Neuroaesthetics: Exploring Aesthetics and Brain From Emotional Perspective

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Abstract. In contemporary society, individuals often exhibit diverse emotional reactions in response to aesthetic experiences that resonate with or diverge from their personal preferences. Positive emotions typically arise when encountering aesthetics that align with one's preferences, while negative reactions are provoked by aesthetics that contradict them. This article delves into the intricate relationship between aesthetics, the brain, and emotions. It encompasses four primary dimensions: the historical context of aesthetic emotions, brain regions associated with these emotions' genesis, the role of empathy and its influence on individuals, and the significance of the human reward system in shaping aesthetic preferences. Furthermore, the practical implications of neuroaesthetics and challenges are discussed. As the field of neuroaesthetics continues to evolve, advancements in technology and a deeper understanding of the brain will pave the way for novel research directions.

Keywords: Neuroaesthetics, Aesthetic emotions, Cognitive neural mechanism.

1 Introduction

"Aesthetics" first emerged in mid seventeen century, credited to Alexander Baumgarten (Gregor, 1983). Baumgarten described aesthetics as "a theory of liberating arts, a lower theory of knowledge, and an art of beautiful thinking analogous to reason" (Euron, 2019). A contemporary definition of aesthetic centers on the principles underpinning the work of specific artists or artistic movements. Aesthetics permeates nearly every facet of daily life, spanning from nature and architecture to literature and everyday objects. Aesthetics is frequently seen as crucial in determining the value of objects and places. People often gravitate towards items with greater aesthetic appeal or those aligning with their aesthetic preferences (Fingerhut et al., 2021). With growing scientific interest in the formation and impact of aesthetic experiences on human behavior, there has been a surge in related experiments and publications. Academically, aesthetics is a philosophy branch examining how individuals perceive, interpret, and emotionally connect with art and various objects.

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A key aspect of aesthetics is its ability to evoke emotional responses in individuals. Surrounding oneself with beauty often elicits feelings of happiness. Consequently, items aligning with an individual's aesthetic values can induce positive emotions. Conversely, encountering objects or environments deemed unappealing can create discomfort (Schellekens & Goldie, 2011). Such experiences underline the profound connection between aesthetics and human emotions. Emotion is typically defined as a response experienced by sentient animal. This often encompasses both conscious and unconscious experiences, psychological arousal, and manifested behaviors. Aesthetics can elicit both positive and negative emotional reactions. Emotions directly linked to aesthetic experiences are termed "aesthetic emotions." The variability in aesthetic experience formation among individuals and its impact has led to increased attention in a newly-emerged interdisciplinary field known as Neuroaesthetics, which delves into the neuroscience underpinnings of human aesthetic experiences. The intersection of aesthetics and neuroscience has yielded fascinating insights into the way the human brain engages with artistic and aesthetic experiences. Over the past decade, research in neuroaesthetics has flourished, shedding light on the cognitive and emotional processes that underlie our responses to beauty and art. In this review, we explore the neural basis of aesthetic emotions, considering their historical context, the brain regions involved, the role of empathy, and the influence of the human reward system.

2 Aesthetic Emotions

Emotions have always been intricately linked to the human experience of art and beauty. As aesthetic experiences typically evoke a rich tapestry of feelings, understanding the emotional aspects is vital to fully grasp the phenomenon of aesthetic appreciation. Studies indicate that over 20 emotions can be triggered by aesthetic experiences. Emotions stemming from aesthetic experiences are classified into four categories: prototypical, pleasing, epistemic, and negative. Prototypical aesthetic emotions encompass feelings of beauty, attraction, being deeply moved, awe, and nostalgia, among others. Pleasing aesthetic emotions include joy, humor, arousal, energy, and relaxation. Epistemic emotions comprise surprise, interest, intellectual challenge and insight. Negative emotions encompass sadness, boredom, confusion, anger, and fear (Schindler, 2017).

Several key emotions are closely intertwined with our aesthetic responses, and they are associated with specific brain regions. For instance, the emotion of awe, often associated with encountering vast natural landscapes or grand works of art, is linked to activation in the prefrontal cortex (PFC) and the anterior cingulate cortex (ACC). These brain regions are involved in processing complex and emotionally significant information. The experience of beauty and pleasure in response to aesthetic stimuli is associated with the activation of the orbitofrontal cortex (OFC) and the ventral striatum. The OFC is particularly important in encoding the hedonic value of stimuli, while the ventral striatum is a key component of the brain's reward system, releasing dopamine in response to pleasurable experiences. On the contrary, some aesthetic experiences evoke negative emotions, such as disgust or aversion. These emotions

often involve the insula, a region deep within the brain associated with the processing of emotional and bodily sensations. The insula's involvement indicates the physical and emotional intensity of such negative reactions. Artistic creations often evoke complex emotional responses, including sadness and melancholy. These emotions are associated with the activation of regions like the amygdala and the hippocampus. The amygdala is involved in processing emotional salience, while the hippocampus plays a role in memory formation and contextualizing emotions. Experiences of moral elevation, often triggered by acts of kindness or moral beauty, involve the medial prefrontal cortex (mPFC). This region is associated with social cognition and the processing of moral and ethical values.

