



## The neural foundations of aesthetic appreciation

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### ABSTRACT

The study of the cognitive and neural underpinnings of aesthetic appreciation by means of neuroimaging techniques has yielded a wealth of fascinating information. Although the results of these studies have been somewhat divergent, here we provide an integrative view of the early approaches, which identified some of the core mechanisms involved in aesthetic preference. Then, a number of more specific issues under the perspective of recent work are addressed. Finally, we propose a framework to accommodate these findings and we explore future prospects for the emerging field of neuroaesthetics.

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### Contents

1. Introduction	39
2. Neuroimaging techniques reach to the arts	41
2.1. Psychological processes related with the visual appreciation of aesthetics	41
2.2. Neural activity identified by the early neuroimaging studies	42
2.3. Models of cognitive processes underlying visual aesthetic preference	42
2.3.1. Temporal span	43
2.3.2. Decision and attention	43
2.3.3. Affective processes	44
3. Outstanding issues raised in recent neuroimaging approaches to aesthetic appreciation	44
3.1. Recognition and familiarity	44
3.2. Bottom-up vs. top-down pathways	45
3.3. The influence of expertise	45
4. Summary and future prospects for neuroaesthetics	46
Acknowledgements	47
References	47

**Abbreviations:** BA, brodmann area; DOC, dorsal occipital cortex; EEG, electroencephalography; FG, fusiform gyrus; fMRI, functional magnetic resonance imaging; IOG, inferior occipital gyrus; IPS, intraparietal sulcus; MEG, magnetoencephalography; PFC, prefrontal cortex; TPJ, temporoparietal junction.

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### 1. Introduction

Objects created by visual artists, such as oil paintings, sculptures, etchings, drawings, watercolors and even glossies and decorative arts and crafts, constitute remarkable physical expressions of the human capacity to produce and appreciate beauty. All human cultures have studied, discussed and engaged in these activities, though most often from a humanistic, subjective and descriptive perspective. Neuroscientists and neuropsychologists have recently approached the traditionally philosophical field

of aesthetics aiming to characterize the neural and evolutionary foundations of our species' capacity to appreciate beauty and art. This approach, known as neuroaesthetics, has begun to provide some insights into the neurobiological bases of aesthetic appreciation (Chatterjee, 2011; Dissanayake, 1992; Jacobsen, 2010; Miller, 2000, 2001; Nadal and Pearce, in press; Ramachandran and Hirstein, 1999; Skov and Vartanian, 2009; Zeki, 1999a,b).

Until recently, researchers could only empirically study the biological mechanisms underlying artistic and aesthetic appreciation and creation by examining single cases of patients suffering from brain lesions or neurodegenerative diseases. Despite their great inherent interest, such accounts were often anecdotal and difficult to understand in the absence of an adequate theoretical framework. Chatterjee (2011) refers to them as "informative anecdotes" (Chatterjee, 2011, p. 54). Meaningful conclusions regarding the impact of different neurological conditions on artistic and aesthetic activities have only emerged after the cases have been gathered and analyzed together by Bänzner and Hennerici (2006), Bogousslavsky (2005), Chatterjee (2004a, 2006), Miller and Hou (2004) and Zaidel (2005, 2010). The main conclusions derived from these analyses merit examination before we turn to neuroimaging studies.

*General observations.* Despite their proficient visuo-motor and musical skills, artists are vulnerable to the same visual, motor, auditory and cognitive neuropsychological deficits that affect other people. The difference, in Chatterjee's (2004a) words, is that artists manifest these deficits in strikingly eloquent ways. Most of the studied artists continued to be artistically motivated, productive and expressive after the onset of their condition. Personal style is usually preserved to a certain extent, probably due to the years devoted to practicing their skills (Zaidel, 2005). There is no direct relation between suffering from neuropsychological conditions and improvised quality of art production. Chatterjee (2004a) notes several instances in which the effects of the condition on the artworks were aesthetically surprising and pleasing.

*The effect of strokes on artistic production.* There is a noticeable change in the work of most artists who have suffered a stroke. Many of them resume their creations, though only after overcoming various forms of disability. Some of these artists had to change from working with their dominant to their non-dominant hand (Bänzner and Hennerici, 2006). Although lesions in either hemisphere seem to leave traces on the production of artists (Zaidel, 2005), spatial disorganization (perspective, third dimension, contours), neglect and distortion in facial representation are more obvious in the artworks of artists who suffered a right hemisphere stroke (Bänzner and Hennerici, 2006).

