

THE BEAUTY AND THE BRAIN

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BRAIN²

Why beauty and not art ?

What is art ?

“You can't say something is art or not art anymore. That's all finished... Warhol made it no longer possible to distinguish something that is art from something that is not” (Arthur Danto, *After the End of Art*, 1997)

“The connection between art and aesthetics is a matter of historical contingency, and not part of the essence of art” (Arthur Danto, *After the End of Art*, 1997)



Andy Warhol, Brillo(1964)

Oldest painting



32.000 years old
Chauvet cave in Ardeche

Oldest written language



SUMERIA
3,200 B.C



EGYPT
3,200 - 3,000 B.C



INDUS VALLEY
2,500 B.C.



CHINA
1,500 - 1,200 B.C

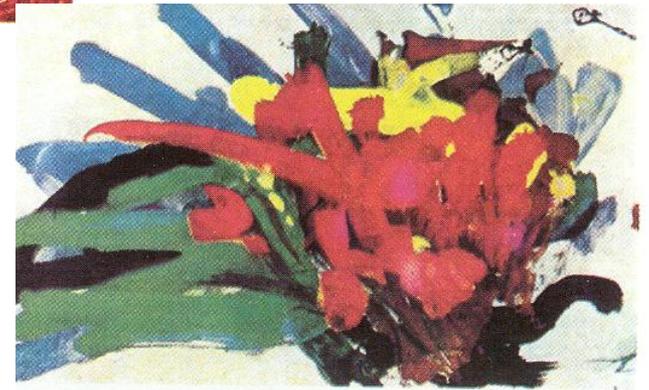
Graphic art predates written language

Art is oldest form of graphical information communication (Humphrey 1998, Mithen 1999)

Is art uniquely human ?



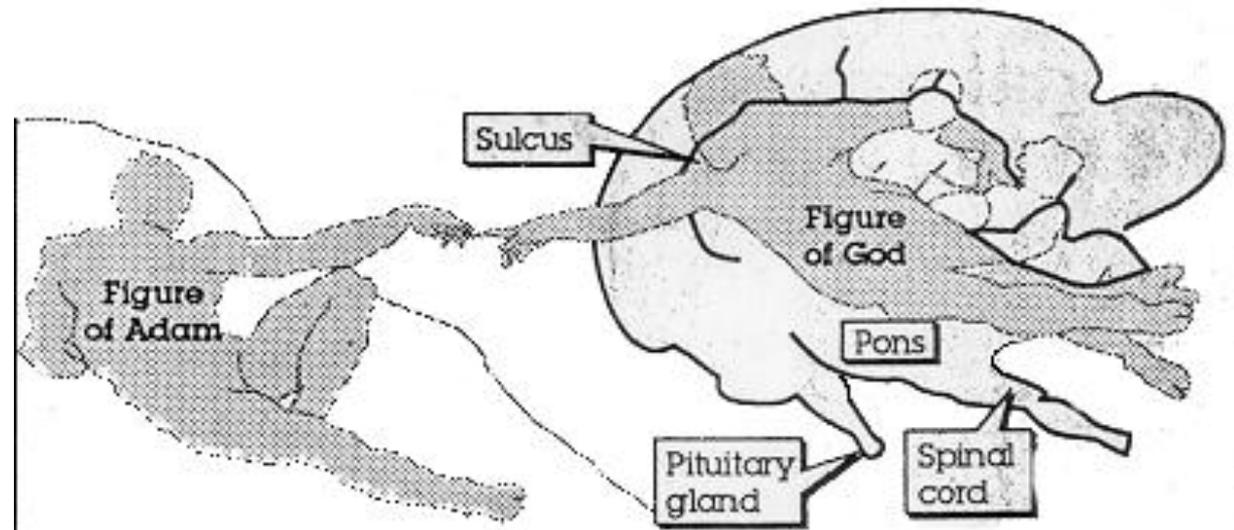
Chimpanzee art
(Desmond Morris 1962)



Chimpansees can create art but cannot write

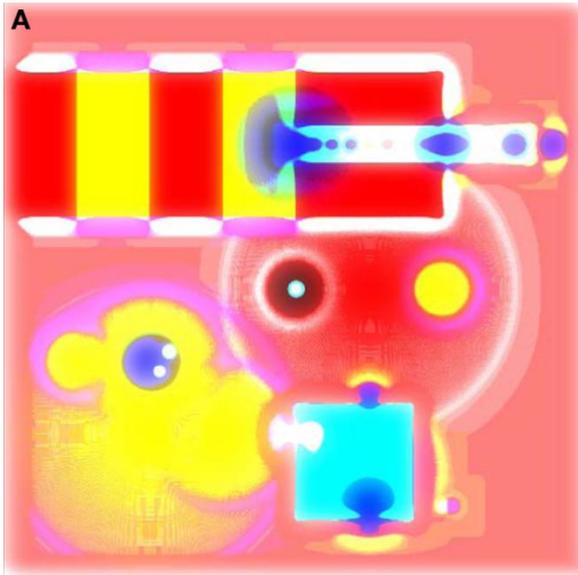
A man paints
with his brains
and not
with his hands

(Michelangelo)

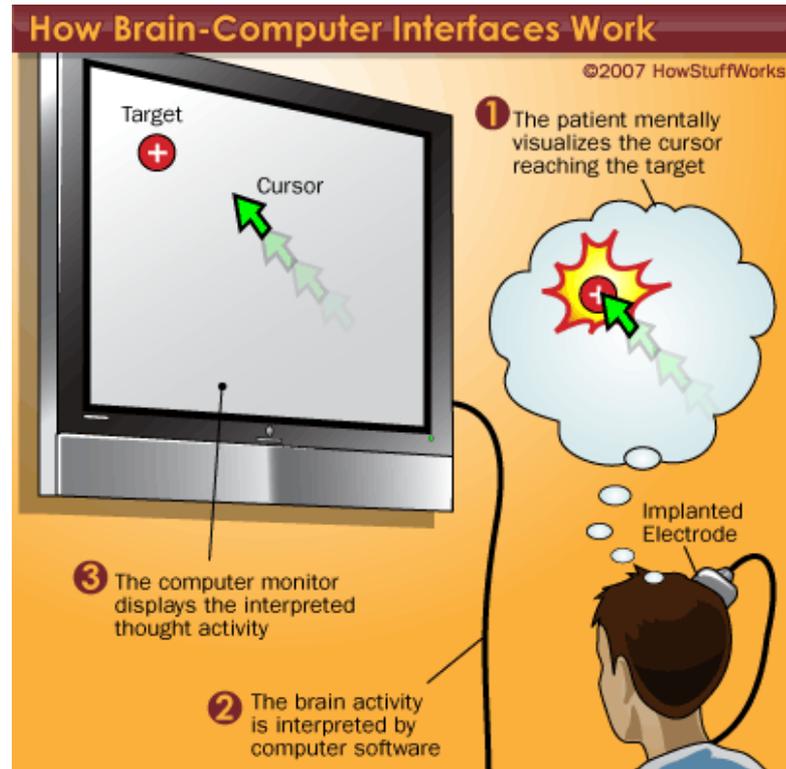


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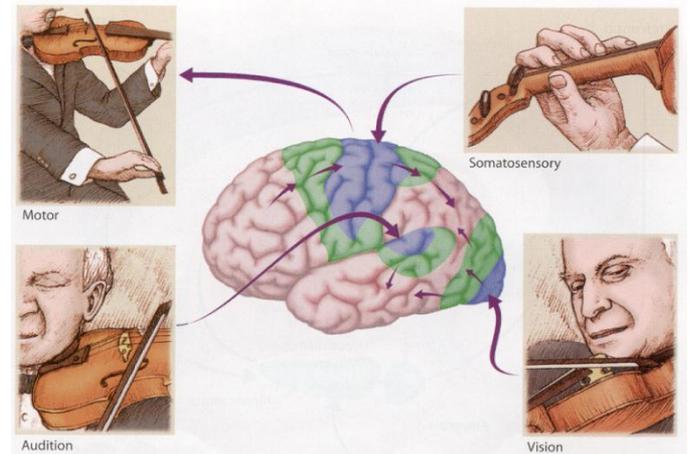
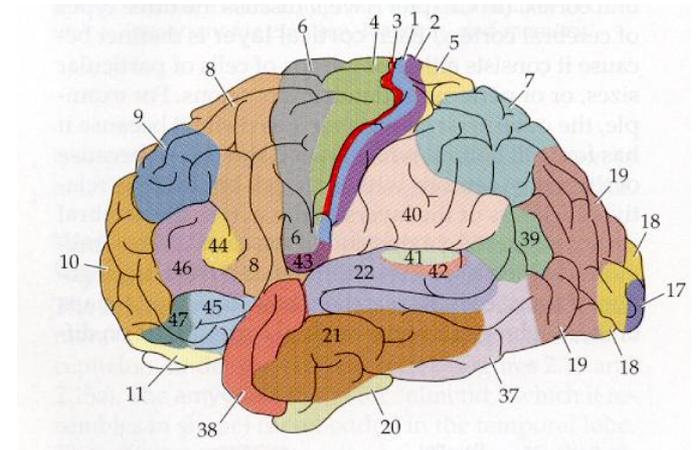
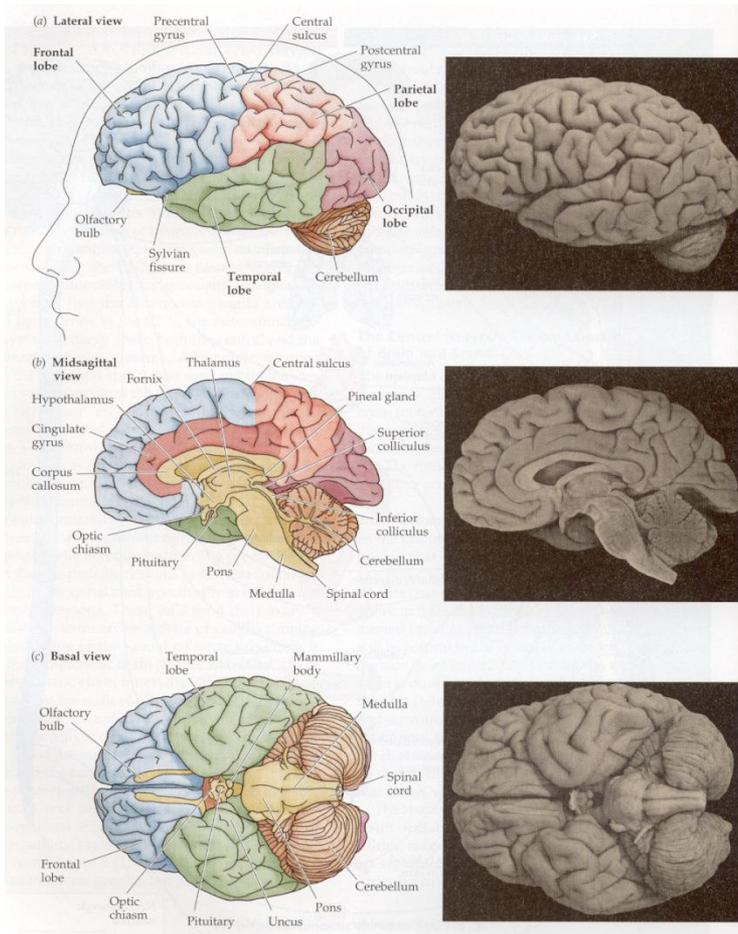
Munssinger 2010



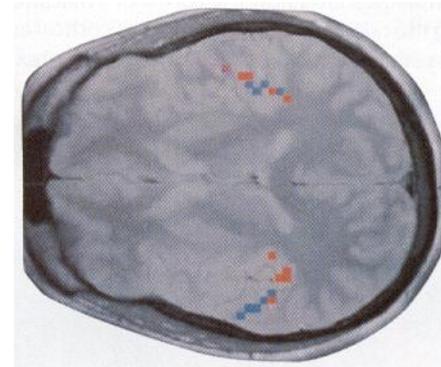
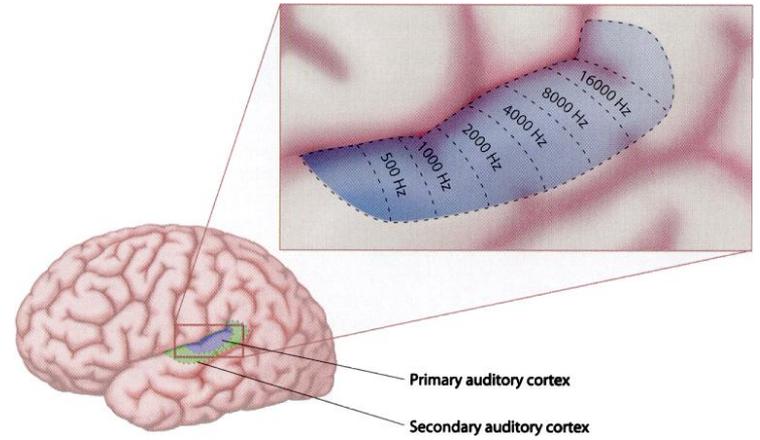
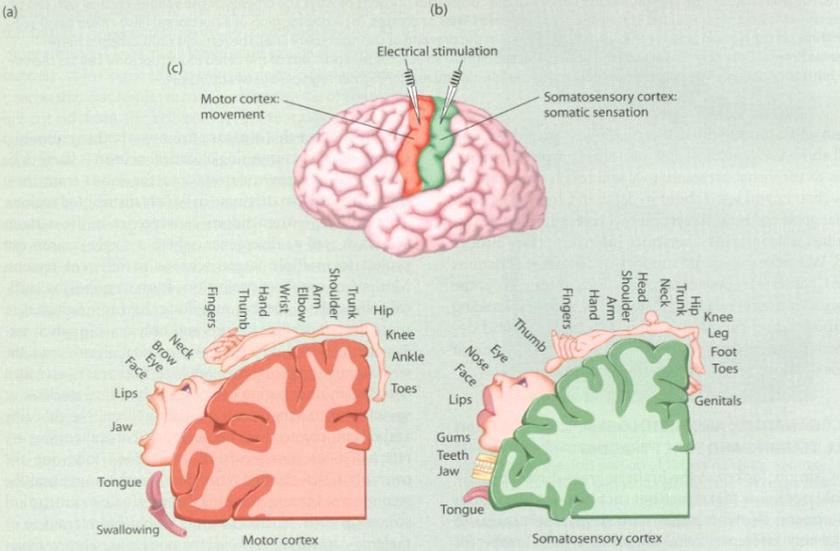
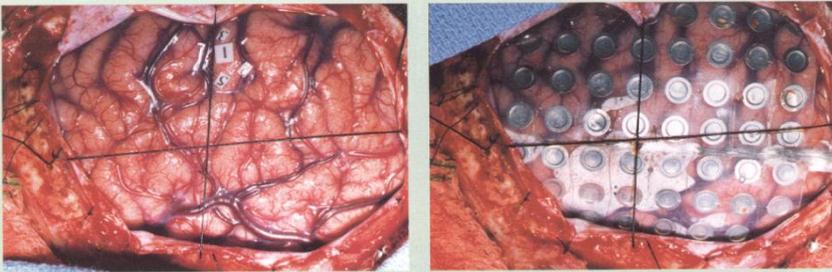
How does the brain work ?

Anatomy of the brain

Anatomy



Anatomy



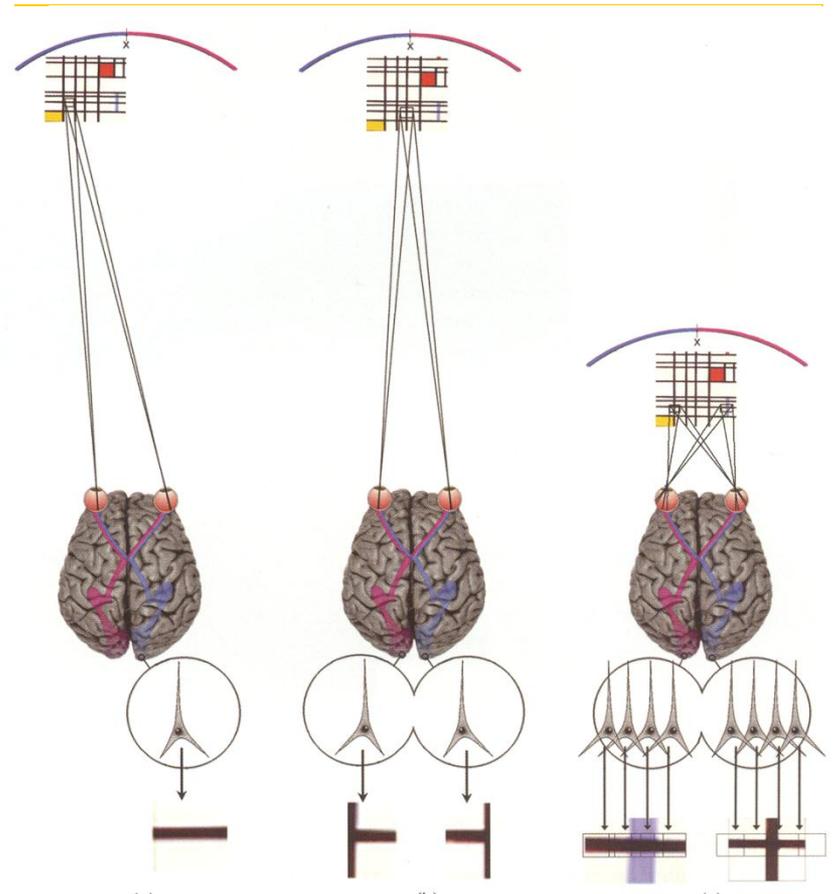
How does the brain work ?

The brain is modular

Visual system

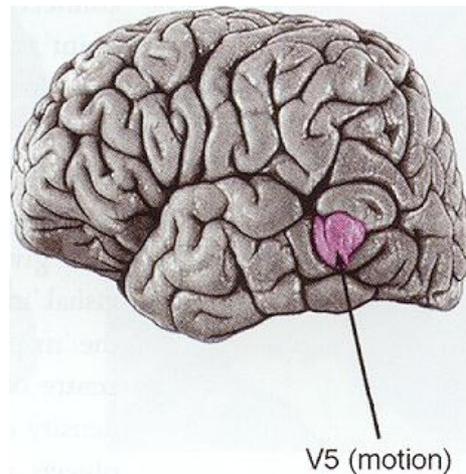
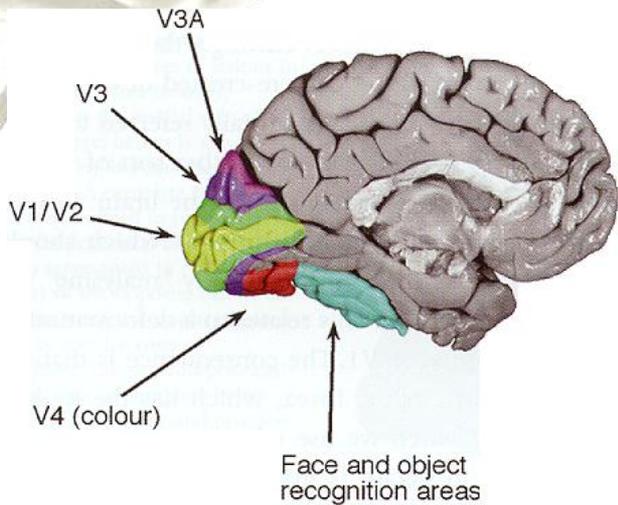
Different cells mediate different info

Certain cells only fire when exposed to the **color red**, or to movement, or to a vertical line, or to a face, or even only to a facial expression



Visual system

Different attributes of visual system are handled at different locations

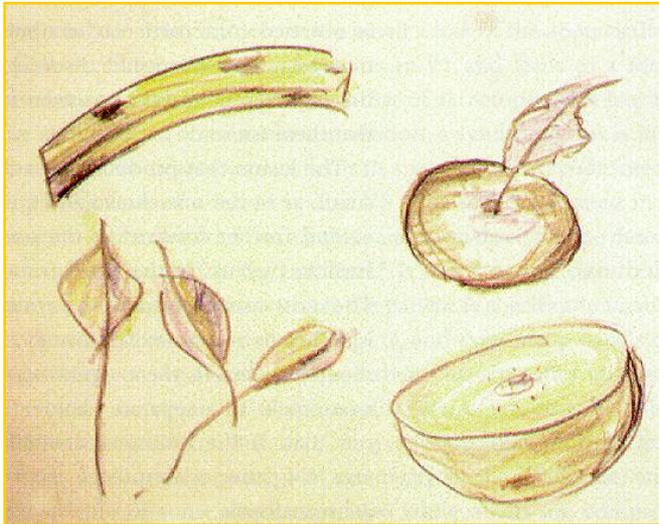


Visual system

Not only vision is modular, but also its consciousness and thus also the aesthetic appreciation