Aesthetic emotions differ from basic emotions like happiness, sadness, or fear. They are more complex and can encompass feelings of wonder, awe, chills, or the sublime. Unlike basic emotions, which often have clear and direct survival implications, aesthetic emotions are often tied to cognitive processing, reflection, and contemplation. Emotional responses to aesthetics can differ based on factors like personality, culture, social roles, gender, and the nature of the artwork.

3 Related Brain Regions

Recent advances in neuroimaging techniques have allowed researchers to pinpoint the neural regions implicated in the generation of aesthetic emotions. This section reviews studies that have identified brain structures such as the prefrontal cortex, insula, and ventral striatum as key players in processing aesthetic stimuli.

The Orbitofrontal Cortex (OFC) plays a central role in processing aesthetic emotions related to beauty and pleasure. It helps evaluate and assign hedonic value to sensory experiences, including those related to art and aesthetics. Activation in the OFC is often observed when individuals find something aesthetically pleasing. It receives visual stimuli from the cortical areas of the temporal lobe. Neurons in the OFC associate visual data with primary reinforcing stimuli. Through associative learning, the OFC can influence emotions. The OFC shows activation when individuals assess various artworks, including paintings, sculptures, and photographs. Consequently, the orbital frontal cortex is deemed integral to aesthetic evaluations (Cattaneo et al., 2015). Ventromedial Prefrontal Cortex (vmPFC) is involved in the emotional appraisal of aesthetic stimuli. It contributes to the overall positive affect and emotional responses associated with beautiful or aesthetically pleasing objects and experiences. Anterior Cingulate Cortex (ACC) is implicated in the experience of awe and wonder in response to grand or extraordinary aesthetic stimuli. It helps process complex and emotionally significant information, contributing to the profound emotional responses often associated with awe-inspiring art or nature. The insula, located deep within the brain, is associated with both positive and negative aesthetic emotions. It is involved in processing emotions like disgust and aversion, as well as emotions related to empathy and emotional resonance when engaging with art that portrays human emotions. The ventral striatum, a key component of the brain's reward system, is activated in response to aesthetically pleasing stimuli. It releases

dopamine, contributing to feelings of pleasure and reinforcing aesthetic preferences. Another brain region involved in aesthetic appreciation is the lateral occipital lobe (LO). The LO serves as the visual cortex, receiving stimuli from the optic nerve and containing specialized zones for visual signal analysis. Experiments indicate that the LO plays a pivotal role in appreciating representative artworks. Using transcranial magnetic stimulation (TMS), researchers explored the LO's potential role in aesthetic appreciation. They discovered that interfering with LO activity during aesthetic evaluation reduces the appreciation of representative artworks, while perceptions of abstract artworks remain unchanged (Cattaneo et al., 2015).

Collectively, these regions represent a network that collaboratively processes aesthetic stimuli, evaluates them, and generates the rich emotional responses that we often associate with art and beauty.

4 Empathy

When observing artwork, individuals sometimes experience a connection, either physically or psychologically, to the content, leading to a unique emotion: empathy. Empathy involves the capacity to comprehend and resonate with the emotions of others (Freedberg, 2007). It is closely tied to the existence of mirror neurons in human brain. Mirror Neuron network of brain regions, including the premotor cortex and inferior parietal lobule, is involved in empathy and emotional resonance when observing the emotions expressed in art. It helps individuals understand and share the feelings of others through aesthetic experiences.

Mirror neurons were initially identified in monkeys. These neurons activate when monkeys attempt a task or action that they've observed. Subsequent research, employing tools like TMS and functional magnetic resonance imaging fMRI, revealed analogous neurons in humans. Mirror neurons activate either when an individual engages in an action or observes someone else performing it (Kilner & Lemon, 2013). Humans' ability to resonate with others' emotions stems from the activation of mirror neurons. Empathy is pivotal in shaping the human aesthetic experience. Robert Vischer, in 1873, underscored empathy's role in human aesthetics. He highlighted that specific design elements or artwork characteristics might induce physical arousal in viewers. Such arousal amplifies viewers' emotional reactions to artworks (Ganczarek et al., 2018).

