Design &Health
International Academy for Design and Health

POLITECNICO MILANO 1863
DIPARTIMENTO DI ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO

Milano, Italy 11-14 April 2024

Design & Health

13TH WORLD CONGRESS & EXHIBITION

REVITALIZING HEALTH BY SALUTOGENIC DESIGN

Healthy environment | Healthy people

Neurobiological salutogenic mechanisms of architectural beauty

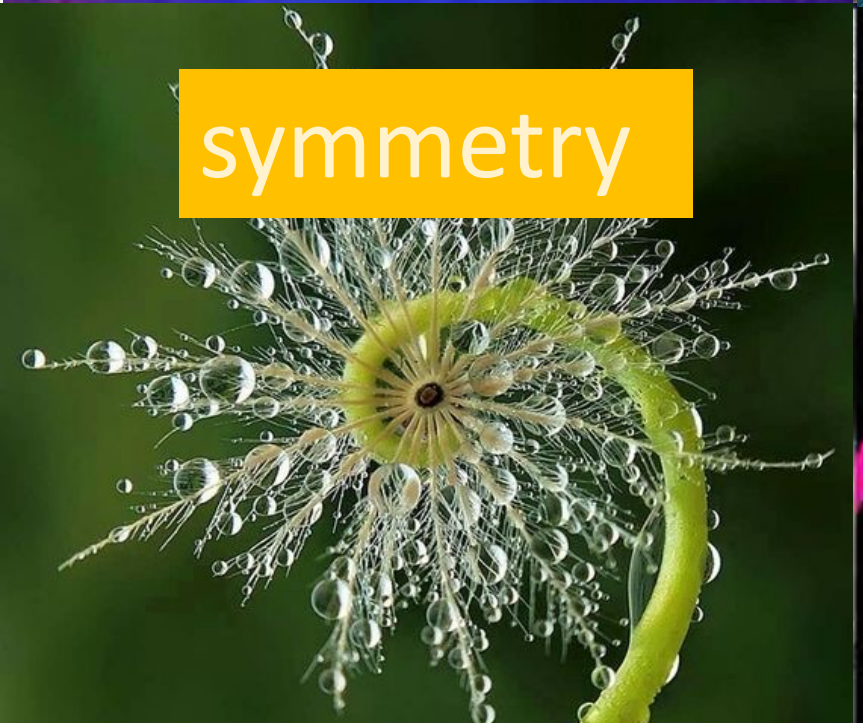
Enzo Grossi

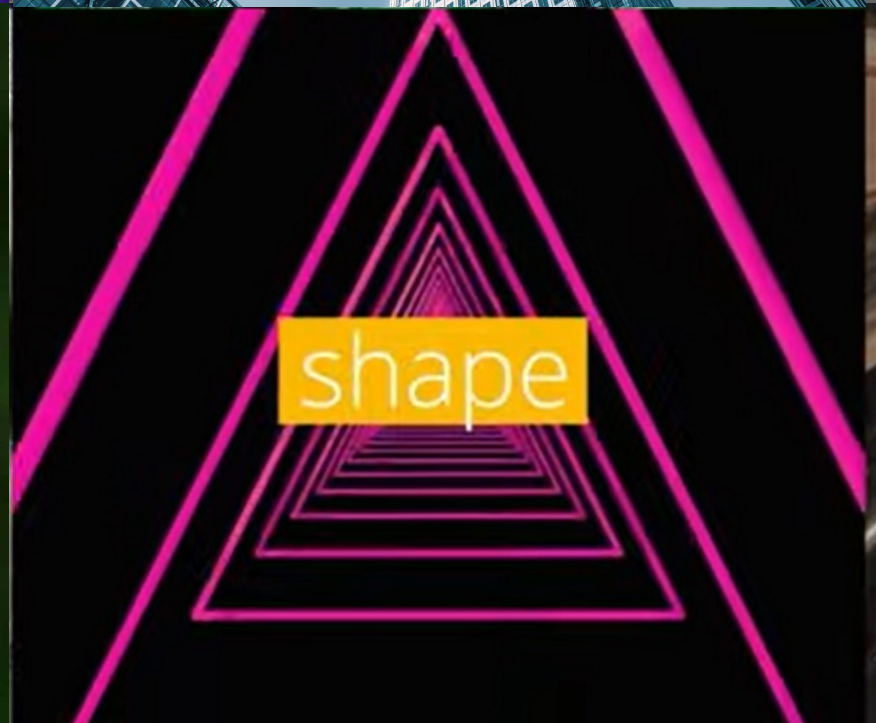
Bracco Foundation, Milano

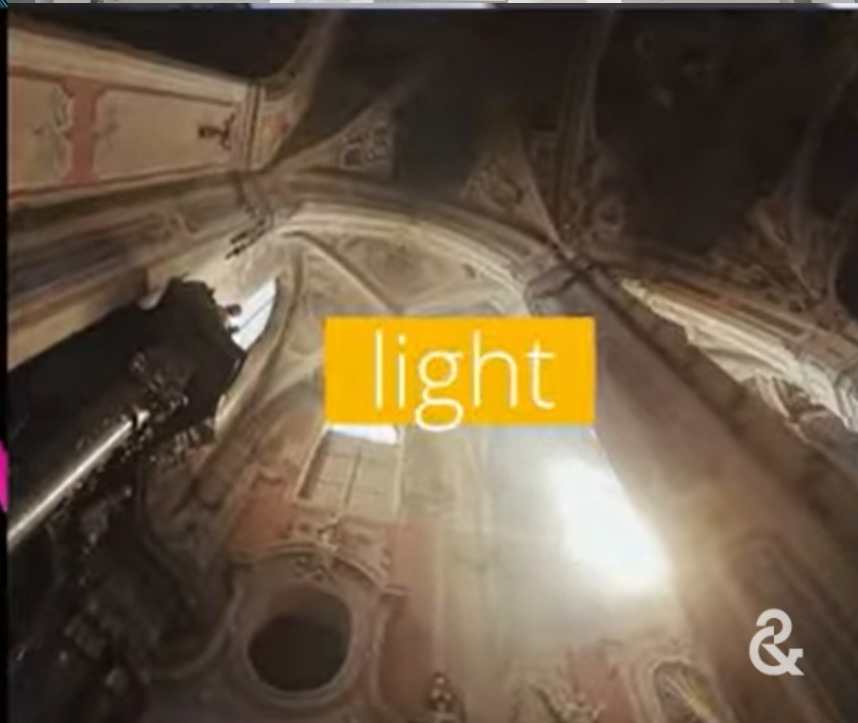

colour


proportion


direction


symmetry


shape


light

colour

proportion

direction

shape

symmetry

light

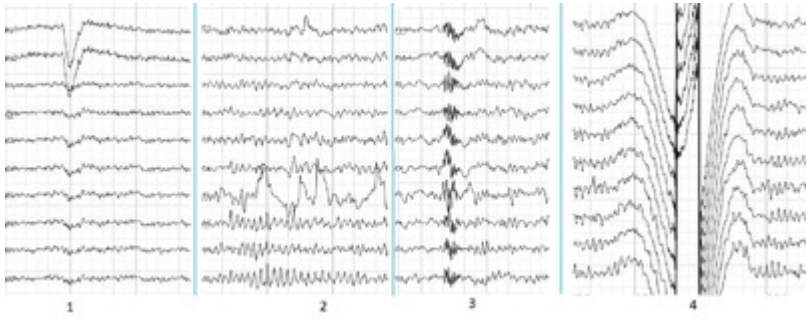
physiology

blood pressure

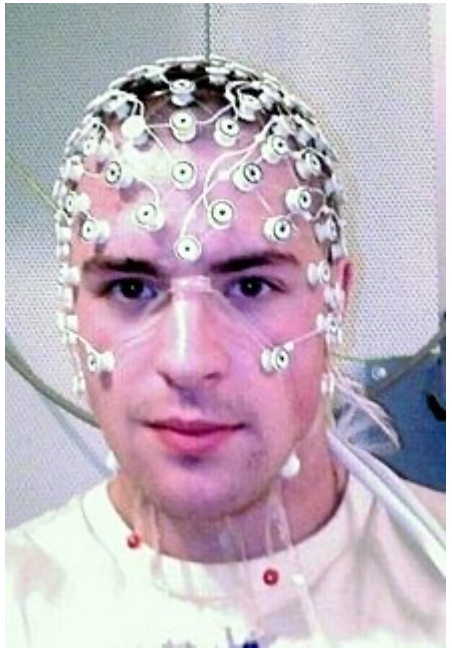
heart rate

