Neuroculture and Aesthetics: Exploring the Multidisciplinary Ambiance of Art, Beauty and the Human Brain

Neurocultura e Estética: Explorando o Ambiente Multidisciplinar da Arte, da Beleza e do Cérebro Humano

To develop a complete mind: Study the science of art; Study the art of science. Learn how to see. Realize that everything connects to everything else.
Leonardo da Vinci

All religions, arts, and sciences are branches of the same tree. All these aspirations are directed toward ennobling man's life, lifting it from the sphere of mere physical existence and leading the individual toward freedom, 1937.
Albert Einstein

M. da Mota Gomes[1] [Orcid: https://orcid.org/0000-0001-8889-2573]

ABSTRACT

This narrative review addresses the intersection between neuroculture and aesthetics, exploring the intricate relationship between neuroscience and the perception of beauty. The presentation begins by mentioning the philosophical foundations of aesthetics and moves on to the neural basis behind the sensory and emotional processing of beauty. Progressing further, it presents the intricate networks involved in interactions and responses to art, elucidating the brain's mechanisms for appreciating artistic stimuli. Finally, it investigates the neural networks associated with deriving personal and symbolic meaning from art forms, shedding light on how our brains deduce meaning and value from aesthetic experiences. Thus, there is an integration of studies based on the connectome with neuroaesthetics, on how the complete network of neural connections in the brain influences and shapes the way we perceive, interpret, and appreciate beauty. Furthermore, the article addresses the impact of virtual reality and artificial intelligence on traditional concepts of creativity, challenging existing paradigms. Concluding, it explores the potential educational and therapeutic applications of 'Visual Thinking Strategies' in promoting artistic engagement with potential educational and therapeutic applications.

Keywords: Aesthetics, Art, Artificial Intelligence, Cognitive Processes, Perception, Neuroscience, Culture

RESUMO

Esta revisão narrativa aborda a intersecção entre neurocultura e estética, explorando a intrincada relação entre neurociência e a percepção da beleza. A apresentação começa mencionando os fundamentos filosóficos da estética e avança para a base neural por trás do processamento sensorial e emocional da beleza. Progredindo ainda mais, apresenta as intrincadas redes envolvidas nas interações e respostas à arte, elucidando os mecanismos do cérebro para apreciar estímulos artísticos. Por fim, investiga as redes neurais associadas à obtenção de significado pessoal e simbólico das formas de arte, esclarecendo como nossos cérebros deduzem significado e valor de experiências estéticas. Assim, há uma integração de estudos baseados no conectoma com a neuroestética, sobre como a rede completa de conexões neurais cerebrais influencia e molda a maneira como percebemos, interpretamos e apreciamos a beleza. Além disso, o artigo aborda o impacto da realidade virtual e da inteligência artificial nos conceitos tradicionais de criatividade, desafiando os paradigmas existentes. Concluindo, explora as potenciais aplicações educativas e terapêuticas das 'Estratégias de Pensamento Visual' na promoção do envolvimento artístico com potenciais aplicações educativas e terapêuticas.

Palavras-chave: Estética, Arte, Inteligência Artificial, Processos Cognitivos, Percepção, Neurociência, Cultura

[1]Federal University of Rio de Janeiro – Institute of Neurology (INDC-UFRJ), School of Medicine, Rio de Janeiro, RJ, Brazil

Corresponding author: Marleide da Mota Gomes, Instituto de Neurologia, Universidade Federal do Rio de Janeiro, Av. Venceslau Brás 95, Botafogo, Rio de Janeiro 22290-140
E-mail: mmotagomes@acd.ufrj.br
Funding statement: The author did not receive funding for this work.
Declaration of author´s competing interests: The author declares no competing interests.

INTRODUCTION

This article, the first in a seven-part series about neuroaesthetics and visual art, sheds light on the intricate relationship between art, beauty, philosophy, neuroscience, and complex systems theories.

Leonardo da Vinci's and Albert Einstein´s quotes presented at the beginning of this article captures the essence of interdisciplinary learning, the interconnection of knowledge and the importance of observation and understanding, with Art being within this.

