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Can Brain-Computer Interface Predict Change in Anxiety During an Art Experience? Preliminary data from the ASBA project

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1. INTRODUCTION

Museums and the arts can have a significant positive impact on people's health and wellbeing. But it's important to assess the real impact that artifacts and museum areas can have. Numerous studies have demonstrated that the psycho-physical impact of art is dependent on the visitor's unique qualities as well as the piece itself. Personality, artistic inclination, prior museum visits, stress and anxiety levels, and other factors can all have a big impact on how beneficial art actually is. Standardized scales have long been used in psychology to assess psychological factors like stress and anxiety levels. In controlled studies, this is simple to accomplish, but in field investigations, it is far more challenging.

The use of psychometric measures (e.g. scales and questionnaires) in real-world contexts is very complicated. In our case, museums themselves would have to implement measurements on their visitors. To make the measurement of the effects of museums' spaces on perceived well-being simple and feasible, it is, therefore, possible to use a combination of visual-analog tools, which are very quick to perform and immediately understandable (e.g. through the use of emoticons or other visual forms), and advanced, wearable and inexpensive technological tools. One such tool is the BCI (Brain-computer interface), an easy-to-wear tool that can provide easy-to-process biometric data. In addition, various low-priced BCI devices are available on the market, which allows their purchase even in certain quantities. BCIs offer a potential solution by providing objective measures of brain activity related to emotional and cognitive states (Torres et al. 2020). Previous research has explored the use of BCIs for artistic expression (see. Vanutelli, Salvadore, and Lucchiari 2023) and studying affective states (Nijholt et al. 2018), as well as for training and intervention in various contexts (Cao 2020).

However, before these technologies can be concretely used to effectively measure the effect of any experience or treatment on well-being, their operation needs to be validated. In our study, we administered before and after the experience in the museum both a standardized scale for anxiety (the State-Trait Anxiety Inventory, STAI; Spielberger et al. 1971) and at the same time measured through BCI the basal EEG for two minutes (one minute with eyes open and one minute with eyes closed), again before and after the experience. We then sought to assess whether a significant change in state anxiety measured through STAI corresponded to a significant change in some EEG parameters. Currently, we have collected data on 30 people engaged in various experiences in some museums. The data from the initial data analysis show that indeed some EEG parameters seem to be able to signal a significant increase in well-being. In particular, the power of prefrontal alpha rhythm seems to be a good candidate to play this role.

This study is part of the ASBA project (Anxiety, stress, Brain-friendly museum approach; Banzi et al. 2023), which aims to investigate the effect of museum experience on individual wellbeing using a variety of elicitation methods, such as Mindfulness, Art therapy and Visual thinking strategies. In this

paper we focus on potential us of BCI to predict changes in anxiety levels in museum settings. Specifically, we aim to validate the use of BCIs by comparing changes in electroencephalogram (EEG) parameters with changes in self-reported anxiety levels, as measured by STAI and visual-analogical scales.

2. METHODS

2.1 Participants

The study included 30 participants (age range: 18-65 years) who engaged in various guided and well-structured experiences at a museum. Participants were recruited through dedicated websites, social media and local advertisement. Exclusion criteria included history of neurological or psychiatric disorders, and use of medications that could affect cognitive or emotional functioning. The study was approved by the ethical board of University of Milan-Bicocca, Italy.

2.2 Procedure

Participants completed the STAI and underwent a two-minute baseline EEG recording (one minute with eyes open and one minute with eyes closed) before and after the museum experience. EEG data were collected using a commercially available, wearable BCI device (the Muse headband) with dry electrodes placed on the forehead and temporal regions.

2.3 Data analysis

Changes in STAI scores (state anxiety) and EEG parameters (e.g. prefrontal alpha power) were analysed using paired t-tests or non-parametric equivalents, depending on the distribution of the data. Correlations between changes in STAI scores and EEG parameters were also examined.

3. RESULTS

Preliminary data analysis showed a significant decrease in STAI scores (indicating reduced state anxiety) after the museum experience ($p < 0.05$). Additionally, there was a significant increase in prefrontal low alpha power, a marker of relaxation (Sharma & Singh 2015), after the experience ($p < 0.05$). Changes in STAI scores were positively correlated with changes in prefrontal alpha power ($r = 0.42$, $p < 0.05$).

4. DISCUSSION

The findings suggest that BCIs can be used to predict changes in anxiety levels during art experiences in museum settings. The observed increase in prefrontal alpha power and its correlation with reduced state anxiety align with previous research on the relaxing effects of art (Belkofer et al. 2014) and museum experiences.

This preliminary study demonstrates the potential of BCIs for predicting changes in anxiety levels during art experiences in museum settings. By combining self-report measures with objective EEG data, BCIs offer a promising tool for evaluating the psychological and physiological effects of cultural experiences.

However, this study is limited by its small sample size and lack of a control group.

Future research with larger samples and control conditions is needed to validate the use of BCIs for assessing the impact of art experiences on mental well-being. Additionally, exploring the potential of BCIs for real-time monitoring and personalized interventions in museum settings could further enhance the visitor experience and promote well-being.

Further research is needed to establish the validity and practical applications of this approach that promise to enhance the feasibility of those applications aimed to extend the missions of museums from cultural heritage conservation to cultural well-being, such as the ASBA project.

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