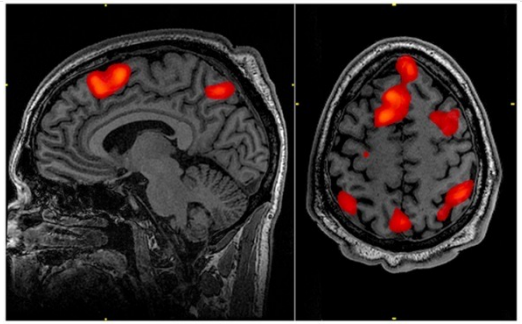
breathing

skin temperature



EEG

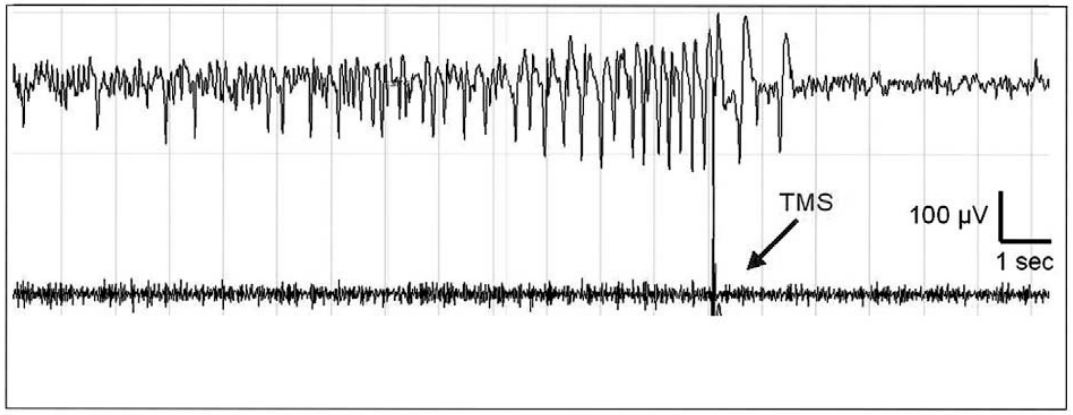


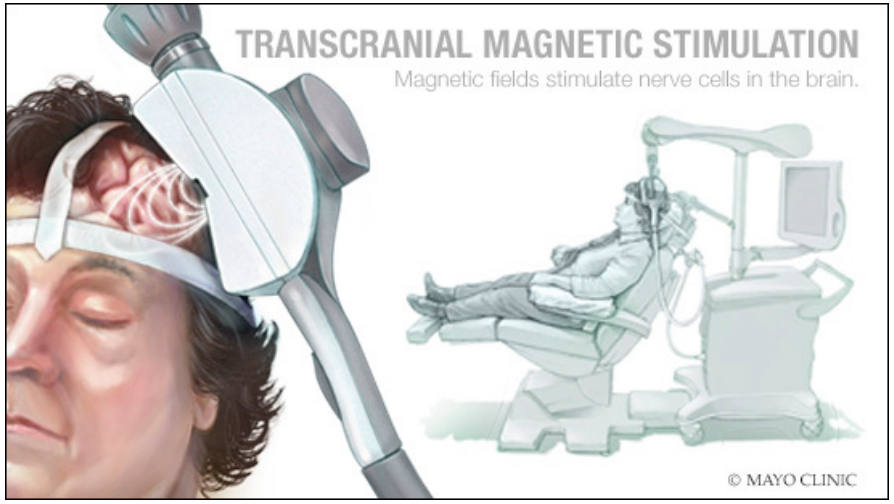


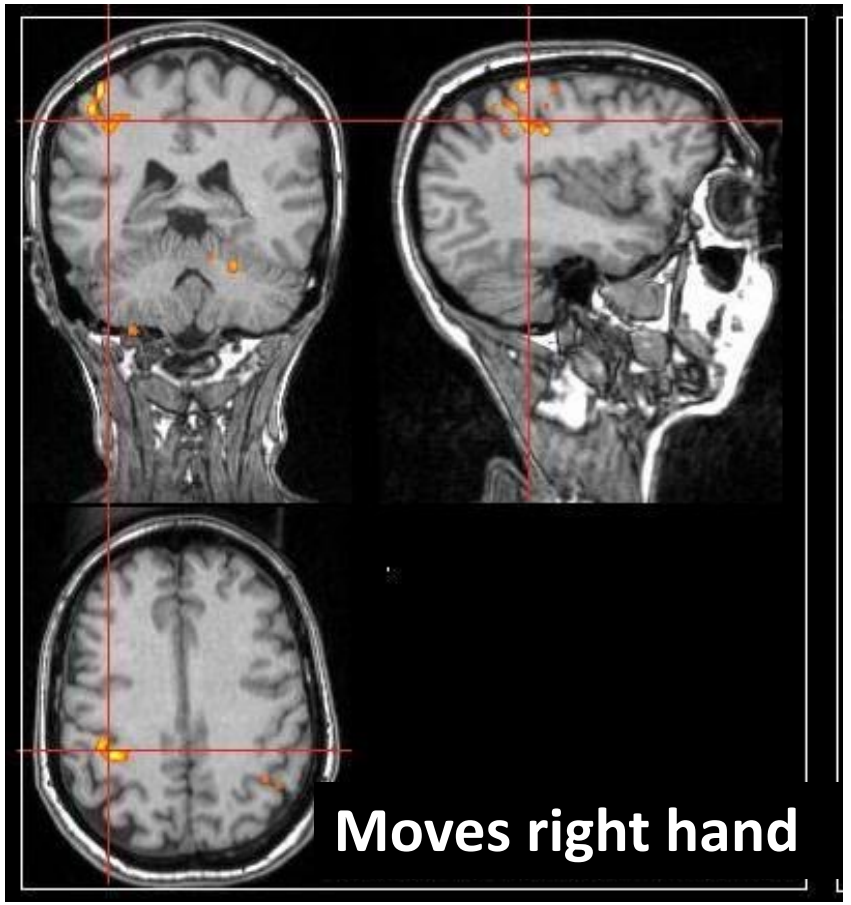
NEUROESTHAETICS

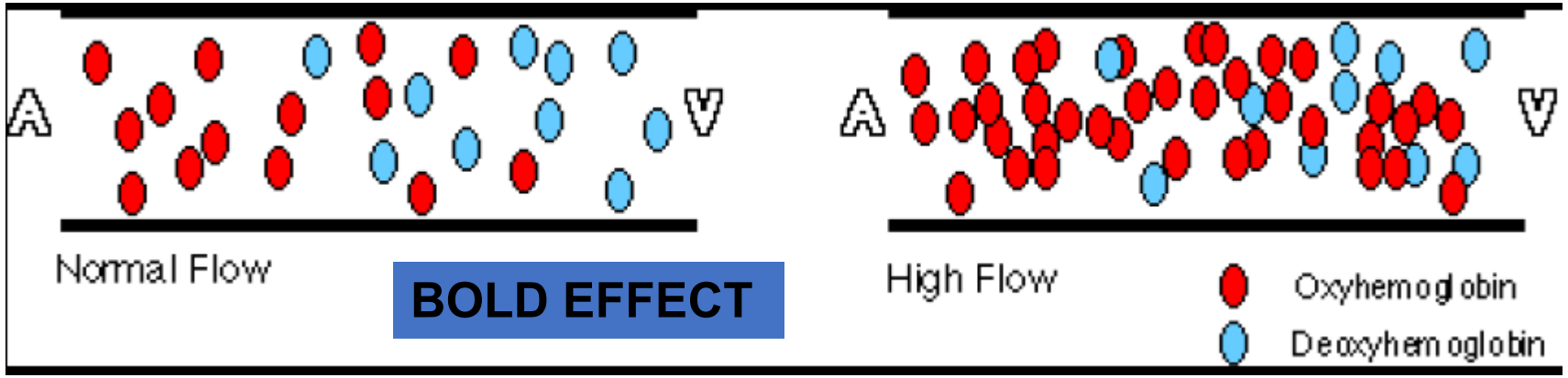
Perception, Emotion, Attention, Action following beauty stimuli

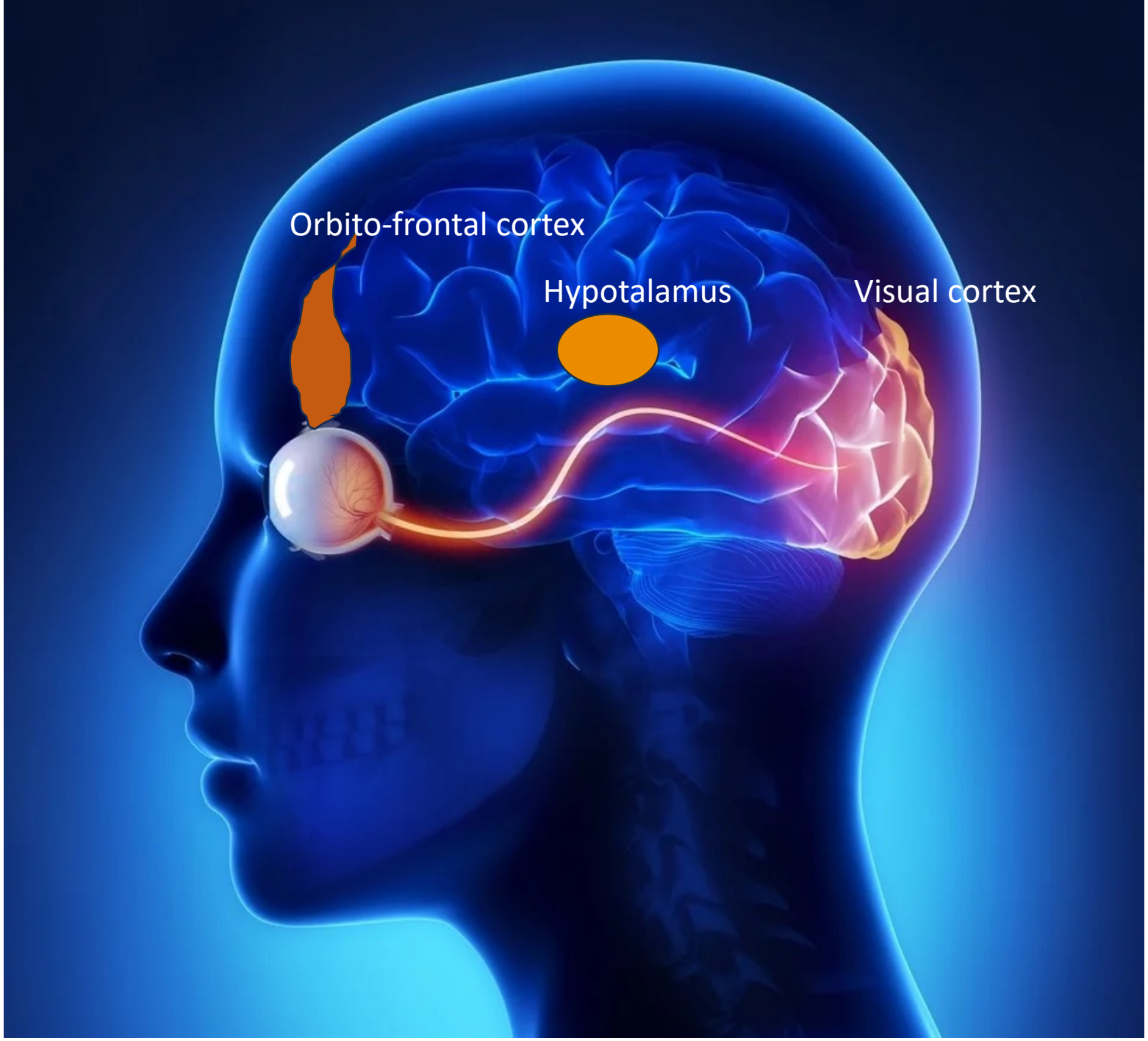
(a)






Moves right hand


A
V
Normal Flow
BOLD EFFECT
A
V
High Flow
Oxyhemoglobin
Deoxyhemoglobin


Orbito-frontal cortex
Hypotalamus
Visual cortex

Semir Zeki

Neural Correlates of Beauty

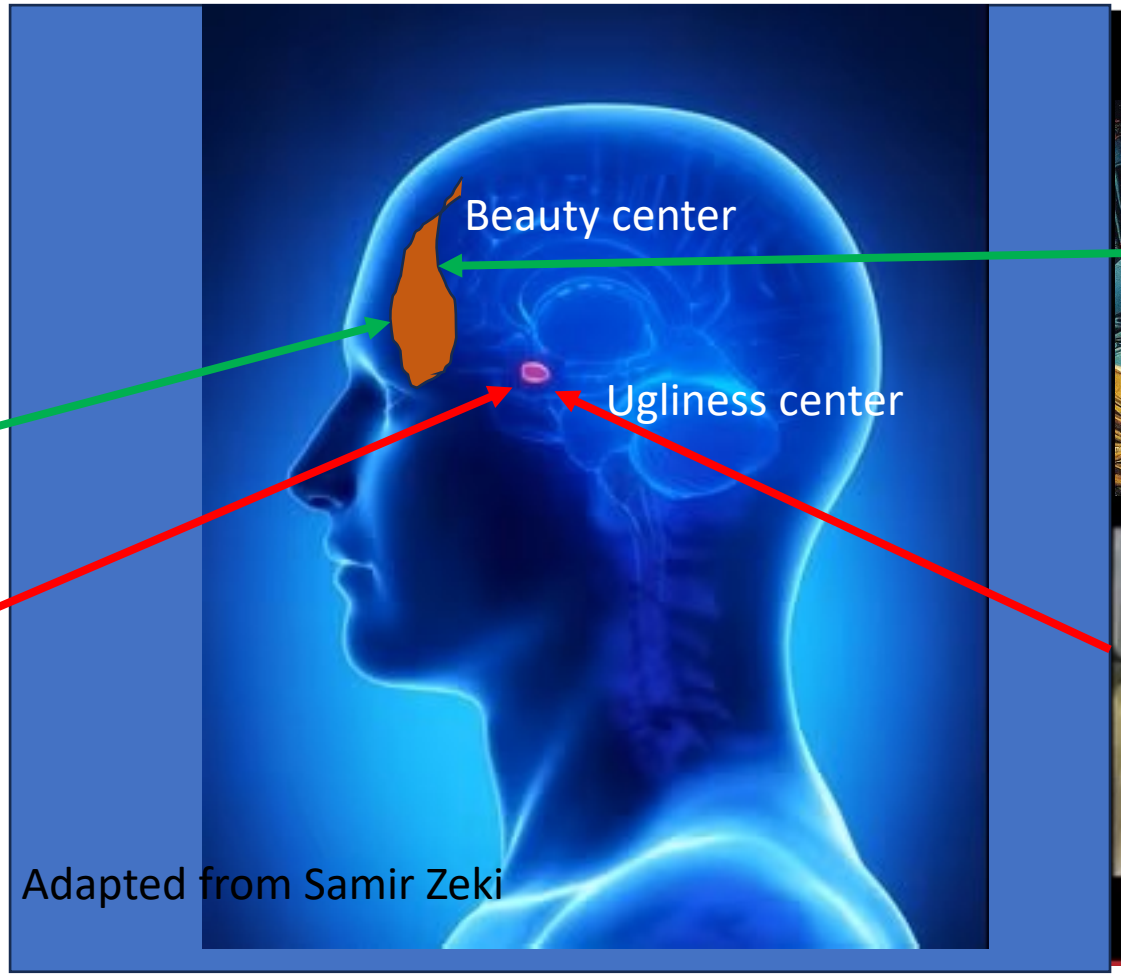
J Neurophysiol 91: 1699–1705, 2004;

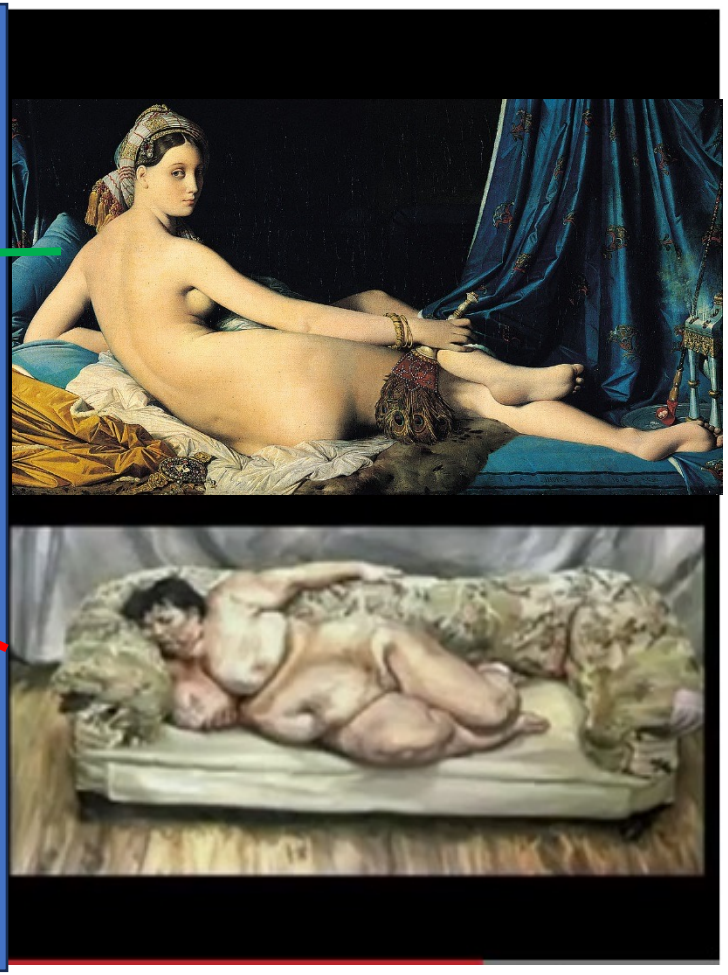
Hideaki Kawabata and Semir Zeki
Wellcome Department of Imaging Neuroscience, University College, London WC1E 6BT, United Kingdom