Within this path, we explore how art can be seen as a form of communication and how the sensation of beauty is experienced and understood through a multidisciplinary lens in a privileged aesthetics neuroscience-based approach. It begins by stating that art is a powerful form of communication and is a means by which artists convey ideas, emotions, and complex narratives to the public. However, the interpretation of art is not limited to the artist's intention but depends on the subjective experience and cultural context of the viewer. This perspective forms the basis for exploring the article.

Consequently, the appreciation of beauty can be examined across levels of increasing complexity within the brain, spanning from basic sensory and emotional processing to socio-affective and cognitive processes through 'social brain' networks, and finally reaching the complex brain networks associated with social behaviors and interactions. However, creativity, Neuroaesthetics, the Social Brain, and complex social behaviors and interactions are complex processes that involve various brain networks. Research in this field is ongoing, and advances in neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) have allowed scientists to gain deeper insights into the brains of both artists and non-artists and compare brain activity in response to various visual stimuli, in this way researchers can identify regions associated with artistic production and appreciation in the general population. Also, they study how the brain networks function and interact during social interactions and emotional processing. These networks often work in concert and can vary in their specific contributions depending on the task or context and research in neuroscience on them is ongoing, and our understanding of these networks continues to evolve.

In the next sections, we examine aspects related to Neuroculture, Aesthetics, and the Social Brain (including increasing levels of complexity), which are fascinating and multidimensional endeavors and there are several important issues and interrelationships to be considered. These previous sections finally reach future perspectives, including aesthetics in the age of artificial intelligence and the use of Visual Thinking Strategies (VTS) for practical purposes.

Humanistic approach to aesthetics

First, we must understand that art is a form of communication, in fact, John Dewey (1859-1952), philosopher and reference in the field of education, called it 'the most universal and freest form of communication'[12]. However, it is not the aim of this article to study aspects related to communication in the arts, despite it being fundamentally linked to artistic expression and to aesthetics, which is the branch of philosophy that explores concepts of beauty, taste, and the perception of art.

The conceptions of aesthetics and aesthetic experience were clarified by European philosophers of the 18th century when art became separated from other spheres of human experience and aesthetic interests 'What is felt and imagined' moved away from the general purpose and the everyday pleasures.

The philosophical dimension of the study of beauty explores how thinkers from various schools of philosophy have dealt with its concept. As for semiotics, it concerns the study of signs and symbols and is presented as a tool for understanding how art communicates complex ideas and emotions. As for the study of beauty, there is a long history that precedes the formalization of aesthetics as a philosophical field. It dates back to ancient Greece and Rome, to ideas of beauty that were often associated with proportion, symmetry, and harmony, with beauty seen as an essential quality in art and the natural world. During the Middle Ages, religious and moral aspects of beauty became significant and beauty was often linked to spiritual and moral qualities. At that time, theologians such as Saint Augustine emphasized that beauty reflects the divine, highlighting the transcendent and moral aspects of beauty. During the Renaissance, we saw a revival of classical aesthetics, with a focus on humanism and the appreciation of beauty in art, architecture, and nature. In the Enlightenment, philosophers such as David Hume contributed to the development of aesthetics by exploring questions of taste and aesthetic judgment. However, German philosophers such as Alexander Baumgarten and Immanuel Kant formalized the study of aesthetics in the 18th century, with Baumgarten being the first to introduce the term 'aesthetics', while Kant provided a comprehensive framework for understanding beauty, the sublime, and judgment. aesthetics. Furthermore, Kant made significant contributions to the field of aesthetics, particularly in his 'Critique of Judgment' (1790), which had a profound influence on the development of modern aesthetics and is considered a cornerstone of this field. In particular, his notion of 'purposeless intentionality' is central to his aesthetics, as it suggests that in aesthetic experiences we perceive objects as if they were created for a specific (teleological) purpose, even if they were not. Consequently, the study of beauty has evolved, with diverse philosophical, cultural, and religious perspectives contributing to our understanding of this concept. However the formalization

of aesthetics as a distinct philosophical field in the 18th century marked a crucial turning point in the systematic exploration of beauty, art, and the nature of aesthetic experience. These early foundations of aesthetics generated modern discussions about beauty, taste, and the philosophy of art.

