Misurare le emozioni provocate dall’osservazione di un opera d’arte

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Acknowledgments

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Neuroelectric brain imaging during a real visit of a fine arts gallery:
a neuroaesthetic study of XVII century Dutch painters

A Neuroaesthetic Study of the Cerebral Perception and Appreciation of Paintings by Titian Using EEG and Eyetracker Measurements
Francesco Babildoni1,2, Dario Rosi1,2, Patrizia Cherubino1,2, Alessandro Tretie,2, Daniela Piccomi2, Anton Giulio Maglione3, Giovanni Vecchiato3, and Fabio Babiloni1,2,3,4

Neurophysiological correlates of embodiment and motivational factors during the perception of virtual architectural environments
Giovanni Vecchiato1, Andrea Jelic2, Gaetano Tieri3,4, Anton Giulio Maglione3, Federico De Matteis3, Fabio Babiloni1

Electroencephalographic Correlates of Sensorimotor Integration and Embodiment during the Appreciation of Virtual Architectural Environments
Giovanni Vecchiato1,2, Gaetano Tieri1,3, Andrea Jelic1,4, Federico De Matteis3, Fabio Babiloni1, and Giovanni Vecchiato1

The Enactive Approach to Architectural Experience: A Neurophysiological Perspective on Embodiment, Motivation, and Affordances
Andrea Jelic1,3, Gaetano Tieri1,3, Federico De Matteis3, Fabio Babiloni1, and Giovanni Vecchiato1

The great beauty: a neuroaesthetic study by neuroelectric imaging during the observation of the real Michelangelo’s Moses sculpture

Rene Magritte “call of peaks”
Knowledge of the external world
The major part of the external sensory inputs is simply not retained

- Each second we are exposed to an estimated billion of bits of information that reach us through all our senses, yet humans are capable of processing only around 10-100 bits of that information, letting most of the input go by unnoticed.
- The total amount of the «internal memory» of our brain is about 10 Gigabyte.
- Emotion is an internal process that gives a «value» to such sensory inputs, allowing to the important inputs to be remembered and retained in the brain to drive future behavior.
Emotions is a word that comes from the ancient Latin words «ex motus», meaning «moved by…»

Emotions indicates thus a «somatic answer» from the different organs of our body to an external world stimulation, and its appreciation of such answer from our consciousness.

Thus, emotions are in the between from the external world stimulation (a sound, an object) and the value we internally attribute to such stimulation.

Written literature since thousand years to now underline the link between the body reactions and the internal evaluation of events or facts we called emotions (e.g., the heart stopped to beat for the scary or the heart beats faster when he saw her…)

There are several brain structures (amygdala, thalamus, neocortex) involved in the somatic answers to the external stimuli.

However, in many occasions such «somatic answers» were generated in a subtle and tiny way, that can be detected by acquisition devices but not directly from the consciousness of the «owner».

The importance of the emotions
Neuroaesthetic

- Neuroaesthetic refers to the study of the neural bases of beauty perception in art.
- Such study are usually performed recording the cerebral hemodynamic responses (with functional magnetic resonance imaging; fMRI) to the observation of computer screen reproductions of paintings or sculptures.
- However, in all the published scientific reports related to the study of brain activity with fMRI, MEG or EEG modalities, the fruition of the paintings or the sculptures were made possible to the subjects through a presentation on a screen of a series of images of such fine arts works.
- However, it appears now possible to record the brain activity during the fruition of real masterpieces in a fine arts gallery environment or churches, where they are usually observed by visitors.
Knowledge of the world
• Organisms do not passively receive information from their environments, which they then translate into internal representations.

• Natural cognitive systems participate in the generation of meaning, engaging in transformational and not merely informational interactions: they enact a world.
Enactive knowledge of the world

- Cognition is not the representation of a pre-given world by a pre-given mind but is rather the enactment of a world and a mind on the basis of a history of the variety of actions that a being in the world performs.
- Enaction is the idea that organisms create their own experience through their actions.
- Organisms are not passive receivers of input from the environment, but are actors in the environment such that what they experience is shaped by how they act.
- We are not disembodied observers of space.

Instead, the value and the meaning of an architectural environment originates in the architecture-body interaction.
The enactive approach to architectural experience describes through the concepts of emobodiment and affordances the interactive interface between the body and architecture.

- Such interface is composed by three layers which dynamically participate in the architectural relationship between cognitive activity and experience.
- The embodied action defines cognition as bodily interaction with the environment through sensorimotor coupling of perception and action.
- The sense-making represents cognitive beings as self-individuating and sense-producing systems thanks to their bodily organization.
- These three aspects influence the human being through his/her body schemas and affective component, as well as architectural affordances.
Enactive approach to architecture

• The way people perceptually experience the world (including architectural spaces), is governed by the dynamic sensorimotor activity of the human organism as a whole and the particular condition’s of the man’s embodiment.

• Our engage with the architecture through embodied actio and that our experience of architecture is constituted by the complex patterns of sensorimotor activity.

