Aesthetic perception and judgments via optic brain imaging method (fNIRS)

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Aesthetic perception and judgments have been parts of our daily life as it has been an indispensable component of our interaction with the environment and exert behaviors through this executive function of the frontal brain regions with respect to its roles in decision-making and executive control such as planning, judgment, reasoning. Recent studies in the scientific literature have already indicated that the medial prefrontal cortex (mPFC), especially ventromedial prefrontal cortex (vmPFC) and medial orbitofrontal cortex (mOFC) and also left dorsolateral prefrontal cortex (dlPFC) are activated when people judged objects to be beautiful and pleasant (Nakamura and Kawabata, 2015; Di Dio et al., 2016; Cattaneo, et al., 2020). Dorsolateral PFC has mostly been considered to be a regulator on vmPFC in moral and beauty judgement and also is thought to play a causal role in visual aesthetic evaluation (Dashtestani, et al., 2018; Cattaneo, et al., 2014). Ventromedial PFC is generally concerns with regulation of emotional values, encoding and predicting good outcomes, also crucial for enabling certain affective content to influence subjective value (McClure, et al., 2004; Jessup and Koechlin, 2014). Medial orbitofrontal cortex (mOFC), is strongly related to the vmPFC in terms of function. Orbitofrontal cortex participates in value-based decision-making processes. The vmPFC, particularly the medial orbitofrontal cortex, allows to convert different subjective reward scales into a common unit scale to allow comparison of values driving selection. Neural activation in the mOFC is weaker when judging images as ugly. The evaluation of beauty is more dominant and fluent compared to appraisal of ugliness (McClure, et al, 2004; Domenech, and Koechlin, 2015; Nakamura, 2015; Funahashi, 2017). Perceptual fluency is defined as a subjective experience that represents the ease with which to process an image. Therefore it increases liking and the experience of fluency is affectively positive (Reber, 1998,2004). In line with all these findings, the aim of the study is to find whether there are differences between curved and sharp images in aesthetics and perceptual fluency, also what are the main prefrontal areas in this process.

The first part of this study, preference evaluation test, was conducted with 230 participants, using a survey with 258 images adapted from Bar and Neta's (2006) previous work. Every curved image has its own counterpart that is a sharp angled image in the survey. Curved and sharp objects in the survey were also classified as patterns and real objects. The data was analyzed with ANOVA Single Factor. Our findings indicate that participants like curved real objects more than the sharp counterparts ($F(1, 458)=45.55$, $p<0.05$). However, the preferences of the participants were in favor of sharp angles for patterns ($F(1, 458)=147.3$, $p<0.05$). Appropriate to the previous findings, our results have indicated that people found curved real objects more pleasant or beautiful, opposed to patterns with sharp angles.

After the evaluation of the results from the survey, an image group consisting of the most and the average liked curved and sharp objects were examined by fNIRS technique(Ayaz et al., 2006) to find extensive understanding for activations in dlPFC, mPFC and OFC. The technique is a method of monitoring neurophysiological oxygenation and investigates hemodynamic changes in the cerebral cortex. (Peng and Hou, 2020). The data source is taken from a pad consistingof 10 sensors, 4 light sources and 16 optodes to be placed on the forehead. The sensors can receive data at 2Hz frequency from 16 regions located in the prefrontal cortex. The spatial resolution of optodes is on the centimeter scale and information can be obtained from a depth of 1.5 cm. Optode 1-4 corresponds to the left DLPFC, optode 5-8 corresponds to the left medial anterior PFC regions (Ayaz et al., 2006). In the medial region, optode 5-6 correspond to the left dorsomedial PFC and optode 7-8 to the frontopolar PFC regions. The regions under the 9-16 optode correspond to the symmetrical parts of the PFC in the right brain lobe. After placing the pad, our participants completed the tasks consisting of 60 images by showing the image screen of 5 seconds, the decision-making screen of 3 seconds, and the fixation screen of 8 seconds. The keys participants needed to press to indicate liking or dislike will randomly switch in each block to avoid lateralization biases. The obtained data were analyzed with paired sample t- test. A paired-samples t-test was conducted to observe whether there are significant levels of difference between image screen and decision screen and liking or not liking through the sharp and curved objects. In the image screen phase, there was a marginally significant difference in the scores for oxy9 parameter for sharp (M=.0056; SD=.0518) and curved (M=-.0023;SD=.04811) conditions (t(15)=2.071; p=.056), and also a significant difference has been observed for hbr9 parameter sharp(M=-.0039; SD=.02377), curved (M=.0001; SD=.02005) conditions (t(15)=-2.238; p=.041), and hbr11 sharp(M=-.0010; SD=.03044) and curved(M=.0027;SD=.02891) conditions(t(15)= -2.903; p=.011). In the decision screen phase, there was a marginally significant difference in the scores of both oxy16 and hbr16 parameters for sharp (M_{oxy16}= -.0411; $SD_{oxy16;}$=.11309; M_{hbr16}=.0574; SD_{hbr16}=.12816)and curved (M_{oxy16}=-.0523; SD_{oxy16}= .12192; M_{hbr16}=.0728; SD_{hbr16}=.12934) conditions(t_{oxy16}(11)=1.806; p=.098; t_{hbr16}(11)=-1.906;p=.083) besides, a significant difference was found in both oxy2 and hbo2 parameters sharp (M_{oxy2}=-.0500; SD_{oxy2}=.05959; M_{hbo2}=-.0152; SD_{hbo2}=.03838) and curved (M_{oxy2}=-.0642; SD_{oxy2}=.07314; M_{hbo2}=-.0249; SD_{hbo2}=.04111)conditions (t_{oxy2}(11)=2.302; p=.036; t_{hbo2}(15)=2.421; p=.029). The reaction times for the sharp (M=1133,3189; SD=256,28796 and curved (M= 1140.0932; SD=258.74169) objects (t(15)=-.775; p=.450) were compared for evaluation of perceptual fluency, and there is no significant difference between reaction times.

The general aspects obtained from the literature indicates that higher left frontal activity is associated with a general approach or behavioral activation motivation system, whereas higher right frontal activity is associated with the avoidance or withdrawal system (Moshirian, 2019; Coan, 2004). With this perspective, our preliminary results have illustrated that there is an activation mean change in right dlPFC when participants saw curved objects. Moreover, there is a marginal significance in activation mean change at right frontopolar PFC regions furthermore a significant in activation mean change at left dlPFC when participants decided over the curved objects. In conclusion, the current findings indicate that there might be a relation between PFC regions and the objects' contour type, on the other hand, there is no connection between perceptual fluency and contour type.

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