Achromatopsic (V4 lesion) artist's drawing, made from memory

Hemineglect patient self portraits during recovery

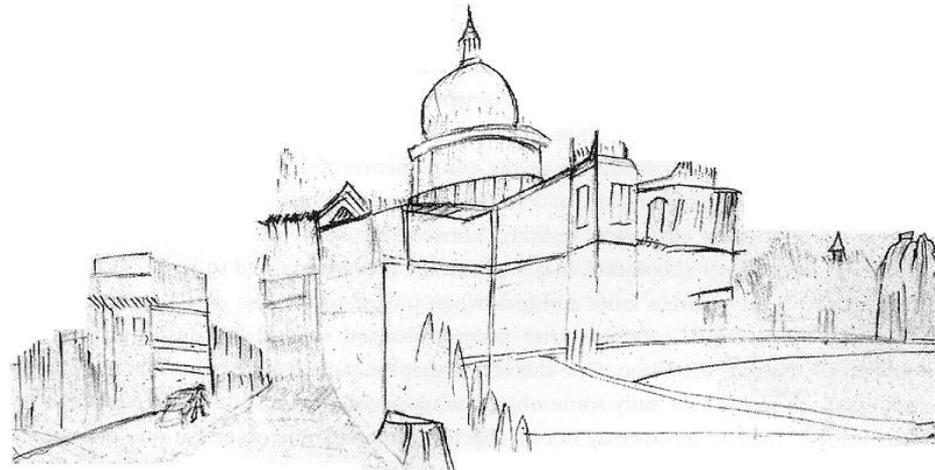


Visual system

No master area exists to which all processed info is relayed in order to become conscious

In stead conscious vision is the sum of micro-consciousnesses each from each area (V4,V5 etc)

Eg patient with object agnosia can draw St Paul's cathedral but cannot recognize what he has drawn



Two pathways of complex information processing

Emotional brain

Attaches value to incoming information

Amygdala – ACC – VMPFC / OFC

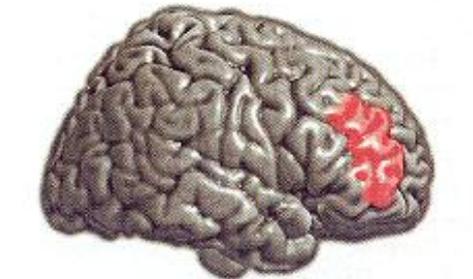
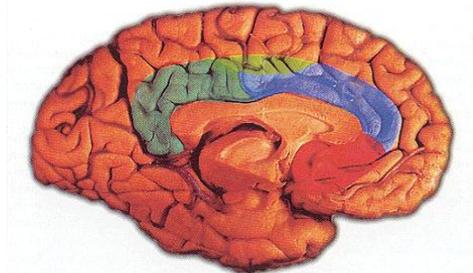
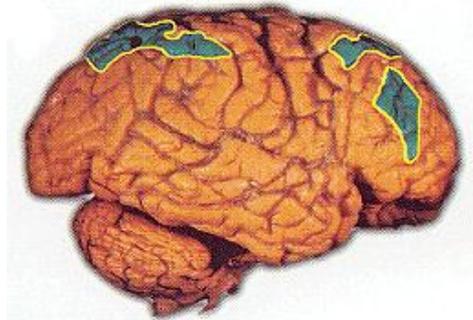
Cognitive brain

Detailed feature analysis

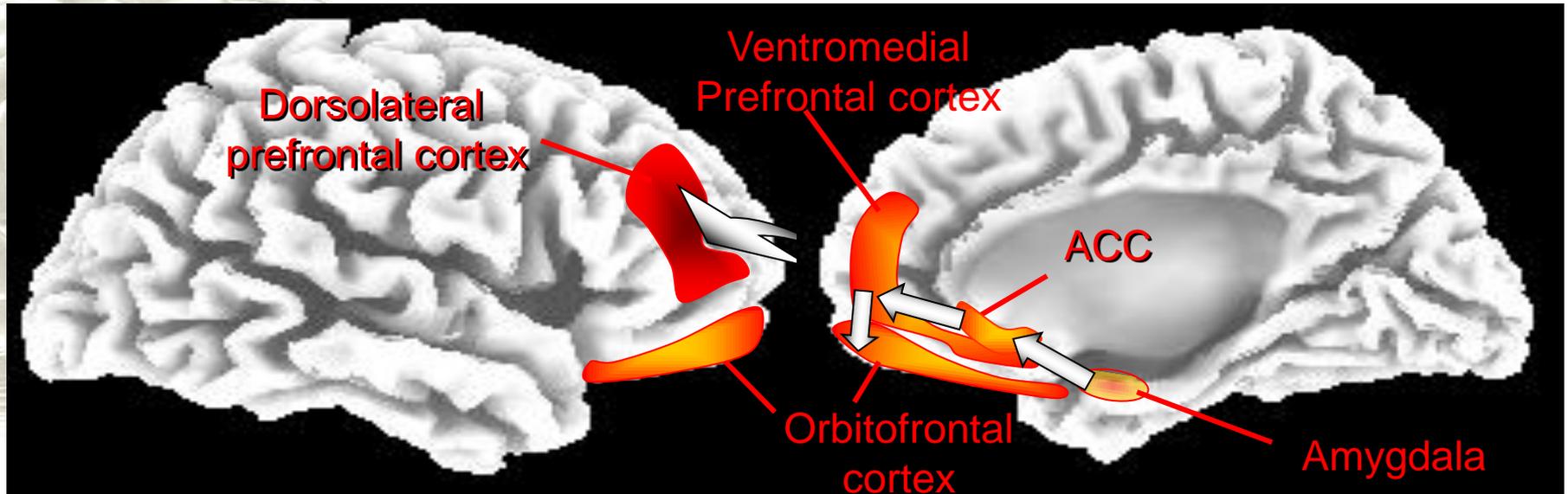
Hippocampus – PCC – parietal occipital temporal cortices

Integration of emotion and cognition

DLPFC



Emotional pathways

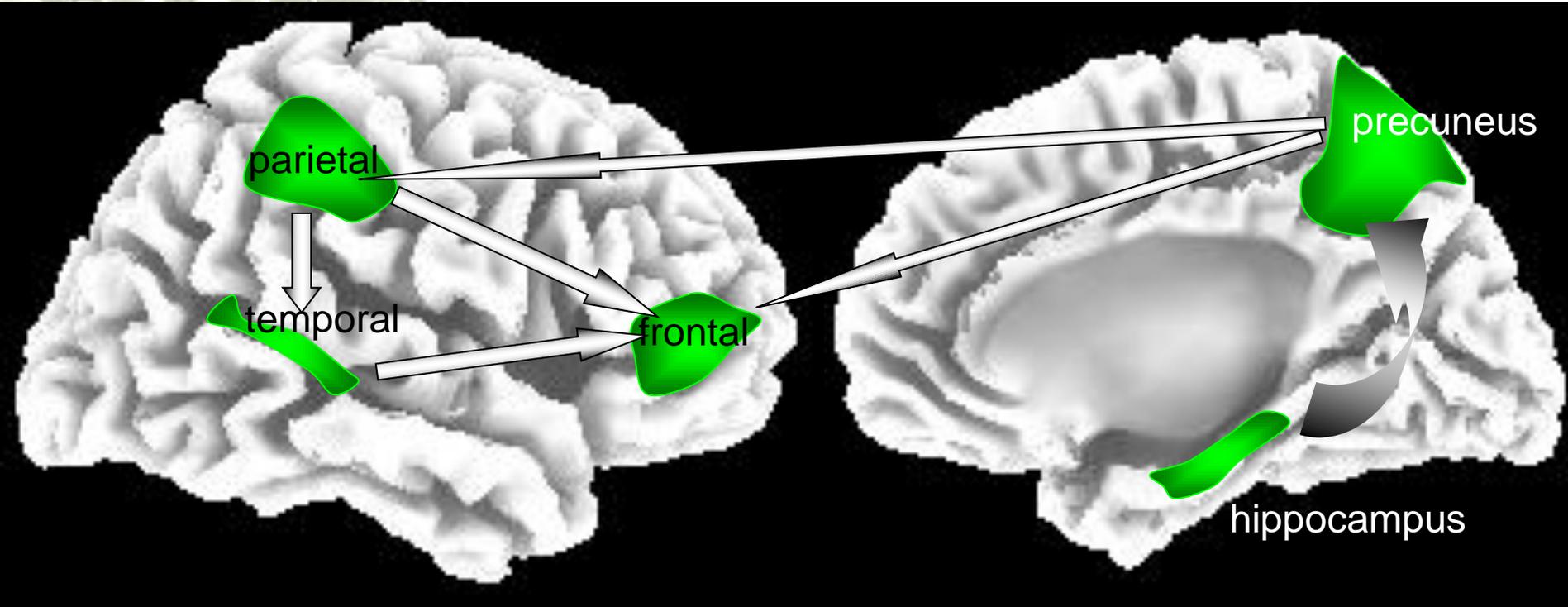


Emotion is priority mode

Activates sympathetic system to mobilize energy for 4Fs (fight, flight, feed, fornicate)

Activates reward system for adaptive learning (stimulus is important)

Cognitive pathways



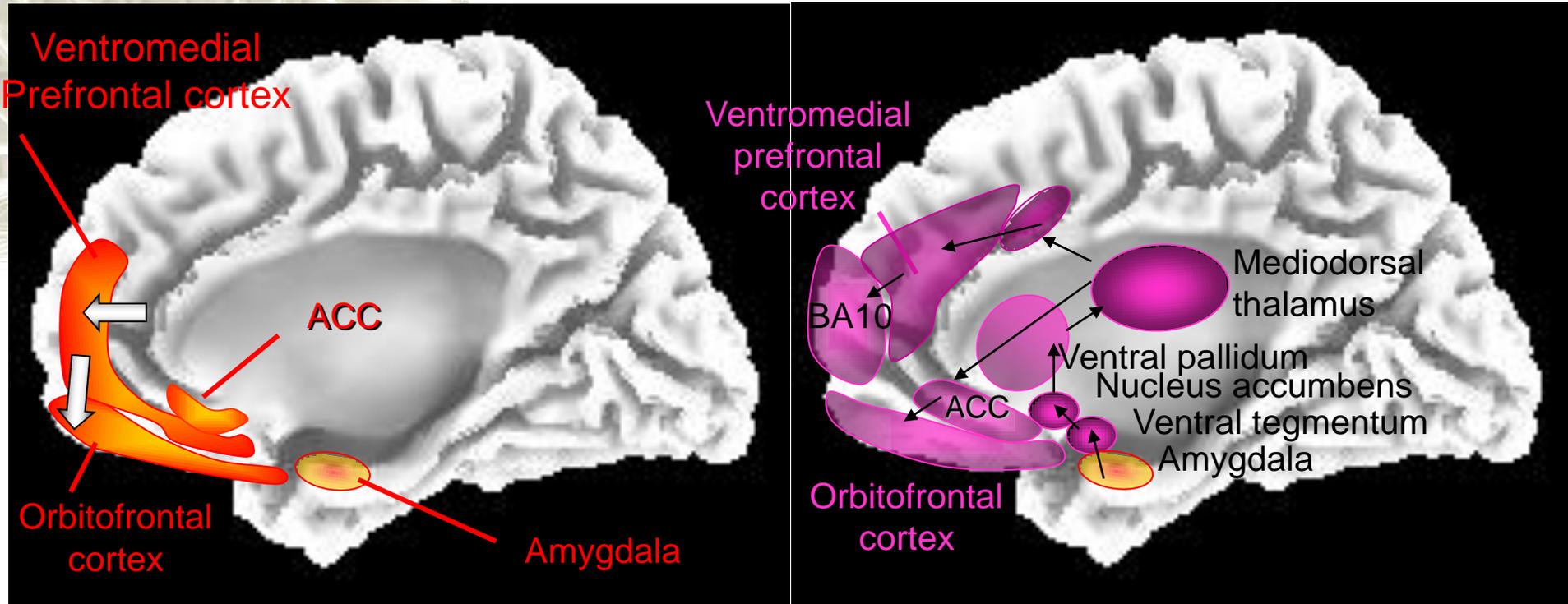
Information only makes sense if related to the 'self'

Self-perception network activated

Information is updated with what is stored in memory

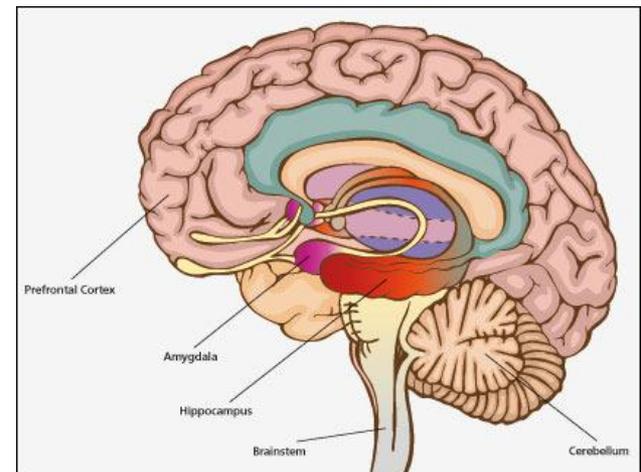
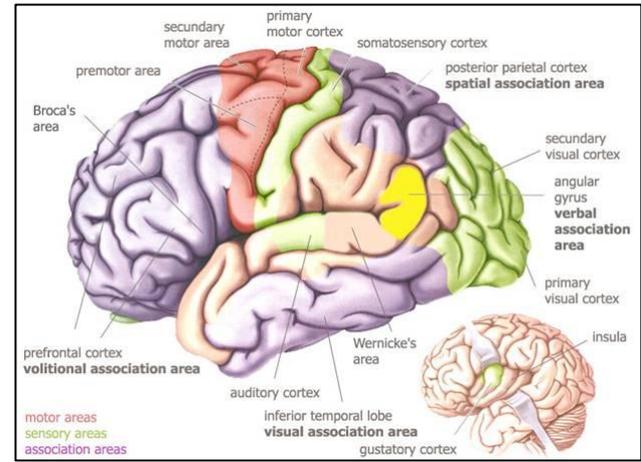
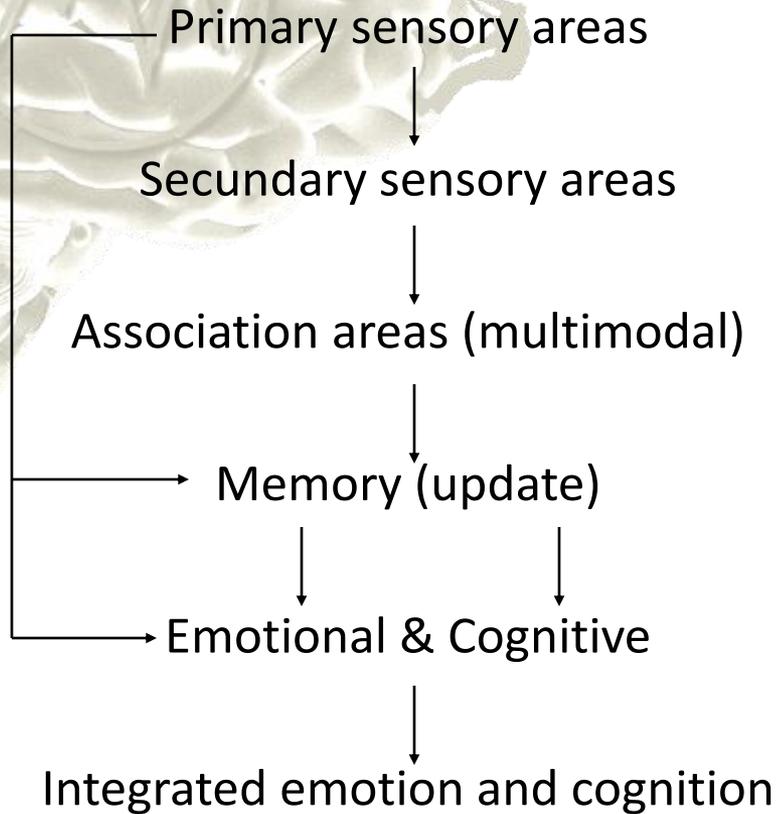
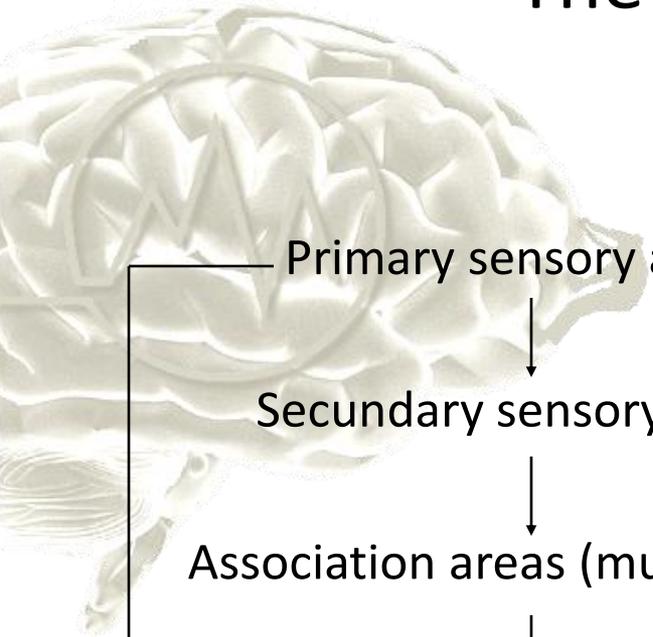
Memory system activated

Emotional and reward system overlap

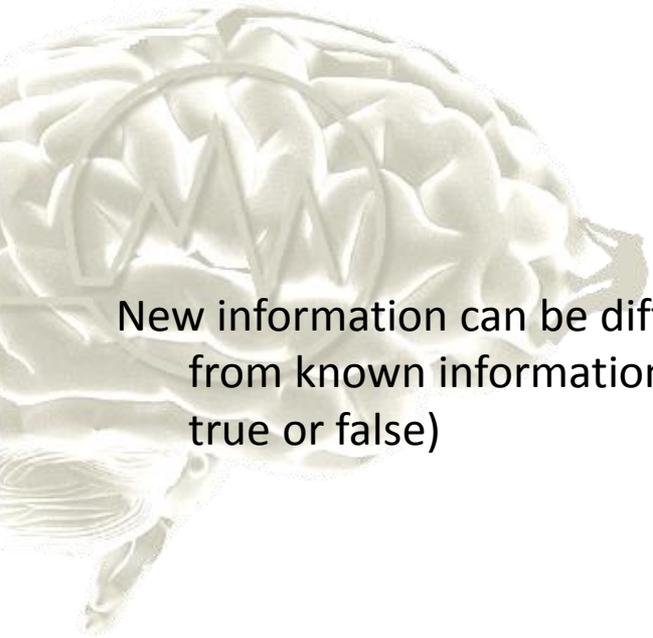


Reward system guides adaptive behaviour (adapt to environment)
Learning mechanism (hotter/colder)

The complex human brain

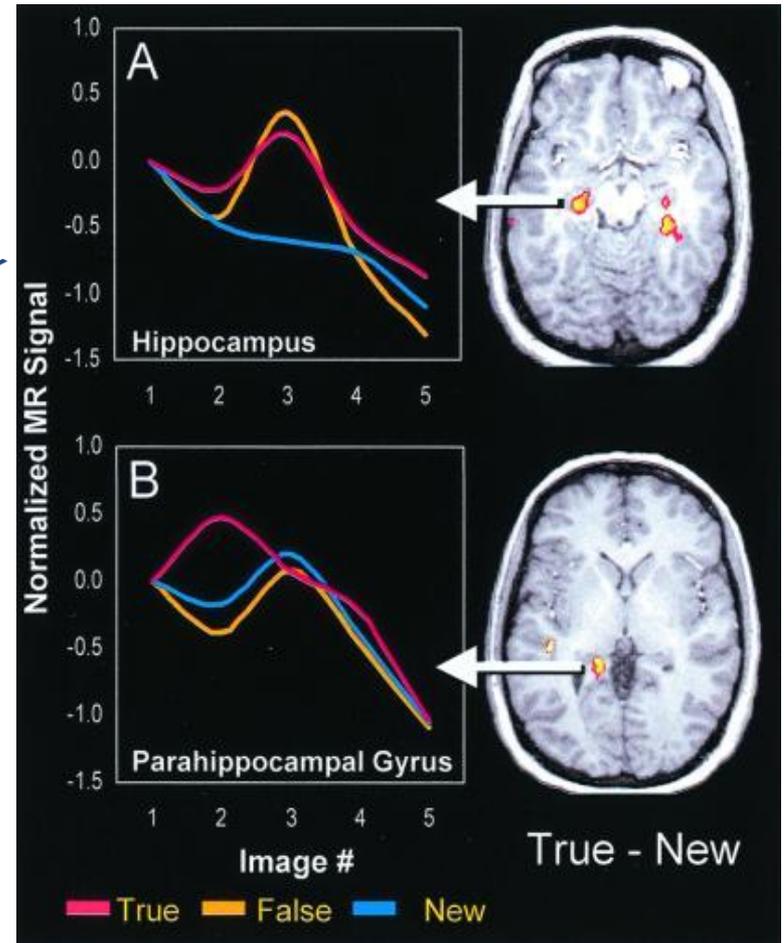


Recognizing art



New information can be differentiated from known information (whether true or false)

