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A Farewell to Art: Aesthetics as a Topic in Psychology and Neuroscience

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Abstract

Empirical aesthetics and neuroaesthetics study two main issues: the valuation of sensory objects and art experience. These two issues are often treated as if they were intrinsically interrelated: Research on art experience focuses on how art elicits aesthetic pleasure, and research on valuation focuses on special categories of objects or emotional processes that determine the aesthetic experience. This entanglement hampers progress in empirical aesthetics and neuroaesthetics, and limits their relevance to other domains of psychology and neuroscience. Substantial progress in these fields is only possible if research on aesthetics is disentangled from research on art. Here we define aesthetics as the study of how and why sensory stimuli acquire hedonic value. Under this definition, aesthetics becomes a fundamental topic for psychology and neuroscience, because it links hedonics (the study of what hedonic valuation is in itself) and neuroeconomics (the study of how hedonic values are integrated into decision-making and behavioral control). We also propose that this definition of aesthetics leads to concrete empirical questions, such as how perceptual information comes to engage value signals in the reward circuit, or why different psychological and neurobiological factors elicit different appreciation events for identical sensory objects.

Keywords: art, aesthetics, aesthetic experience, sensory valuation, empirical aesthetics, neuroaesthetics
Empirical aesthetics and neuroaesthetics seek to understand the psychological and neurobiological processes involved in aesthetic creation and appreciation. Empirical aesthetics was founded in the nineteenth century. It was the second experimental field of psychology, after psychophysics (Fechner, 1865, 1871, 1876; Nadal & Vartanian, 2019). Neuroaesthetics, in turn, emerged as one of several subfields of human cognitive neuroscience in the 1990s, when modern neuroimaging became available to researchers (Chatterjee & Vartanian, 2014; Nadal, Gomila, & Gálvez-Pol, 2014; Skov & Vartanian, 2009). Both fields continue to grow fast, and to contribute many and important empirical findings that advance our understanding of the function and biology of the human mind (Chatterjee, 2011; Nadal & Pearce, 2011).

Although empirical aesthetics and neuroaesthetics are both thriving enterprises, there is little agreement as to what “aesthetics” actually is. Consequently, there is little agreement as to what empirical aesthetics and neuroaesthetics are sciences of. According to most accounts, empirical aesthetics and neuroaesthetics study two problems: (1) The problem of valuation, or how the human mind appraises sensory objects; and (2) The problem of art experience, or how the human mind appreciates art. Chatterjee (2011), for instance, formulates it like this: “The term aesthetics is used broadly to encompass the perception, production, and response to art, as well as interactions with objects and scenes that evoke an intense feeling, often of pleasure.” (Chatterjee, 2011, p. 53.)

The problem of valuation and the problem of art experience are, however,
often treated as two sides of the same coin, as if art and aesthetics were intrinsically interrelated. This leads to hypotheses that entangle the two problems: the problem of art experience becomes focused on how art elicits aesthetic pleasure; and the problem of valuation becomes focused on special categories of objects—artworks—or emotional processes—aesthetic emotions—that determine the aesthetic experience.

The solution to this confusion, and the way forward for empirical aesthetics and neuroaesthetics as healthy research paradigms with clearly delineated problems, is to separate the questions about sensory pleasure from the questions about art experience. Pearce and colleagues (2016) argued that the best way to do so is to distinguish between a *Cognitive Science of Aesthetics*, which studies how sensory valuation is formed (but is not limited to art objects), and a *Cognitive Science of Art*, which studies the many neurobiological process associated with experiencing art (beyond the question of how artworks elicit pleasure or beauty). By adopting this distinction, a cognitive science of aesthetics would deal with scientific questions related to how a stimulus acquires hedonic value, while a cognitive science of art would deal with scientific questions related to how the brain represents and experience a specific set of object categories—visual art (Vartanian & Skov, 2014; Wiessman & Ishai, 2010), music (Ellison et al., 2015; Koelsch & Siebel, 2005), dance (Calvo-Merino et al., 2005; Kirsch, Ugresi & Cross, 2016), literature (Jacobs, 2015; Jacobs & Willems, 2017), or film (Heimann et al., 2019; Vodrahalli et al., 2017).