Before the modern studies regarding aesthetics and the brain, there were the ones by Gustav Theodor Fechner, in 1876, who laid the groundwork for understanding the relationship between physical stimuli and the sensations they evoke, delving into the field of psychophysics—the link between sensations and the neural activities that produce them[2]. Over a century later, pivotal contributions by Semir Zeki and V.S. Ramachandran shaped the field of neuroaesthetics.

Semir Zeki's use of FMRI to investigate brain responses to visual art was instrumental in initiating neuroaesthetic research. His methods provided a foundational approach to studying the neural underpinnings of aesthetic perception. V.S. Ramachandran expanded our understanding of beauty's neural basis, exploring how specific visual features, like symmetry and composition, influence aesthetic preferences[2, 7, 10, 13]. Nadal and Chatterjee, 2019[6] addressed the combined view of the Nature of Art, Neural Mechanisms, Adaptability of the Brain, Universality, Diversity, Art Appreciation, and Cultural Influence. Ultimately, they concluded that although art is universal, its forms and content are shaped by cultural, temporal, and personal factors, offering a glimpse of the intersection between neurobiology, culture, and individual experiences.

A journey from beauty to aesthetic perception until Connectome-Based Neuroaesthetics

The sensation of beauty, and aesthetics, involves a combination of sensory stimuli, cognitive processing, emotional response, cultural influences, and individual variation.

The perception of aesthetics corresponds to a complex interaction between the human brain and society, as we feel aesthetics through the influenced combination of biological, psychological, and cultural factors. Consequently, it is a deeply subjective experience that can vary widely from person to person and across different contexts and cultures, intertwined with our sensory and emotional experiences of the world.

Research in this field often involves a combination of approaches that can provide valuable insights into the role of particular brain areas. The trajectory from initial studies on neurologically healthy individuals to the inclusion of diverse populations, including artists, non-artists, and individuals with varying levels of art training, reflects the field's commitment to understanding the universality and variability of aesthetic experiences. Besides, neuropsychological data from brain-damaged patients may be used to test causal hypotheses aside from the ones neuroimaging studies correlational data[2].

The term 'neuroaesthetics,' coined by Semir Zeki has transformed into an interdisciplinary field involving collaboration among neuroscientists, psychologists, art historians, and other experts. This cooperation emphasizes the need for diverse insights to achieve a comprehensive understanding of art aesthetics, favoring the exploration of neural mechanisms underlying a broad spectrum of aesthetic experiences closer to the cognitive neuroscience of aesthetic perception[7].

Furthermore, the integration of advanced neuroimaging techniques, cognitive sciences, and exploration of diverse populations, including those with neurological conditions, enriches our knowledge about the neural processes underlying aesthetic experiences. Overall, there is gradually a deepening appreciation of the complexity of art aesthetics through the lens of neuroscience and interdisciplinary collaboration. Thus, the field continues to evolve, offering new insights into the neural basis of creativity, aesthetic preferences, and the impact of cultural and individual differences on the perception and appreciation of art.

This section delves into the domains of Neuroscience, Neuroculture, and Neuroaesthetics to understand how the human brain processes and responds to art and beauty. Neuroaesthetics is a subfield of neuroscience that examines the neural basis of aesthetic experiences. Thus, it explores how the brain perceives and reacts to artistic stimuli, shedding light on the biological foundations of our aesthetic preferences.

Firstly, the concept of Neuroculture is presented, which unfolds the importance of Neuroscience innovations beyond the study limits of researchers in the area and reaches society as a whole. It is an emerging field that examines how cultural contexts shape our neural responses and aesthetic preferences. The article emphasizes the importance of understanding the dynamic relationship between culture and neuroscience in shaping our aesthetic perceptions. This discussion helps bridge the gap between the biological and cultural aspects of art appreciation. Therefore, neuroscientific knowledge is not restricted to laboratories alone but readily captures the attention of the general public even with some skepticism and rejection [8,9] .

Since ideas, concepts, and images in neuroscience circulate widely in culture and are portrayed in literature, cinema, works of art, mass media, and commercial products, therefore shape social values and consumption practices. Thus, the interaction between art and science offers an opportunity to raise awareness among the scientific community and the public about the social and ethical implications of scientific advances in neuroscience.