Submitted 18 July 2003; accepted in final form 20 November 2003

Area A1mOFC

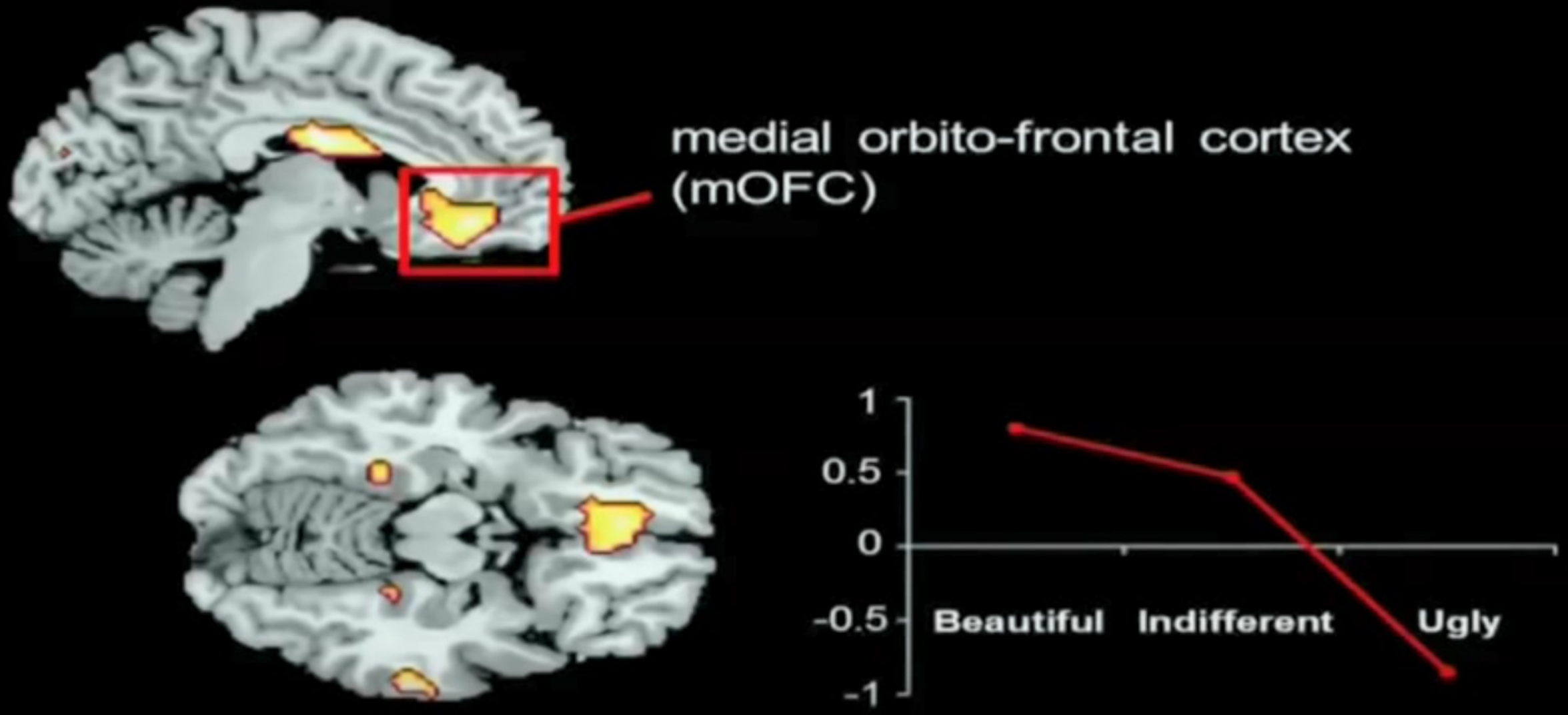
Amygdala





The neurobiology of beauty | Semir Zeki | TEDxUCL

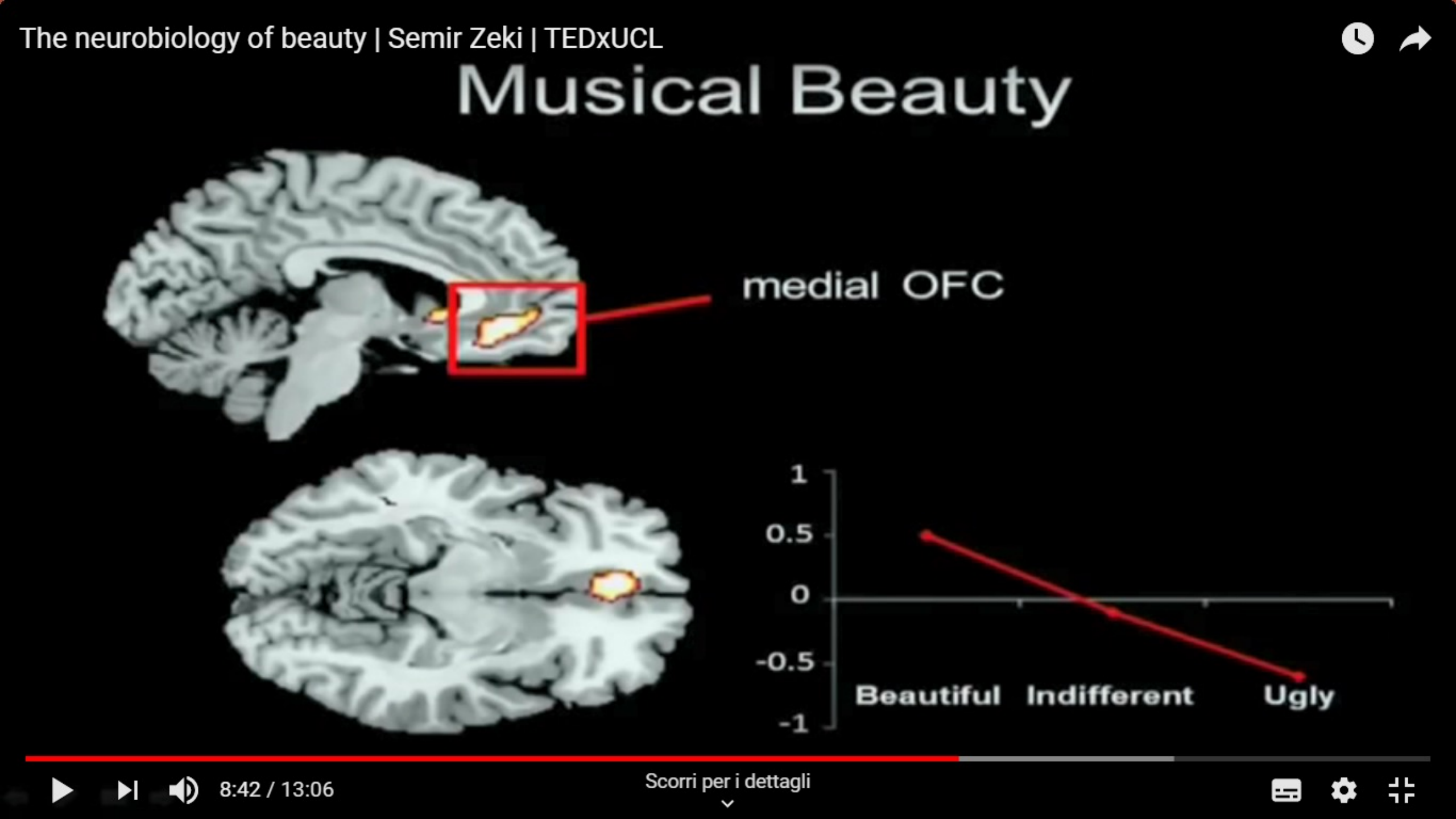
Visual Beauty



8:18 / 13:06

Scorri per i dettagli

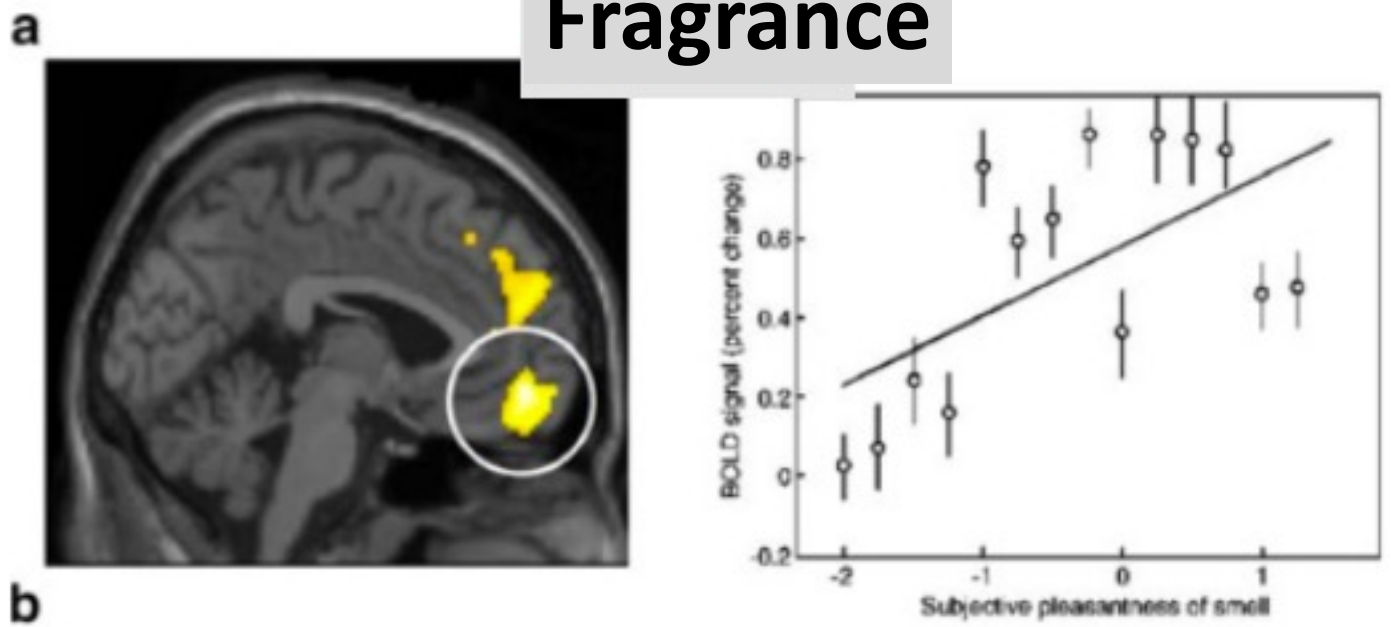
The neurobiology of beauty | Semir Zeki | TEDxUCL



8:42 / 13:06

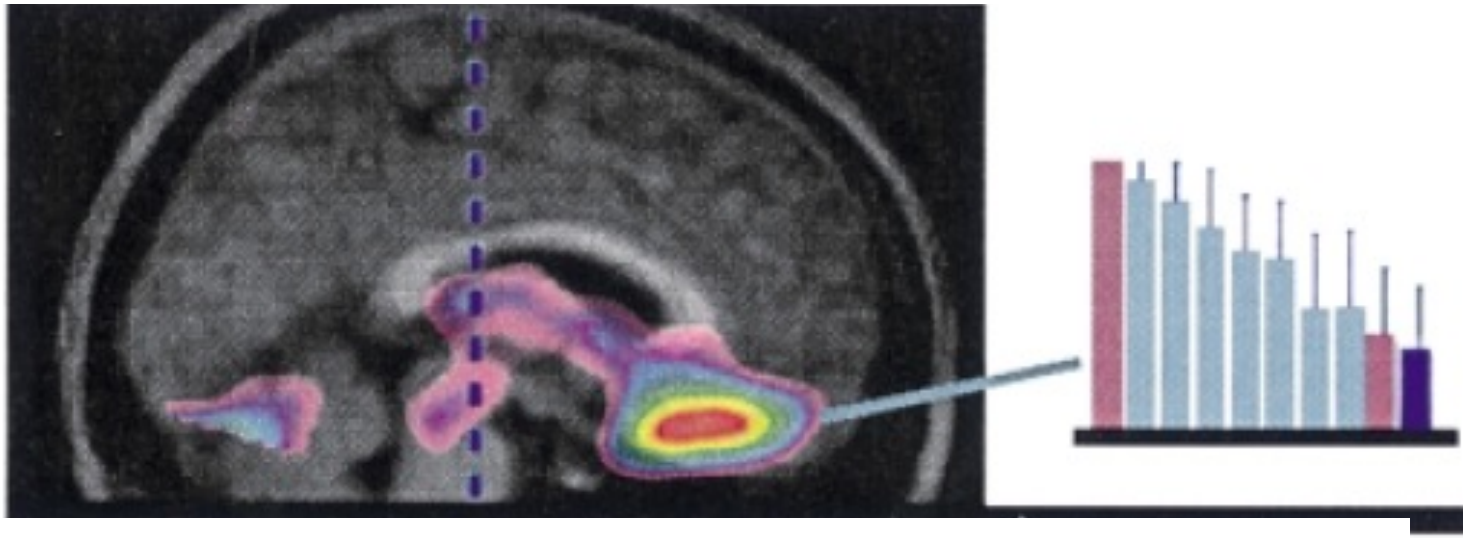
Scorri per i dettagli

Fragrance



Sound

TASTE



Brain (2001), **124,** 1720–1733

Changes in brain activity related to eating chocolate

From pleasure to aversion

Dana M. Small,[1,3] Robert J. Zatorre,[1] Alain Dagher,[2] Alan C. Evans[2] and Marilyn Jones-Gotman[1]

[1]*Neuropsychology/Cognitive Neuroscience Unit,*
[2]*McConnell Brain Imaging Center, Montreal Neurological Institute, McGill University, Montreal, Canada and*
[3]*Northwestern Cognitive Brain Mapping Group, Northwestern University School of Medicine, Chicago, USA*

Correspondence to: Dana M. Small, Northwestern Cognitive Brain Mapping Group, 320 East Superior St Searle 11-465, Chicago, IL 60611, USA
E-mail: d-small@northwestern.edu

frontiers in
HUMAN NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
published: 13 February 2014
doi: 10.3389/fnhum.2014.00068

