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Aesthetic value of paintings affects pain thresholds ☆

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ABSTRACT

Pain is modulated by cognitive factors, including attention and emotions. In this study we evaluated the distractive effect of aesthetic appreciation on subjectively rated pain (visual analogue scale;VAS) and multi-channel evoked potentials induced by CO_2 laser stimulation of the left hand in twelve healthy volunteers. Subjects were stimulated by laser in the absence of other external stimulation (baseline condition) and while looking at different paintings they had previously rated as beautiful, neutral or ugly. The view of paintings previously appreciated as beautiful produced lower pain scores and a clear inhibition of the P2 wave amplitude, localized in the anterior cingulate cortex; the inhibition of P2 wave amplitude was lesser or not significant during the presentation of the ugly or neutral paintings, respectively. Dipole source localization analysis of the LEP peaks showed significant changes during different conditions, with a shift from the posterior to the anterior right cingulated cortex while looking at paintings previously rated as beautiful.

Our results provide evidence that pain may be modulated at cortical level by the aesthetic content of the distracting stimuli.

1. Introduction

Although the aesthetic experience has been proven to play a pivotal role in human behaviour through different eras and cultures, the neural correlates of appreciation end creation of beauty have being studied only in the last years (reviews in Ramachandran & Hirstein, 1999; Zeki, 1999, 2004a, 2004b; Leder, Belke, Oeberst, & Augustin, 2004; Cavanagh, 2005; Jacobsen, 2006; Conway & Livingstone, 2007). During the last decade neurosciences have gained substantial advances in understanding some emotional, cognitive and biological components of aesthetics. The aesthetic experience is promoted by components and principles of the sensory modalities involved, which, for the visual aesthetics, have been related to shape (Rentschler, Jüttner, Unzicker, & Landis, 1999), symmetry (Baudouin & Tiberghien, 2004) and complexity (Jacobsen, Schubotz, Höfel, & Cramon, 2006), proportions (Green, 1995; Davis, 2007; Di Dio, Macaluso, & Rizzolatti, 2007) of the object, triggering subjective cognitive and emotional components. Perception mechanisms (Reber, Schwarz, & Winkielman, 2004; Zeki, 2004a, 2004b, 1999; Ramachandran & Hirstein, 1999), novelty or typicality (Hekkert, Snelders, & van Wieringen, 2003; Leder et al., 2004), learning and culture (Rentschler et al., 1999; Jacobsen, 2006), intention (Höfel & Jacobsen, 2007), evaluative judgement (Zeki, 2004a, 2004b; Jacobsen et al., 2006; Volz, Schubotz, & von Cramon, 2006), individual reward value (Gray, Braver, & Raichle, 2002; Kawabata & Zeki, 2004; Rolls, 2004; Rogers et al., 2004; Grimm et al., 2006; Volz et al., 2006), affective and emotional content (Leder et al., 2004), creativity (Bogousslavsky, 2005) and imagery (Finke, 1996), are interrelated for subjective aesthetic experience settlement. Models for a framework of brain and psychological mechanisms in aesthetic processing have been proposed, outlining multiple stages (perception, explicit classification, implicit classification, cognitive

☆ Pain modulation and beauty.

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mastering and evaluation) (Leder et al., 2004) and levels of analysis (diachronia, ipsichronia, mind, body, content, person and situation) (Jacobsen, 2006). The effects of brain injures on aesthetics have received increasing attention and these studies provided new insights for knowledge of brain mechanisms involved in aesthetics as well as for the definition of new parameters in the clinical assessment (reviews in Clifford Rose, 2006; Chatterjee, 2004, 2006).

According to Zeki (2001), there can be no satisfactory theory of aesthetics that is not neurobiologically based. Aesthetic perception seems a sum of cognitive and emotional items, which expresses very well the individuality of human brain, based on the sensorial, cultural and affective experiences. The study of the neural basis of aesthetic may contribute to the knowledge of the individual variability in health and diseases, which is one of the most important characteristics of the human brain (Zeki, 2001).The knowledge of the neural basis of aesthetics may contribute to the study of the effects of aesthetic experiences on other brain functions.