Pearce and colleagues’ (2016) suggestion, though, has had little following among researchers in empirical aesthetics and neuroaesthetics. Most continue to treat the study of art experience and the study of sensory pleasure as aspects of the same problem. For example, in a recent introduction to aesthetics, Brielmann and Pelli (2017) acknowledge that empirical aesthetics has two different research foci: “one
broad—research on beauty, aesthetic pleasure, and preference—and one narrowly focused on art—research on the perception, evaluation, and creation of art.” Despite this explicit acknowledgement, and although Brielmann and Pelli (2017) write that they “take the broader focus, and include art as one of many stimuli that elicit aesthetic responses” (Brielmann & Pelli, 2017, p. R858), they almost exclusively review literature on how art stimuli trigger pleasure. They make no mention of research on sensory pleasure that studies non-art objects such as food, money, or sex. Thus, even while conceding the fundamental difference between art experience and sensory pleasure, they continue to present “art pleasure” as distinct from non-art pleasures.

The idea that art experience and sensory valuation are facets of the same problem has, at least, four consequences that hinder progress in empirical aesthetics and neuroaesthetics. First, it perpetuates notions of aesthetic experience and art that emerged in Europe during the eighteenth and nineteenth centuries, owing to the expansion of the market economy and the rise of the bourgeoisie, which found in art and good taste ways to assert its social standing.

Second, by assuming that certain sensory objects are special—i.e., different from “normal” or “ordinary” objects—and therefore able to elicit special hedonic responses, the phenomenon of aesthetic appreciation becomes severed from the concept of hedonic appraisal in general. Not only is this separation evidently at odds with what is known about the neurobiology of hedonic valuation, but treating “aesthetic” pleasure as special, distinct to “non-aesthetic” pleasure experienced through the interaction with “ordinary” sensory objects, isolates empirical aesthetics and neuroaesthetics from other fields of psychology and neuroscience (Skov, 2019a; Skov & Nadal, 2018, 2019).
Third, the ideas of “art” and “aesthetics” carry with them a number of historical assumptions that are imported into psychological and neuroscientific theories of aesthetic appreciation without much consideration, even when their conceptual foundations are at odds with our current understanding of how the brain works (Hayn-Leichsenring & Chatterjee, 2019).

Finally, equating aesthetic appreciation with the experience of art distorts how aesthetic values arise. To see aesthetic appreciation mainly as a system for assessing the aesthetic qualities of art objects separates it from its evolutionary history, and thus from a true understanding of why it is equipped with the computational mechanisms it is. As a result, most current theories in empirical aesthetics and neuroaesthetics are unable to explain why specific computational factors influence aesthetic valuation.

We flesh out these points below. By making these fundamental issues explicit we hope to convince other researchers, both in empirical aesthetics/neuroaesthetics and psychology/neuroscience more broadly, that it is necessary to divorce the study of sensory valuation from the study of art experience. Moreover, we suggest that, henceforth, the term aesthetics should be restricted to the study of sensory valuation. We also outline how a science of aesthetics can be precisely defined, and we describe how such a scientific study of aesthetic appreciation can be fruitfully related to existing fields of inquiry in contemporary neuroscience.

**How and Why did Art and Aesthetic Valuation become Entangled?**

The idea that art and aesthetics fit together like hand in glove has become so familiar it is rarely questioned. But familiar does not mean good: The idea that art and
aesthetics are intrinsically bound together does not hold up to historical facts: “The connection between art and aesthetics is a matter of historical contingency, and not part of the essence of art” (Danto, 1997, p. 25). Art and aesthetics were made to fit each other. This was only possible because art was created as a distinct category of activities, and aesthetic experience became a special and proper way of engaging with art. That art and aesthetics seem to fit each other says little about art and aesthetics themselves. It does, however, say a lot about how and why the Western tradition of thought has conceived them and, ultimately, entangled them.

The creation of art

Some activities we classify as sports, others as games. Even the same activity can be a sport or a game, depending on the circumstances. The distinction has little to do with the nature of those activities, but it helps make sense of our social reality. Sports, Olympic sports, and games are not natural kinds: They do not reflect significant natural boundaries that are independent of culture and history. They are human kinds: they reflect culturally meaningful boundaries. Art is also a human kind. There is nothing in the nature of art that sets it apart from non-artistic activities. Like other human kinds, the category art helps us simplify our complex social reality by organizing it into manageable chunks. And like other human kinds, it is the product of historical discourse: “Art as we have generally understood it is a European invention barely two hundred years old” (Shiner, 2001, p. 3).