The experience of mathematical beauty and its neural correlates

***Semir Zeki*[1]*, *John Paul Romaya*[1], *Dionigi M. T. Benincasa*[2] *and Michael F. Atiyah*[3]**

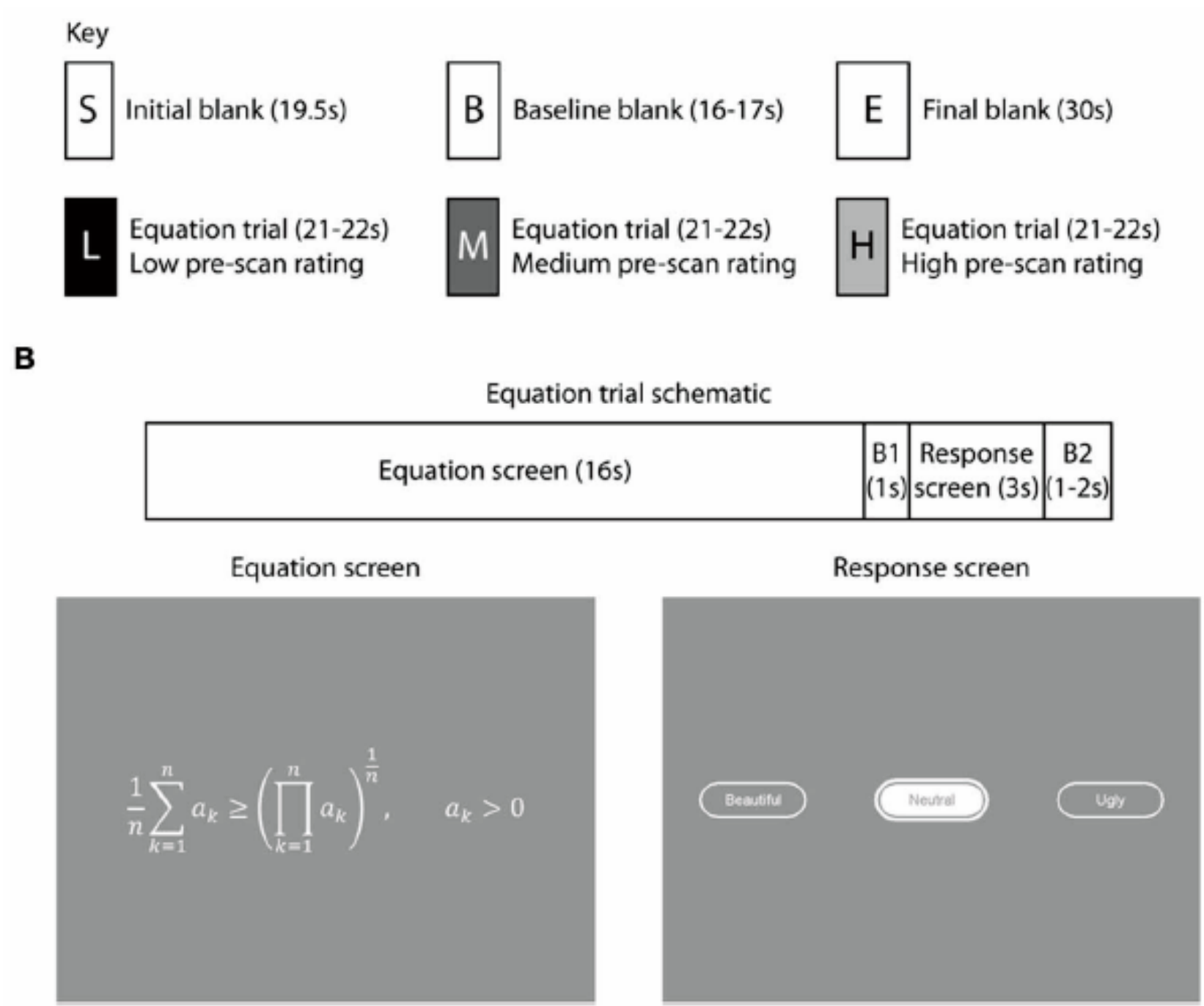
[1] *Wellcome Laboratory of Neurobiology, University College London, London, UK*
[2] *Department of Physics, Imperial College London, London, UK*
[3] *School of Mathematics, University of Edinburgh, Edinburgh, UK*

Edited by:
Josef Parvizi, Stanford University, USA

Reviewed by:
Miriam Rosenberg-Lee, Stanford University, USA
Marie Arsalidou, The Hospital for Sick Children, Canada

***Correspondence:**
Semir Zeki, Wellcome Department of Neurobiology, University College London, Gower Street, London, WC1E 6BT, UK
e-mail: s.zeki@ucl.ac.uk

Many have written of the experience of mathematical beauty as being comparable to that derived from the greatest art. This makes it interesting to learn whether the experience of beauty derived from such a highly intellectual and abstract source as mathematics correlates with activity in the same part of the emotional brain as that derived from more sensory, perceptually based, sources. To determine this, we used functional magnetic resonance imaging (fMRI) to image the activity in the brains of 15 mathematicians when they viewed mathematical formulae which they had individually rated as beautiful, indifferent or ugly. Results showed that the experience of mathematical beauty correlates parametrically with activity in the same part of the emotional brain, namely field A1 of the medial orbito-frontal cortex (mOFC), as the experience of beauty derived from other sources.


Key
S
Initial blank (19.5s)
B
Baseline blank (16-17s)
E
Final blank (30s)
L
Equation trial (21-22s)
Low pre-scan rating
M
Equation trial (21-22s)
Medium pre-scan rating
H
Equation trial (21-22s)
High pre-scan rating
B
Equation trial schematic
Equation screen (16s)
B1 (1s)
Response screen (3s)
B2 (1-2s)
Equation screen
Response screen
$\frac{1}{n}\sum_{k=1}^{n} a_k \geq \left(\prod_{k=1}^{n} a_k\right)^{\frac{1}{n}}, \qquad a_k > 0$
Beautiful
Neutral
Ugly

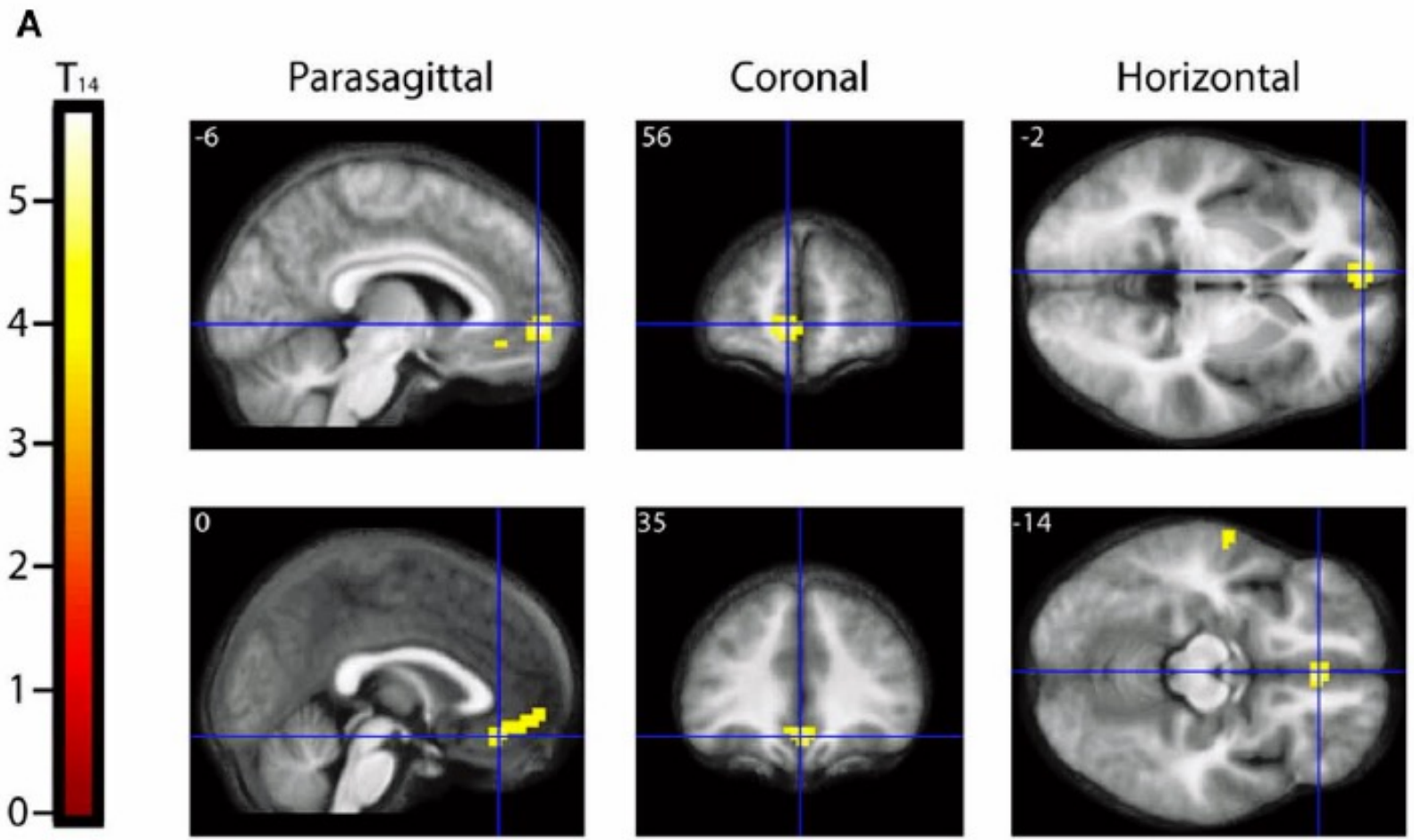
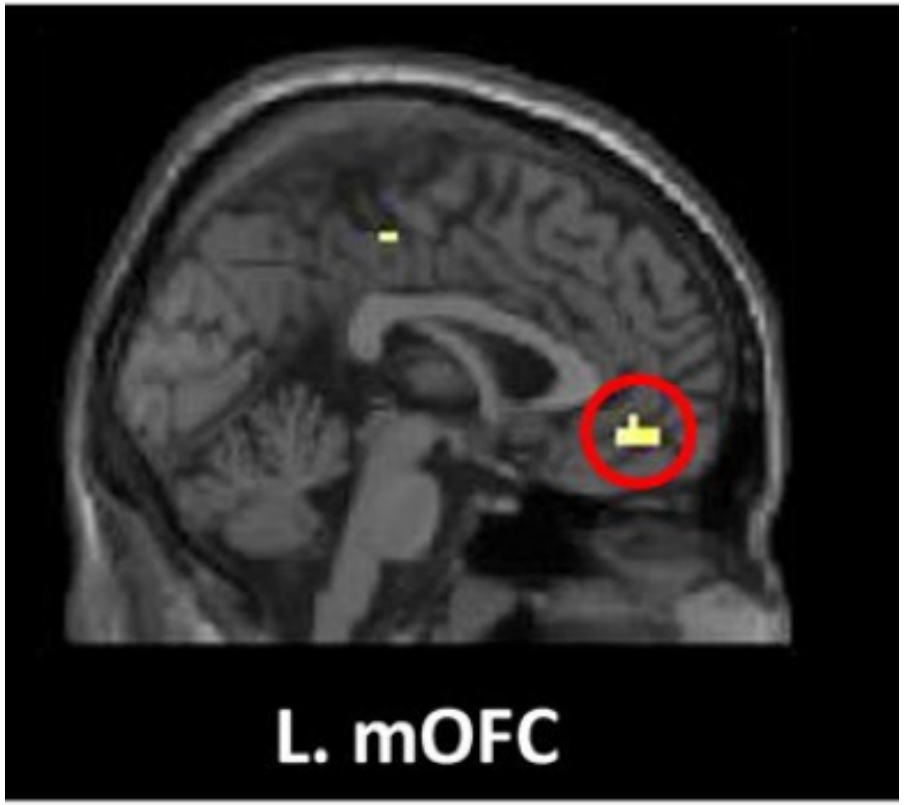


FIGURE 3 | Parametric "Activations" with Beauty. (A) Second level

two hot-spots, pinpointed wi



Received: 8 January 2019 | Revised: 3 May 2019 | Accepted: 11 May 2019

DOI: 10.1002/brb3.1335

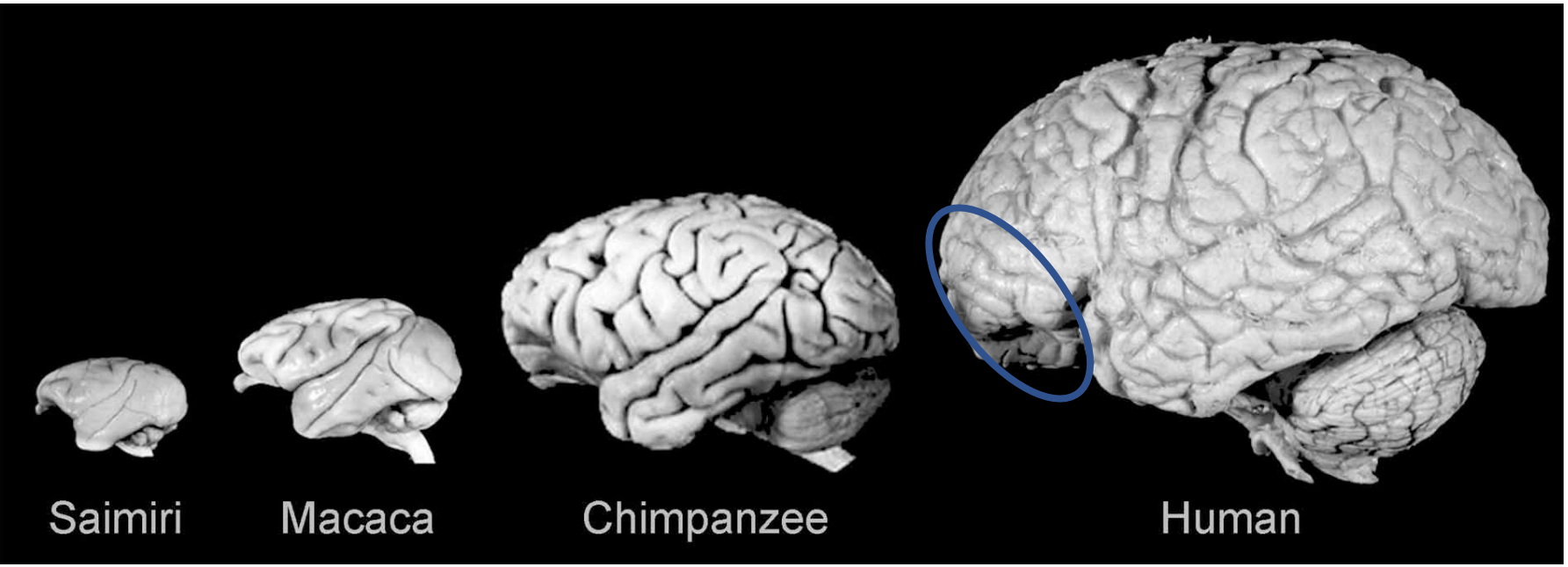
Check for updates

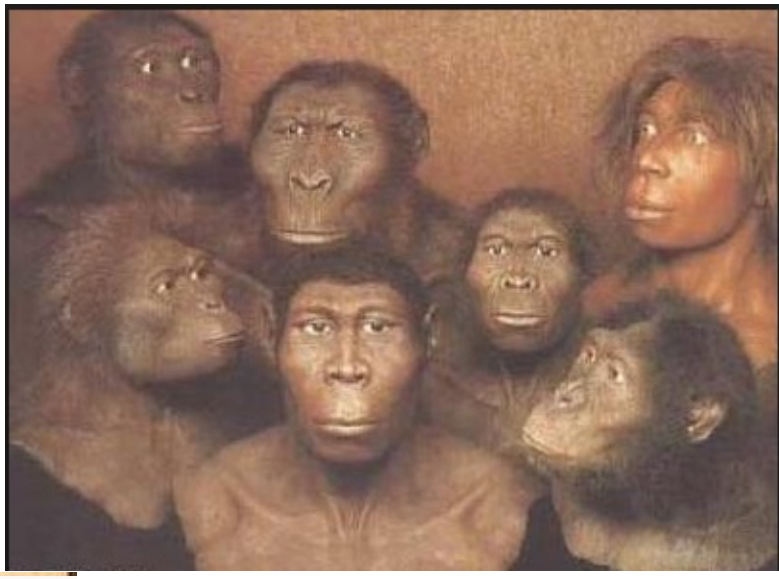
Brain and Behavior Open Access WILEY

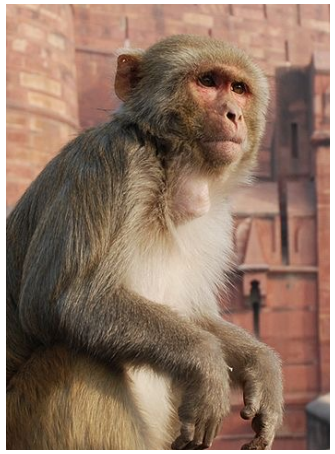
ORIGINAL RESEARCH

Neural correlates of appreciating natural landscape and landscape garden: Evidence from an fMRI study

