A non-Invasive Approach to Extract the User's Patterns of Visual Arts Exploration through Wearable Technologies Application: the NEFFIE Project

Diana Trojaniello, Matteo Zardin, Marco Mura, Alberto Sanna
Center for Advanced Technology in Health and Wellbeing
IRCSS San Raffaele Hospital
Milan, Italy
e-mail: trojaniello.diana@hsr.it, zardin.matteo@hsr.it, mura.marco@hsr.it, sanna.alberto@hsr.it

***Abstract*— Understanding human cognitive perception processes during visual art fruition represents both a neuroscientific and technological challenge. By addressing the cognitive processes behind the art appreciation and by employing the last generation technologies to analyze human bio signals, the NEFFIE project aims to propose a new approach to emphasize the visual art fruition experience while increasing the awareness of what we actually see. The project consists of four different experimental phases, including both In-Lab and Out-Lab evaluations: I) In-Lab images rating; II) In-Lab functional Magnetic Resonance Imaging fMRI -based study; III) In-Lab Wearable-based study; IV) Out-Lab Wearable-based study. Through these experimental steps, the NEFFIE project will develop a unique platform based on Artificial Intelligence human-centric algorithms to identify each person's unique fingerprint of visual art perception and discovery. The current idea-paper aims to describe the above-mentioned experimental phases.**

Keywords - visual art; wearable; fMRI; artificial intelligence; machine learning.

I. INTRODUCTION

In literature, Visual Arts (VAs) including paintings, sculptures and photography have been always defined as an aesthetic expression of interiority and of the human soul. VAs reflect the artist's opinions, feelings and thoughts in the social, moral, cultural, ethical and religious context of his historical period. Philosophers and semantic scholars, however, argue that an objective language exists that, regardless of the eras and styles, should be codified in order to be understood by everyone, but so far efforts to demonstrate this claim have been found unsuccessful.

Thanks to the technology advancements, nowadays it is possible to understand more precisely how the subjective process of aesthetic appreciation of VA forms takes place. Recent studies showed that "aesthetic experience" involves brain areas devoted to different functions [1], such as the body representation and its movements, and the analysis of the hedonic value of perceived stimuli. The above-mentioned brain areas are activated automatically when people observe VA forms, even if they have not been asked to judge them critically. Functional Magnetic Resonance Imaging (fMRI) allow to identify the brain areas associated with the aesthetic experience.

However, such an in-depth study has physical and non-physical limits, e.g., the impossibility to present images for a longer time interval, necessary for the observer to ensure deep contemplation. This is why new technologies and sensors (i.e., wearable devices able to monitor physiological signals) could be employed to monitor physiological parameters in un-constrained environments thus allowing a longer VA form fruition in a quasi-real life context.

Monitoring methods such as ElectroEncephaloGraphy (EEG), Eye-Tracking (ET), Face Recognition (FR). PhotoPletismoGraphy (PPG) and Galvanic Skin Response registration (GSR) allow to collect physiological data highly correlated with the brain activity and emotions through wearable devices mounted on the subjects [2]. For example, the usage of such methods through an integrated multi-sensors platform allow to register the electrical activity produced by populations of neurons on the observer cerebral cortex (EEG), while detecting eye movements and fixation points (ET), to identify which aspects of the VA form capture the attention of the observer and reach his consciousness. In addition, by including the emotions as expressed by the face (FR) and electro dermal activity variation (GSR) it is possible to detect the emotional activation level of the observer.

The NEFFIE project will develop a unique multi-sensors platform based on Artificial Intelligence (AI) human-centric algorithms to identify each person's unique fingerprint of visual art perception and discovery in un-constrained environments. The current idea-paper aims to describe the experimental activities flow that will allow to develop the NEFFIE platform. The paper is organized as following: in Section I the introduction has been reported; in Section II the project experimental phases have been described; in Section III conclusion and future works have been reported.

II. PROJECT EXPERIMENTAL PHASES

In the following sections (A, B, C, D), the four experimental phases of the NEFFIE project (In-Lab images rating, In-Lab fMRI based study, In-Lab Wearable based study, Out-Lab Wearable based study) have been briefly described.