The idea that the sort of activities referred to as art constitutes a single class began taking shape during the Renaissance (Tartakiewicz, 1971). In the late seventeenth and early eighteenth centuries, the classification of the arts had become a hot topic in European intellectual circles, with many proposals in circulation. Kant
(1790/2007), for instance, divided the arts into speaking arts (poetry and eloquence), plastic arts (painting, sculpture, architecture and gardening), and arts of the beautiful play of sentiments (music and the art of color). But the decisive step towards the modern system of arts was Batteux’s 1746 (1746/2015) treatise. Batteux separated what he called the fine arts—music, poetry, painting, sculpture and dance—from the mechanical arts. Fine arts, he believed, sought to imitate nature, but selecting only the beautiful, and their sole purpose was to give pleasure. Eloquence and architecture combined pleasure and usefulness, so they were placed in a separate group (Kristeller, 1952).

The notion of a common essence to all arts that justifies their inclusion in a common category has stayed with us, but the awareness of the historical contingency of the modern system of the arts has been lost. The category art does not reflect a natural division of human activities or capacities: “The branches of the arts all have their rise and decline, and even their birth and death, and the distinction between ‘major’ arts and their subdivisions is arbitrary and subject to change” (Kristeller, 1952, p. 45). There is nothing in the nature of painting that makes it more an art than landscape gardening or eloquence, just as there is nothing in the nature of judo that makes it more an Olympic sport than karate.

**The creation of aesthetic appreciation**

From the mid eighteenth century to the late nineteenth century, the fine arts became associated with inspiration and genius, and were supposed to be appreciated in a refined fashion. Crafts were considered merely to require skill and knowledge of conventions, and were relegated to an inferior status (Shiner, 2001). Artworks became autonomous objects, devoid of functional purpose, to be fully appreciated without
reference to context (Carroll, 2008). This was accompanied by a change in what people expected from craft and art. Whereas craft could produce only ordinary functional pleasure, by being useful or amusing, art was expected to propitiate a refined and elevated contemplative pleasure, an aesthetic pleasure (Shiner, 2001). The aesthetic contemplation of art was, thus, stripped of the defining traits of craft: purpose and common pleasure. In addition, sight and hearing became privileged conducers of this distinct form of aesthetic pleasure: “(...) the shift from ‘taste’ to the ‘aesthetic’ came about partly as a result of giving a more intellectual character to the pleasures of the ‘higher’ senses of the eye and ear in order to further distance them from ordinary sensual enjoyments” (Shiner, 2001, p. 141). Whereas art had traditionally engaged people’s social, moral, religious or recreational interests, now disinterested contemplation was regarded as the appropriate response to objects classified as art.

The separation of art and craft, the elevation of the fine arts, and the institution of a special form of aesthetic pleasure, were all products of intellectual, cultural, social, political, and economic factors. The most important among these were the expansion of the market economy, and the desire for an improved social status of a growing middle class. Art became a commodity for the bourgeoisie, and good taste became an important sign of social standing (Carroll, 2008; Shiner, 2001). Once interwoven, art and its proper aesthetic contemplation became signs of refined taste and good social position. This new way of understanding art and aesthetic experience was elaborated to fit the philosophical paradigms and the social landscape that emerged throughout the 18th century:
The standard concept of aesthetic experience, then, took hold in the eighteenth century for at least two, inter-related reasons. There was the intellectual or philosophical task of rationalizing membership in the Modern System of the Arts in terms of some criterion, on the one hand, and the social pressure to arrive at a criterion that reflected the emerging bourgeois practices of consuming the fine arts, on the other hand. The aesthetic theory of art appeared to fit the bill on both counts (Carroll, 2008, p. 153).

In sum, the notion of a special kind of aesthetic experience in response to art is based on eighteenth century philosophical paradigms and socioeconomic changes. It is not based on a systematic analysis of human behavior, nor on an understanding of how the brain works. The link between art and aesthetic experience does not, therefore, reflect an understanding of human nature. It is the lasting consequence of the elevation of a particular set of activities—the Beaux Arts—above others, and of the elevation of a particular set of people—the European bourgeois—above others.