This interrelationship is creating opportunities and a dire need for educational initiatives that broadly improve neuroscience literacy. Thus, neuroscience literacy is not only a desirable ideal, but a necessity so that society can

maximize the potential benefits of neuroscience by effectively putting knowledge into practice. Therefore, responding to the growing need for communication that improves neuroscience literacy requires action on the part of neuroscientists at the institutional level and beyond.

Regarding this evolution, a quick search on Pubmed shows how the terms Neuroscience*, Neuroaesthetics, and Neuroculture have been used in articles registered in this bibliographic database under the title/abstract or in 'all fields', which deduces that the generic term neuroscience is widely used and there is a delay in the consecration of the more specific terms Neuroaesthetics and Neuroculture.

'Neuroscience*'		'Neuroaesthetics'		'Neuroculture'	
title/abstract	all fields	title/abstract	all fields	title/abstract	all fields
46,553 From 1967	623,976 From 1945	177 From 2008	217 From 2008	9 From 2009	9 From 2009

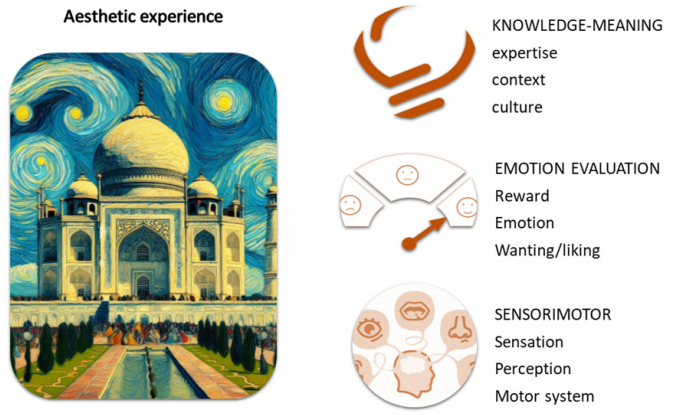

Figure 1. 'Aesthetic triad' based on Chatterjee and Vartanian 2 epitomized by 'Taj Mahal's Timeless Allure: Enigmatic Splendor' - from Image Creator of the DALL·E platform with recommendations given by the author of this paper.

Consequently, Neuroculture and Aesthetics have several interconnections, as Neuroaesthetics investigates how the brain processes and responds to artistic and aesthetic experiences and explores the neural mechanisms underlying our perception of beauty, art, and aesthetics. Aesthetic judgment tasks, which involve evaluating the beauty or artistic qualities of various stimuli, engage a network of neural circuits in the brain. These circuits are responsible for processing sensory information, emotional responses, and cognitive evaluations. While the exact neural pathways can vary depending on the nature of the aesthetic judgment (e.g., visual art, music, literature), there are some common brain regions and networks that are often implicated in such tasks. It's important to note that aesthetic judgments are highly subjective and can vary greatly among individuals. Additionally, the specific brain regions involved can depend on factors like the type of aesthetic stimulus and personal preferences. Research in the field of Neuroaesthetics continues to shed light on the neural underpinnings of aesthetic experiences and judgments, but the interplay of emotion, cognition, and perception in aesthetic evaluations is a complex and ongoing area of investigation.

The foundations of aesthetic feeling are overviewed by Chatterjee and Vartanian as the triad that encompasses the sensorimotor, emotional evaluation, and meaning knowledge systems, as described in Figure 1[2].

Neuroaesthetics based on Zeki and Ramachandran has been undergoing current integration with connectome studies that took place in the late 2000s and early 2010s when the complete network of brain connections gained attention in neuroscience. Consequently, researchers delve deeper into understanding brain connectivity and network-level interactions, exploring how this pervasive network influences various cognitive functions. There is also growing interest in understanding the neural underpinnings of aesthetic experiences with an emphasis on the role of brain connectivity and network-level interactions in the perception of art and beauty.