True information can be differentiated from false



Cabeza 2001

Art and memory

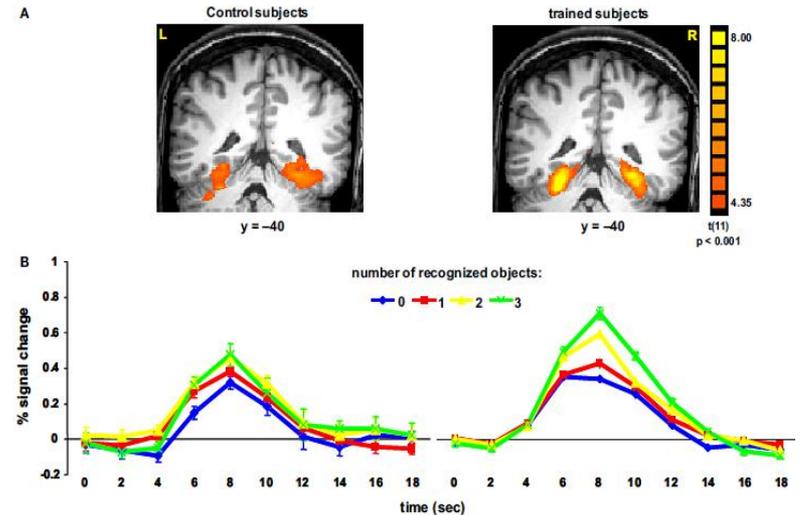
Recognizing cubist art (Wiesmann 2010)

Picasso, Braque, Gris

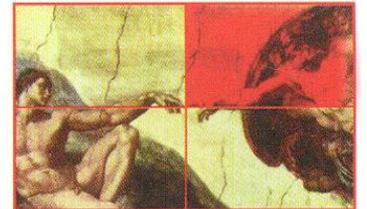
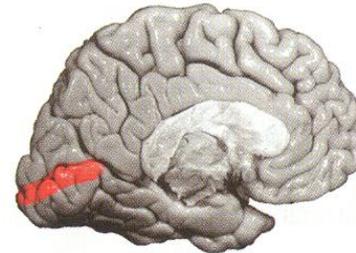
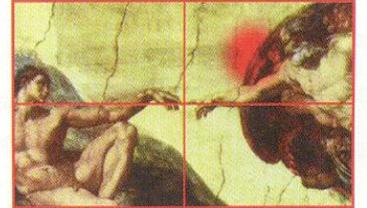
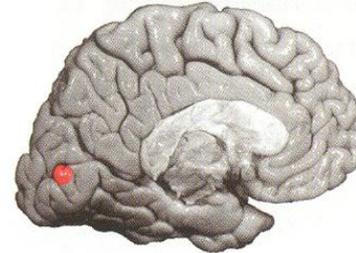
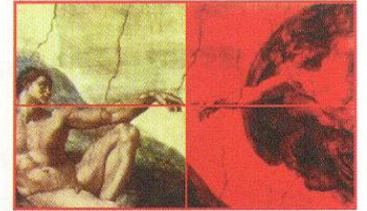
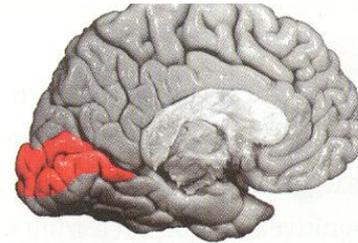
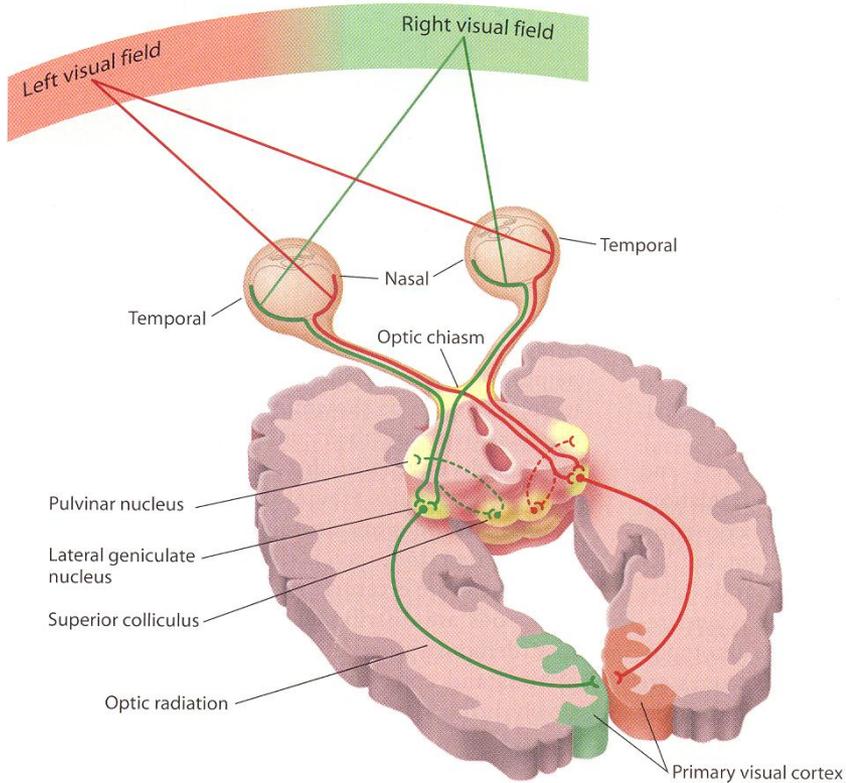


Trained people recognize more paintings correctly associated with higher parahippocampal activity

Is same as other recognition



Functional anatomy of visual system



Visual tract development

Visuotopic organization

Rat, cat, rabbit... humans

Brainstem, superior colliculus, LGN and cortex

Arises in response to sensory input

Cannot be genetically coded for (Deacon, 1997)

100 billion neurons, with 1.000 to 10.000 synapses each

30.000 genes

= 1 gene per 3 billion synapses

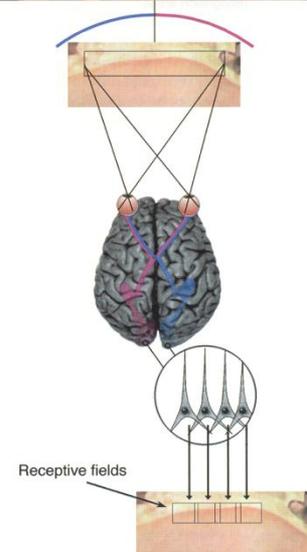
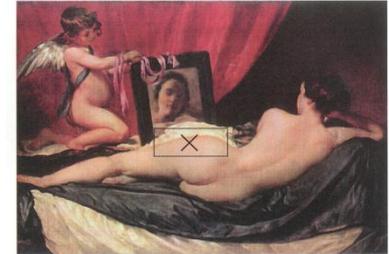
Rules for self-organization are coded for

Kohonen neural network

Based on Darwinistic principle

Self-organization creates Hebbian modules

Important for reorganization



Nature vs nurture doesn't exist : it's both

Brain can't be rigid or it can't adapt

Critical period of fine tuning of genetically coded structure

Love created, love destroyed, love regained (Harry Harlow)

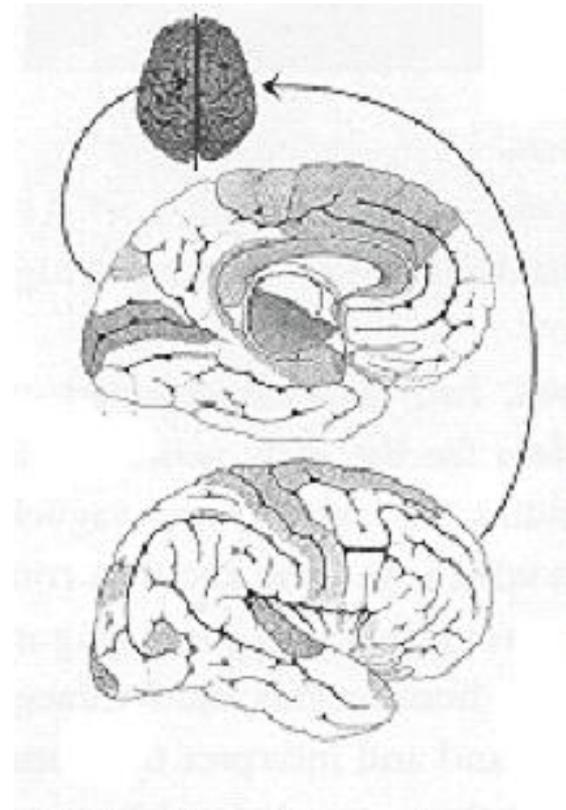
Love created genetically (inborn mother bond)

Love destroyed (isolation separation)

Love regained if in time and/or brothers/sisters

Vision created, vision destroyed, vision regained

Moreau operates 8 year old congenital cataract



Nature vs nurture doesn't exist : it's both

Brain can't be rigid or it can't adapt

language created (Chomsky), language destroyed, language regained (Feral children)

Victor, le sauvage d' Aveyron (1797)

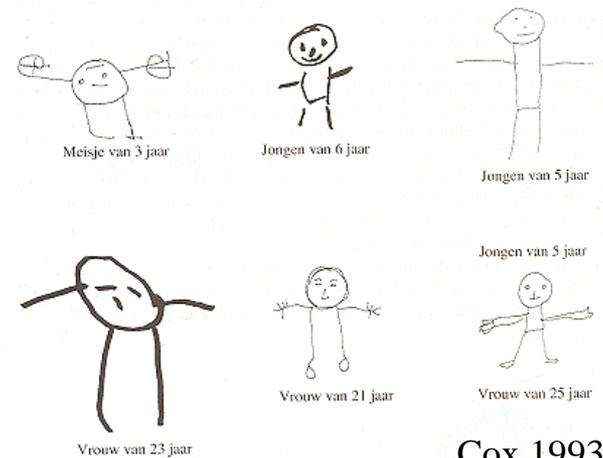
Amala and Kamala (1920) (Mowgli)

Art created, art destroyed, art regained

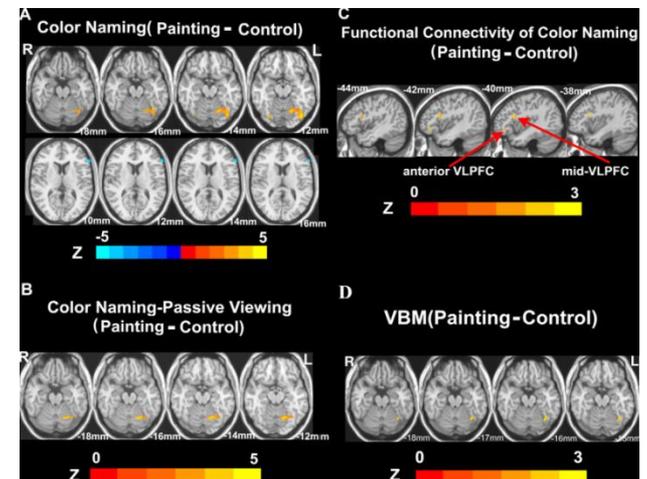
Isolated Turkish village with almost no contact to pictorial art (Cox 1993)

Painting majors showed more activation in (Long 2011)

- color selective areas (V4)
- increased correlation between left V4 and the left VLPFC during color naming.
- increased gray matter density in the left V4



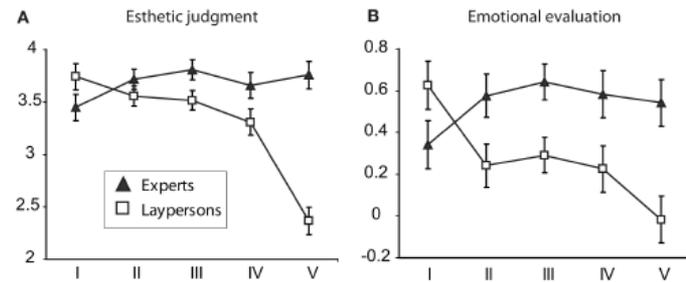
Cox 1993

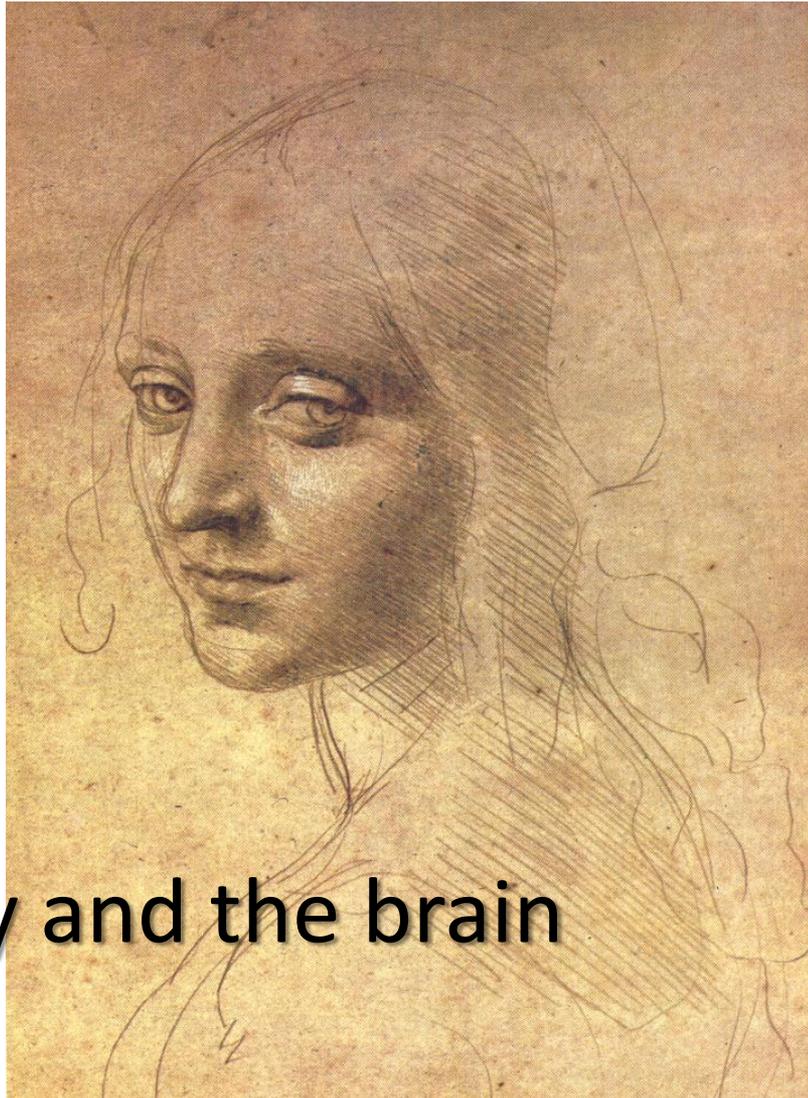
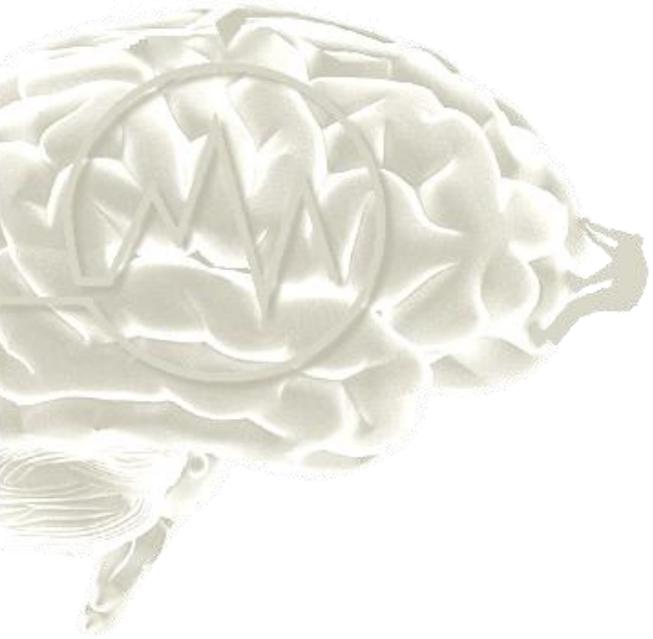


Is beauty learned ?

Universal beauty ?

For experts abstract art has equal emotional valence and aesthetic value as figurative art in contrast to non-experts (Pihko 2011)





The beauty and the brain

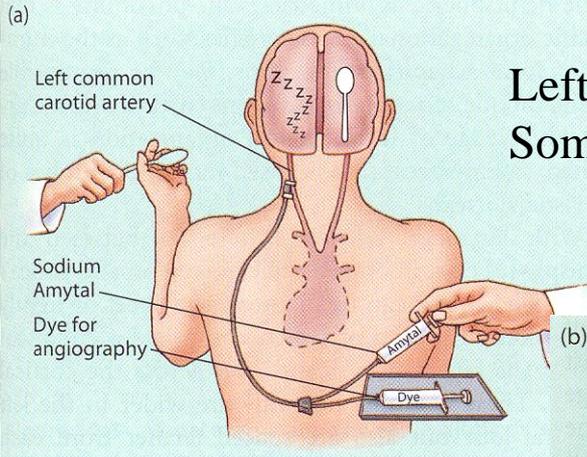


The Master and his Emissary

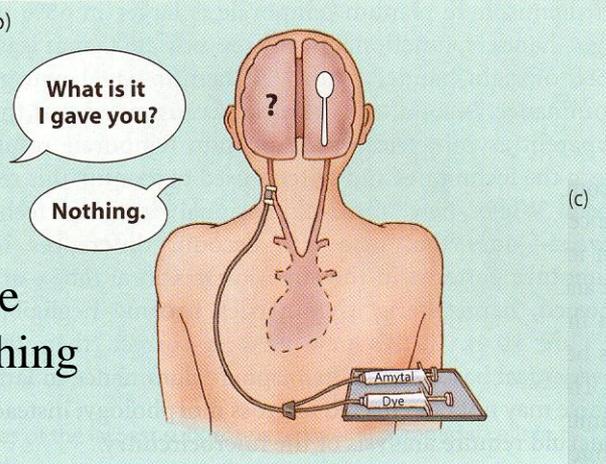
The right-sided master of the brain and its left-sided emissary



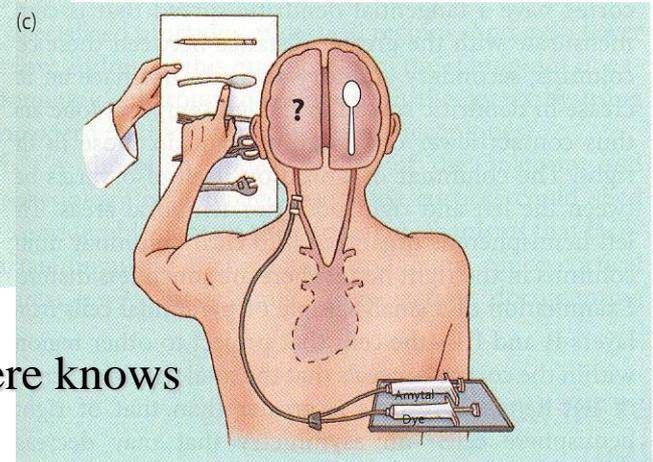
Communication in brain



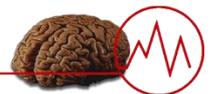
Left hemisphere asleep : no language
Somatosensory stimulus reaches right hemisphere



Left hemisphere remembers nothing doesn't 'know'



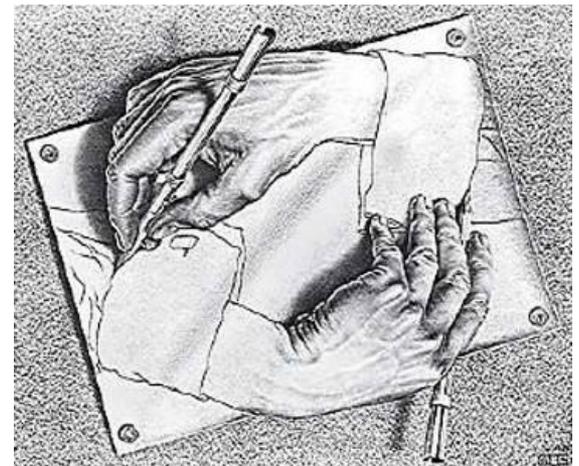
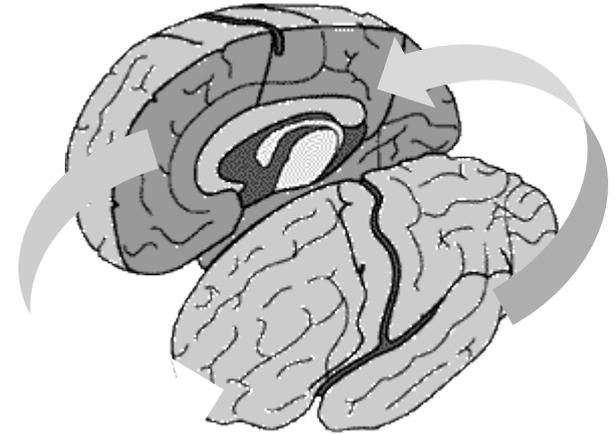
Right hemisphere knows but can't say



left vs right doesn't exist : it's both

Thought (McGilchrist 2009)