• We are not disembodied observers of space

• Instead, the value and the meaning of an architectural environment originates in the architecture-body interaction.

• The enactive framework provides an interpretation of embodiment which makes the body necessary for the experience of architecture.

• Such framework emphasizes the intrinsic connection between architecture and human mind/body through action.

• The sensorimotor theory of perception and the enactive conception of perception is anticipatory and action-oriented

• Architecture is then understood and perceived by providing designed affordances as possibilities for action.

• Affordances can exist and be understood perceptually precisely because body schema connects perception and bodily capacity to act.

• Body schema enables an architectural subject to move through the spatial setting in a consciously effortless manner and over time to establish habitual pattern of use.

• Experimental approaches based on virtual reality can be beneficial to investigate complex human perception underlying the experience of architectural environments and to help architects design environments better suited to users’ changing needs.
Measure the emotion during the art perception
Several neuroimaging studies have used GSR as an objective indicator of automatic emotional processing, for example, fear conditioning, and the role of specific brain areas such as amygdala (Buchel and others 1998; Morris and others 1998).

Variation of Galvanic Skin Responses (GSR) have been then associated to variation of the arousal of the emotive state of the subject.

Variation of the Heart Rate have also been linked by a variety of psychophysiological studies to the variation of the positive/negative quality of the emotions experienced by the subject.

Dozen of studies suggested that the vision of sad, or even boring films generated a decrease of the HR when compared to the baseline conditions (Bosch et al., 2001; Ritz, Steptoe et al., 2000; Kreibig et al., 2007)

In addition, positive emotions trigger increased HR values.
Beyond memory: two systems competing in the brain for approach/withdrawal behavior

Approach / Avoidance motivational systems

Two broad systems underlie learning and affect:
Behavioral Approach System (BAS) - Gray (1994)
Behavioral Inhibition System (BIS) - Carver and White (1994)

➢ BAS – guiding behavior in response to incentives; an approach tendency towards the desired stimulus;

➢ BIS – guiding behavior in response to threats; a withdrawal tendency from undesirable stimulus.
Solid scientific results for these observations

Neural correlates of Approach / Avoidance tendencies


The Frontal Asymmetry Paradigm – left vs right hemispheric dominance
Two hemispheres, two functions

Approach vs Avoidance

LEFT HEMISPHERE
APPROACH
TENDENCIES

RIGHT HEMISPHERE
AVOIDANCE
TENDENCIES
Neuroaesthetic and neuroarchitecture: measuring the cerebral activity during the art perception

- It is possible to measure the perception of the beauty in front an artistic paint?
- It is possible to measure the likeness of the subject in front of a particular architectural element (a corridor, a room)?
- The main index to be used is the unbalance of the alpha activity on the prefrontal cortex (approach / withdrawal index).
- Two art exhibitions were visited, one of the dutch painter Jan Vermeer (XVII century) and the other of the italian painter Tiziano (XVI century).
Using the EEG variables to assess the perception of fine arts masterpieces and architectural elements
A visit to the an ancient building in Rome
A visit to an ancient building in Rome
Eye tracker – fixation and heatmaps
A visit to the MAXXI
A visit to the MAXXI
A visit to the MAXXI
A visit to the MAXXI
The perception of internal spaces in a virtual reality structure

- 12 subjects participated to the study with 3D virtual reality structure available in IRCCS Fondazione S.Lucia, Rome
- Three rooms have been designed in real size (5x5 m) and tested with different interior designs: empty, modern and cutting edge furniture
- 4 minutes of free exploration in the 3D virtual reality environment
- Enrolled volunteers expressed judgments for each virtual scenario about Familiarity, Novelty, Comfort, Pleasantness, Arousal
Cerebral activity correlated to the positive perception of internal space in the evaluated group
Architectural competition by measuring the perception of the final users

<table>
<thead>
<tr>
<th>Competition 1</th>
<th>Competition 2</th>
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<tbody>
<tr>
<td>School Residence (Malles, IT)</td>
<td>Mala Strana Square (Prague, CZ)</td>
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<table>
<thead>
<tr>
<th>Corridor</th>
<th>Courtyard</th>
<th>External</th>
<th>Skyview</th>
<th>In place</th>
<th>Lateral view</th>
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<td><img src="image17" alt="In place 3" /></td>
<td><img src="image18" alt="Lateral view 3" /></td>
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1 2 3 Architect Team 4 5 6 Architect Team
The outcome of the measurements

Competition 1: School Residence (Malles, IT)

Perceived pleasantness of each proposal

- Team 1
- Team 2
- Team 3

Mean = 5.82  Mean = 5.23  Mean = 6.15

Eye fixation in defined hotspots

- Corridor
- Courtyard
- External

Team 1
Team 2
Team 3
The outcome of the measurements

Competition 2: Mala Strana Square (Prague)