*The impact of visual agnosia.* The specific effect of visual agnosia on artists' creations depends to a large extent on whether object recognition problems are related with their perceptual or conceptual features (Chatterjee, 2004a). In the first case, artists will often not render the overall form and composition of the depicted objects, but will include some of their conspicuous features. In the latter case, artists are still adept at drawing when copying, but seem completely incapable when asked to draw from memory, and have to rely on their knowledge of the world.

*The impact of aphasia.* Bänzner and Hennerici (2006) argue that there is little evidence indicating a significant impact of aphasia on the creation of visual art, which suggests that verbal and visual production may be related with distinct output channels. However, Bogousslavsky (2005) and Chatterjee's (2004a) revisions reveal that whereas the production of some aphasic artists seems to be largely unaffected, other artists become more expressive, and yet others begin producing works with different contents, suggesting that this condition may be too broad as a window into the biological bases of artistic and aesthetic production.

*The impact of degenerative diseases.* Artists suffering from Alzheimer's disease seem to gradually lose the ability to represent the world with precision, but are able to make use of color and form in aesthetically appealing ways (Miller and Hou, 2004). Chatterjee (2004a) notes that the production of these artists continues only as part of the general routines that the artists performed throughout their lifetimes, and only if others around them provide the necessary setting to do so. Some patients with a specific form of frontotemporal dementia, known as semantic dementia, which involves neural degeneration in the left anterior temporal lobe, exhibit new interest in art. These patients approach their pictorial activity compulsively, in spontaneous spurts of creative production, often painting repetitive motifs, leading to progressive improvements to their painting. These depictions are usually realistic, lacking in symbolism or abstract elements (Miller and Hou, 2004).

*Other neurological conditions.* Epilepsy and migraine have been found to increase the variety of visual elements available to artists who suffer from these conditions, as well as a source of inspiration to them (Chatterjee, 2004a).

These observations reveal that neurological conditions can have diverse –and maybe even distinctive– effects on artistic production. But what about their influence on the other side of the artistic coin –appreciation? What can similar cases tell us about the biological underpinnings of aesthetic appreciation? Given the very few studies that have been carried out on this issue, and their anecdotal nature, we cannot offer a comprehensive response. At present we can only provide a tentative and provisional picture.

*The effect of strokes on artistic appreciation.* Griffiths et al. (2004) describe a patient who suffered an infarct that left him unable to experience emotion in response to music. The lesion mainly affected the left insula, but extended into the left frontal cortex and amygdala. Speech, which was also initially affected, was recovered after 12 months. However, even though his perception of diverse musical features was normal, 18 months after the stroke the patient was still emotionally unaffected by music, despite the fact that during that time he was able to enjoy other activities. These observations led the authors to suggest that perceptual and emotional components of music processing might rest on functionally and anatomically distinct neural networks, and that the insula is a crucial piece in the neural underpinnings of the emotional response to music.

*The impact of degenerative diseases.* Halpern et al. (2008) found that artistically untrained patients with Alzheimer's disease were consistent in their preference for visual art on repeated presentations, despite being unable to remember they had seen the art on previous occasions. It seems, thus, that the neurodegeneration that causes Alzheimer's disease does not prevent these patients from expressing aesthetic preference, and that their preferences are as stable over time as those of healthy people. Two reports of patients with frontotemporal dementia describe how their preferences for music changed remarkably (Boeve and Geda, 2001; Geroldi et al., 2000). These three patients began compulsively listening to music they had not previously enjoyed, playing it for hours on end.

*Other neurological conditions.* Sellal et al. (2003) present a case of an epilepsy patient who underwent left temporal lobe resection, which only spared the hippocampus, the parahippocampal gyrus, and the amygdala. This case is interesting because the surgically removed brain region corresponds roughly to that which typically degenerates in the form of frontotemporal dementia mentioned above. During the first year after surgery the patient became aware that he no longer enjoyed listening to rock music, and that he now preferred Celtic or Corsican polyphonic singing. His taste in literature also shifted, in this case from science fiction to Kafkaian-inspired novels. The authors report that the patient also began showing increased preference for realistic paintings, enjoying the

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