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Neuroaesthetics

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Neuroaesthetics is a young discipline that examines the biological basis of aesthetic experiences. Aesthetic experiences emerge from sensory-motor, emotion-valuation, and semantic-knowledge systems. Areas of inquiry include people, places, and things. Investigations of people include our response to human beauty and appearance and the consequences of that response. Places encompass our response to nature and the built environment. Things usually refer to art; abstract objects like mathematics and language also fall under the purview of neuroaesthetics. Viewers are more consistent in their response to natural kinds (people and landscapes) than to artifacts (art and architecture). The brain harbors domain-specific and domain-general aesthetic responses. For example, the fusiform face area of the brain responds robustly to beautiful faces, whereas the parahippocampal place area responds to beautiful landscapes. Domain-general reward structures like the orbitofrontal cortex, ventromedial prefrontal cortex, and the nucleus accumbens respond to the pleasure of beauty. Semantic areas, typically the medial and lateral temporal cortex, incorporate meaning. Network neuroscience approaches suggest that emotionally moving aesthetic experiences engage the default mode network and reward structures.

History

Gustav [Fechner \(1876\)](#) initiated scientific aesthetics in the late 19th century. He thought that preferences could be studied *from below* (induction from experimental data) as opposed to *from above* (deduction from first principles). He described an outer psychophysics that examined object properties and people's preferences. He also anticipated an inner psychophysics, linking neural systems to aesthetics. In the 20th century, D. E. [Berlyne \(1971\)](#) advanced biological aesthetics by investigating physiological arousal in his studies.

Ernst Pöppel organized a group of scholars who published *Beauty and the Brain*, in which the term neuroaesthetics first appeared ([Rentschler et al., 1988](#)). Later, Semir [Zeki \(1999\)](#) popularized the term in writings about aesthetics and the visual system. The first systematic information processing models of aesthetics were proposed by Anjan [Chatterjee \(2003\)](#) and Helmut [Leder and colleagues \(2004\)](#). Moving away from sequential models, [Chatterjee and Vartanian \(2016\)](#) proposed the *aesthetic triad* as an iterative framework for neuroaesthetics.

Core concepts

Aesthetic triad

The aesthetic triad refers to aesthetic experiences that emerge out of interactions of three large-scale networks dedicated to sensory-motor, emotion-valuation, and semantic-knowledge systems ([Chatterjee & Vartanian, 2016](#)). The sensory-motor systems process the color, form, line, composition, and dynamic nature of images. The emotion-valuation system of the triad refers to affective and emotional responses, often pleasure or reward for beauty, but also nuanced mixtures of emotions. Ventromedial prefrontal cortices, the orbitofrontal cortex, the nucleus accumbens, and the insula are important neural structures implementing these experiences. The

semantic-knowledge system of the triad refers to how personal histories, education, cultural background, and contextual information about art modulate the aesthetic experience and engage the medial and lateral temporal areas.

Empathy and mirror neuron systems

Mirror neuron systems bridge perception, action, and emotions [see [Mirror Neurons](#)]. They underpin embodied simulation of our bodies. People viewing depictions of actions, gestures, and dance internally simulate those experiences. These mechanisms are also involved in feeling empathy, as people experience emotions when viewing expressive art ([Freedberg & Gallese, 2007](#)).

Transformative power

Art can be used for different purposes. Two areas of interest are ways in which art can move people and ways in which art can advance understanding ([Pelowski, 2015](#)). Art can inspire wonder and awe and curiosity. The feeling of being moved is associated with activity within the default mode network ([Vessel et al., 2019](#)). Network neuroscience studies identify synchronized neural activity across distant regions of the brain that coordinate to serve specific functions such as attention or decision-making. Such studies show that aesthetic experiences are dynamic states, toggling between the default-mode network, the salience network, reward structures, and domain-specific sensory cortices.

Paradoxical facilitation

Sometimes, people with neurologic illness produce art that changes in ways that critics and observers regard as a paradoxical improvement compared to their previous work ([Chatterjee, 2004](#); [Pelowski et al., 2022](#)). For example, some people with frontotemporal dementia develop new artistic impulses. People with Alzheimer's disease (famously Willem De Kooning) pare down their prior styles and retain the essentials of their oeuvre. People with stroke and traumatic brain injury can also dramatically change their artistic styles. The implication of these clinical observations is that no one brain center is responsible for art production. Rather, depending on the content and the style of depiction (e.g., realistic, expressionist), when one channel is blocked by neurological illness, motivated artists find other means of expression through brain systems that are still intact.

Questions, controversies, and new developments

Can aesthetic experiences be reduced to neural activity?

This question applies to any domain of cognitive neuroscience such as perception, language, or emotions [see [Levels of Analysis](#); [Mechanistic Explanation](#)]. Aesthetic experiences are multifaceted, and although it does not make sense to reduce them to neural activity, cognitive science can advance understanding through neuroscientific findings. For example, neural responses to beautiful faces can be automatic and influence behavior, even when people are unaware of these responses. As another example, the observation that the

default mode network is active when encountering especially moving art points to an inward self-reflective orientation produced by such encounters.

Considering aesthetic experiences beyond beauty

Recent approaches in neuroaesthetics extend beyond asking about straightforward liking or judgments of beauty to query nuanced mixtures of emotions. For example, negative affect mixed with pleasure can make aesthetic experiences more powerful ([Menninghaus et al., 2017](#)). Several groups identify a broader range of affective and cognitive impacts to characterize aesthetic experiences. These impacts include positive affect (such as feeling pleasure or calm or compassion), negative affect (such as being angry or upset), immersive states (such as being engaged or experiencing wonder), and the potential for transformation (such as feeling enlightened or edified) ([Christensen et al., 2023](#); [Pelowski et al., 2017](#)).

Are there aesthetic emotions?

Some prominent researchers challenge the idea that aesthetic emotions exist. They posit that aesthetic emotions have no unique features; they are best viewed as general emotions. On this view, since they also argue that “art” is not a special kind of object, rewards and emotions are deployed generally ([Skov & Nadal, 2020](#)). Others counter that artworks are culturally salient artifacts. They suggest that aesthetic experiences are special and not like other valuations such as those expressed by utilitarian preferences. On this account, some emotions, like wonder and delight, are quintessentially relevant to aesthetics ([Fingerhut & Prinz, 2020](#)).

Developments in cross-cultural approaches

Most studies focus on Western art using American and European participants ([Darda & Cross, 2022](#)). This bias is changing as stimuli datasets are becoming more culturally diverse, and studies are being conducted in other parts of the world ([Zhang et al., 2017](#)). Such expansion of the lens of scientific aesthetics is welcome if cognitive science is to understand universal and culturally contingent aspects of human aesthetic experiences.

Broader connections

Neuroaesthetic principles are being applied to the built environment ([Djebbara et al., 2019](#)). The beauty of interiors activates the ventromedial prefrontal cortex ([Vartanian et al., 2013](#)), suggesting that architecture engages the same reward circuits as do the fundamental rewards of food and sex [see [Reinforcement Learning](#)]. Biophilia, our preference for nature, considers how elements of nature are incorporated in design. Human aesthetic responses to architecture distill into three components: coherence, fascination, and hominess, each with a distinct neural signature ([Coburn et al., 2020](#)).

A growing interest focuses on how exposure to and participation in the arts contributes to health and well-being ([Fancourt & Finn, 2019](#); [Trupp et al., 2025](#)). Arts in health care is dedicated to humanizing clinical care

by integrating the arts—including literary, performing, and visual arts—and design into therapy and medical education.

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