

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

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**Abstract**— Recent studies have been showed as the perception of real or displayed masterpieces by ancient or modern painters generate stable neuroelectrical correlates in humans. In this study, we collected the neuroelectrical brain activity correlated with the observation of the real sculpture of Michelangelo's Moses within the church where it is actually installed in a group of healthy subjects. In addition to the cerebral activity also the heart rate (HR) and the galvanic skin response (GSR) were collected simultaneously, to assess the emotional engage of the investigated population. The Moses sculpture was observed by the group from three different point of views, each one revealing different details of the sculpture. In addition, in each location the light conditions related to the specific observation of the sculpture were explicitly changed. Results showed that cerebral activity of the subjects varied significantly across the three different views and for light condition against no light condition ( $p < 0.04$ ). Furthermore, the emotional engage estimated on the whole population is higher for a point of observation in which the Mose's face is directed toward the eyes of the observers ( $p < 0.02$ ). Finally, the cerebral appreciation of the investigated group was found maximum from a perspective in which all the details of the sculpture could be easily grab by the eyes. Results suggested how the perception of the sculpture depends critically by the point of view of the observers and how such point of view can produce separate emotional and cerebral responses.

## I. INTRODUCTION

Recent studies have been showed as the perception of real or displayed masterpieces by ancient or modern painters generate stable neuroelectrical correlates in humans[1-3].

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However, the investigation of the proper brain reactions to the perception of architectural spaces as well as volumetric human artifacts (e.g. sculptures, statues) has not been proposed yet in literature. The interest for such study relies on the fact that the fruition of volumetric information introduces a further degree of freedom to the observer's perception that is not present in the observation of paintings in an art gallery. This because the bi-dimensional displacement of the information related to the paintings when compared to the perception of sculpture and architectonic volumes. To understand whether the point of observations plays a role in the cerebral and emotional fruition of architectonical artifacts and sculptures it was decided to analyze the cerebral reactions of a group of subjects during an observation of the Michelangelo's Moses sculpture. Such sculpture is located in the ancient church of San Pietro in Vincoli in Rome, and it presents the interesting feature that the Moses face has the orientation not toward the observer but rather tilted toward the right side of him/her. Figure 1 clarifies such statement. Thus, in the Moses sculpture the observers are not pointing on the Moses face. If Moses was a paint, there will be no other available information available. However, since it is a sculpture it is then possible to collect the different cerebral and emotional reactions to its observation from different points of views. Thus, it has been decided to collect both neurometric and emotional responses of the observers during the contemplation of the sculpture from different points of views that are significant for the gathering of different details related to the sculpture.

In this study, we collected the neuroelectrical brain activity (through EEG) in a group of healthy subjects correlated with the observation of the real sculpture of Michelangelo's Moses within the church where it is actually installed in Rome. In addition to the EEG, also the heart rate (HR) and the galvanic skin response (GSR) were collected simultaneously to assess the emotional engage of the investigated population. The indexes employed to assess emotional and cognitive appreciation during the observation of such sculpture have been previously defined in literature [4-5]. While the emotional engage is described by mixing the HR and GSR together, the cognitive factors are indexed by the estimation of the EEG asymmetry over the prefrontal cortex. In fact, it is known as an important model for the approach-withdrawal motivational model of cerebral appreciation suggests as the left- and right-anterior brain regions are part of two separate neural systems underlying



approach and withdrawal motivation, respectively [6]. Relatively greater left frontal activity, either as trait or a state, indicates a propensity to approach or engage a stimulus while relatively greater right frontal activity indicates a propensity to withdraw or disengage from a stimulus (see for a review [7]). To our knowledge, this is the first study that collects brain activity during the observation of sculpture in an original architectonic space.

## II. METHODS

### A. Experimental design

The experiment has been performed in one of the finest church in Rome, “San Pietro in Vincoli”, in which the Michelangelo’s Moses sculpture is located. In particular, during the whole experimental session, each subject was guided through the church by an experimenter bringing her/him in front to the Michelangelo’s Moses in three different points of observation (POV) adopted. The entire experimental procedure consisted in a 1 minute resting sequence of open eyes before the visit, 1 minute baseline sequence observing a white wall within the church before the visit, 1 minute of observation in each one of the points of view considered. Fig.1 showed the position of the subject in the point of view #1 (hereafter named POV#1), at 5 mt. from the Michelangelo’s Moses.



Figure 1. The subjects are positioned as a first point of view (POV#1) in the front of the sculpture, at a distance of 5 mt from the Moses.

Then, the experimenter asks the subject to start the naturalistic vision of the sculpture. Sixty seconds of free vision of the Moses was then performed by the subject, without any pronounced words. During the sculpture observation, subjects were asked to minimize their facial and gestural movements. At the end of the stimulation, the experimenter asked the subject to rate the painting according to his/her perceived pleasantness (ranging from 1, ugly, to 10, beautiful) and then guided him/her to the next point of view of the Moses sculpture. The experimenter noted the time of the beginning and the end of each observation as well as the related pleasantness score pronounced by the subjects.