1. thought originates in the right (master) hemisphere,
2. is processed for expression in speech by the (emissary) left hemisphere,
3. and the meaning integrated again by the right (which alone understands the overall meaning of a complex utterance, taking everything into account)

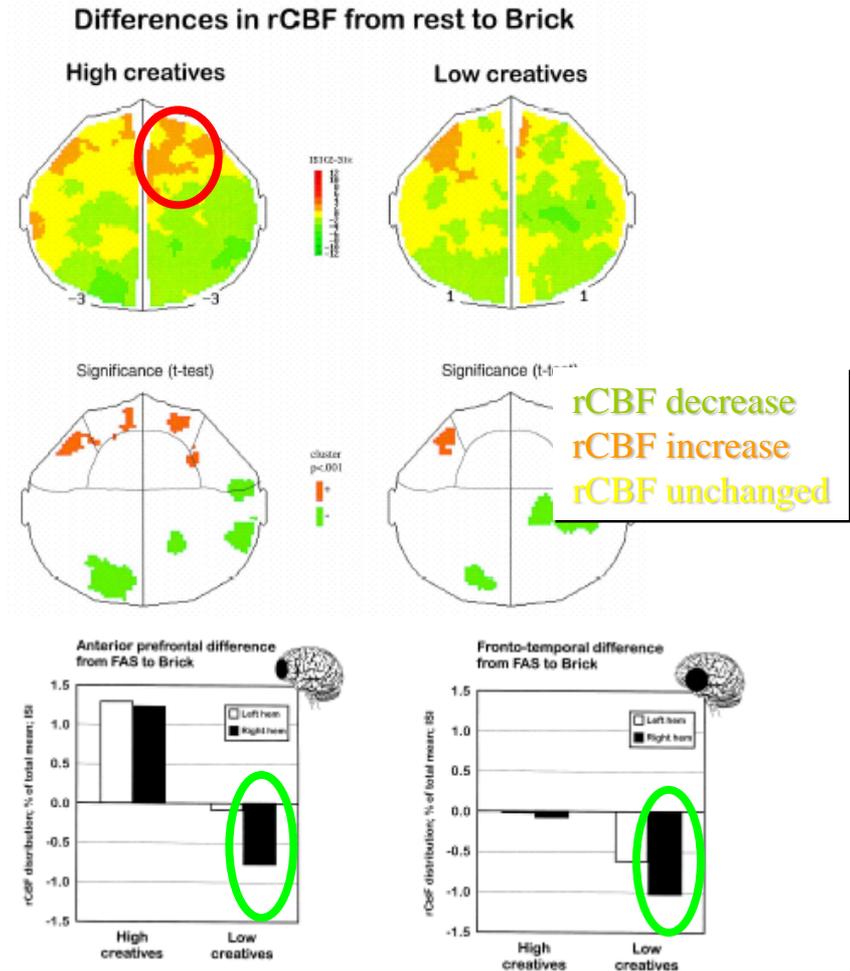


The creative mind

Creative mind uses **right and left** frontal lobe for creative activity
 Low creative mind uses **only left** frontal lobe

Right frontal lobe is involved in spontaneous production of non-verbal representations

Left in verbal analysis (Gainotti 1993)



Communication in brain

Artists

EEG when mentally composing drawings of their own choice

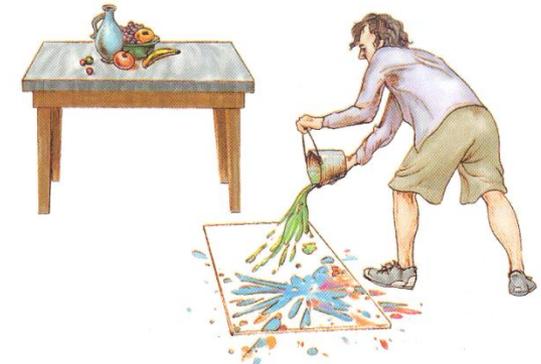
Strong **right hemispheric dominance**
in terms of synchronization in
the artists

TABLE I. Statistical comparison between strengths of synchronization, measured by E , of right and left hemisphere while mentally drawing

Frequency band	Artists	Non-artists
Delta	NS (R**)	NS (R***)
Theta	R** (R***)	NS (R*)
Alpha	R** (R***)	NS (R*)
Beta	R*** (R***)	NS (R**)
Gamma	R*** (R***)	NS (NS)



Left-hemisphere painting



Right-hemisphere painting

Folk psychology of art created
with different hemispheres



Communication in brain

Artists

Higher beta and gamma phase synchrony when looking at paintings

Right hemisphere increased synchrony

EEG when looking at art

Artists vs. Non-artists : Looking at Paintings

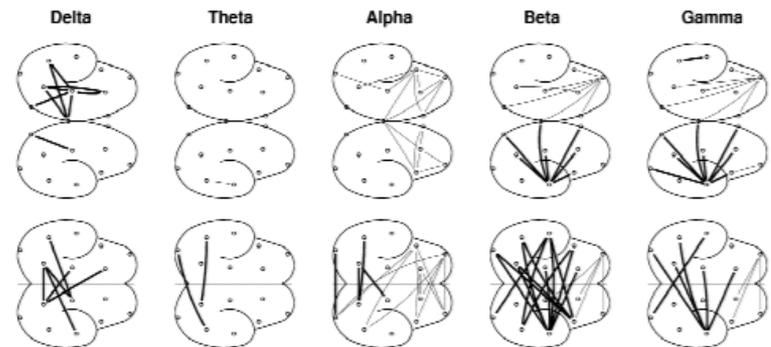


Table 1

Statistical comparison (nonparametric Wilcoxon test for matched samples) between the degrees of phase synchronization of right and left hemisphere

Frequency band	Artists		Non-artists	
	Looking at paintings	Imagining paintings	Looking at paintings	Imagining paintings
Delta	n.s.	n.s.	n.s.	n.s.
Theta	$0.01 < P < 0.05$	$P < 0.001$	$0.01 < P < 0.05$	$0.01 < P < 0.05$
Alpha	$0.001 < P < 0.01$	$0.001 < P < 0.01$	n.s.	n.s.
Beta	$0.001 < P < 0.01$	$0.001 < P < 0.01$	n.s.	n.s.
Gamma	n.s.	n.s.	n.s.	n.s.



The meaning of art

“Because the medium of the resulting work is not conventionally-referring language, whatever meaning it has will not be expressible in any other terms than those of the work itself” (Eric Matthews, *The Philosophy of Merlau Ponty*, 2002)

Thus any thought, created by the right hemisphere, not communicated in words, but by painting, music, sculpture, etc cannot be accurately expressed/translated in words

If skipped eg in painting

1. thought originates in the right (master) hemisphere,
2. ~~is processed for expression in speech by the (emissary) left hemisphere,~~
3. and the meaning integrated again by the right (which alone understands the overall meaning of a complex utterance, taking everything into account)

Art = information communication

Artists use right side of the brain when looking at and creating visual art

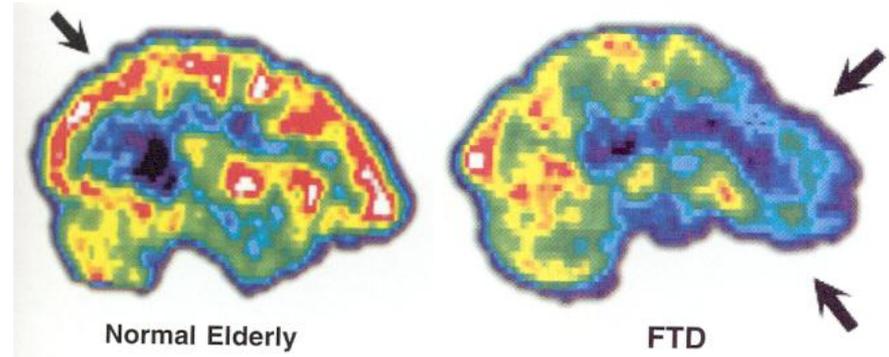
Right side of brain is involved in non-verbal visuo-spatial representations (Liotti 1996)

High creativity is hampered by left hemisphere inhibition (Bogen 1969)

In autists art worsens on improved language (Humphrey 1998)

Semantic FTD induces visual creativity (Miller 2004)

Art is oldest form of information communication (Humphrey 1998, Mithen 1999)



Art in FTD

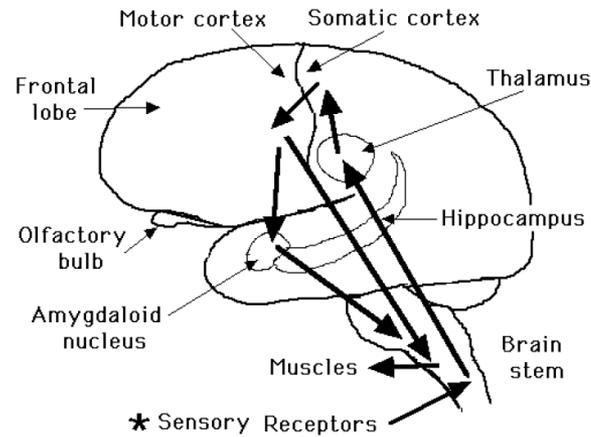


Beauty in context

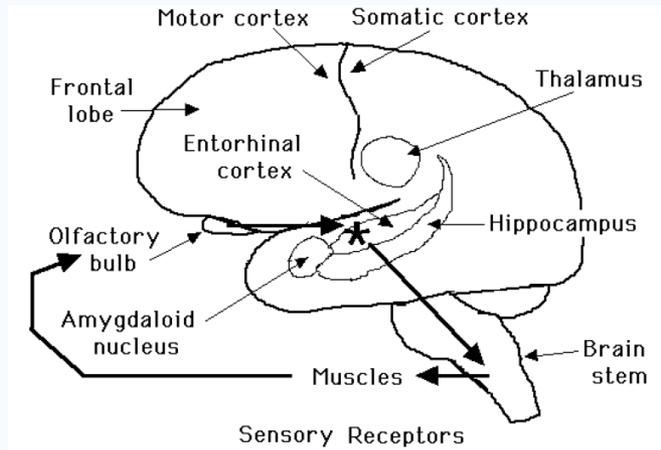
Ceci n'est pas une pipe.

Neurophilosophy of perception

perception = passive



perception = active



Walter Freeman 2000



Raphael 1510



Botticelli 1480



Hals 1648



Raphael 1510



Raphael 1510



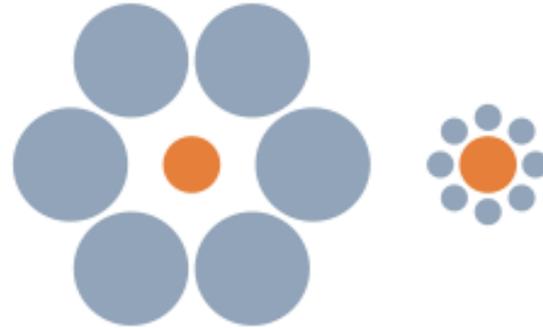
Why active perception ?

Merleau-Ponty (Phénoménologie de la Perception 1945)

Object of perception cannot be seen in isolation because it is embedded in a context.

It exists in relationship to other things, which gives it its meaning in the world.

Thus perception is the intentional sensing of information (looking for) within a context.



Context in art

Belvedere torso

by Apollonius son of Nestor

First C BC copy of sculpture from
2nd C BC

Original taken to Cleopatra by
Marcus Antonius

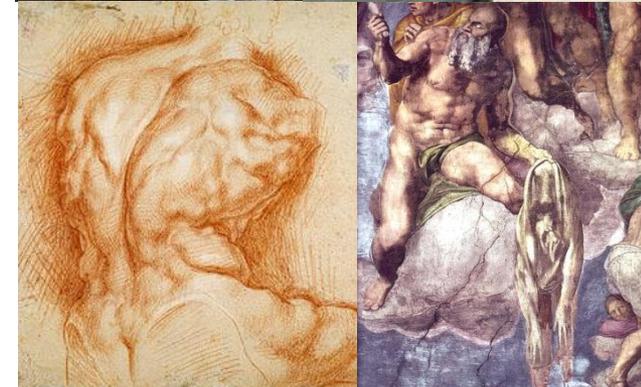
After Battle of Actium (31 BC) taken
back to Rome by Octavius Augustus

Copy made by Apollonius

Pope Julius II asks Michelangelo to
reconstruct it. He refuses because it
cannot be improved, but uses it in
his paintings

So do many other painters (eg
Rubens)

Inspiration for Rodin's *Penseur* and
reconstruction has been attempted

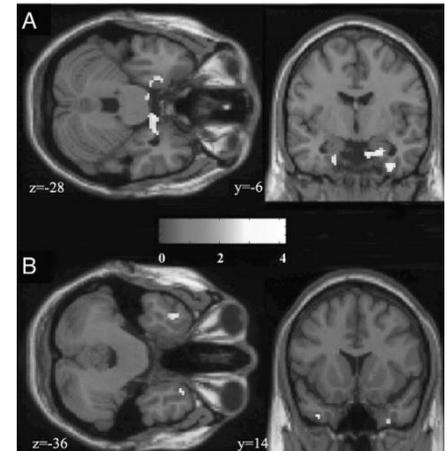
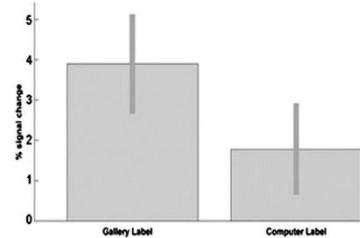
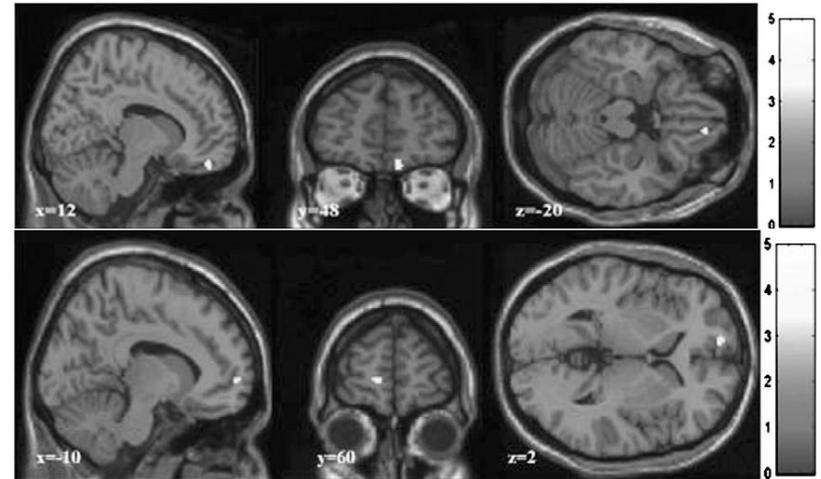


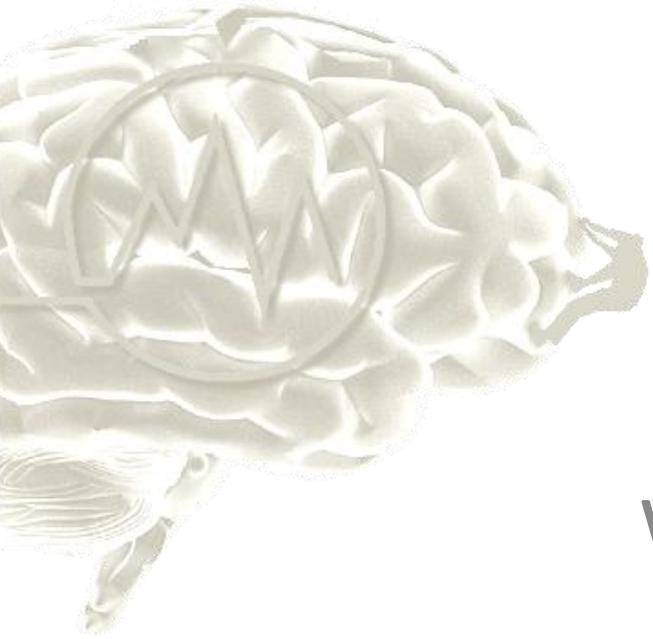
Context and beauty

Context and beauty in art (Kirk 2009)

Beauty (contextual) correlates with activity in the medial OFC and frontopolar cortex

Context, independent of aesthetic value, correlates with bilateral activations of temporal pole (social aspects) and bilateral amygdalohippocampal area (pull contextual info from memory)





What is beauty ?

What is beauty ?

Pythagoras (580–500 BCE)

Beauty relates to mathematics

Phi= 1,61 (golden ratio)

Beauty is symmetry and proportion

Thomas Aquinas (1224–1274)

beauty = 1. integrity, 2. proportion, 3. clarity

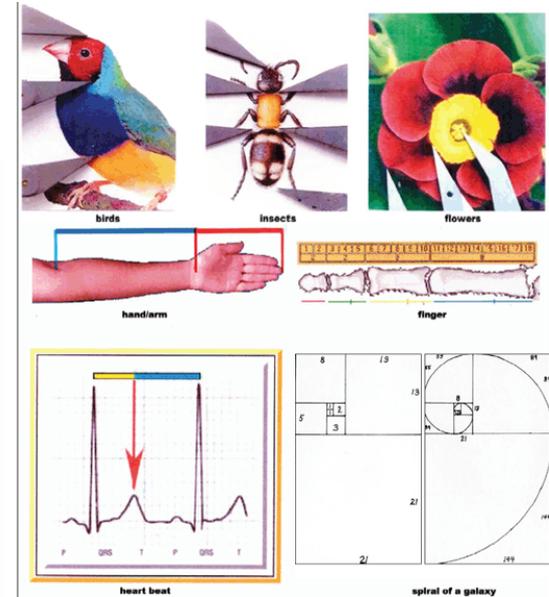
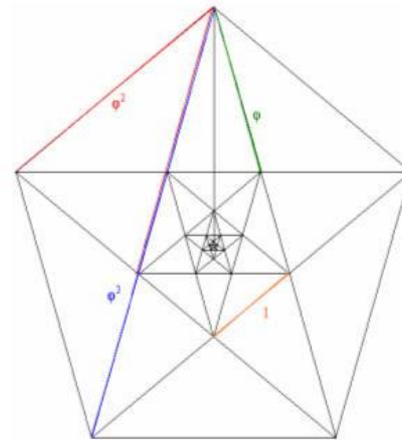
Id quod visum placet (that which pleases on seeing it)

Beauty = visual pleasure

Immanuel Kant (1724–1804)

beauty possesses objective and subjective qualities

Cfr golden ratio



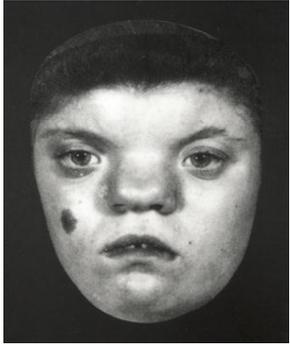
Objective beauty the Golden ratio

“I love it that people find me beautiful.
But in fact the amount of mm between my eyes
and chin is a matter of mathematics”