**Perceived pleasantness of each proposal**

<table>
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<th>Team</th>
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<tr>
<td>Team 4</td>
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<tr>
<td>Team 5</td>
<td>5.38</td>
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<tr>
<td>Team 6</td>
<td>6.21</td>
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**Eye fixation in defined hotspots**

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<tr>
<td>Team 4</td>
<td>40%</td>
<td>30%</td>
<td>30%</td>
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<tr>
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<td>50%</td>
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Using the cerebral variables to assess the perception of fine arts masterpieces in art galleries
A visit on the art gallery (Rome, Scuderie del Quirinale, expositions of the Italian painter Tiziano, 16th century)
Subjects preparation inside the art gallery

- 28 subjects for each gallery visit (22-50 years); 60 seconds each painting
The eyetracking and the collection of brain activity during the art gallery visit
A visit to the art gallery (Jan Veermeer painting, January 2013)
A visit to the art gallery (Tiziano painting, April 2013)
«Annunciazione» of Tiziano (April 2013)
A visit on an art gallery (Vermeer and Dutch painters)
A visit on the gallery (Tiziano)
Brain recordings in front to 13m² of Tiziano painting (Martirio di San Lorenzo)
Observation of a Rome landscape for all the subjects at the end of the gallery visit (January 2013 and April 2013)
Observation of a Rome landscape for all the subjects at the end of the gallery visit (January 2013 and April 2013)
There are paintings that developed more «approach» activity than «withdrawal».
Common results for the 60 visitors of the two exhibitions

- Approach indexes was consistently higher during the observation of galleries of portraits (both for Tiziano’s and Vermeer’s paintings) wrt landscapes (in Vermeer’s paintings) or religious subjects (in Tiziano’s paintings) (ANOVA p<0.005)
- Results holds separately also for visitors of both art galleries
Portraits against landscapes in Vermeer paintings
Measuring the cerebral variables to assess the perception of sculptures
In fact, the observation of a masterpiece looks differently on a screen or on a wall of an art gallery.

The sculpture allows the observation from different point of views, a situation not possible with the paintings.

Research issue: It is possible that cerebral and emotional reactions to the observation of a statue vary significantly in agreement with the point of view chosen?

We performed a study with the aid of cerebral and cardiac measurements for the evaluation of interest and emotional engage of a group of subjects during the observation of the Michelangelo’s Moses sculpture in Rome.
The visit
Point of view 2 (POV#2)
Point of view 3 (POV#3)
Differences in Point of view 2 (POV#2) with light off and on

POV#2  

POV#2L
Variation of the Interest index across the points of observation with and without the light on

ANOVA returns significant change of the interest index across the points of view (p<0.04)
Variation of the Emotional index across the points of observation with and without the light on.

ANOVA returns significant increase of the emotion across the points of view (p<0.04).
• Data suggest that the **cerebral interest** is higher when it is possible to get all the information about the structure observed (POV3).

• Emotional impact was greater when the eyes of the participants **meet the eye of Moses**.

• Light presence seems to have a role for informational details (for the interest index) but not for the emotional index.
Discussion

• This research provided neuroelectrical evidences of the activity of the prefrontal cortical areas in occurrence of the evaluation of a succession of aesthetic stimuli, as provided by the observation of real sculpture in a church.

• We could answer YES to the initial research question whether it was possible that cerebral and emotional reactions to the observation of a statue vary significantly in agreement with the point of view chosen.

• Data suggested as the human face is a valuable source of information and emotion for us.

• Results of this research suggested the existence of a possible preferred path of observation of sculptures in museum as well as in expositions.
Using the EEG variables to assess the perception of the listening of classical literature
Noi leggiavamo un giorno per diletto di Lancialotto come amor lo strinse; soli eravamo e senza alcun sospetto.

Per più fiate li occhi ci sospinse quella lettura, e scolorocci il viso; ma solo un punto fu quel che ci vinse.

Quando leggemmo il disiato riso esser baciato da cotanto amante, questi, che mai da me non fia diviso.

la bocca mi baciò tutto tremante. Galeotto fu 'l libro e chi lo scrisse: quel giorno più non vi leggemmo avante».

Mentre che l’uno spirto questo disse, l’altro piangea; si che di pietade io venni men così com’io morisse.

E caddi come corpo morto cade.
Noi leggiavamo un giorno per diletto di Lancialotto come amor lo strinse; soli eravamo e senza alcun sospetto.

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E caddi come corpo morto cade.
Noi **leggiavamo un giorno per diletto** di Lancialotto come amor lo strinse; **soli eravamo** e senza alcun sospetto.  

**Per più fiate li occhi ci sospinse** quella lettura, e scolorocci il viso; ma solo **un punto** fu quel che **ci vinse**.  

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The use of EEG and the measurement of HR and GSR allows to estimate the ongoing appreciation and emotion of people in front to the real masterpieces. This is useful since the real masterpieces and manufactures are different from their representation on the screen. Cognitive Neuroscience is ready to move from the laboratory within the places in which the normal people live (working and leisure environments) and also to assess their mental «well being». …

Summarizing

Thank you for your attention!