The study by Alcalá-López *et al*. 2018[1], created the 'Social Brain Connectome' or 'Social Brain Atlas' which was later unfolded into the 'Artistic Brain Connectome' by van Leeuwen *et al*. 2022[13]. The first is based on a comprehensive meta-analysis of neuroimaging studies on social cognition, providing a systematic definition of the social brain through neural activity, while identifying thirty-six core social brain hubs spread across four hierarchical functional networks (lower sensory, limbic, intermediate, and high associative neural circuits). The 'Artistic Brain Connectome', extends insights from the 'Social Brain Connectome' to understand how the brain processes information related to visual art and creativity at the core social brain hubs and four networks: Perception, Animation, Interaction, and Construction, representing different stages of perceptual

Some Core 'Large-scale brain networks': [1]The salience network (SN) is key for switching between the default mode network (DMN) and the central executive network (CEN) depending on the task or stimulus salience, and they play crucial roles in different cognitive functions. These networks work in concert, dynamically interacting with each other to facilitate various cognitive functions for adaptive and flexible behavior in response to different environmental demands. Dysregulation or dysfunction in them has been implicated in various neuropsychiatric disorders and cognitive impairments
The SN which includes the ventrolateral prefrontal cortex (VLPFC) and anterior insula (jointly referred to as the fronto-insular cortex; FIC) and the anterior cingulate cortex (ACC) responds to the degree of subjective salience, whether cognitive, homeostatic, or emotional. It is involved in the detection and

and cognitive processing related to art and creativity. This conceptual framework aims to establish a bridge between social cognition and aesthetics and the cognitive processes associated with the visual arts. The interconnectivity of neural networks associated with both social cognition and the processing of visual arts is understood, aligned with the principles of social cognitive neuroscience, seeking to understand the neural basis of complex social behaviors and cognitive processes. The 'Artistic Brain Connectome' provides a theoretical framework for understanding how the brain engages in creative activities within a social context.

The following sections of this text propose a study of the first two networks of the 'Artistic Brain Connectome' in the context of the basic sensory and emotional processing of beauty. Furthermore, the third network (Interaction) is explored in terms of balancing internal states and sensory inputs for regulating social behavior, and the fourth network (Construction) in the context of multimodal knowledge synergy for personal and symbolic meaning in experience. Consequently, the next sections set the stage for a comprehensive exploration of the neural mechanisms underlying aesthetic experiences and visual arts processing.

Basic Sensory and Emotional Processing of Beauty

Aesthetic appreciation involves the brain's processing of sensory information to evaluate and derive pleasure from various forms of art, beauty, or visual stimuli. Consequently, aesthetics is, in part, a result of the way our brain processes sensory information, with certain neural pathways and structures being involved in the perception of beauty and aesthetics. This includes brain areas associated with visual processing, emotional processing, and reward systems. Visual aesthetics, for example, are processed in the visual cortex, while emotional responses to aesthetics involve brain regions such as the amygdala and prefrontal cortex. Consequently, aesthetic experience, mainly aesthetic perception, is reflected by the dynamic interaction between brain systems involved Lower Sensory Network and Limbic Network, by van Leeuwen et al., 2022[13] (Figure 2).

However, individual psychological factors such as personal preferences, experiences, and cognitive biases also play a significant role in how we perceive aesthetics. What one person finds aesthetically pleasing, another does not. This variation can be influenced by past experiences, cultural background, and personal taste.

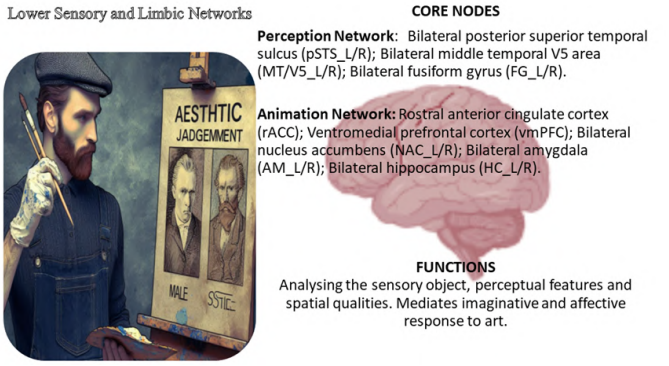

Figure 2. Schematic representation of the neural circuits implicated in aesthetic judgment tasks based on van Leeuwen et al., 2022[13]. The image source of 'Art's Alchemy: Contours of Perception and Emotion' is the Image Creator of the DALL·E platform with recommendations given by the author of this paper.