Paulina Porizkova

Golden ratio mask

Very unattractive



Unattractive



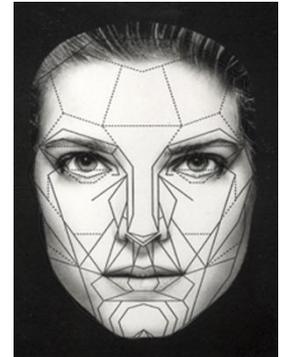
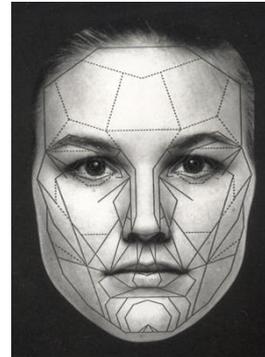
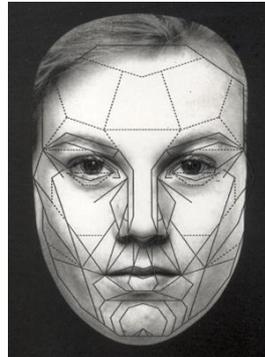
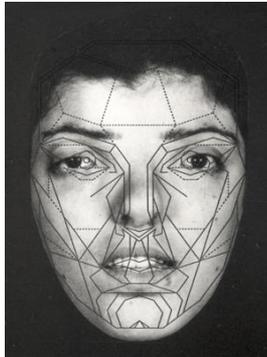
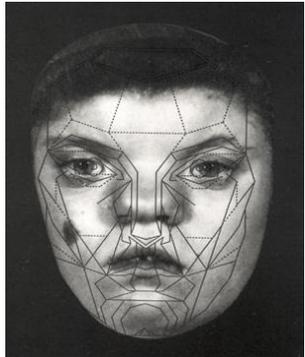
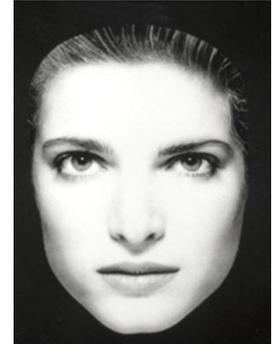
Average



Attractive



Very attractive



The more attractive the better the golden ratio mask fits

<http://www.beautyanalysis.com>



Golden ratio and the brain

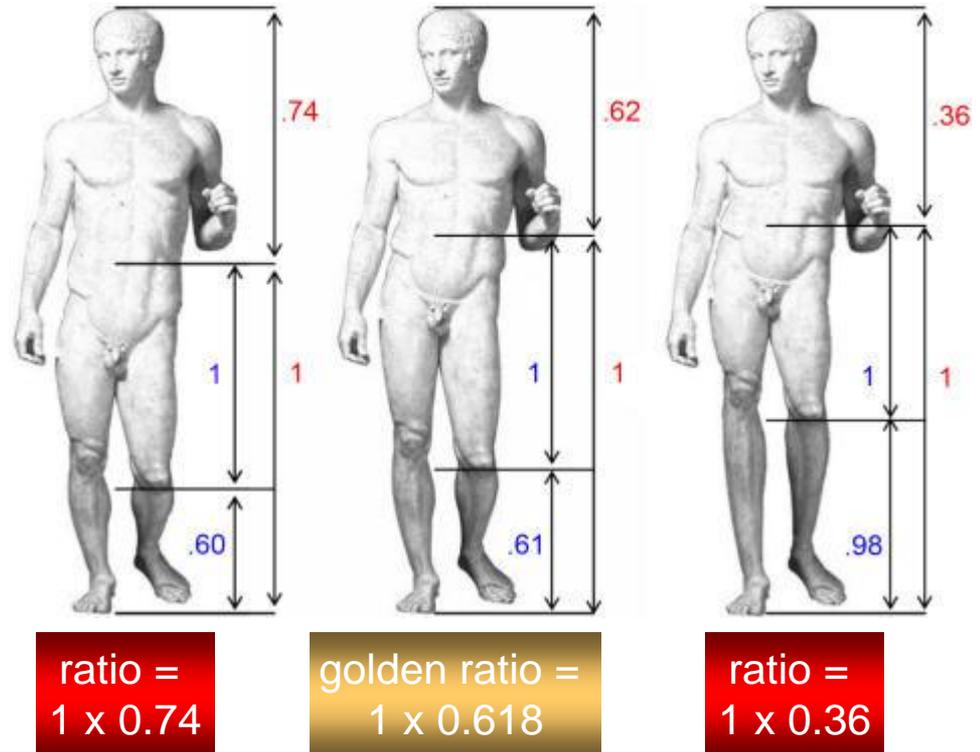
Pythagorean beauty

Objective and subjective beauty

Objective beauty

Canonical (original) works versus modified

Subjective beauty/esthetic appreciation



Pythagorean beauty

Objective beauty

Right DLPFC

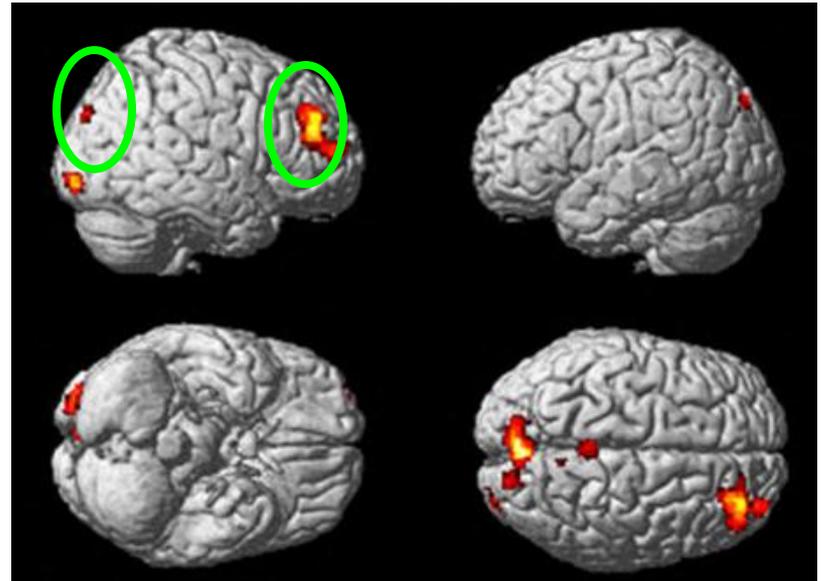
Right parietal cortex

Left ACC

Right insula

} cognition

} salience



Pythagorean beauty

Objective beauty

Right DLPFC

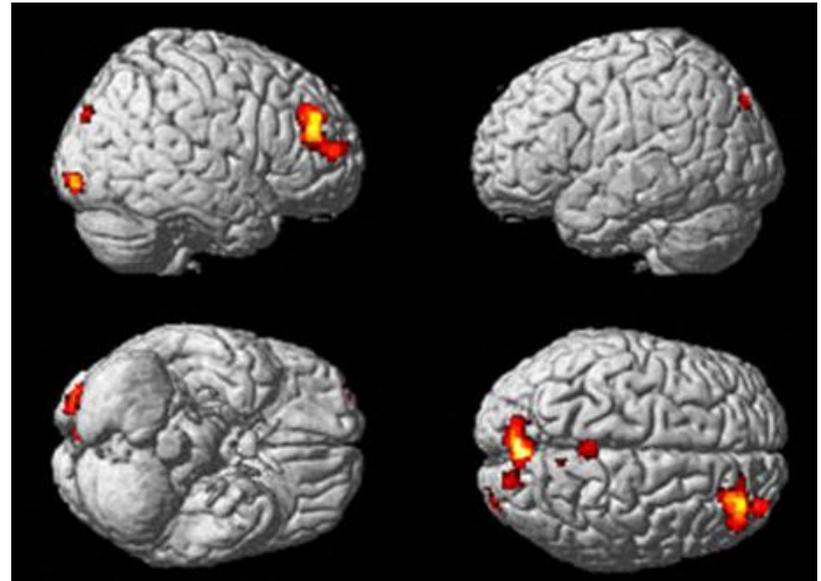
Left ACC

Right insula

Right precuneus

Subjective beauty

Right amygdala





Kantian cognitive art

Foetale MRI , true FISP, 2005



"Le penseur", Auguste Rodin, 1880

Cognitive networks

Three networks in the brain (Vincent 2008)

Dorsal attention system

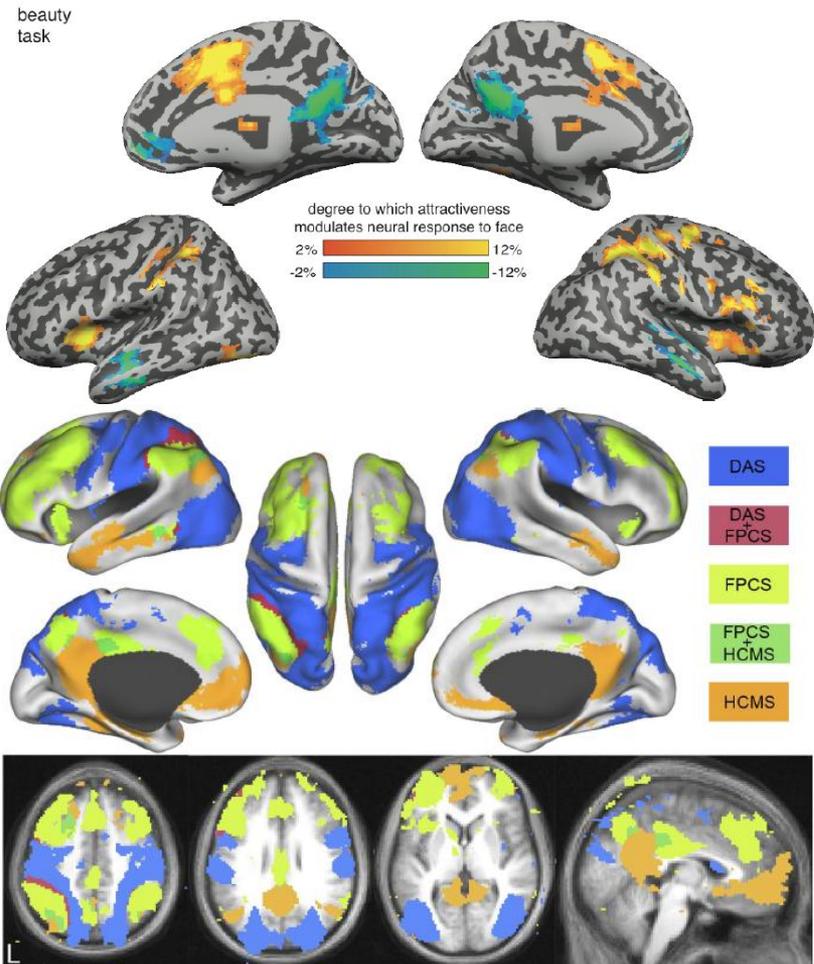
externally directed cognition including covert and overt shifts of spatial attention, eye movements, and hand-eye coordination (Corbetta 2002)

Hippocampal cortical memory system

passive mental states linked to internally directed cognition including recollection of the past and thinking about the future (= default network) (Buckner 2008, Raichle 2001)

Frontoparietal control system

executive control systems guide decision-making by integrating information from the external environment with stored internal representations (Miller 2000)

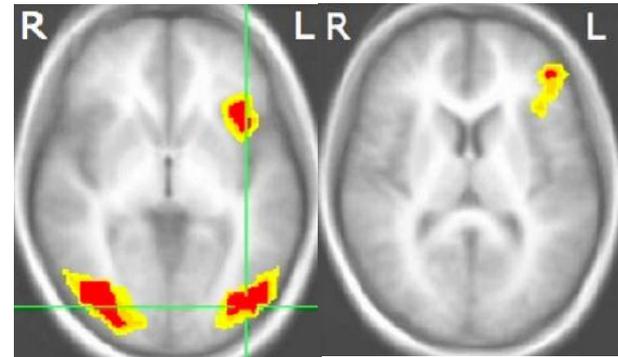


Anti-correlated

Cognition and art

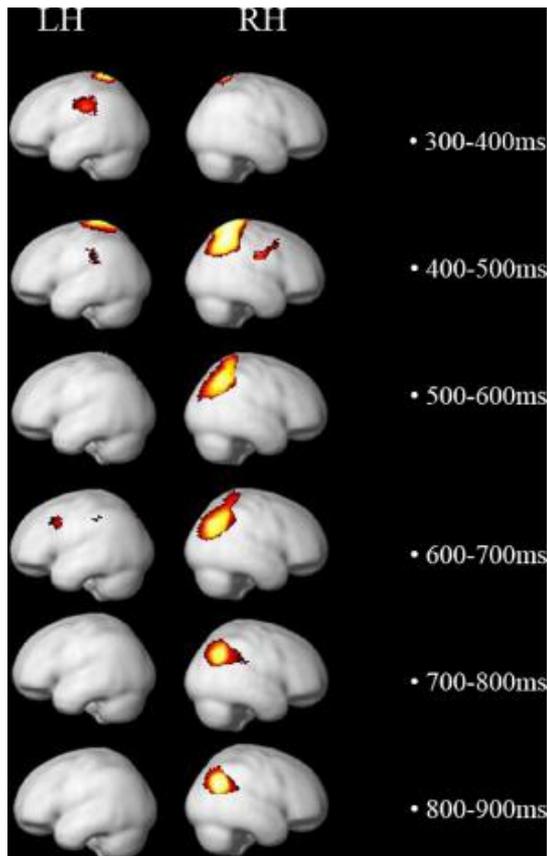
Cognitive aspects of art

Frontoparietal involvement in cognitive aspects (information in painting) of art (Cupchik 2009)

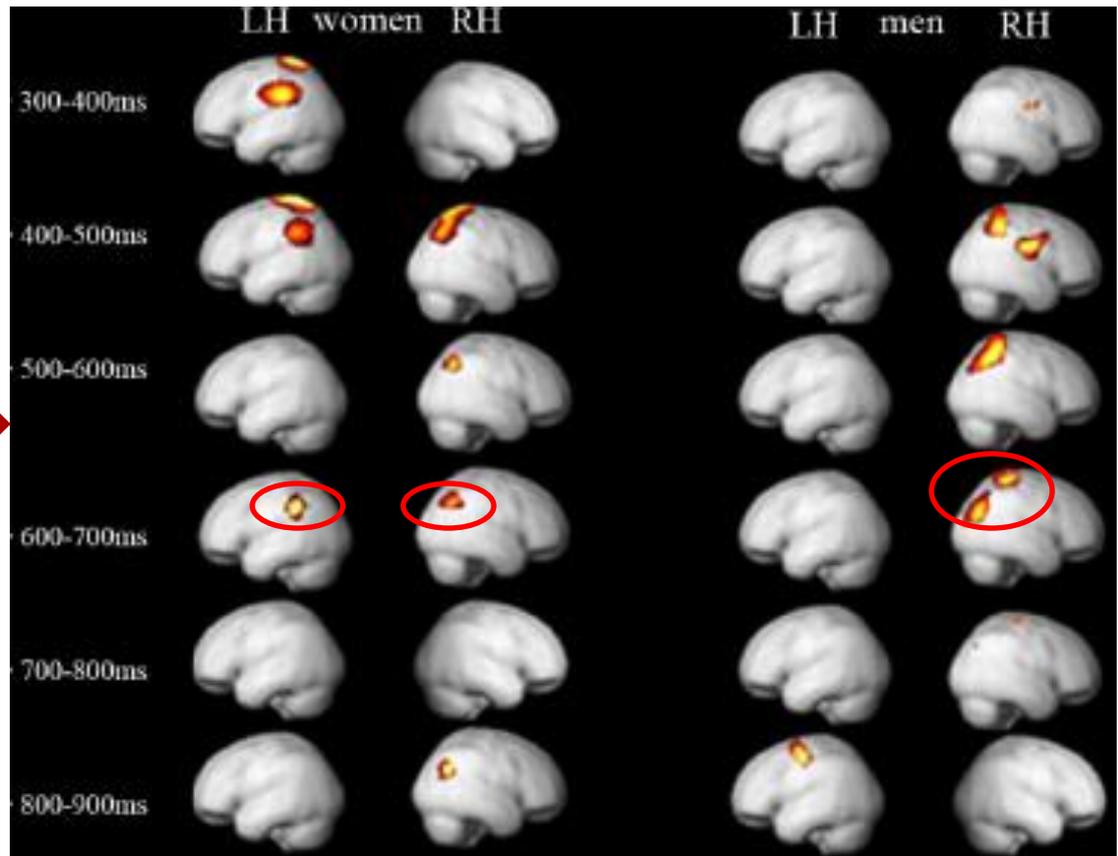


Cupchik 2009

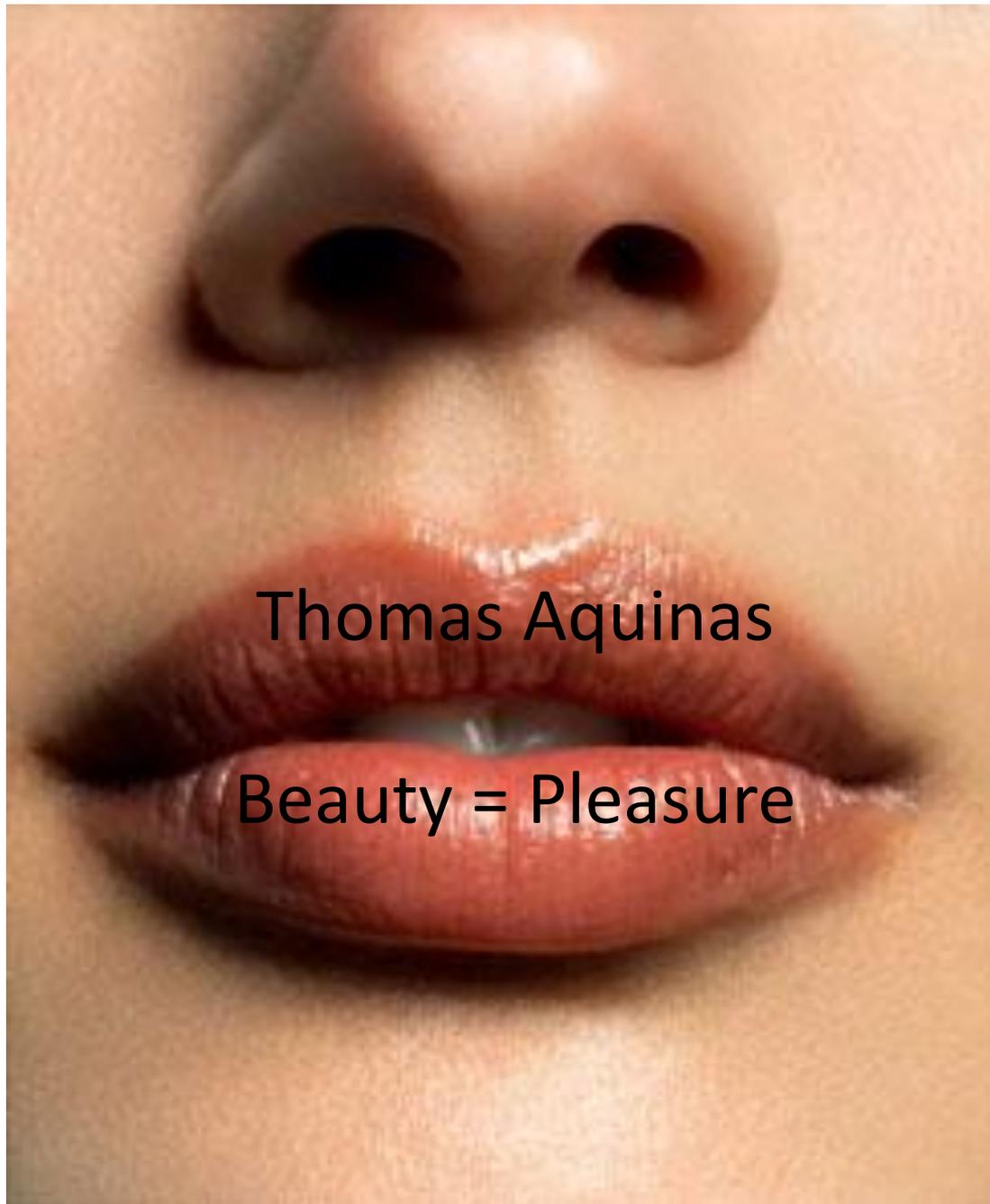
Neural correlates of beauty decision in men & women



Cella-Conde 2009



Bilateral parietal activation in women, rightsided in men



Thomas Aquinas

Beauty = Pleasure

Philosophy of pleasure and pain

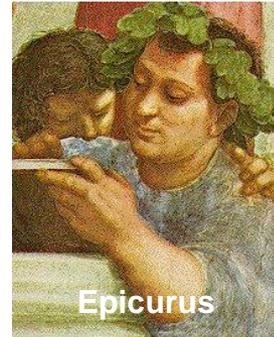
Epicurus (341-270 BC)

Pursuit of pleasure and absence of pain is **purpose of life**, but without excesses (based on Plato and Aristotle and Democritus)

Ataraxia: peace and freedom from fear

Aponia: the absence of pain

Happiness = pleasure - pain

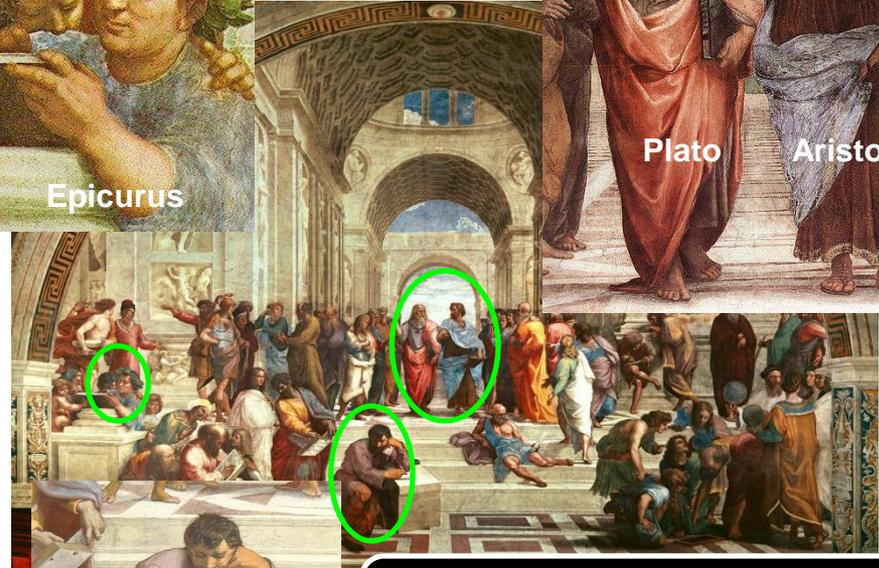


Epicurus



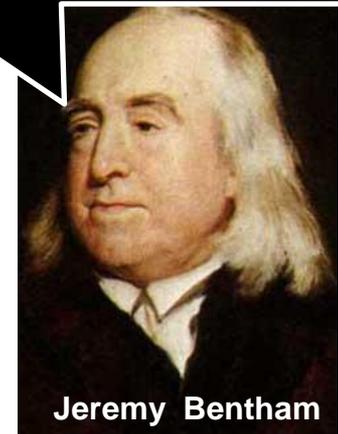
Plato

Aristotle



Democritus

"Nature has placed mankind under the governance of two sovereign masters, pain and pleasure."