Wei Zhang[1] | Xianyou He[1,2] | Sizhe Liu[1] | Ting Li[1] | Jinhui Li[1] | Xiaoxiang Tang[3] | Shuxian Lai[4]


Saimiri
Macaca
Chimpanzee
Human





Science 2022 Sep 9;377(6611)

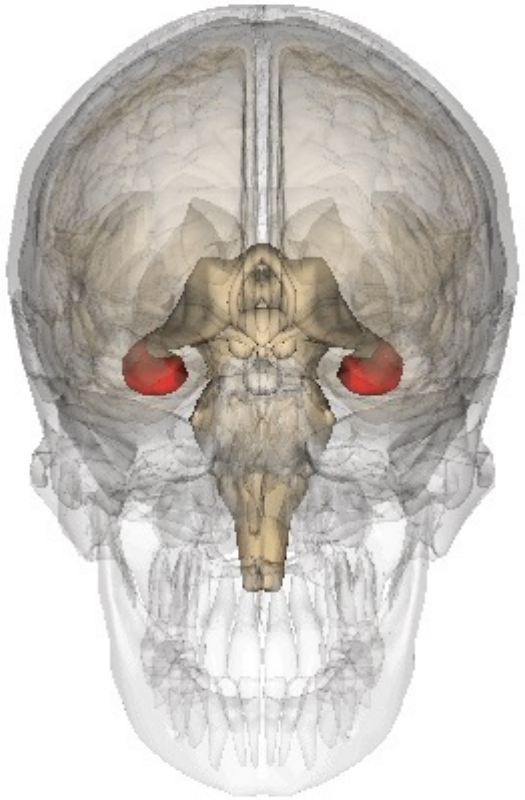
Human TKTL1 implies greater neurogenesis in frontal neocortex of modern humans than Neanderthals

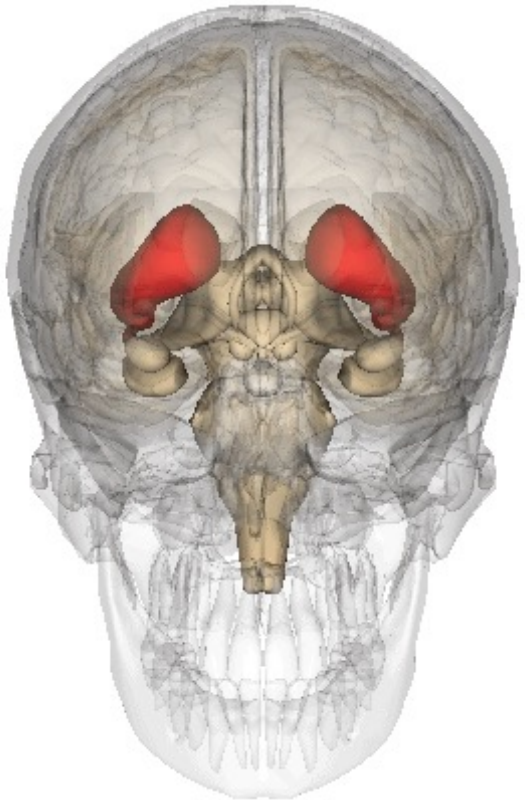
Anneline Pinson , Lei Xing , Takashi Namba , Nereo Kalebic , Jula Peters , Christina Eugster Oegema , Sofia Traikov , Katrin Reppe , Stephan Riesenberg , Tomislav Maricic , Razvan Derihaci , Pauline Wimberger , **Svante Pääbo**

What happens in the brain when beauty center is activated?

Caudate nucleus

Dopamine

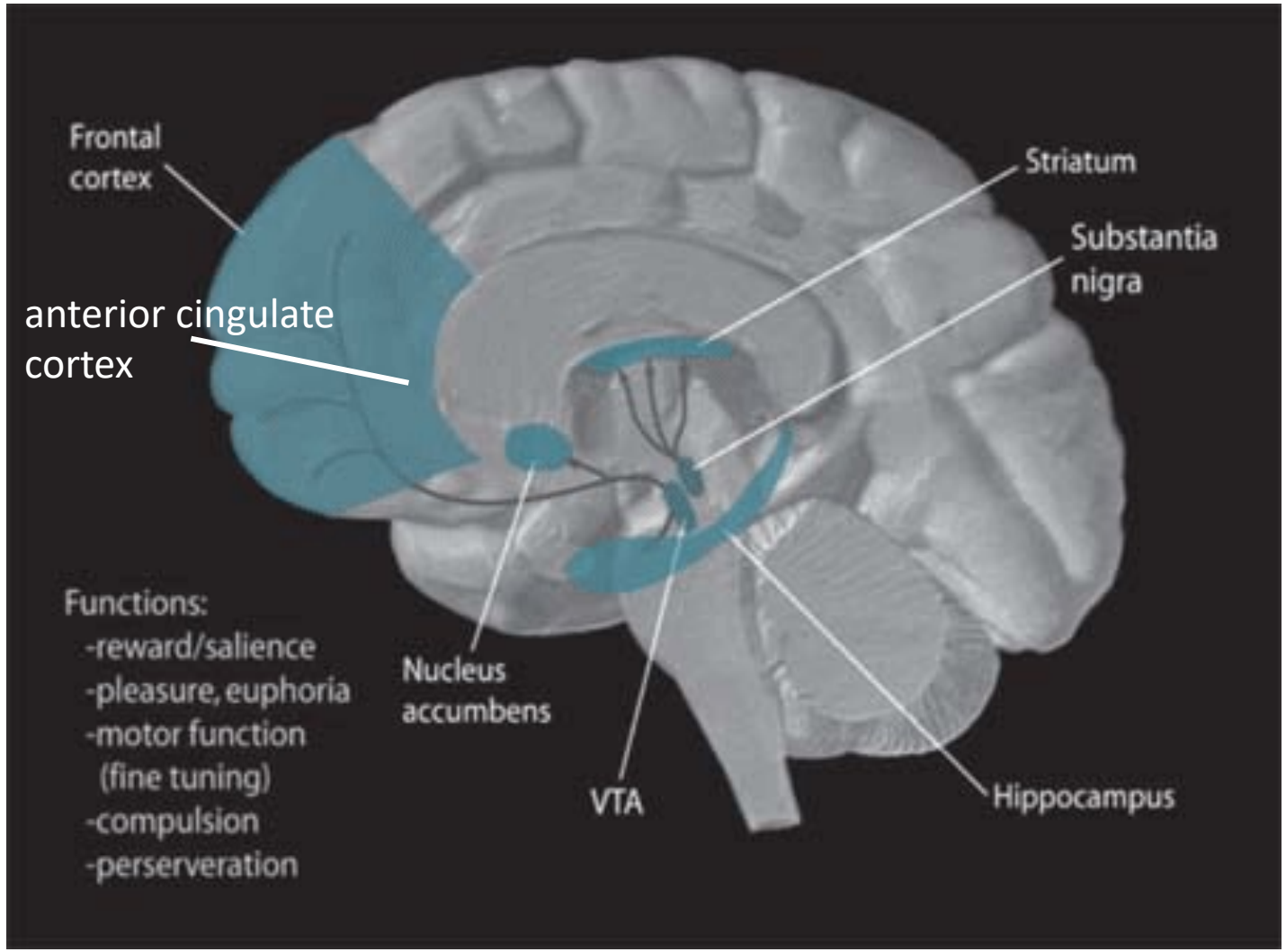




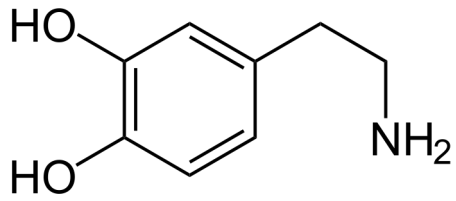
Hippocampus

Dopamine and Serotonin

The reward system



Numerous neuroimaging studies (PET and fMRI) attest that beauty stimuli activate brain structures rich in dopaminergic neurons, such as the nucleus accumbens, anterior cingulate cortex, substantia nigra and ventral tegmental area (VTA)



Dopamine

LETTER

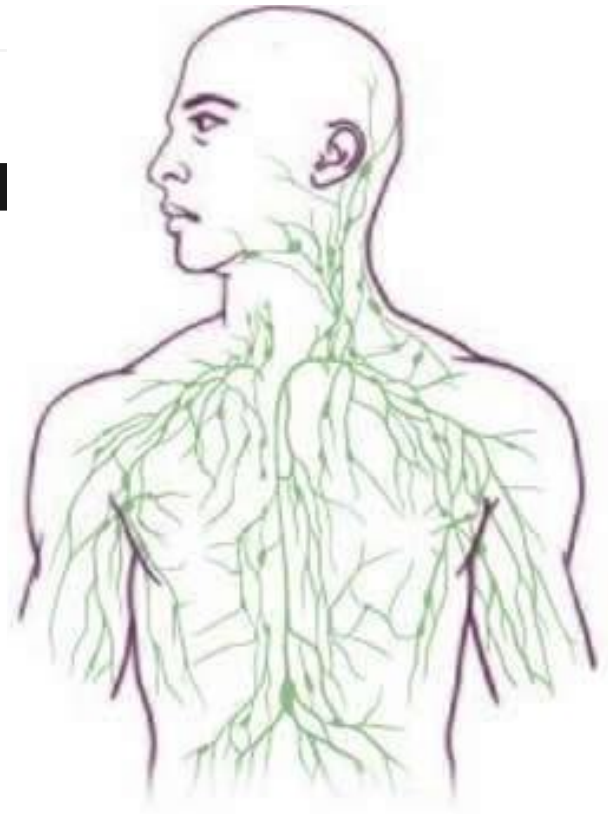
2015 doi:10.1038/nature14432

Structural and functional features of central nervous system lymphatic vessels

Antoine Louveau[1,2], Igor Smirnov[1,2], Timothy J. Keyes[1,2], Jacob D. Eccles[3,4,5], Sherin J. Rouhani[3,4,6], J. David Peske[3,4,6], Noel C. Derecki[1,2], David Castle[7], James W. Mandell[8], Kevin S. Lee[1,2,9], Tajie H. Harris[1,2] & Jonathan Kipnis[1,2,3]

Researchers Find Missing Link Between the Brain and Immune System

Implications profound for neurological diseases from autism to Alzheimer's to multiple sclerosis.