Balancing Internal States and Sensory Input for Social Behavior Regulation

The third processing level of the 'Social Brain Connectome', Interaction network, plays an important role in mediating between incoming, potentially significant sensory information and internal states and goals (Figure 3). This network contains the core areas (mainly, anterior insula (AI) and anterior mid-cingulate cortex (aMCC)) of the Salience Network[1] which weighs the significance and relevance of incoming sensory information against current homeostatic priorities in regulating social behavior. It also mediates mirroring behaviors and empathy.

The Interaction Network plays a key role in interpreting incoming sensory information based on current behavioral goals, and more particularly, in assigning salience (significance) to art and creative output. This network is therefore likely to be integral to the construction of significance in art, based on the perceived salience of artworks. Artworks tend to be highly valued in themselves, invested with emotional and cultural associations, and often encountered under conditions of 'ceremony' and heightened expectation; accordingly, they tend to be salient stimuli for many viewers. However, the salience of a particular artwork is heavily modulated by prior personal familiarity, the socio-emotional context in which we view it, and our behavioral stance toward it. Salience Network regions have functional connections to vmPFC and other core nodes from the Limbic (Animation) Network, enabling affective modulation of salience coding. Taken together, concerning art processing and visuospatial creativity, this network appears to play a key role in deciding whether to engage deeper or whether to disengage from an artwork.

integration of salient stimuli from both the external environment and the internal state of the body and helps in determining what is personally relevant or important at a given moment and directs attention accordingly.

The DMN is a large-scale brain network that comprises the posterior cingulate (BA 23 and 31), posterior parietal cortex (BA 7, 39, and 40), and the ventromedial prefrontal cortex, which is active when the brain is not engaging in a specific task. It is often associated with self-referential thoughts, mind-wandering, daydreaming, and introspection.

The CEN comprises the dorsolateral prefrontal cortex and posterior parietal cortex and is engaged when a cognitively demanding task requiring attention is being performed. It is associated with higher cognitive functions such as working memory, problem-solving, decision-making, and cognitive control. It is engaged when an individual is actively focused on a task that requires attention and goal-directed behavior. The DMN and CEN are anticorrelated as activity within the first increases, and the other decreases[4].

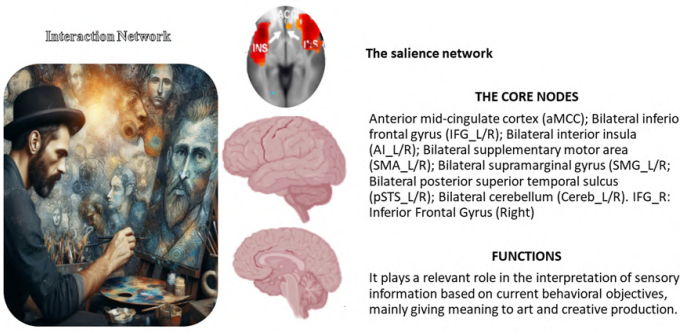

Figure 3. Simplified Interaction Network adapted from Leeuwen et al., 2022[13]. Images source: 'Art's Interpretive Power: Meaningful Nexus' from Image Creator of the DALL·E platform with recommendations given by the author of this paper, and The Salience Network from Wikimedia Commons.

Synergizing Multimodal Knowledge for Personal and Symbolic Meaning in Experience

There is a profound impact of society and culture on aesthetic sensibilities as cultural norms and values influence our perception of beauty, and cultural practices shape the development and functioning of the brain, possibly through neural plasticity. Besides, there is a cultural neurodiversity acknowledging that the brain can operate differently in different cultural contexts.

Also, there is a close relationship between complex social behaviors and social cognitive neuroscience, both focusing on understanding the neural and cognitive processes underlying intricate social interactions. Higher-order cognitive functions related to complex social behaviors, such as moral reasoning, social decision-making, and social norm processing. This level involves the integration of aesthetic experiences into broader social contexts, highlighting the interplay between aesthetics and social interactions.