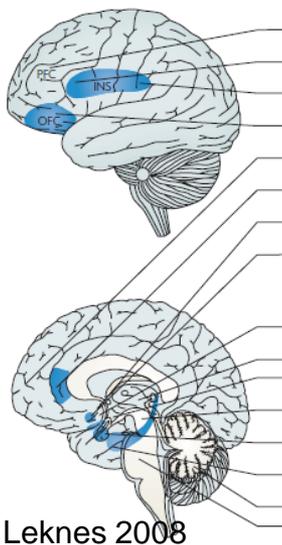
Jeremy Bentham

Bentham (1748-1832)

Utilitarianism: One has to maximize pleasure and minimize pain...

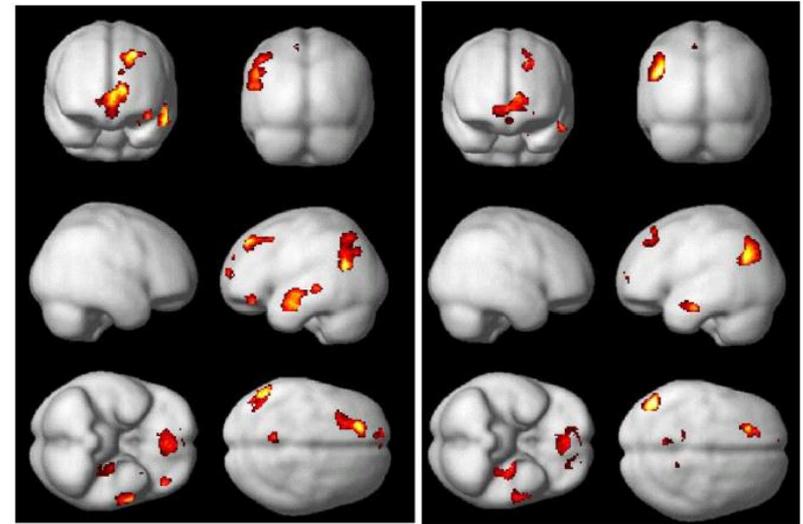
Not only purpose of life but also **mechanism of life**

Pain/avoidance/sadness & pleasure/seeking/happiness networks overlap



Region	Pleasure/reward	Pain
Lateral prefrontal cortex	• Humans, fMRI, taste reward ¹⁰¹	• Humans, H ₂ O PET, hyperalgesic pain ¹⁰² • Humans, fMRI, pain ¹⁰³
Anterior insula	• Humans, fMRI, food cravings ¹⁰⁴ • Humans, H ₂ O PET, chocolate reward ¹⁰⁵	• Humans, fMRI, pain ¹⁰⁶ • Humans, fMRI, placebo analgesia ¹⁰⁶
Posterior insula	• Humans, fMRI, hypothetical reward ¹⁰⁷	• Humans, direct brain stimulation ¹⁰⁸ • Humans, fMRI, pain ¹⁰⁹
Orbitofrontal cortex	• Humans, fMRI, pleasant touch ⁷⁴ • Humans, fMRI, chocolate reward ¹¹⁰	• Humans, fMRI, pain ¹⁴ • Humans, fMRI, placebo analgesia ¹⁰⁶
Medial prefrontal cortex	• Humans, H ₂ O PET, pleasurable music ¹¹⁴ • Humans, fMRI, monetary reward ¹⁰⁸	• Humans, fMRI, pain ^{110,111}
Anterior cingulate gyrus	• Monkeys, electrophysiology ¹¹² • Humans, H ₂ O PET, chocolate reward ¹¹³	• Humans, fMRI, pain ¹¹³ • Humans, opioid PET ¹¹³
Dorsal striatum	• Humans, fMRI, fruit juice ¹¹⁴ • Humans, fMRI, monetary reward ¹¹⁵	• Humans, dopamine ligand PET, pain ¹¹⁶ • Humans, fMRI, pain ¹¹⁷
Nucleus accumbens/ventral striatum	• Humans, fMRI and dopamine ligand PET, monetary reward ¹¹⁸ • Rodents, hedonic hotspot, taste reactivity ¹¹⁹ • Humans, dopamine ligand PET ¹²⁰ ; drug reward	• Humans, dopamine ligand PET ¹²¹ • Humans, fMRI, expectation of pain ¹⁴ • Rodents, pain-induced analgesia ¹²²
Ventral pallidum	• Rodents, taste reactivity ¹²³	• Rodents, tracing, pain affect ¹²⁴ • Humans, μ -opioid PET, sustained pain ¹²⁵
Thalamus	• Humans, H ₂ O PET, chocolate reward ¹¹⁵	• Humans, fMRI, placebo analgesia ¹⁰⁶
Hypothalamus	• Humans, H ₂ O PET, pleasurable music ¹¹⁷	• Rodents, tracing of nociceptive pathway ¹²⁶ • Humans, direct brain stimulation ¹²⁷
Midbrain	• Humans, H ₂ O PET, chocolate reward ¹¹⁵ • Humans, H ₂ O PET, pleasurable music ¹¹⁴	• Humans, fMRI, anticipation of pain ¹²⁸ • Humans, fMRI, pain ¹²⁹
Amygdala	• Humans, H ₂ O PET, pleasurable music ¹¹⁴ • Primates, reward anticipation/learning ¹³⁰	• Humans, fMRI, pain ^{102,103} • Humans, fMRI, anticipation of pain ¹²⁸
Hippocampus	• Humans, fMRI, unexpected reward ¹³¹ • Humans, H ₂ O PET, pleasurable music ¹¹⁴	• Humans, fMRI, pain ¹³²
Cerebellum	• Humans, fMRI, unexpected reward ¹³³	• Humans, fMRI, pain ¹³³
Brainstem	• Rodents, taste reactivity ¹³⁴ • Rodents, conditioned place preference ¹³⁵	• Humans, fMRI, pain ¹³³ • Rodents, pain ¹³⁶

Leknes 2008



Sadness-Cognition

Happiness-Cognition



Why pleasure and pain ?

Pleasure and displeasure are signs of physiological usefulness of a stimulus

"joy and sorrow are the distinguishing mark of things beneficial and harmful"
(Democritus)

Pleasure is force that orients behavior to approach and consume stimulus

"one may also think that, if all humans seek pleasure, that is because they desire to live" (Aristotle)

Brain has to calculate priority between multiple simultaneous needs and stimuli, thus it requires common currency to compare needs and stimuli (McFarland 1975)

Pleasure is the common currency (Cabanac 1992)

Pleasure is motivational capacity of consciousness

Helen of Troy's beauty has launched a thousand ships and caused a war (Homer, 8th cBC)

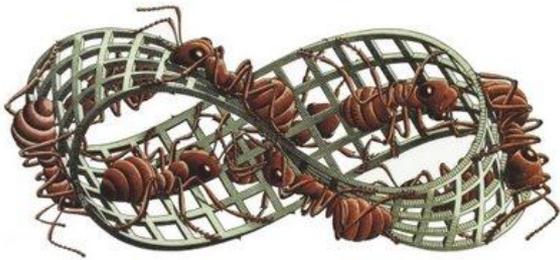


Context and pleasure

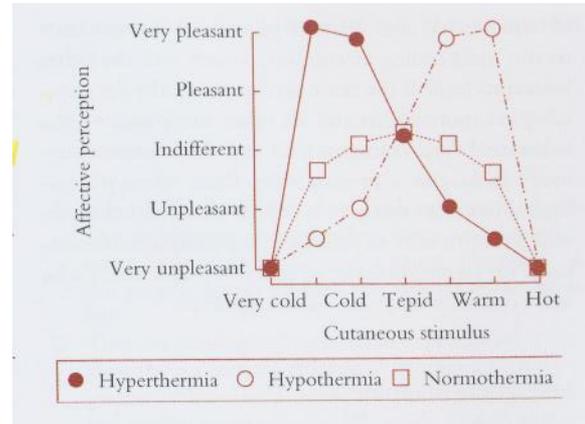
Pleasure and pain depend on context

Heat stimulus is pleasant when it is cold, but unpleasant when is hot (Mower 1976)

Mechanism of hedonic homeostasis



SM: masochists derive pleasure from receiving pain, but only certain kinds of pain in certain situations



Desire and pleasure

Happiness = **pleasure** without **desire** ?

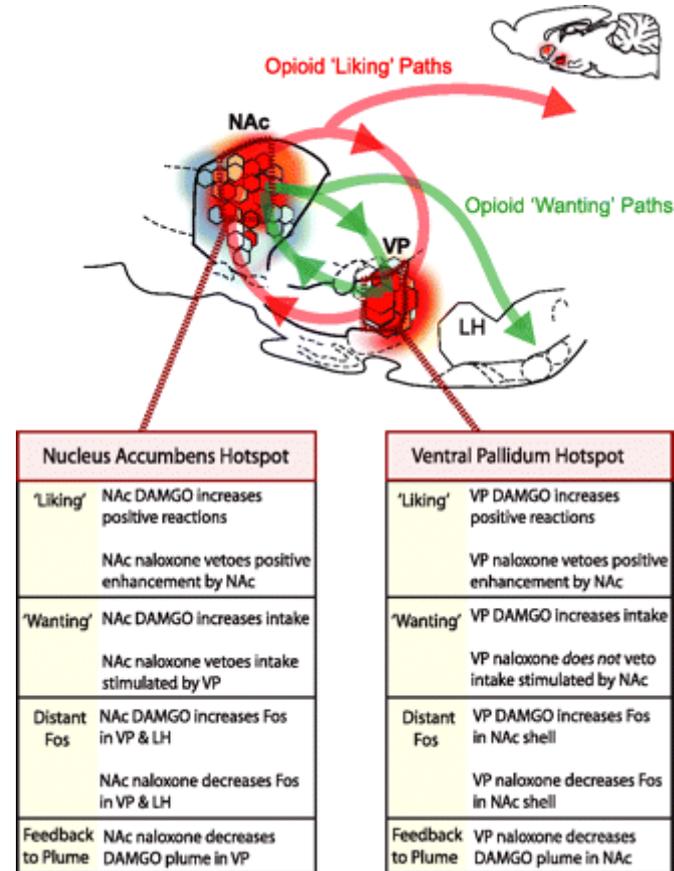
Dopamine system encodes **desire / motivation** (Berridge 2007)

Opioid system encodes **pleasure** (and desire) (Smith 2007)

Nacc + VP = liking

Nacc – VP = wanting

Orbitofrontal cortex, has connections to both the opioid and dopamine systems

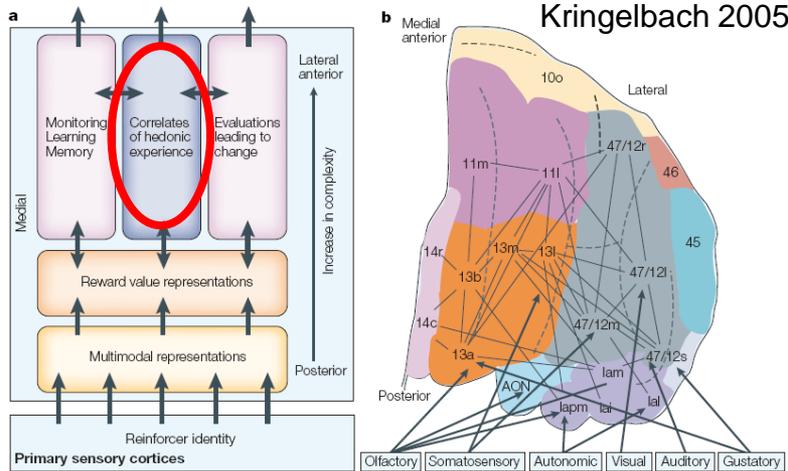


Smith and Berridge 2007

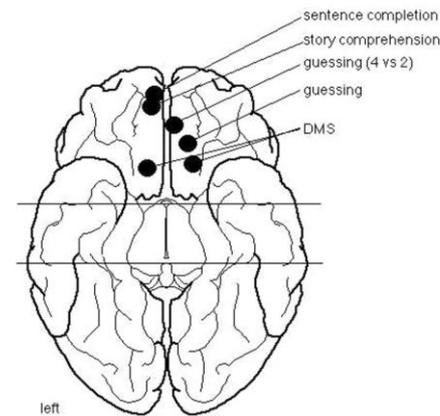
Orbitofrontal cortex function

Links reward to hedonic experience

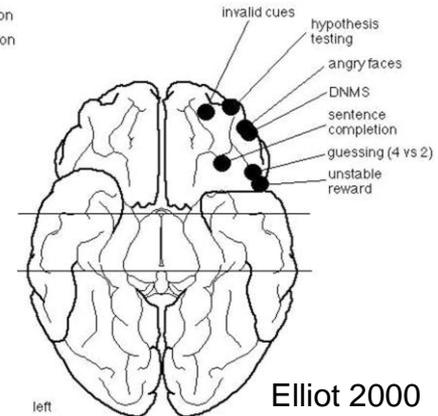
lateral OFC is activated when the tendency to select previously rewarded responses has to be overridden



Tasks activating medial OFC



tasks activating lateral OFC



Elliot 2000

Reward in art

Reward circuit in art (Lacey 2011)

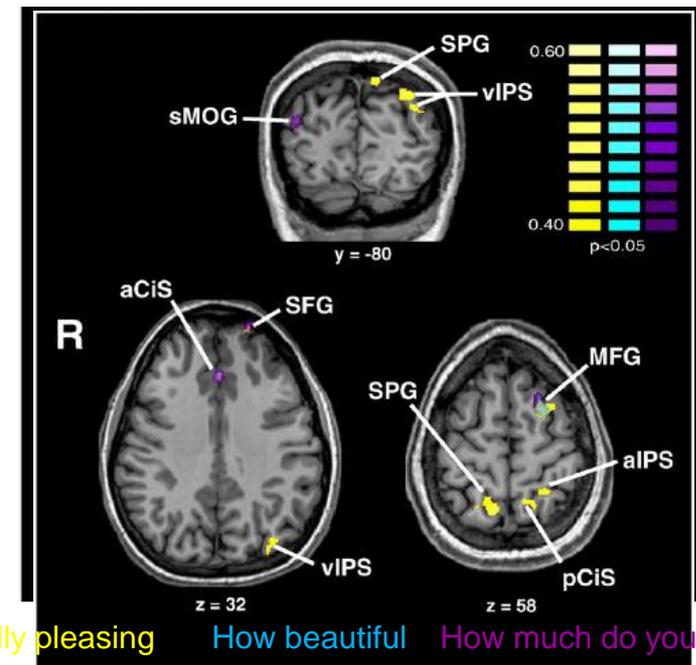
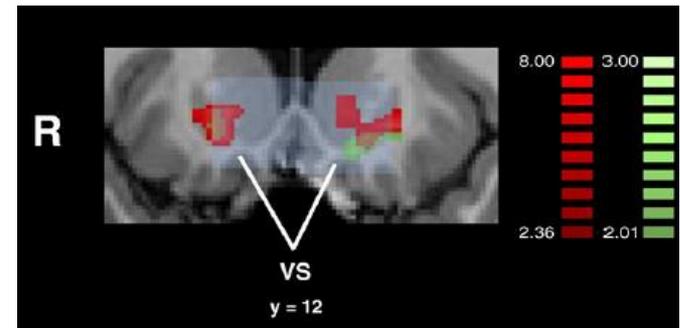
the appeal of visual art involves activation of reward circuitry

based on artistic status alone (ie is specific for art)

independently of its hedonic value

Analogous to Kant “Beauty pleases immediately...apart from all interest”

Might explain the ‘art infusion’ effect (Hagtvedt 2008): products sell better when advertised with art

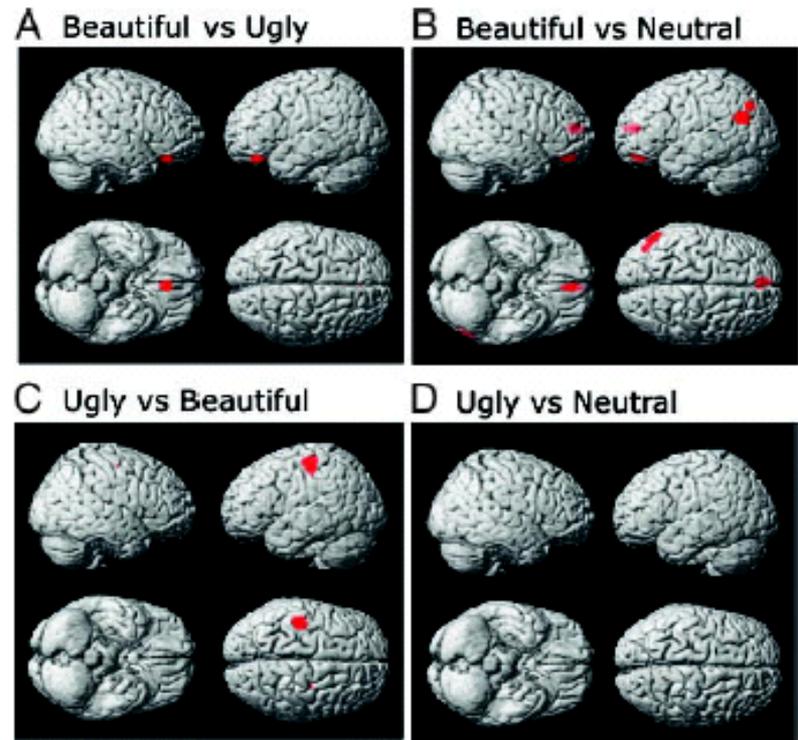
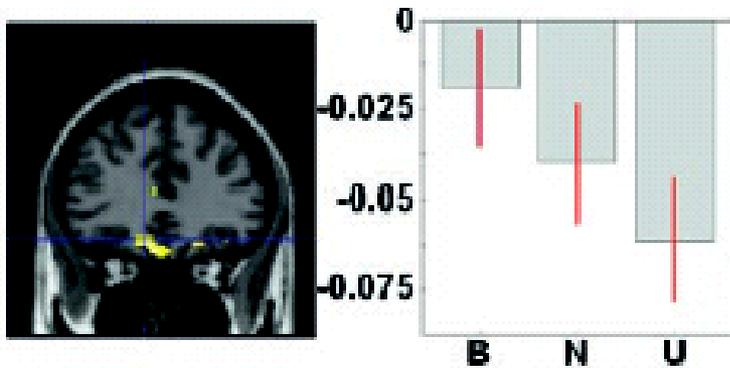


How esthetically pleasing How beautiful How much do you like it

Beauty in Art

Neural correlates of beauty in art

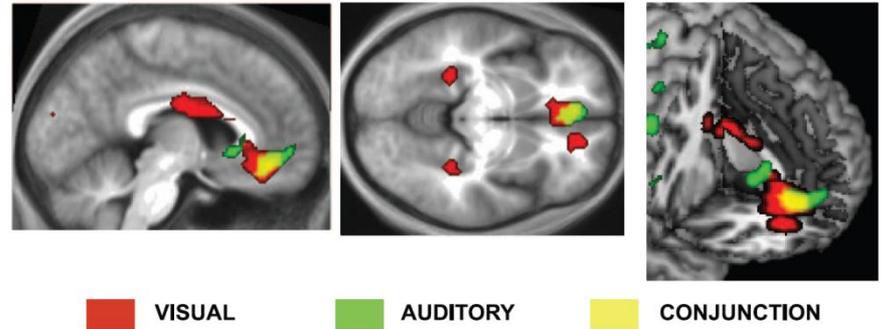
Orbitofrontal activity **differs**
between beauty and ugly
irrespective of kind of painting