Three different point of views have been employed. The position of the subjects in those three points of view is

presented in the Figures 1, 2 and 3. In particular, the point of view #2 is located on the right side of the sculpture, directly in front of the Moses face (POV#2; Fig.2). The point of view #3 (POV#3) was instead located about 10 mt from the Moses face, in front of the sculpture (Fig.3). The distance of the subjects with respect to the Moses face was roughly the same for the POV#1 and POV#2 (e.g. about 5 mt) while was the double for the POV#3.



Figure 2. The second point of view (POV#2) was located on the right of the sculpture, directly towards the face of the Moses. Subjects are positioned at the same distance from the Moses that in the other points of view.



Figure 3. The subjects are positioned as a third point of view (POV#3) in the front of the sculpture, at a distance of 10 mt from the Moses.

The entire visit was repeated two times, one with the observation of the sculpture with the natural light, and the other with the observation of the sculpture with the artificial light available from the church. The sequence of artificial and natural light was randomized across the subjects. The visits of all the subjects were performed at noon in a series of days characterized by good weather and stable condition of light within the church. The comparison between these two conditions was made to analyze the effect of the artificial illumination over the sculpture appreciation.

### B. EEG, HR and GSR recordings and signal processing

Twenty normal subjects ( $27.3 \pm 1.5$  years, half males) were involved in the experiment. For all of them the electroencephalographic (EEG) activity were recorded, together with the acquisition of their heart rate (HR) and the Galvanic Skin Conductance (GSR). The EEG activity was recorded by means of a portable 24-channel system (BEmicro, EBneuro, Italy). The HR and GSR information was taken by using the NEXUS-4 system by Mindbrain BV, The Netherland). Informed consent was obtained from each subject after the explanation of the study, which was approved by the local institutional ethic committee. Electrodes were disposed according to the 10-20 international system. The Fpz channel has been used as reference. The impedances were kept below  $5k\Omega$  and the signals have been acquired at a sampling rate of 256 Hz. Raw EEG traces were first band pass filtered (hp=2 Hz; lp=30 Hz) and the Independent Component Analysis (ICA) was then applied to detect and remove components due to eye movements, blinks, and muscular artefacts. The EEG signals have been transformed by means of the Common Average Reference (CAR) and the Individual Alpha Frequency (IAF) has been calculated for each subject in order to define the frequency bands of interest according to the method suggested in the scientific literature [7]. Each EEG trace has been band pass filtered in order to isolate the spectral components in the theta and alpha band from the whole EEG spectrum. The filtered traces have been used to calculate the Global Field Power (GFP; [8]) that was computed by using information from electrodes placed on frontal areas of the subjects. This because the several studies in literature describing the prefrontal cortex as a central areas in the analysis of pleasantness [9-11]. We reversed the GFP waveform in order to have the activity of de-synchronization pointing up. The formula defining the AW index is the following:

$$AW = GFP_{\alpha\_right} - GFP_{\alpha\_left} \quad (1)$$

where the  $GFP_{\alpha\_right}$  and  $GFP_{\alpha\_left}$  stand for the GFP calculated among right (Fp2, F4, F8) and left (F7, F3, Fp1) electrodes, in the alpha band, respectively. The waveform of AW cerebral index has been estimated for each seconds and then averaged for all the duration of the observation in each POV. Then, the AW signals of each subject have been averaged to obtain a mean waveform and statistical analyses will be performed by using the z-score transformation. The AW index was then standardized according to the baseline EEG activity acquired at rest within the church, before the

starting of the visit. Autonomic information were taken by collecting HR and GSR and by composing the emotional index EI as described Vecchiato et al. [10] Both AW and EI were referred to the mean and standard values of them obtained during the baseline acquisition, by realizing a z-score transformation of the indexes.

### C. Statistical analysis

Analysis of variance (ANOVA) was applied on the cerebral variable Approach/Withdrawal and to the autonomic variable Emotional Index with the factor Point of View (POV) with three levels (POV#1, POV#2, POV#3) and the factor LIGHT with two levels (natural, artificial). Duncan post hoc test was used at a  $p < 0.05$  level of significance.

## III. RESULTS

### A. Behavioral data

The performed ANOVA for the verbal scores revealed a statistical significant effect for the factor POV ( $F=6.8510$ ,  $p=0.02357$ ), with the POV#2 having the higher score reported (9.66 on a scale of 10). The factor LIGHT also was significant for the verbal judgments ( $F=12.129$ ,  $p=0.03939$ ), with an increase value of the scores for the condition with the artificial light than the natural.

