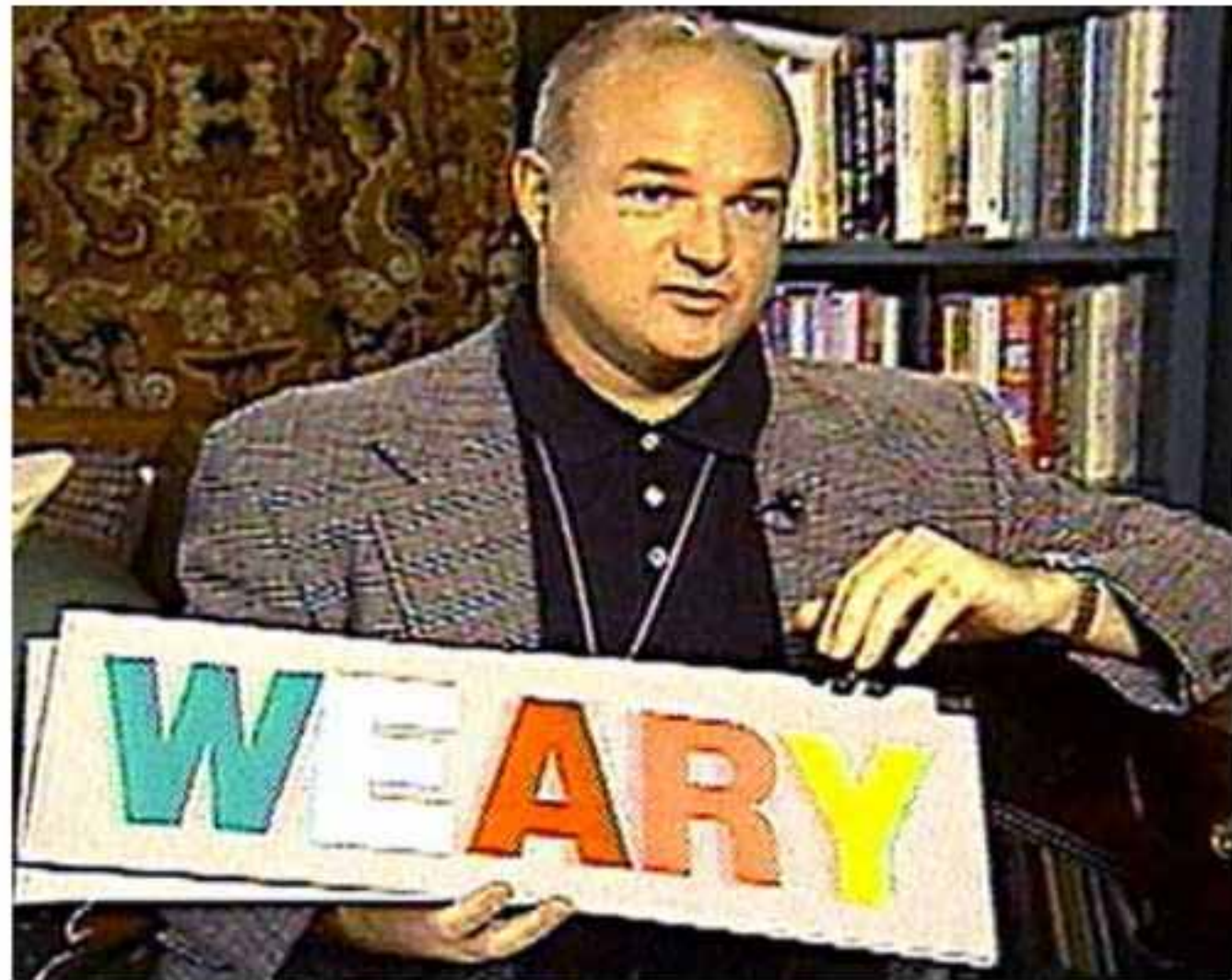
A B C D E F G H I
J K L M N O P Q R
S T U V W X Y Z

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

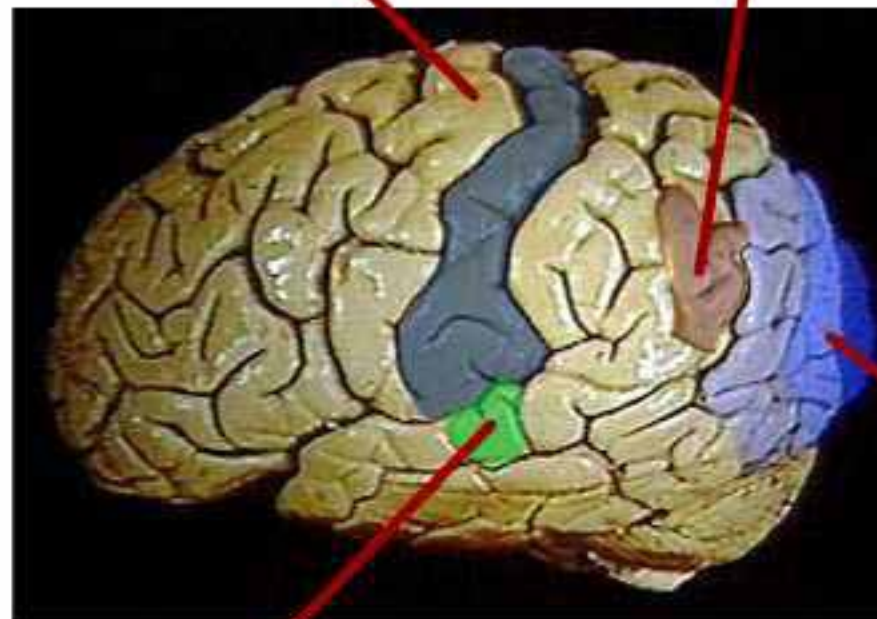
Do artists have special brains?

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

...and finally

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

...and finally

Poets have greater pulling power

Artists may use their right hemisphere more

But both sides get in on the act

...and finally

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!