A. In-Lab images rating

The first phase of the project consisted in an *image (photo) rating study.* A total of 218 images have been collected and divided in two groups of images, i.e., Neffie Group (N-G) and Control Group (C-G). The N-G images were characterized by an high presence of reflections and in

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general complex elements, while the C-G ones were characterized by a simpler content. Eighty healthy subjects have been included in the study and divided into 4 groups. Each group was asked to rate on a 7-points Likert scale the 218 images, presented in a random way, with respect to one of the four following dimensions: a) presence of reflections; b) complexity; c) beauty; d) stimulating. The results obtained in this first study allowed to identify a sub-set of images (n=61) characterized by higher levels of complexity and able to arouse the observer.

B. In-Lab fMRI-based study

The second phase of the project consisted in a *fMRI based study*. The study has been designed on the basis of the results obtained in the previous phase by including the subset of 61 images identified in the *In-Lab image rating study*. Thirty-six healthy subjects will take part to the study and will be invited to receive a fMRI evaluation while observing the 61 N-G images and 61 C-G matched ones. The main objective of this phase is to evaluate the BOLD signal variation through the fMRI technique in those brain area involved in the complex visual stimuli analysis (N-G images). In general, this phase of the project aims to establish a relation between the brain activity and the aesthetic experience of the subject while observing N-G and C-G images. In addition, the eye-tracking technique will be employed to measure the fixation points and the image area, which is more involved in the visual exploratory pattern of the subject. This study will start in the first part of 2020.

C. In-Lab Wearable-based study

The second phase of the project consisted in a *wearable sensors based study* performed in-lab environment under the supervision of a researcher. The main objective of this phase was to identify the minimum viable number of sensors able to describe in the most accurate way the aesthetic experience (i.e., emotion level through valence and arousal levels identification) of the subject while observing a VA form. A multi sensors platform has been developed including the following devices: EEG, ET, GSR and PhotoPletismoGraphy PPG. The platform allowed the researchers to register the subjects bio-signals synchronized with the visualization of a number of images extracted by the Nencki Affective Picture System (NAPS) database.

Figure 1. The In-Lab Wearable based study experimental setup.

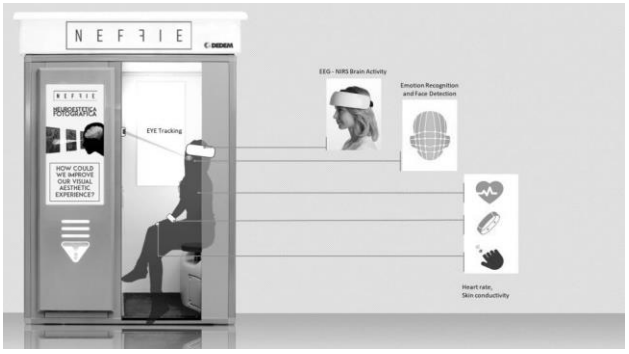

Figure 2. The Out-Lab Wearable based study experimental setup.

Forty-three subjects have been enrolled in this study. Bio-signals were recorded during the presentation of visual stimuli (baseline image, eliciting image) from NAPS, which were at the same time evaluated by the subjects (self-reports on arousal, valence and emotional label). Figure 2 shows the experimental setup adopted for the experiment. AI algorithms including Neural Networks and Support Vector Machines have been then applied in order to find the most accurate one to identify arousal and valence levels (i.e., with respect to the reference values associated to each image as reported in the NAPS database).

D. Out-Lab Wearable-based study

The last phase of the project consisted in the application of the previous phase in an un-constrained environment. The same setup as developed and used in the *In-Lab wearable based study phase* has been placed inside a photo booth provided by an external company (as shown in Figure 3). The photo boot has been equipped with a touch screen. The subjects will be invited to enter in the photo booth and to wear the wearable devices placed inside and then to start the experiment. A set of images among those 61 ones selected in the *image rating study* will be presented on the screen while the subject bio-signals will be registered. Once the image presentation will be concluded, the subject will be requested to choose among one of them to be printed. The printed image will be the reinterpretation of the observed image on the basis of the bio signals registered and analyzed.

This study will start in March 2020.

III. CONCLUSIONS AND FUTURE WORKS

The present paper outlines the current experimental phases of the NEFFIE project. The In-Lab fMRI as well as the Out-Lab Wearable based studies will start in the first half of 2020.

REFERENCES

[1] G. Udovičić, J. Đerek, M. Russo, and M. Sikora. 2017. Wearable Emotion Recognition System based on GSR and PPG Signals. In Proceedings of the 2nd International Workshop on Multimedia for Personal Health and Health Care.

[2] E. Vessel, G.G. Starr, N. Rubin, 2012. The brain on art: intense aesthetic experience activates the default mode network Front Hum Neurosci. 2012; 6: 66.

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