Beauty in Art

Neural correlates of beauty in art

Orbitofrontal activity correlates
with **intensity of beauty**
irrespective of kind of art
(paintings & music) (Ishizu 2011)

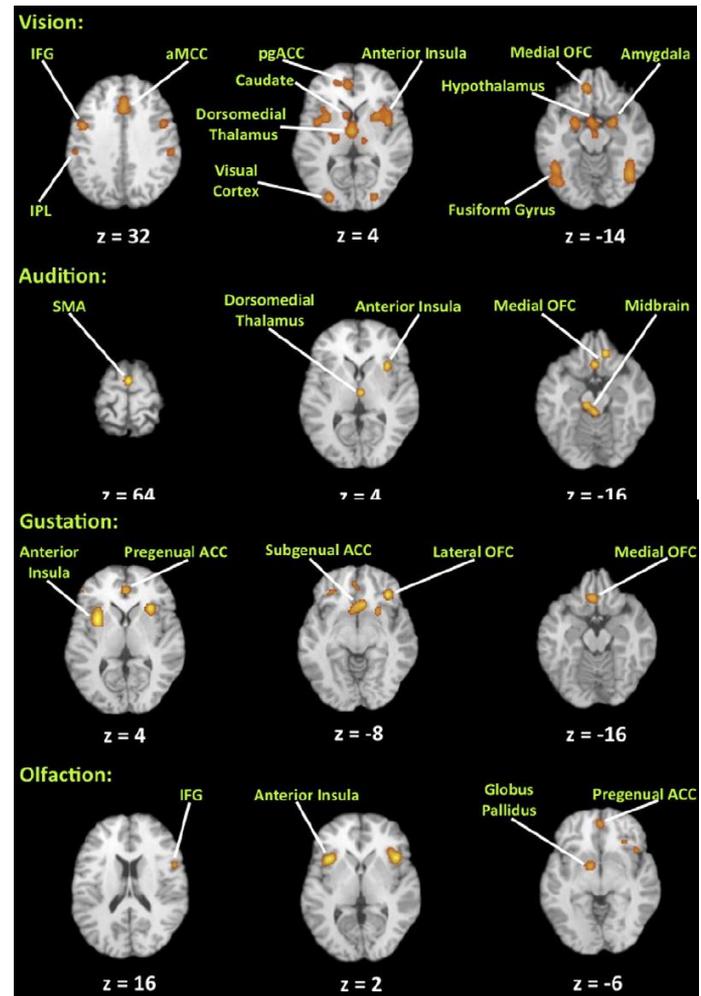


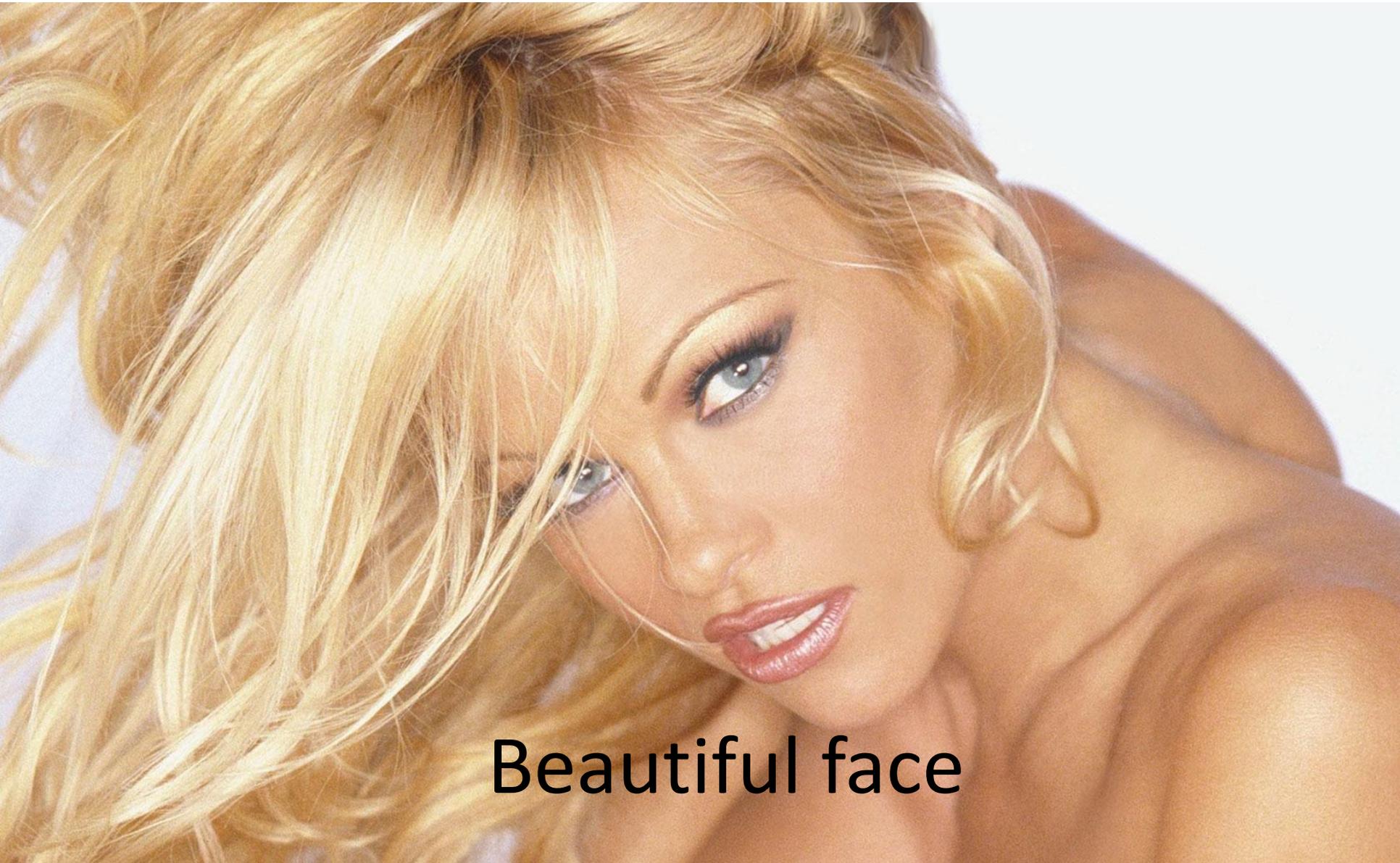
Universal network activity for beauty ?

Aesthetic appraisal across senses
has overlapping network (Brown 2011)

Meta-analysis of 4 senses and
aesthetic appraisal

pgACC+insula +OFC





Beautiful face

Beautiful faces

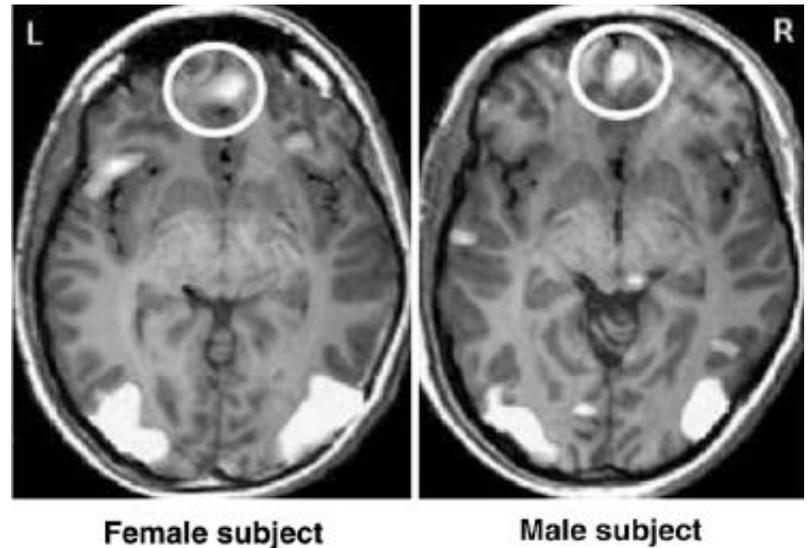
Sex and beautiful faces (Ishai 2007)

Medial orbitofrontal cortex

In heterosexual women and homosexual men, attractive male faces elicited stronger activation than attractive female faces, whereas

In heterosexual men and homosexual women, attractive female faces evoked stronger activation than attractive male faces

mOFC represents the value of salient sexually-relevant faces, irrespective of their reproductive fitness

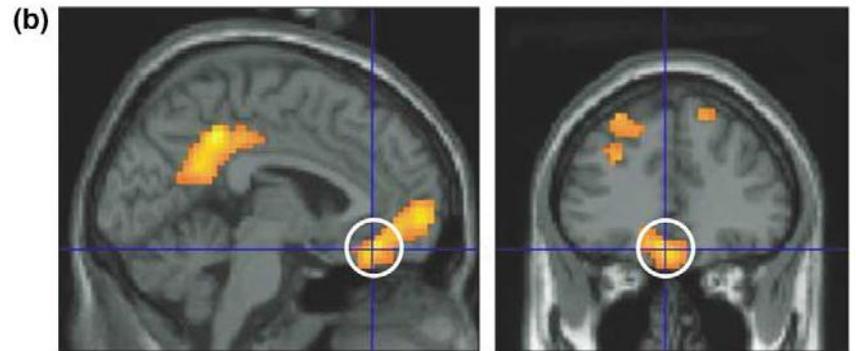
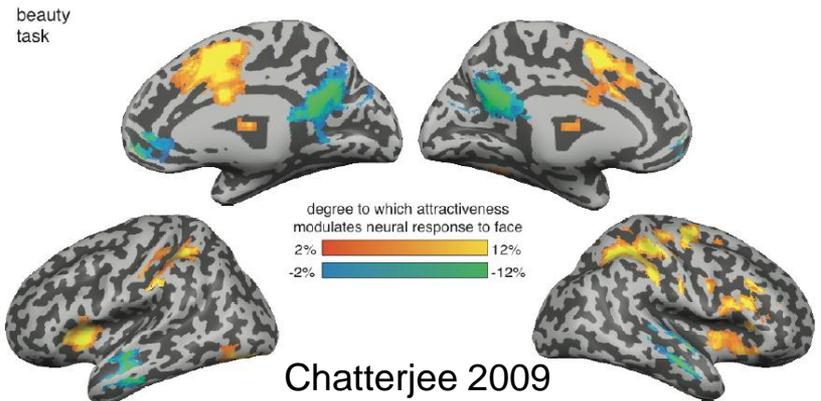


Attractiveness of faces

Facial attractiveness activates

(Aharon 2001; Kranz 2006; McClure 2003; O'Doherty 2003; Rolls 2000, Ishai 2007, Coultier 2008, Winston 2007, Chatterjee 2009)

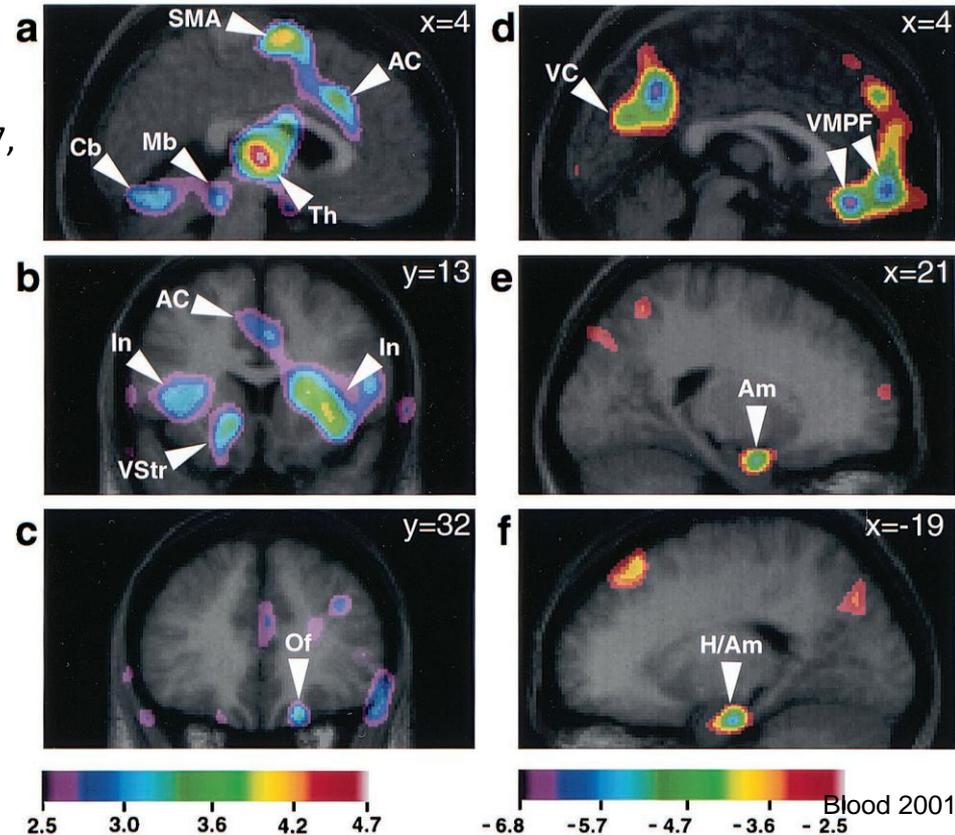
- Nucleus accumbens (reward)
- +
- Amgydala right/bilateral
- Insula and ACC bilateral
(emotion/salience/ANS)
- +
- Medial OFC left (hedonic/beauty)
- +
- vmPFC right/left
- PCC
- STS bilateral (self-perception)
- +
- DLPFC-Parietal control network



Art imitates nature (Aristotle, Poetics)

Facial attractiveness activates (Aharon 2001; Kranz 2006; McClure 2003; O'Doherty 2003; Rolls 2000, Ishai 2007, Coultier 2008, Winston 2007, Chatterjee 2009)

- Nucleus accumbens (reward)
- +
- Amgydala, Insula and ACC (emotion/salience/ANS)
- +
- Medial OFC (hedonic/beauty)
- +
- vmPFC , PCC, STS bilateral (self-perception)
- +
- DLPFC-Parietal control network



Beauty in music activates similar network (Blood 1999, 2001, Koelsch 2005, Brown 2004, Menon 2005), without self-perception network but with auditory areas instead of visual areas

Beauty & sex

Evolution

Natural selection

Sexual selection

= effects of the struggle between the individuals of one sex, generally the males, for the possession of the other sex (Darwin 1871)

Traits are costly (Zahavi 1975)

Signal superior genetic quality

“I have survived in spite of this huge tail, hence I am fitter and more attractive than others”

Investing in beauty

Darwinian aesthetics = sexual selection and biology of beauty (Grammer 2003)



“The sight of a feather in a peacock’s tail, whenever I gaze at it, makes me sick!”

Handicap principle

Handicap principle (Zahavi 1975)

Reliable signals must be **costly** (wasteful, useless,...) to the signaler, costing the signaler something that could not be afforded by an individual with less of a particular trait

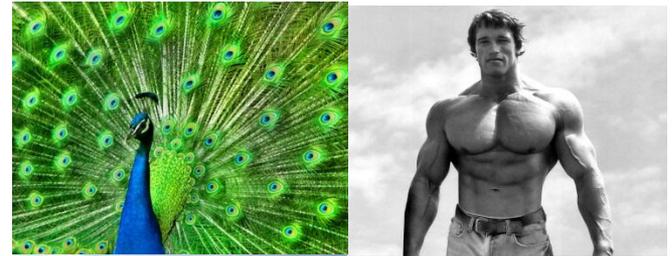
Animals of greater biological fitness signal this status through handicapping **behaviour** or **morphology** that effectively lowers this quality

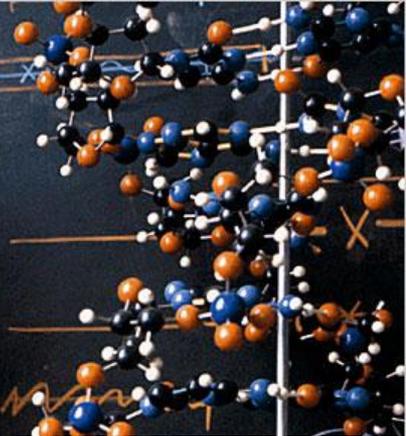
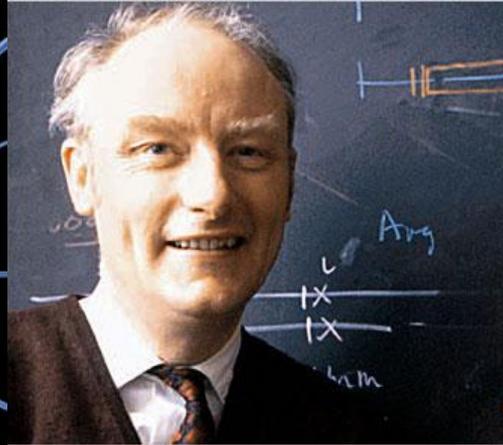
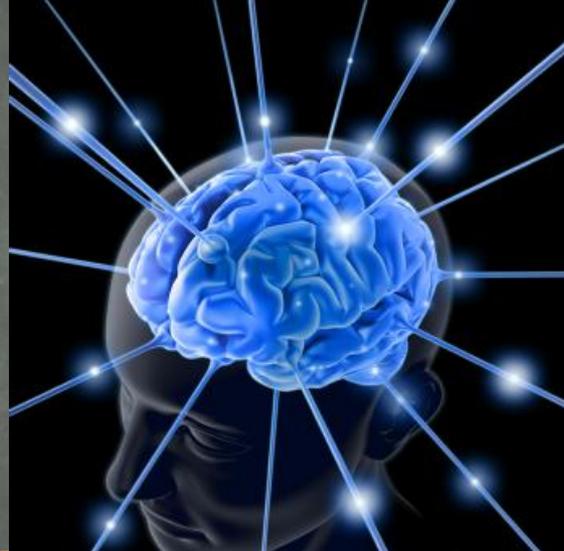
Morphology

- Peacock's tail
- Obesity or body building
- Signs of intelligence
- ...

Behaviour

- Signs of wasteful wealth: expensive cars, jewelry, art, ...
- Time
- Charity





Sexual selection



Highest-ranked characteristics sought in a mate

Rank	Characteristics preferred by males	Characteristics preferred by females
1	Kindness and understanding	Kindness and understanding
2	Intelligence	Intelligence
3	Physical attractiveness	Exciting personality
4	Exciting personality	Good health
5	Good health	Adaptability
6	Adaptability	Physical attractiveness
7	Creativity	Creativity
8	Desire for children	Good earning capacity
9	College graduate	College graduate
10	Good heredity	Desire for children
11	Good earning capacity	Good heredity
12	Good housekeeper	Good housekeeper
13	Religious orientation	Religious orientation



Why does sexual selection favour intelligence ?

Two kinds of sexual selection (Darwin 1871)

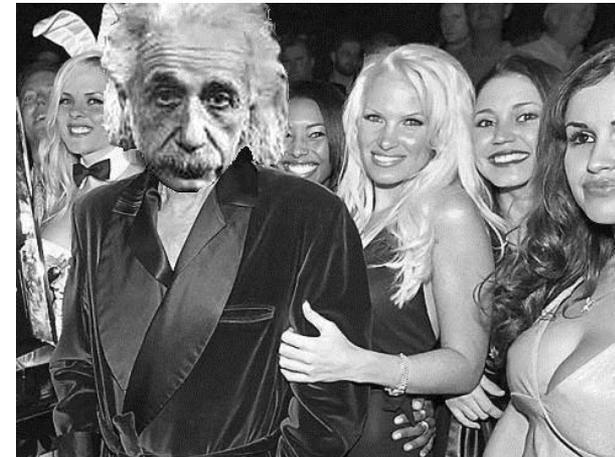
Intrasexual selection

fighting or other aggressive interactions between males
development of elaborate structures to serve as weapons



Intersexual selection

competition among males to attract the attention of females
development of structures or behaviors that attract females
Intelligence ?



Why does sexual selection favour intelligence ?