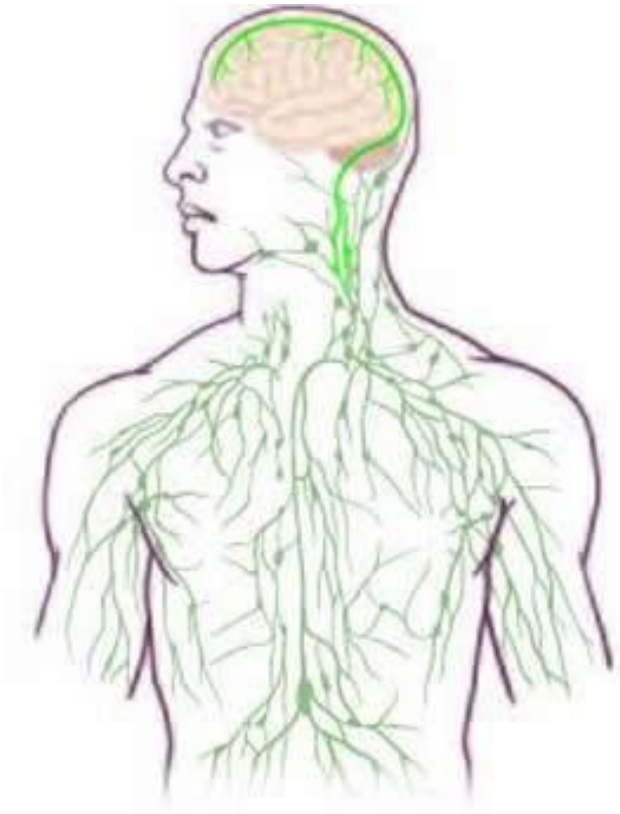
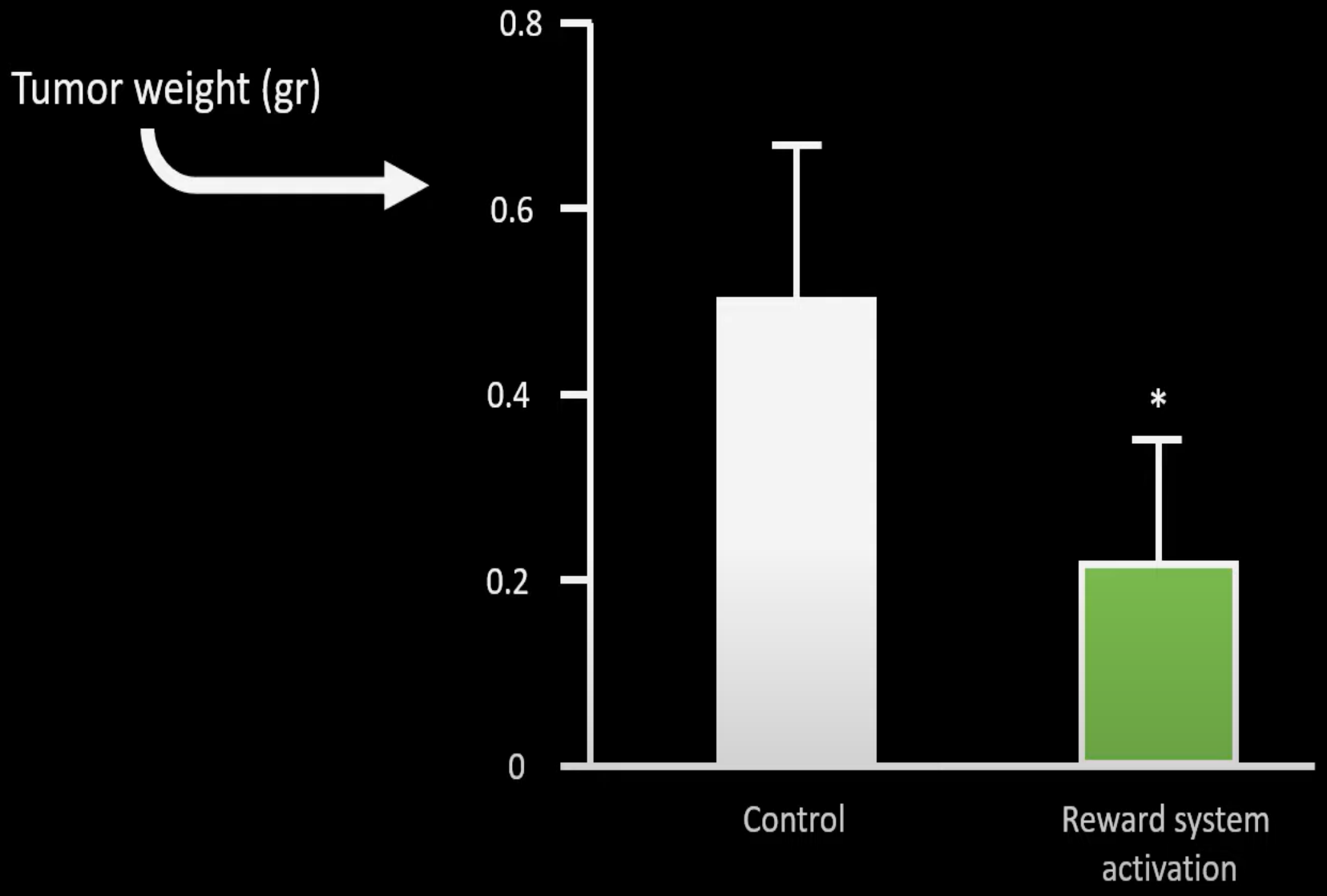


ILLUSTRATION BY DALBERT B. VILARINO

HOW THE BRAIN CONTROLS SICKNESS AND HEALTH

Nature | Vol 614 |23 February 2023

Scientists hope that deciphering the connections between the brain and the immune system will help to treat a range of diseases. **By Diana Kwon**



Ben Shannaan, Schiller et al,

Impact of contour on aesthetic judgments and approach-avoidance decisions in architecture

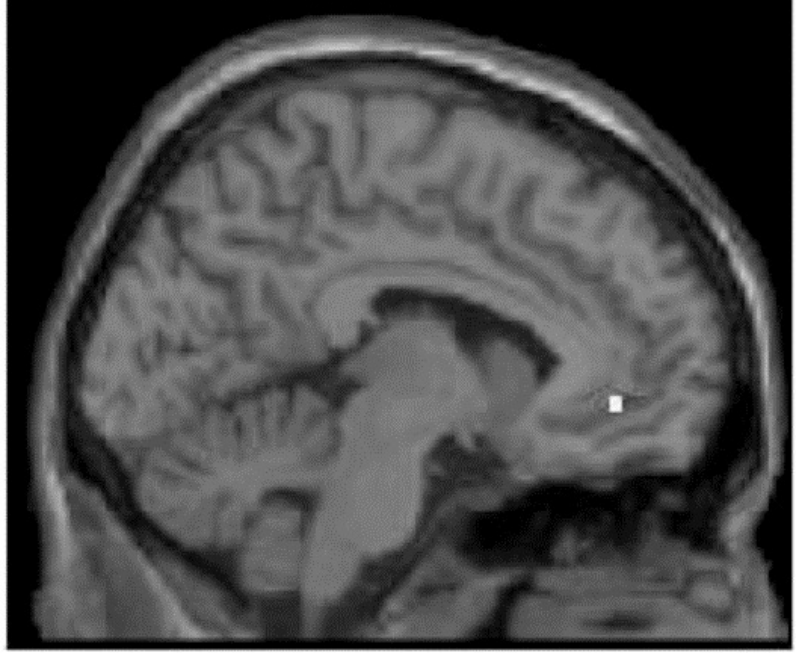
Oshin Vartanian[a,1], Gorka Navarrete[b,c], Anjan Chatterjee[d], Lars Brorson Fich[e], Helmut Leder[f], Cristián Modroño[g], Marcos Nadal[f], Nicolai Rostrup[h], and Martin Skov[i,j]

[a]Department of Psychology, University of Toronto–Scarborough, Toronto, ON, Canada M1C 1A4; [b]Department of Psychology, Universidad de La Laguna, La Laguna, 38205 Santa Cruz de Tenerife, Spain; [c]Department of Psychology, York University, Toronto, ON, Canada M3J 1P3; [d]Department of Neurology, University of Pennsylvania, Philadelphia, PA 19104; [e]Department of Architecture, Design, and Media Technology, University of Aalborg, DK - 9000 Aalborg, Denmark; [f]Faculty of Psychology and Cognitive Science Research Platform, University of Vienna, 1010 Vienna, Austria; [g]Department of Physiology, Universidad de La Laguna, La Laguna, 38071 Santa Cruz de Tenerife, Spain; [h]The Royal Danish Academy of Fine Arts, Schools of Architecture, Design, and Conservation, School of Architecture, DK - 1435 Copenhagen, Denmark; [i]Danish Research Centre for Magnetic Resonance, Copenhagen University Hospital Hvidovre, DK-2650 Copenhagen, Denmark; and [j]Decision Neuroscience Research Group, Department of Marketing, Copenhagen Business School, DK-2000 Copenhagen, Denmark

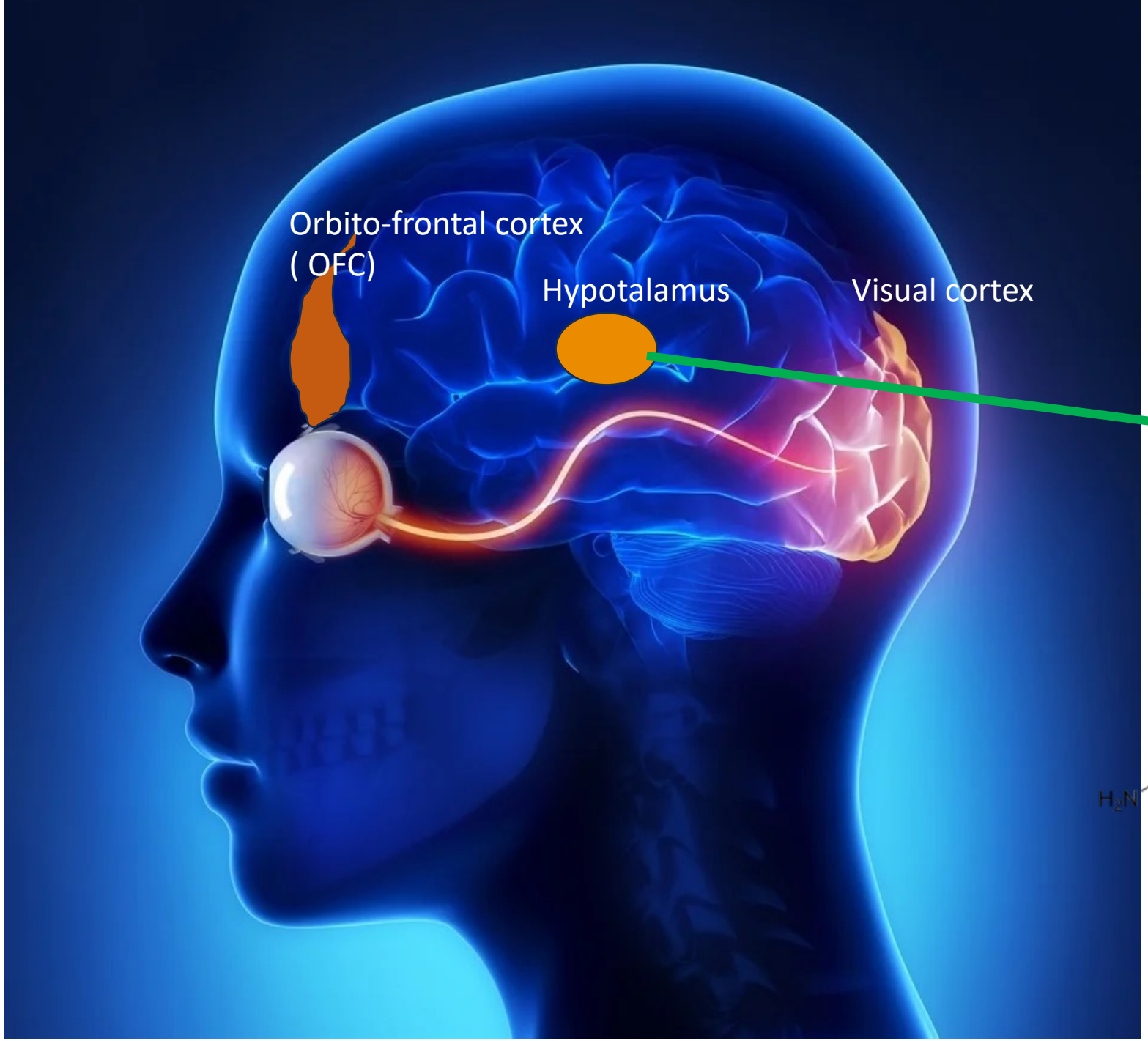
Edited by John C. Avise, University of California, Irvine, CA, and approved April 23, 2013 (received for review February 13, 2013)