5 Reward System

As aesthetic experiences typically evoke positive emotions, the human reward system likely contributes to these aesthetic emotions. This system is responsible for encoding the hedonic value of experiences, reinforcing positive feelings, and motivating behavior. Essential components of the human brain's reward system include the Ventral Striatum, Dopaminergic Pathways, Orbitofrontal Cortex (OFC), Medial Prefrontal Cortex (mPFC), Anterior Insula, prefrontal cortex, amygdala, hippocampus, nucleus accumbens, and various limbic system structures. Specifically,

The ventral striatum, particularly the nucleus accumbens, is a core component of the reward system. It plays a central role in processing pleasure and reward, including the experience of aesthetic pleasure. Activation in the ventral striatum is often observed when individuals find art or aesthetic stimuli to be pleasing, and it is associated with the release of dopamine, a neurotransmitter linked to pleasure and reinforcement. The release of dopamine in response to aesthetically pleasing stimuli, mediated by the reward system, reinforces positive aesthetic experiences. The mesolimbic and mesocortical dopamine pathways are crucial in this regard. These pathways connect various brain regions, including the ventral tegmental area (VTA) and the prefrontal cortex, contributing to the anticipation, experience, and memory of aesthetic rewards. The OFC is involved in encoding the hedonic value of stimuli, including those related to aesthetics. It helps individuals evaluate and assign subjective value to art and beauty, influencing their preferences and emotional responses. Dysfunction in the OFC can lead to alterations in aesthetic preferences. While primarily associated with negative emotions like aversion, the anterior insula is also involved in processing the emotional intensity of aesthetic experiences, especially when those experiences evoke mixed or conflicting emotions. It contributes to the complexity of aesthetic emotions. The amygdala, part of the brain's limbic system, plays a role in evaluating the emotional significance of aesthetic stimuli. It contributes to the emotional depth of aesthetic experiences, including the experience of sadness or melancholy when engaging with art that elicits these emotions.

The reward system oversees the physiological and cognitive aspects of reward processing. It links various stimuli with positive consequences. This system also triggers the release of neurotransmitters like dopamine (Lewis et al., 2021). Artwork aligning with an individual's aesthetic preferences, perceived as beautiful, stimulates the brain's reward system. Consequently, it elicits positive aesthetic emotions. Studies have demonstrated that compared to neutral music, pleasurable tunes significantly activate the caudate nucleus, putamen, and nucleus accumbency, resulting in elevated dopamine release. Moreover, as music appreciation intensifies, reaching the zenith of the aesthetic experience, endogenous dopamine secretion consistently rises. Therefore, there's a positive correlation between dopamine release and an individual's music appreciation (Mavridis, 2015).

6 Applications

The field of neuroaesthetics, which focuses on emotions, is an emerging interdisciplinary domain encompassing psychology, neuroscience, and the arts. The study of emotional neuroaesthetics bears deep importance. A key value of exploring neuroaesthetics lies in deepening our comprehension of human experiences. Delving into neuroaesthetics offers insights into how the mind interprets aesthetic artworks, the neurological circuits driving emotional responses, and the genesis of aesthetic experiences. With a growing understanding of neuroaesthetics, artists can craft artworks rooted in biological underpinnings. They can design creations that evoke specific emotions and sentiments in audiences. Thus, artists can leverage their pieces

to influence viewers and more effectively convey their messages. Emotional neuroaesthetics also plays a crucial role in therapeutic applications. Since different artistic styles could affect people's emotional responses and make people produce different feelings, the study in this realm can contribute to the research in art therapy. Through art, scientists could stimulate specific neurons or boost neuronal activity, potentially altering emotional states and aiding in pain alleviation.

7 Conclusions

Nonetheless, challenges persist in this domain, notably the inherent subjectivity of aesthetic experience. Almost every individual may perceive or feel differently about the same piece of artwork. Thus, addressing individual variances in neuroaesthetics research and mitigating their impact on results warrants further exploration. Additionally, due to the intricate nature of neural systems, pinpointing specific neural circuits associated with emotional responses is challenging. Continued advancements in technology and methodology are essential to navigate these challenges in the study of this field.

The domain of emotional neuroaesthetics remains in its nascent stages. Yet, with technological progress and a deepening grasp of brain functions and emotions, the horizon of potential research broadens. For instance, enhanced therapeutic applications might offer less distressing recovery pathways for both psychological and physical traumas. Improved real-time brain imaging techniques can further the study of instantaneous neurofeedback in the human brain. Neuroaesthetics could also drive advancements in personalized aesthetics and marketing, given the clearer understanding of factors influencing individual emotions.

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