### B. Brain activity related to the different points of view

The estimation of the average AW index for all the subjects along the observation of the Moses sculpture from the different points of view returned the profile showed in Fig.4. The AW index is expressed as a z-score normalized value; when positive, it suggests an appreciation of the group investigated for the particular painting observed, while viceversa when negative. Note as each point of view of the sculpture is characterized by the biometric recordings with natural and artificial light (respectively POV#1, POV#2, POV#3 for natural light or POV#1L, POV#2L and POV#3L for artificial light). ANOVA results returned a significant increase of the AW index related to the interaction of POV x LIGHT factors ( $p < 0.04$ ). The successive Duncan's post hoc tests suggested how the cerebral appreciation of the subjects are increased for the POV#2 and POV#3 over the other conditions of observation. The POV#3 revealed also a statistically significant increase of the cerebral approach activity in both conditions of light (natural and artificial) when compared to the other points of view but POV#2. The AW cerebral index is then maximum in the POV#3 with the artificial light. The cerebral appreciation of the POV#3 is just tied with the appreciation of POV#2 in a natural light. Emotional index, as derived from the measurements of the HR and GSR returned the pattern described by the Figure 5. ANOVA revealed that the factors POV is significant ( $p < 0.025$ ) but not the factor LIGHT ( $p = 0.38$ ). It can be appreciated that the maximum of the Emotional index has been gathered for the lateral point of view #2 when compared with the others point of observations ( $p < 0.0022$ ).



#### IV. DISCUSSION

This paper 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 the real Michelangelo's Moses sculpture from different point of views in the church of S. Pietro in Vincoli in Rome.

#### Approach / Withdrawal EEG

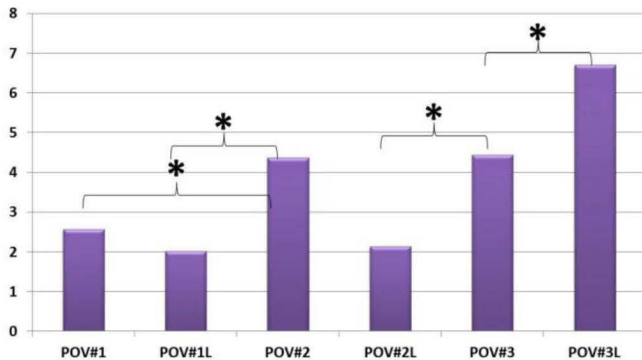


Figure 4. Variation of the Approach/Withdrawal index (AWI) along the church visit. The abscisse numbers represent the point of view of the subjects during the Moses observation. Ordinate values are related to the z-score computed for the unbalancing of the EEG power spectra over the prefrontal cortex. The higher the value over 2 the higher the cerebral approach to the sculpture. Stars over the columns represent a statistical significance of the comparisons performed at  $p < 0,05$ .

#### Emotional index

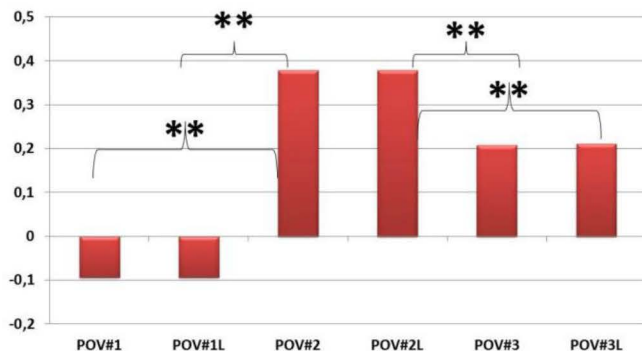


Figure 5. Variation of the Emotional index along the different Moses views. The abscisse numbers represent the point of view of the subjects during the Moses observation. Maximum value of the Emotional index is reached for the observation of the POV#2 with natural and artificial light. The higher the index, the more positive the emotion perceived by subjects. Stars represent a statistical significance of the comparisons performed at  $p < 0,05$  (one star) and  $p < 0,01$  or less (two stars).

Such a finding is in agreement with the observations provided by several studies which used hemodynamic measurements and suggested that the medial orbitofrontal cortex is deeply involved in the perception of beauty [1]. Interestingly, we observed a dissociation between the cortical appreciation of the sculpture (maxima at the POV#3) and the emotions perceived from such observation, maxima at POV#2. An intriguing interpretation of this dissociation is proposed as follows: the POV#2 generate a direct face-to-face interaction between the Moses sculpture and the observer (as shown in Fig.2). This interaction has a high

emotional content, since the face observation is associated with the interaction with the other human or animal beings and thus has an high importance for us. On the other hand, the cortical appreciation of an structure has been generated from a POV which allows to detect all the sculpture in its general details. The POV#3, as presented in Fig. 3, allows to the observers to get all the information from the sculpture of the Moses as well as from the other sculptures associated with it since it is located relatively far from the sculpture when compared to the other POVs (Fig 1-3). By collecting the emotional and cortical responses during the observation of a real sculpture we observed such dissociations of the cerebral signals linked to the different modalities of fruition of the same sculpture. We believe that the observations could be used in a future to generate specialized paths across the museums to induce different emotions and perception of sculptures and artworks in the general public. This will be made possible by the possibility to collect reliable measurements of brain and heart activity not only in the neurophysiology laboratories [11-13] but rather in a challenging environment such as museums, art gallery, churches and archeological sites.

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