	Open	Enclosed
Curvilinear		
Rectilinear		

Reward system activation

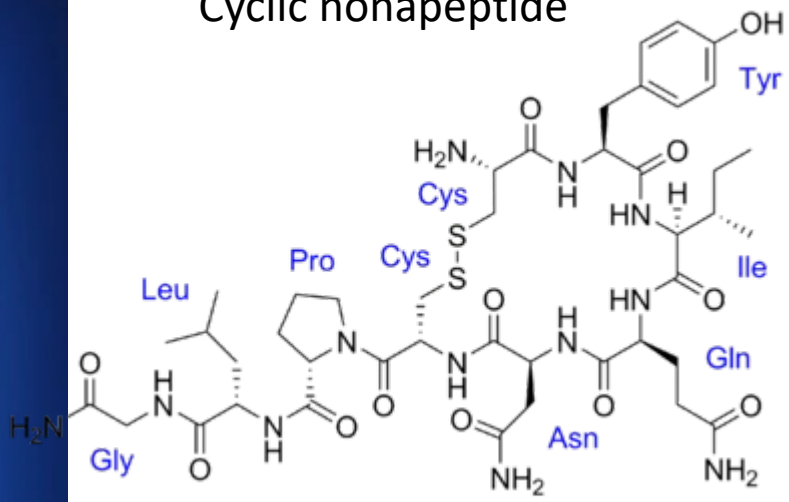


No activation of reward system



Oxytocin

Cyclic nonapeptide



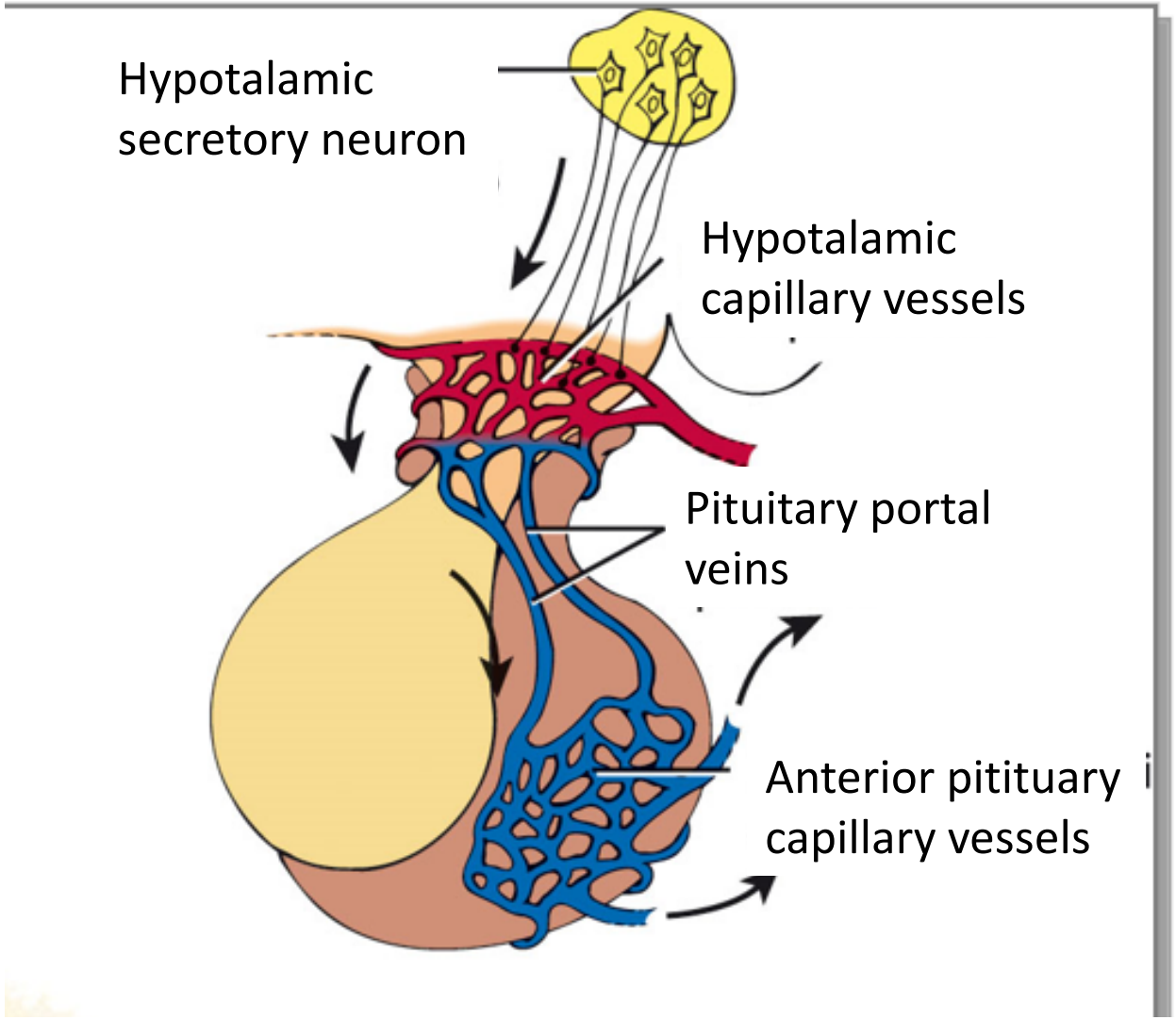
frontiers | Frontiers in Psychology

EDITORIAL
published: 15 June 2022
doi: 10.3389/fpsyg.2022.929741

Editorial: Sensory Stimulation and Oxytocin: Their Roles in Social Interaction and Health Promotion

Kerstin Uvnäs Moberg[1]*, *Henri Julius*[2], *Linda Handlin*[3] and *Maria Petersson*[4]

[1] Department of Animal Environment and Health, Swedish University of Agricultural Sciences, Skara, Sweden, [2] Department of Special Education and Rehabilitation, University of Rostock, Rostock, Germany, [3] School of Health Sciences, University of Skövde, Skövde, Sweden, [4] Endocrine and Diabetes Unit, Department of Molecular Medicine and Surgery, Karolinska Institutet, Stockholm, Sweden



OXYTOCIN

NEUROPEPTIDE PRODUCED BY THE HYPOTHALAMUS AND SECRETED IN THE BRAIN AND IN THE BODY (BY THE PITUITARY GLAND)

PHYSIOLOGICAL ACTIONS

- PROMOTES MATERNAL AND PATERNAL EMOTIONAL BEHAVIOUR
- PROMOTES SOCIAL RELATIONSHIPS AND EMPATHY
- PROMOTES AFFECTIVE-SEXUAL BEHAVIOUR
- HAS ANXIOLYTIC, ANTI-STRESS, ANTIDEPRESSANT ACTIVITY
- MODULATES STATES OF CONSCIOUSNESS
- **BUFFERS STRESS**

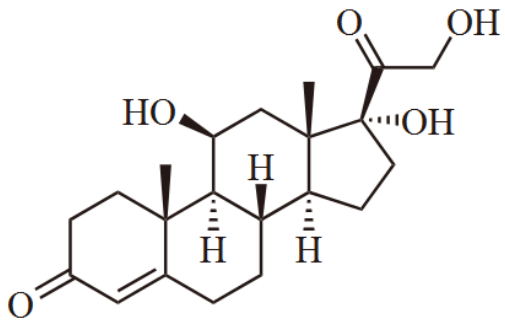
The stress buffering capacity is among the less explored functions of oxytocin

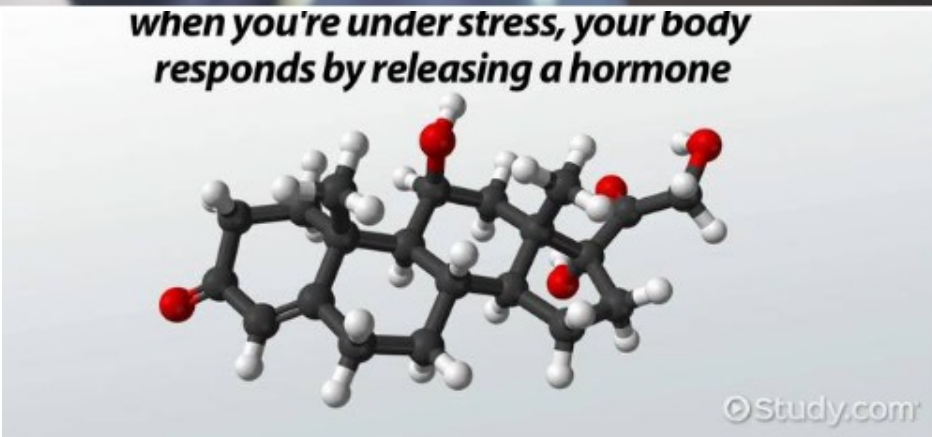
OXYTOCIN COUNTERACT STRESS THROUGH:

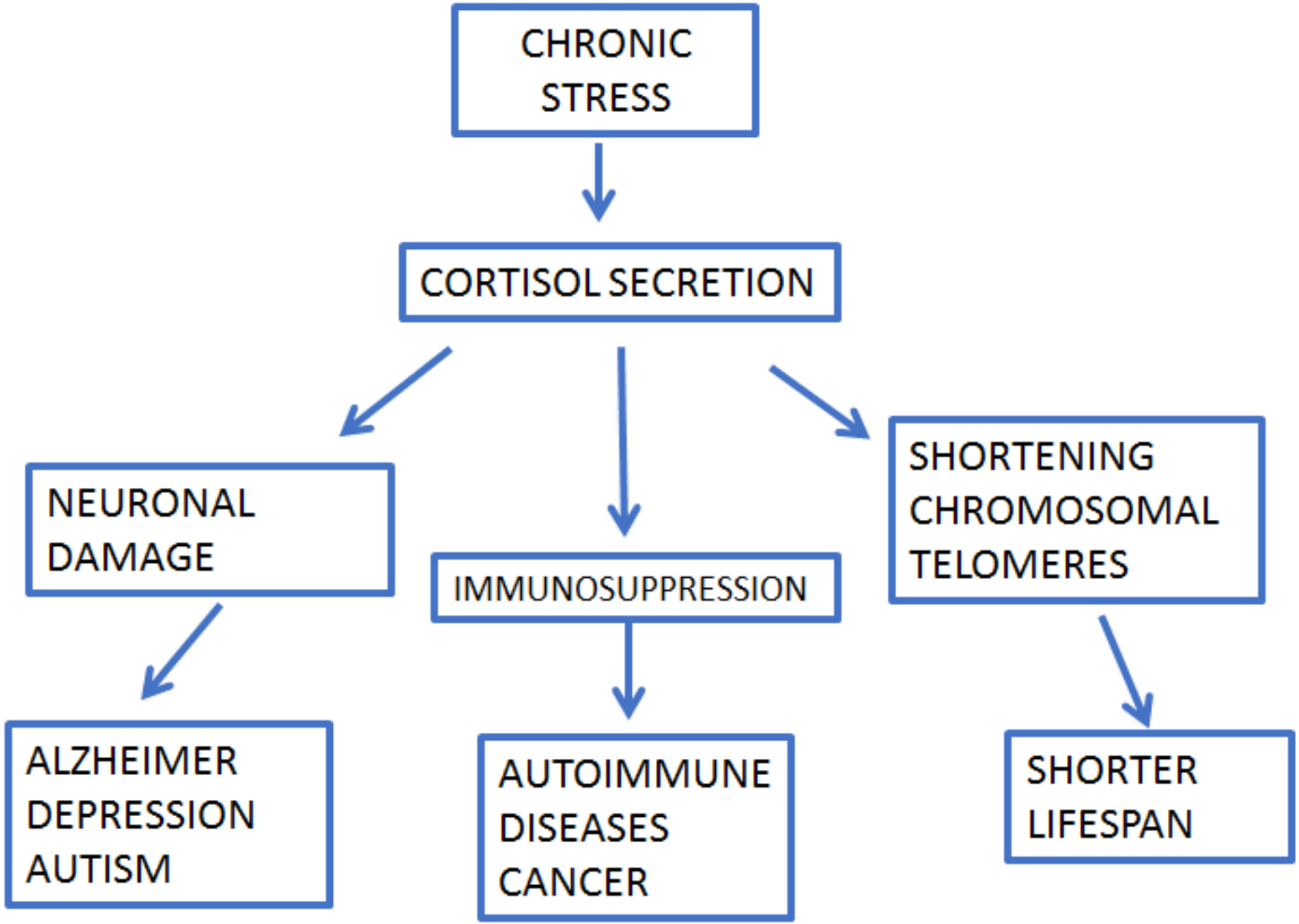
Inhibition of cortisol secretion

Reduction of amygdala activity

CORTISOL: THE "STRESS HORMONE"






CHRONIC STRESS
CORTISOL SECRETION
NEURONAL DAMAGE
IMMUNOSUPPRESSION
SHORTENING CHROMOSOMAL TELOMERES
ALZHEIMER DEPRESSION AUTISM
AUTOIMMUNE DISEASES CANCER
SHORTER LIFESPAN

Psychoneuroendocrinology
Volume 49, November 2014, Pages 161-170

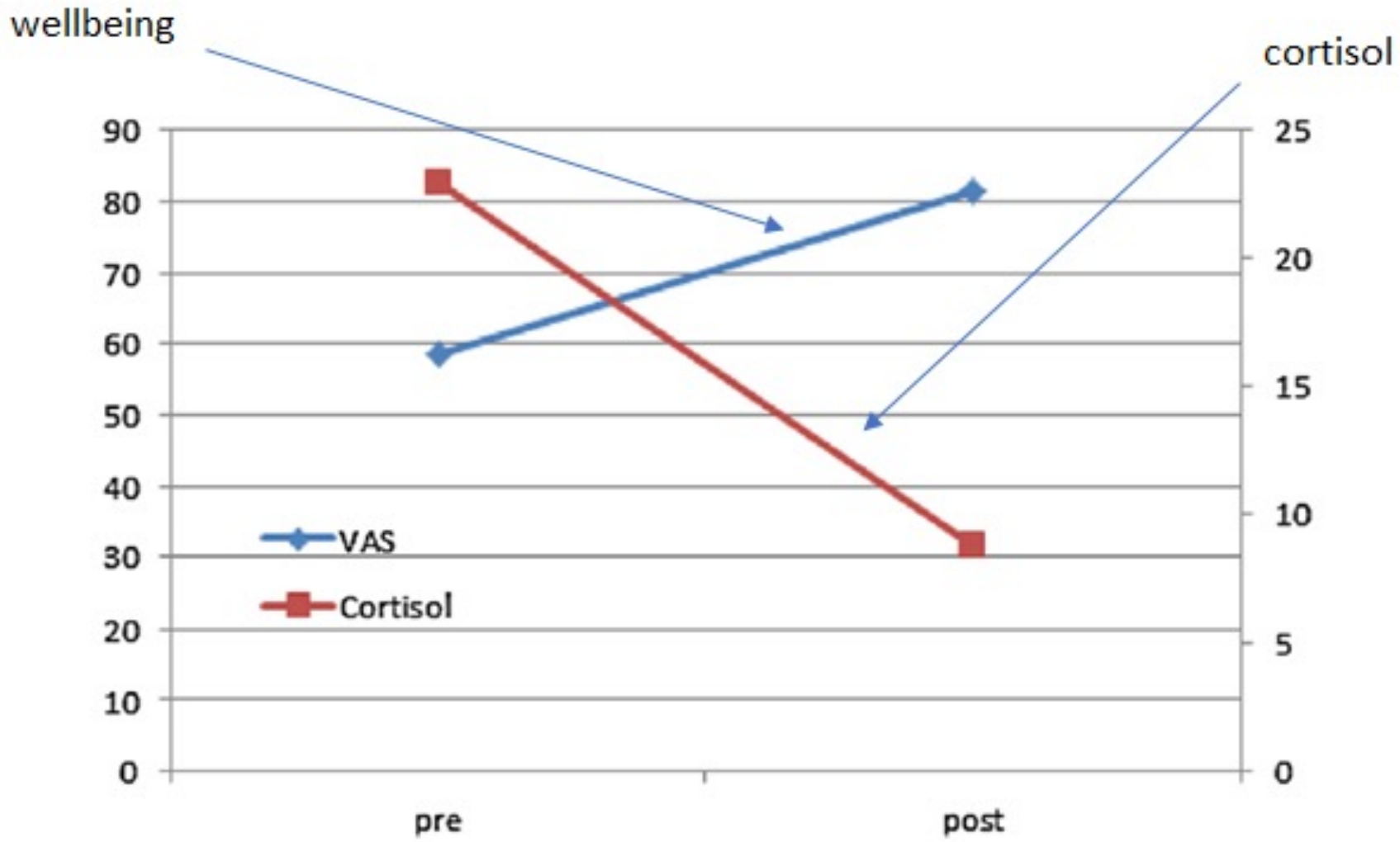
A meta-analytic review of the impact of intranasal oxytocin administration on cortisol concentrations during laboratory tasks: Moderation by method and mental health

Christopher Cardoso, Danielle Kingdon, Mark A. Ellenbogen

18 randomized placebo-controlled studies

The Vicoforte experiment


9-10 aprile 2016
ZRT
LABORATORY
SALIVA TEST
A Laboratory Test Made Simple



Wellbeing score (left scale) and salivary cortisol levels (right scale) before and after the experience.