The Construction Network of the 'Artistic Brain Connectome,' proposed as the fourth and highest processing level by van Leeuwen et al.[13] based on the 'Social Brain Connectome,' is introduced (Figure 4). This level corresponds anatomically with the Default Mode Network (DMN) and is crucial in creating internal models of ourselves and others about the world, besides, this Construction Network within this framework includes the semantic appraisal system, mediating associative knowledge about sensory objects and concepts, as well as vocabulary. This network plays a key role in the appreciation of art by integrating multimodal knowledge systems to assign personal and symbolic meaning to experiences, also this network is involved in generating and critically evaluating creative thoughts and artistic expressions.

Consequently, the 'Construction Network' as the higher level of the social brain connectome appears to align with the idea of complex systems described in the text 'The Social Connectome – Moving Toward Complexity in the Study of Brain Networks...' by Maliske and Kanske, 2022[5]. The text emphasizes a shift in neuroscience from a modular, isolated understanding of brain processes to a more interconnected, complex view. It highlights the importance of studying brain networks as interacting, complex entities, especially in the context of social cognitive neuroscience.

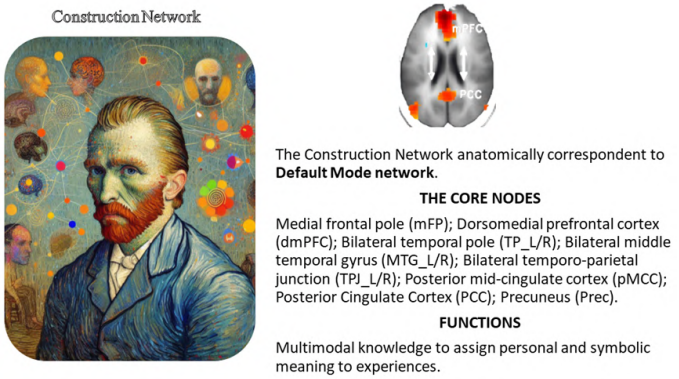

Figure 4. Moving towards the Complex Systems based on van Leeuwen et al., 2022[13]. Images source: 'Symbolic Realms: Interwoven Realities' from Image Creator of the DALL·E platform with recommendations given by the author of this paper, and The Default Mode Network from Wikimedia Common

From now on

Emerging technologies like virtual reality, artificial intelligence (AI), and brain-computer interfaces are likely reshaping the intersection of Neuroculture, aesthetics, and the Social Brain. The idea that creative activities are inherent to humanity is contestable as AI is already being used for this, and even in partnership with some artists[3].

Thus, AI can also have transformative potential in the creation of art, as AI algorithms can generate art autonomously, raising questions about creativity, authorship, and the evolutionary role of artists in a world increasingly influenced by technology.

Consequently, the long-term impact of cultural and aesthetic experiences on mental health, social bonds, and individual development is questioned. To better understand these connections, there is a need for interdisciplinary research in these areas, which has the potential to deepen our understanding of the human experience, shedding light on the profound ways in which culture, aesthetics, and the Social Brain are interconnected. It also raises important ethical questions about how this knowledge should be applied in society[15].

The integration of AI into the art world triggers a transformation of artistic paradigms, inviting us to reevaluate established concepts of creativity, authorship, and the role of artists. Promotes discussions about how technology can empower and challenge artists, redefine artistic practices, and influence the nature of art itself. As the relationship between AI and art continues to evolve, a world of possibilities is opening up, along with a set of profound questions and dilemmas for artists, academics, and society at large.

Art therapy is a field that uses creative expression as a means of promoting psychological healing, self-discovery, and well-being. Consequently, the role of AI in

this context brings opportunities and challenges, and the incorporation of AI into art therapy must be done carefully, with a balance between the benefits of AI-enhanced accessibility and preserving the therapeutic, human-centered aspect of the practice[11].