Event-related brain potentials have been used in order to clarify the process of cognitive and emotive engagement during aesthetic appreciation and judgment. In previous EEG studies on aesthetic and symmetry judgments of graphic patterns, symmetry showed a strong positive correlation with judgments of beauty and was the most important cue. All conditions showed late positive potentials (LPPs), and the authors argued that the aesthetic judgments engaged a two-stage process consisting of early, anterior fronto-median impression formation after 300 ms and right-hemisphere evaluative categorization around 600 ms after onset of the graphic patterns (Jacobsen & Höfel, 2002). In a more recent study, the same authors (Höfel & Jacobsen, 2007) observed that the late positivity, occurring during the aesthetic categorization, required an aesthetics instruction and did not occur spontaneously. In a recent study on the influence of aesthetic perception on event-related potentials (de Tommaso et al., 2007), we have shown that the vision of beautiful artistic pictures or geometrical shapes was linked with an increased amplitude of the target P3b, a large positive-going potential expressing the allocation of attention resources, compared to images judged as ugly or neutral, and that the increase occurred independently from the type of stimulus.

Pain is a complex function of human brain, involving attention and emotions (Rainville, 2002; Villemure & Bushnell, 2002). The manipulation of attention has been used as a therapeutic approach to pain for generations. The process of distraction appears to involve competition for attention between a highly salient sensation (pain) and consciously directed focus on some other information processing activity. Despite the burden of aesthetic experiences during life, the effects of such specific brain functions on pain processing have not been studied, though such information may be important in planning an ideal environment for people undergoing medical treatment for chronic pain. In the last few years, growing attention has been directed toward the structural quality of special care centres and hospitals for people with chronic pain (Lakomek, Neeck, Lang, & Jung, 2002) since pleasant surroundings may have a different impact on pain sensation, depending on aesthetic perception.

Previous studies have been focused on the analgesia induced by the distracting experience of visually immersive virtual reality (Hoffman et al., 2004). Visually induced analgesia has also been correlated with the affective content of pleasant, neutral or unpleasant pictures and pain tolerance has been reported to depend on primal and appraisal processes (de Wied & Verbatena, 2001). Recently, it has been shown that event-related brain potentials (ERPs) elicited by painful and nonpainful electrical stimuli are modified by the affective valence of pictures, with the maximum distractive effect on pain coming from images with positive affective content (Kenntner-Mabiala & Pauli, 2005).

In the last decade, event-related potentials induced by specific activation of thin myelinated and unmyelinated fibres by painful laser stimuli have largely contributed to our knowledge of the central mechanisms of pain elaboration. Multi-channel recordings of laser evoked potentials (LEPs) and the application of dipole source analysis algorithms have discerned two activities. The first LEP component commonly identified is the N1, a negativity that is seen in temporal EEG-leads at about 150 ms following the laser stimulus (or later, depending on the type of laser). Its generator has been localized in the operculo–insular cortex (Valeriani et al., 2000; Garcia-Larrea, Frot, & Valeriani, 2003), and this component has been demonstrated to be involved in focussed attention or spatial discrimination. The second is a large positive-negative complex named N2–P2 with its maximum amplitude at the vertex, generating from the posterior zone of the anterior cingulate cortex (Peyron, Laurent, & García-Larrea, 2000; Valeriani et al., 2000; Garcia-Larrea et al., 2003) and expressing the variations in arousal and emotive reaction against pain (Schlereth, Baumgärtner, Magerl, Stoeter, & Treede, 2003; Iannetti, Zambreanua, Cruccu, & Traceya, 2005). Hence, LEPs seem to constitute a useful method to evaluate the cognitive modulation of pain via aesthetic perception. In the present study we explored the effects of paintings judged as beautiful, neutral or ugly, on subjective pain sensation and multi-channel recorded LEPs in order to assess how the aesthetic content of a visual distractive stimulus modulates pain.

2. Methods

2.1. Subjects

Twelve healthy, right-handed subjects (6 females) in the 22- to 38-year-age range (mean 33.9 ± 3.8) participated in the study. All participants had pursued either undergraduate or graduate studies and had no special experience in painting or art theory. They all had normal or corrected-to-normal vision and none had a history of neurological or psychiatric disorders.

Written informed consent was obtained from all the participants and the study was approved by the Ethics Committee of the Neurological and Psychiatric Sciences Department of the University of Bari.