Cult Med Psychiatry
https://doi.org/10.1007/s11013-018-9593-8

ORIGINAL ARTICLE

Magic Moments: Determinants of Stress Relief and Subjective Wellbeing from Visiting a Cultural Heritage Site

Enzo Grossi[1] · **Giorgio Tavano Blessi**[2] · **Pier Luigi Sacco**[2,3,4]

The Telegraph

Admiring great art 'is good for your health', Italian experiment finds

ATTUALITÀ

La storia

"Un'opera d'arte duce lo stress" ra lo dice che la scienza

Un cronista di "Repubblica" al test in una cupola del '700 nel Cuneese "La visita ha abbassato il cortisolo"

"Dopo avere ammirat... gli affreschi del... di Vicoforte il liv... di tensione è cal...

render- bilità di e "cavie mi hanno peleologo climbing.

Natural news (USA)

Italian case study suggests enjoying artwork can lower the body's stress level by 60 percent

Thursday, May 19, 2016 by: Isabelle Z.

Tags: art appreciation, stress reduction, natural alternatives

Facebook (376)

Twitter

dobrewiadomości

serwis pozytywnych informacji

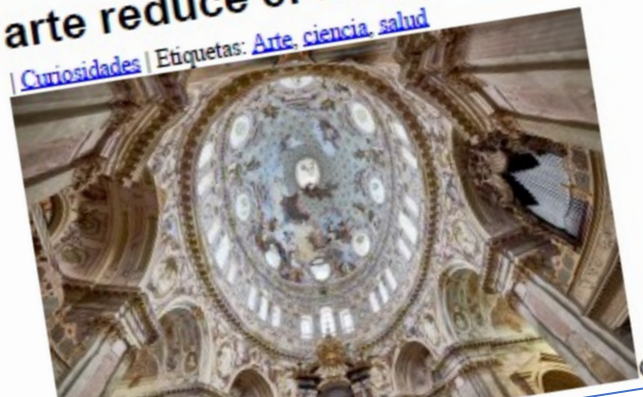
Oglądanie dzieł sztuki redukuje stres i dobrze wpływa na zdrowie

Kwiecień 29, 2016 | 0 komentarzy

ART NEWS

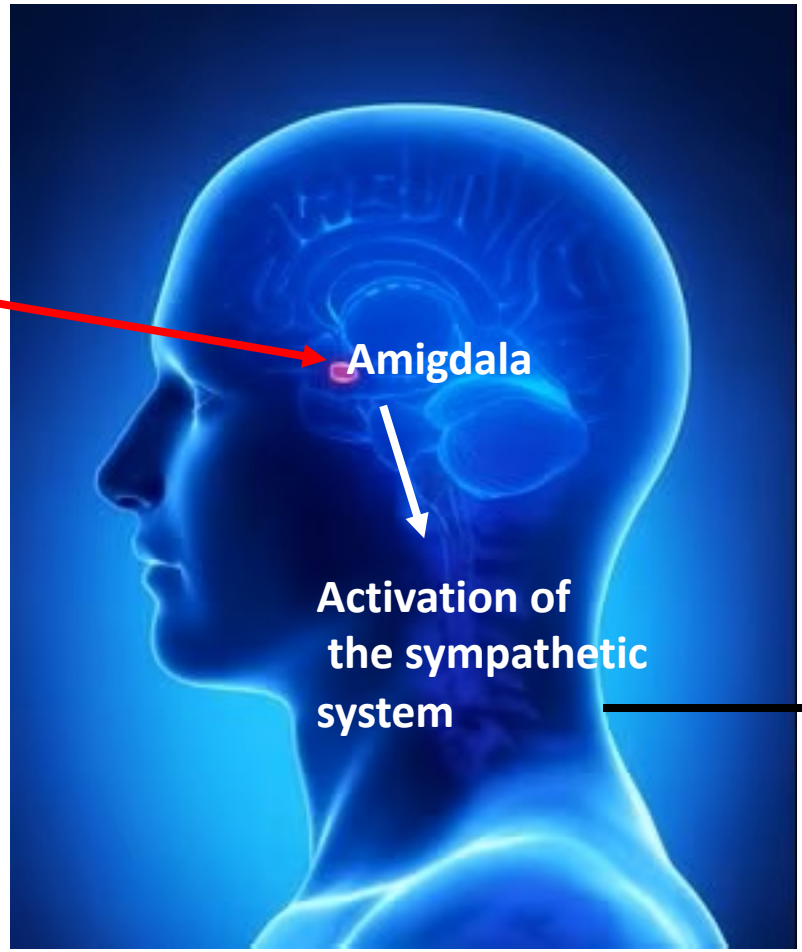
Un experimento científico de la Universidad de Bolonia asegura que el arte reduce el estrés

| Curiosidades | Etiquetas: Arte, ciencia, salud



Cúpula de Vicoforte./ La Reppublica

Anxiety, stress and fear circuit



Tumour growth stimulation and metastasis

Inflammatory white blood cell activation

Psychoneuroendocrinology

Volume 79, May 2017, Pages 160-166

Oxytocin reduces amygdala responses during threat approach

Sina Radke [a d], Inge Volman [a b e], Idil Kokal [a], Karin Roelofs [a b 1], Ellen R.A. de Bruijn [c 1], Ivan Toni [a 1]

J Neurophysiol 123: 587–599, 2020.
First published December 31, 2019; doi:10.1152/jn.00571.2019.

RESEARCH ARTICLE | *Neural Circuits*

Oxytocin increases inhibitory synaptic transmission and blocks development of long-term potentiation in the lateral amygdala

J. W.
[1]*School*
Universi
Hobart,

Submitted

FULL PAPER Adv. Sci. 2020, 7, 2001077

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www.advancedscience.com

Oxytocin Differentially Modulates Amygdala Responses during Top-Down and Bottom-Up Aversive Anticipation

Fei Xin, Xinqi Zhou, Debo Dong, Zhongbo Zhao, Xi Yang, Qianqian Wang, Yan Gu, Keith M. Kendrick, Antao Chen, and Benjamin Becker**

DOPAMINE

OXYTOCIN

SEROTONIN

PLEASURE

REWARD

EMPATHY

SOCIAL RELATIONS

WELLBEING

PAIN

CORTISOL

ANXIETY

DEPRESSION

STRESS DAMAGE

review

Wien Med Wochenschr (2022) 172:234–241
https://doi.org/10.1007/s10354-021-00861-7

wmw
Wiener Medizinische Wochenschrift

Evidence-based art in the hospital

Axel Fudickar · Dag Konetzka · Stine Maria Louring Nielsen · Kathy Hathorn

Diette 2003 [18]	Intervention	108	Pain reduction by natural views during bronchoscopy
Miller 1992 [19]	Intervention	17	Reduction of pain and fear by natural views in burn patients
Schneider 2003 [20]	Intervention	16	Virtual art and nature scenarios reduce fear during chemotherapy
Tse 2002 [21]	Intervention	46	Nature views increase pain threshold and pain tolerance in probands
Frandsen 2014 [11]	Interview	100	Positive effect of art on mood and well-being
Suter 2007 [22]	Interview	37	Improvement of mood by own choice of pictures
Staricoff 2001 [16]	Interview	91	Positive effect of art on mood and stress independent of art style (landscape vs. abstract)
Nielsen 2017 [12, 25]	Interview Thermal camera	68	Art increases well-being independently of art styles Art in day rooms increases patient interaction
Moss 2013 [26]	Interview	20	Art promotes feeling of care, socialization and finding of new interests
Nielsen 2017 [27]	Multidimensional anthropological evaluation EEG, Eye-Tracking	30	Abstract and figurative art can have a positive effect on patients Reception of abstract art induces less cognitive strain than reception of figurative art
Karnic 2014 [28]	Questionnaire	1094	Positive effect of a clinical modern art program on mood, stress, comfort, and expectations
Nanda 2002 [29]	Questionnaire	210	Hospital art makes patients and visitors feel better
McCabe 2013 [30]	Interview/Scale	199	Effect of visual art on levels of anxiety and depression
Heerwagen 1990 [31]	Measurement of heart frequency	40	Pictures in the waiting area reduce heart frequency and restlessness
Coss 1996 [32] [32]	Measurement of blood pressure	72	Nature views reduce preoperative blood pressure
Harper 2015 [33]	Measurement of blood pressure	117	Natural views in examination rooms reduce blood pressure
Ulrich 1993 [34]	Measurement of analgetic consumption	166	Natural views reduce analgetic consumption
Ulrich 2003 [35]	Measurement of pulse-rate and blood pressure	591	Pulse-rate was lower in a nature environment design versus an urban environment design

Beauty

Salutogenic design

Beauty in Architecture

Not a Luxury – Only a Necessity

Special article

Beauty and health: an intriguing liaison?

E. Grossi

Enzo Grossi, MD
Villa Santa Maria Foundation,
Tavernerio, Italy.

Please address correspondence to:
Enzo Grossi
Villa Santa Maria Foundation,
Via IV Novembre,
22038 Tavernerio (CO), Italy.
E-mail: enzo.grossi@bracco.com

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Clin Exp Rheumatol 2022; 42: xx-xx.

ABSTRACT

The exposure to different form of beauty coming from visual art, music, nature, architecture, improves mental health and exerts neurotrophic effects on different parts of the brain. This in turn improves physical health, prolongs life expectancy, and reduces the risk of serious degenerative diseases such as Alzheimer's and cancer. These beneficial actions would not be understandable and plausible if one did not accept the mind-body unity. The 'hegemonic' role of the brain in health and illness can be discerned, for example, in the effect

sun, which with its splendor illuminates the day; ask the moon, which with its glow moderates the darkness of the night. Question them! They will all answer you: Look at us: we are beautiful! Their beauty makes them known. This changeable beauty, who created it, if not the Immutable Beauty?".

While for Leibniz beauty is something we simply are not able to define; for David Hume: *"Beauty is not a quality of the things themselves: it exists only in the mind that contemplates them and each mind perceives a different beauty"* (3).

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Cogn Affect Behav Neurosci. 2020 December ; 20(6): 1200–1215. doi:10.3758/s13415-020-00827-z.

Seeking the "Beauty Center" in the Brain: A Meta-Analysis of fMRI Studies of Beautiful Human Faces and Visual Art

Hu Chuan-Peng[1,2], **Yi Huang**[1,3], **Simon B. Eickhoff**[4,5], **Kaiping Peng**[1], **Jie Sui**[6]

[1]Department of Psychology, Tsinghua University, Beijing, People's Republic of China

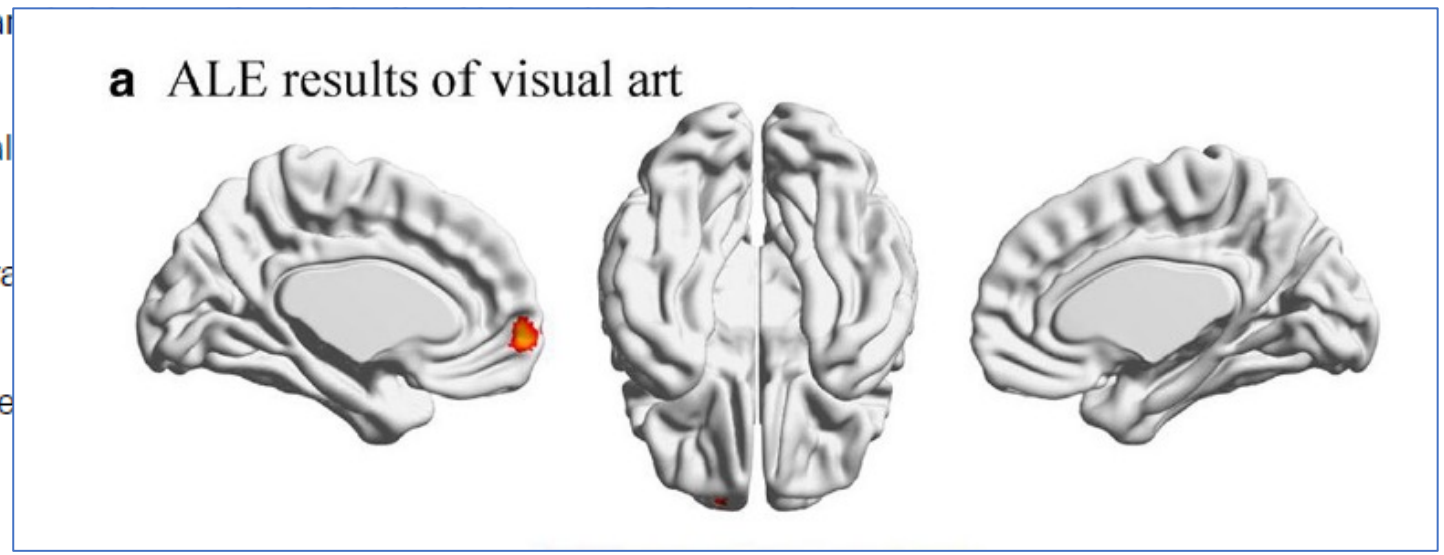
[2]Leibniz Institute for Resilience Research (LIR), Mainz, Germany

[3]School of Business and Management, Shar
People's Republic of China

[4]Institute of Systems Neuroscience, Medical
Düsseldorf, Germany

[5]Institute of Neuroscience and Medicine, Bra
Jülich, Germany

[6]School of Psychology, the University of Abe



17.500 A.C.

36.000 A.C.

Uomo di Cro-Magnon, Paleolitico superiore