The figure below was generated by artificial intelligence (AI) programmed to create images considered harmonized according to the sociocultural context. Thus, AI does not have a true ability to 'feel' beauty in the human sense, as it can be configured to create harmonized images based on different sociocultural contexts. This may involve selecting colors, patterns, styles, and visual elements appropriate to a specific culture or historical era, such as a landscape in the style of Van Gogh. Thus, AI can be used to create aesthetically pleasing images adapted to specific sociocultural contexts, but this creation is based on predefined algorithms and rules, rather than a true appreciation or understanding of beauty. Therefore, AI can be a powerful tool for creating visual content, but its success in generating harmonized images depends on the quality of training and programming carried out by humans!

Another question that concerns practical applications is related to VTS, an art-based technique for engaging individuals with works of art, emphasizing personal and social perspectives, linking artistic perception to social brain networks, and exploring how the VTS recruits these networks. Van Leeuwen *et al.*, 2023[14] study research investigates this as a method of artistic engagement, through an eye-tracking paradigm, shedding light on their influence on gaze patterns and personal resonance with works of art. The study, rooted in the concept of the social brain, reveals that VTS leads participants to focus more on highly salient social cues (animated elements) in works of art, as opposed to merely contextual information. Additionally, audio cues, especially personal reflections, intensify this effect. It is important to highlight that these results remain consistent across all ages and genders, highlighting the robustness of the method. However, it is noted that viewing condition does not have a significant impact on personal resonance with works of art, suggesting a nuanced relationship between gaze and emotional engagement. The findings contribute to the understanding of how VTS affects the social brain, offering insights for educational and therapeutic applications. The study highlights the potential of incorporating physiological and eye-tracking tools in evaluating behavioral and clinical outcomes in interventions that use art for personal well-being. However, there is a case for future research that adapts the experimental setup to real-world viewing conditions, emphasizing the broader applicability of the study's insights.

Figure 5. 'Sleepwalking among Almond Blossom Trees' (left) and 'Whispers of a Sleepy Elderly Man' (right), in the Van Gogh style, post-Impressionism from Image Creator on the DALL·E platform with recommendations given by the author of this paper.

CONCLUSIONS

In conclusion, the study of art aesthetics has undergone a significant evolution, progressing from philosophical reflections to a global vision that greatly values contemporary neuroscientific methods. The multidisciplinary approach, enriched by the 'Artistic Brain Connectome' framework, has deepened our understanding of the neural processes underlying aesthetic experiences, particularly in the context of social cognition and visual arts processing. The exploration of aesthetic judgments, regulation of internal states for social behavior, and integration of multimodal knowledge highlight the intrinsic connection between our appreciation of art and the interactions of neural networks.

The multidimensional perspective acknowledges the complex interplay of biological, psychological, and cultural influences, explaining the variations in aesthetic preferences across individuals and societies.

There is a need for further research using advanced neurophysiological tools and imaging to unravel the intricate neural array connecting art, aesthetics, and the human brain. The intertwining of Neuroculture, Neuroaesthetics, and the Social Brain has a profound impact on the perceptual dynamics of art and beauty.

The contributions of Semir Zeki and V.S. Ramachandran in the 1990s are highlighted as crucial milestones, with Zeki's use of fMRI laying the methodological foundation for neuroaesthetic research, and Ramachandran's work expanding our understanding of the neural basis of beauty.

The exploration of neuroappreciation of beauty spans at least three levels of complexity, as outlined by the 'Artistic Brain Connectome' and the 'Social Brain Connectome.' in their original four levels. Beginning with 'Aesthetic Judgment Tasks,' the investigation uncovers the neural underpinnings of aesthetic experiences, progressing

to the 'Interaction' Network, which plays a central role in mediating responses to art, and culminating in the 'Construction' Network, revealing its involvement in deriving personal and symbolic meaning from art.

Besides, there is a transformative impact of emerging technologies, such as virtual reality and artificial intelligence, that has challenged traditional notions of creativity. Overall, there are profound insights into the intricate relationship between human cognition, cultural influences, and the continually evolving landscape of artistic and aesthetic perceptions.

To conclude, this article addresses VTS as a method of artistic engagement using eye tracking to understand its impact on gaze patterns and perhaps with pedagogical benefits and potential therapeutic applications.

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