Why intelligence ? (Rozsa 2008)

Hamilton-Zuk parasite hypothesis (1982):

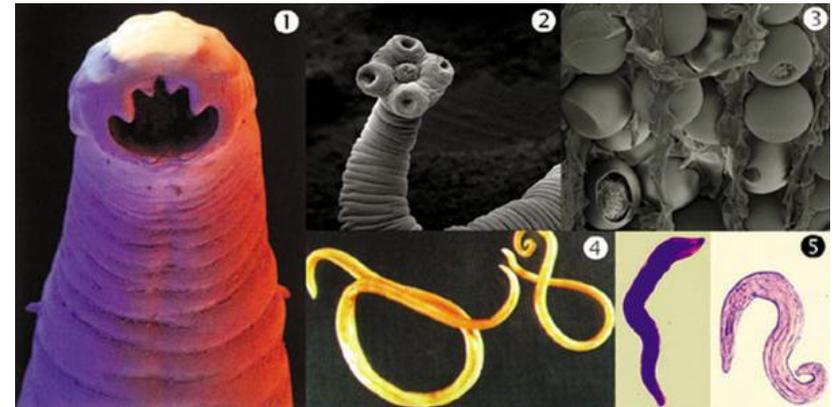
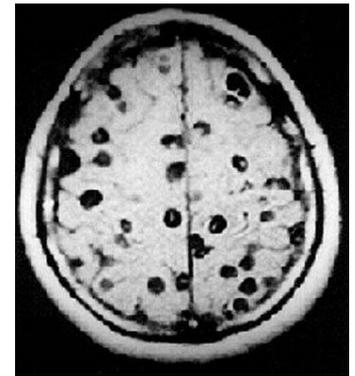
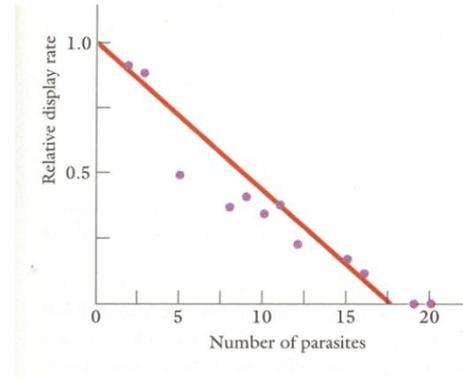
Females choose certain male traits as indicators of heritable parasite resistance

Humans are subjected to very strong selection pressures from pathogens and parasites

Brain is very vulnerable to infections

Human preference for intelligent mates signals genetic resistance against infections

Rise of human species is accidental side effect of this signalling function



Sexual arousal

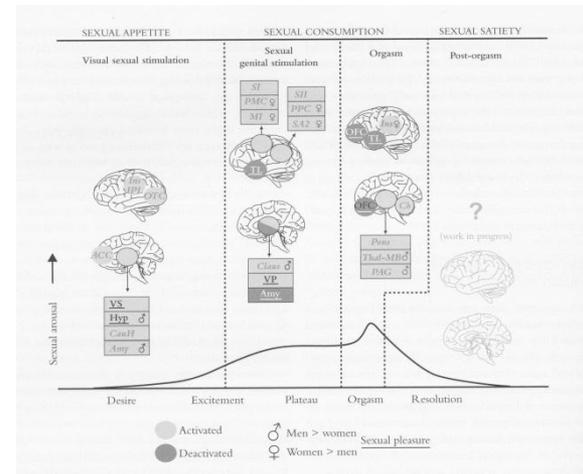
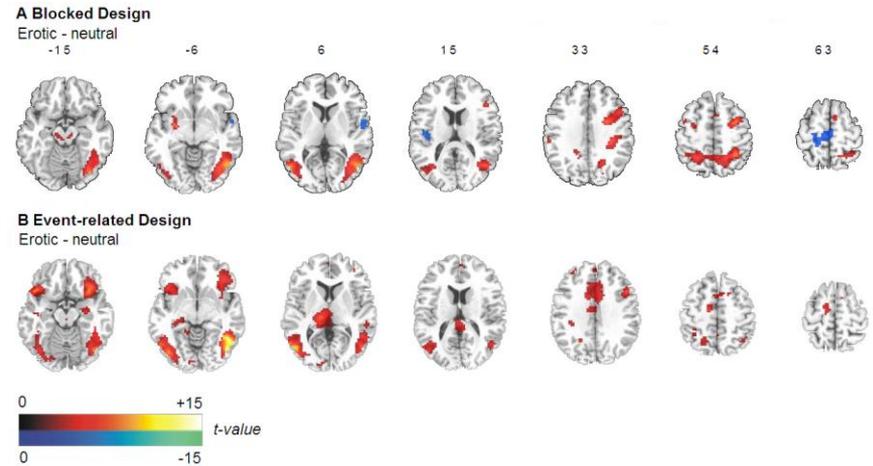
Not all studies demonstrate exactly same network

Males vs female (Karama 2002, Hamann, 2004, Rupp 2007, 2008)

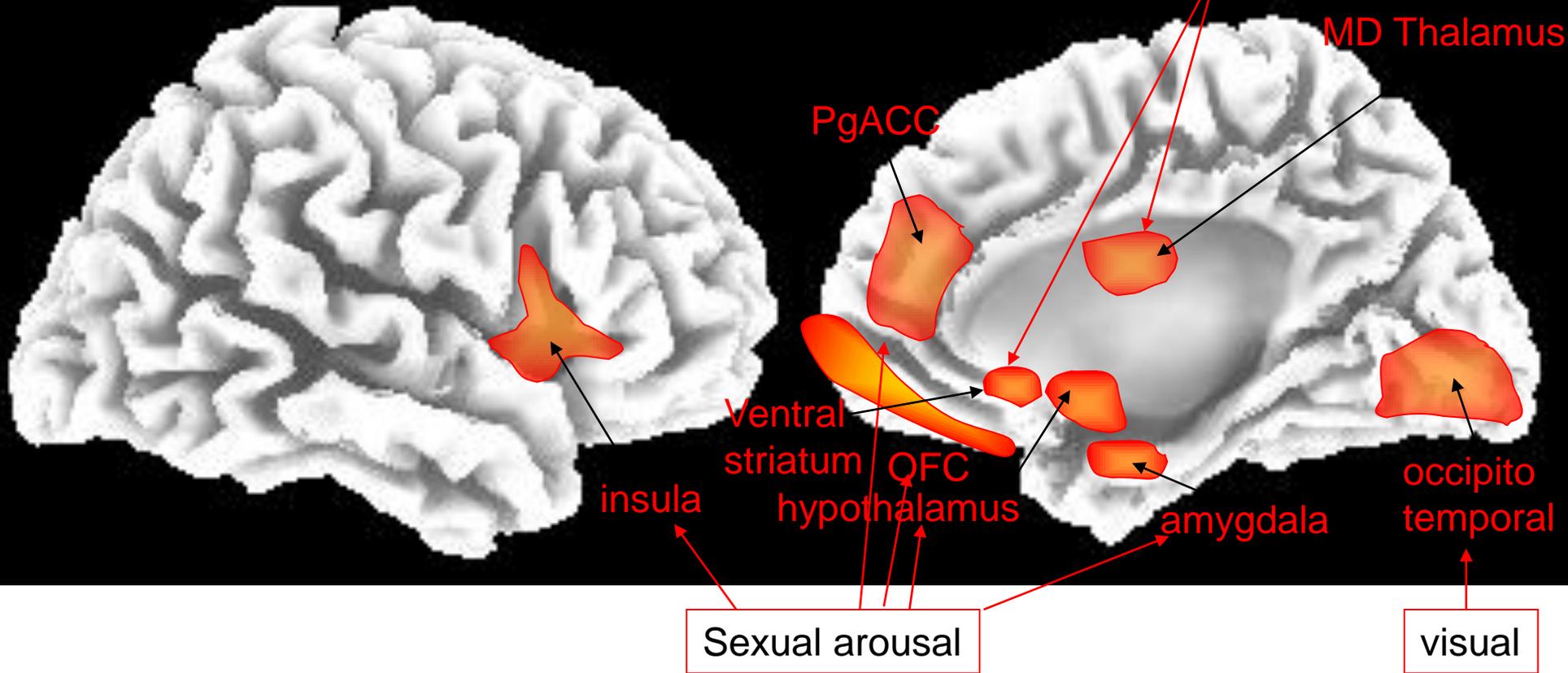
Different stimuli (erotic/porno)

Blocked vs event related differ in network (Bühler 2008)

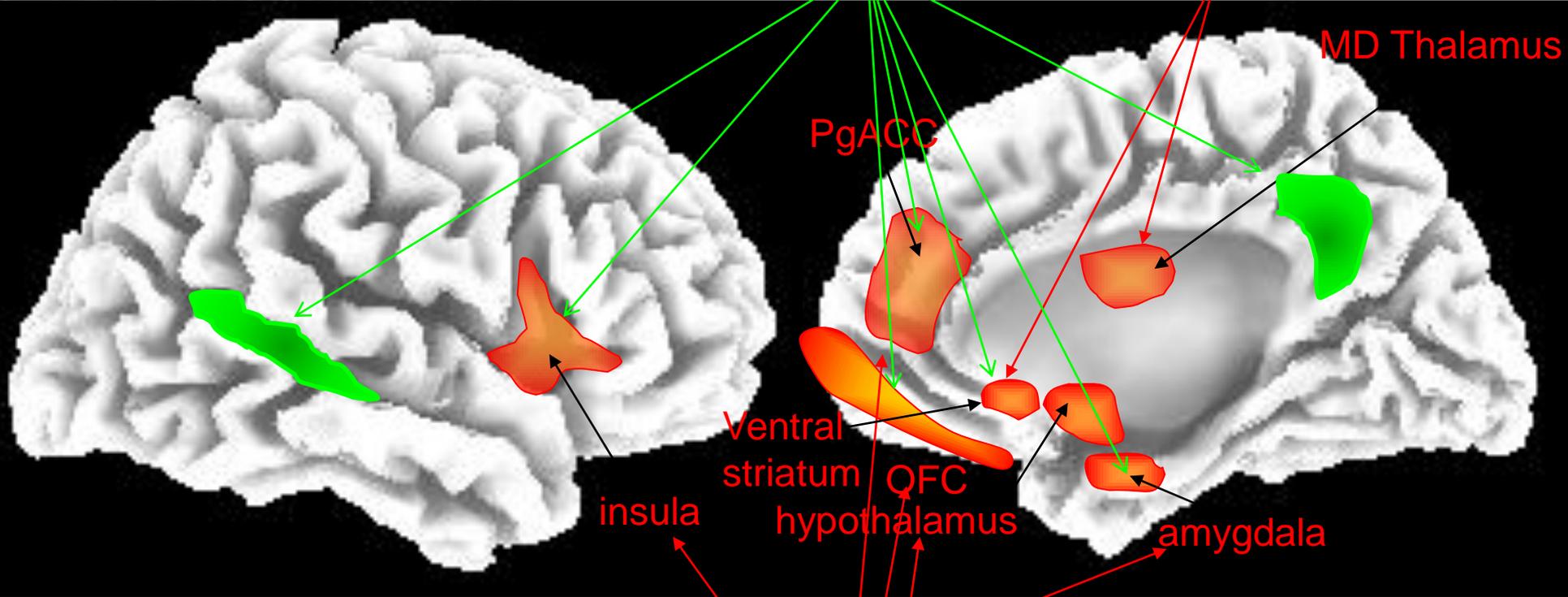
Activation depends on stage of sexual response (Georgiadis 2010)



Sexual arousal network



Sex & human beauty



Human beauty

reward

MD Thalamus

PgACC

Ventral striatum

OFC

hypothalamus

amygdala

insula

Sexual arousal

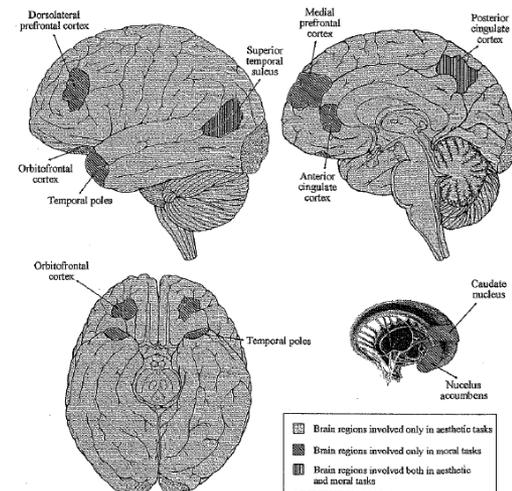
Is beauty goodness ?

Plato's trinity of truth, goodness and beauty

Beautiful people are considered good and accurate (Lorenzo 2010) because beauty is desired (healthy) (Lemay 2010)

"The falseness of a judgment is to us not necessarily an objection to a judgment... The question is to what extent it is life-advancing, life-preserving, species-preserving, perhaps even species-breeding..." (Nietzsche, Beyond good and evil)

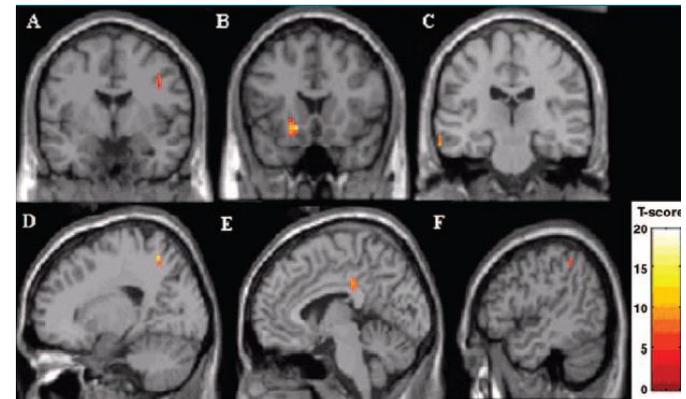
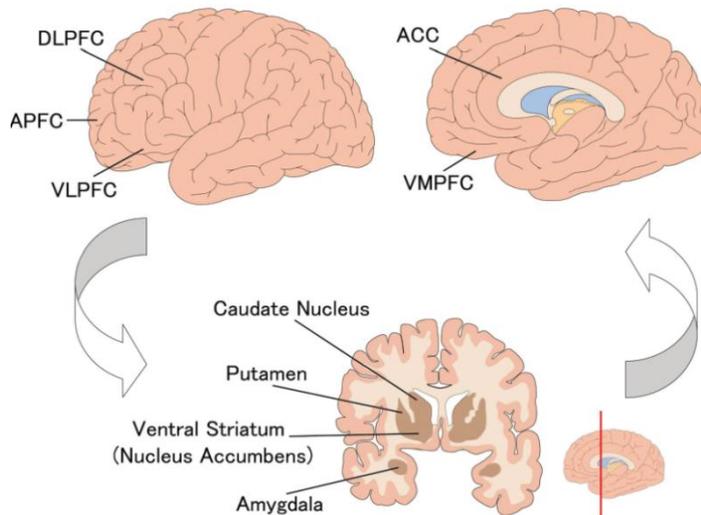
Networks for morality and aesthetical appraisal overlap (Zaidel 2011)



Is beauty truth ?

"Beauty is truth, truth beauty," that is all Ye know on earth, and all ye need to know (John Keats)

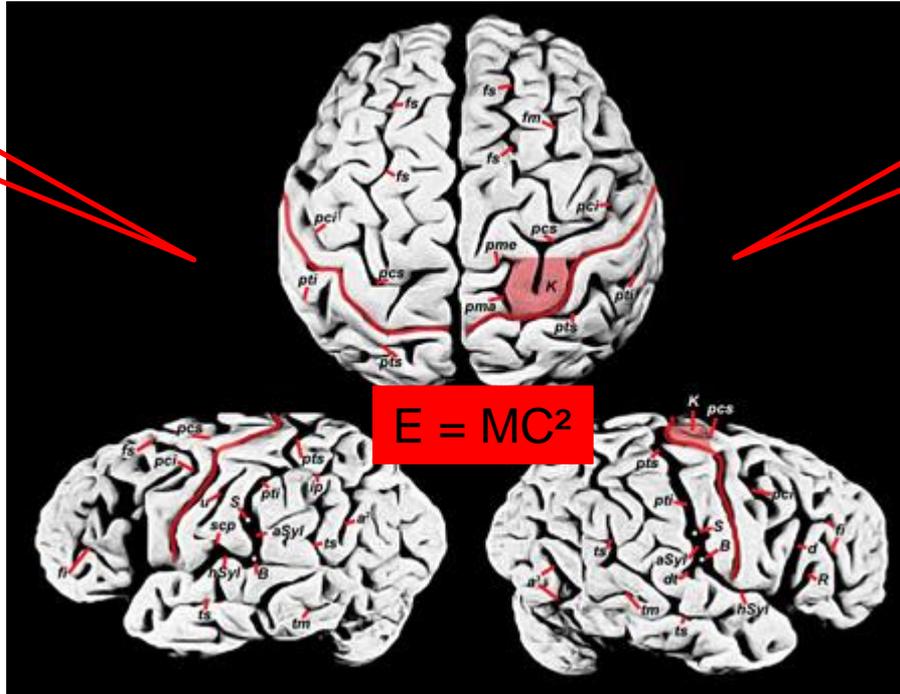
Truth is associated with left-sided PCC, sgACC, temporal, parietal areas (Mohamed 2006)



Einstein's brain

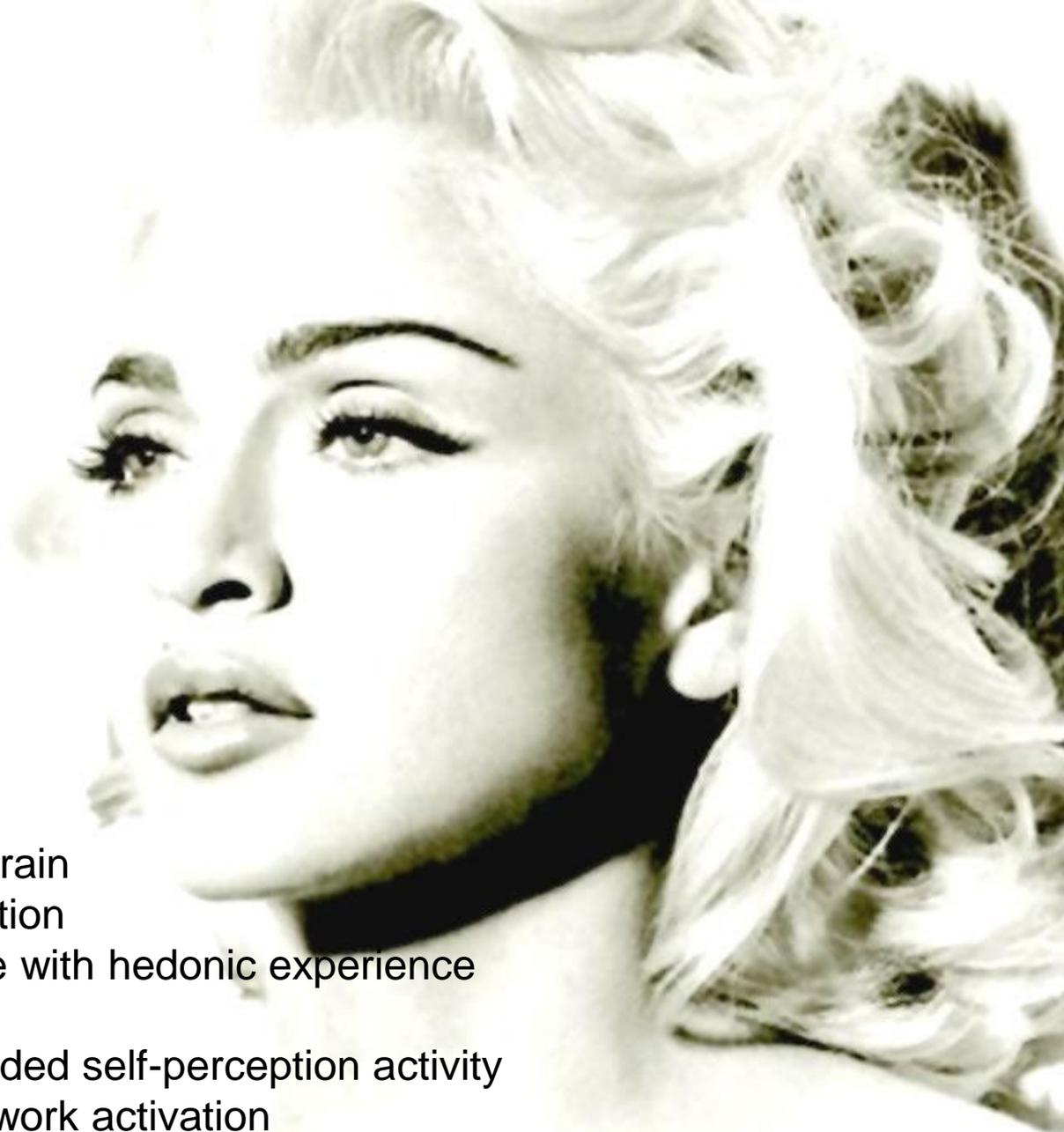
That's true !

That's beautiful !



$E=MC^2$ is true because it is so beautiful (Einstein)

Beauty is right sided version of leftsided truth
= internal consistency



Conclusion

Beauty is construct of brain
Related to sexual selection
Linking reward/pleasure with hedonic experience
Encoded in OFC
Beautiful faces have added self-perception activity
And sexual arousal network activation