**The Problem With Art**

Despite lacking any basis in a scientific understanding of the human mind, the nineteenth century notion linking an arbitrary object category (“art”) with a supposedly special phenomenological experience (“aesthetic”) remains alive today. To a great number of researchers in modern psychology and neuroscience, “aesthetic” continues to mark out a special domain of human experience that involves special
perceptual, cognitive, and emotional states being evoked through the encounter with special objects (e.g., Carbon, 2018, 2019; Menninghaus et al., 2017, 2019; Pelowski et al., 2017a, 2017b; Sherman & Morrissey, 2017; see also Skov & Nadal, 2018, 2019). We present two specific examples that serve to illustrate how the “aesthetic” retains this peculiar nineteenth century meaning.

The first example is taken from a paper, “Stability and Variability in Aesthetics Experience: A Review”, by Jacobsen and Beudt (2017). The authors set out to analyze factors that help determine whether “aesthetic preferences” (p. 2) are universal or subjective. In doing so, they present the phenomenon of “aesthetic” preferences as a special kind of taste: “In aesthetics, we deal with a multitude of factors influencing our preferences, judgments, contemplation, appreciation, liking, and disliking. While we are searching for laws of aesthetics universal for mankind, there is also no accounting for taste. While Homo sapiens appears to be the only primate species capable of fully developed aesthetic processing, there is also no denying that evolution has an influence on our aesthetic appreciation” (Jacobsen & Beudt, 2017, p. 1; our italics). This special kind of aesthetic appreciation is defined as “the evaluation of sensations and perceptions against relevant concepts like the beautiful, the elegant, the harmonious, the melodious, the rhythmical, and the like” (Ibid). The authors, furthermore, stress that “all episodes of aesthetic appreciation for our concern” involve “episodes of mental processing of art” (Jacobsen & Beudt, 2017, p. 1), and accordingly restrict their review of factors that influence aesthetic preferences to studies of different art forms: visual art, photography, music, literature, dance, architecture, and design—what they collectively refer to as “aesthetic domains” (Jacobsen & Beudt, 2017, p. 7). Thus, to Jacobsen and Beudt, the word aesthetics functions as a qualifier: it marks out psychological processes associated
with evaluations of sensation that lead to liking or disliking, but only processes that are distinct in nature—specifically processes that are unique to humans, involve specific appraisal “concepts”, and are prompted by a particular class of sensory objects (art).

The second example, “The Role of Hedonics in the Human Affectome” (Becker et al., 2019), presents a view of aesthetic pleasure from the point of view of mainstream neuroscience. It is a comprehensive review of literature pertaining to “Hedonics”, the core experience of pleasure and displeasure (Becker et al., 2019). The authors explicitly compare research on the neurobiological mechanisms associated with pleasure and displeasure conducted in animals and humans, suggesting a great overlap in how pleasure and displeasure are generated across species. They also—in contrast to Jacobsen and Beudt (2017)—assign negative hedonic responses, including pain, a prominent place in their description of the hedonic system. Indeed, the paper makes a strong argument for the view that it is misleading to treat pleasure and displeasure as strictly separate categories. The authors make no mention of aesthetics until a sub-section on “applied hedonics”. Here, aesthetic hedonics is again thought to encompass a specific “applied context”, where interaction with aesthetic objects such as interior design or architecture may modulate the hedonic system and induce positive hedonic feelings in a special way. In a short section called “Neuroaesthetics” the authors describe how neuroaesthetics research has linked the aesthetic experience to basic reward processes, yet keep open the question of whether or not “aesthetic emotions are distinct from adaptive emotions” (Becker et al., 2019, p. 230). Thus, to the degree aesthetics is seen as playing a role in the neuroscientific study of hedonics it is relegated to its periphery, designating a specific use of the more general system of pleasure and displeasure. This use is viewed as related to interactions with certain
objects—buildings, rooms, music—that affords us a way of modulating the hedonic system, especially by inducing states of positive hedonic values. The nature of this “aesthetic” engagement of the hedonic system may or may not be different from other, “adaptive”, uses.

Both of these examples illustrate how, in contemporary psychology and neuroscience, the study of aesthetics is primarily framed as a *specialty study*, with an uneasy connection to other fields of inquiry. It is viewed as concerned with a specific subset of hedonic taste responses, namely those that involve evaluation of objects belonging to so-called “aesthetic” domains: mainly works of art. Thus, distinct from cases of “adaptive” appreciation “aesthetic” appreciation is seen as designating a separate category of preference judgments that involves the appraisal of aesthetic objects (i.e., art). The notion of aesthetic appreciation is primarily, if not exclusively, associated with positive hedonics responses, perhaps even distinct emotional states. It is widely assumed that this special kind of taste response is unique to the human mind, and not observed in other species.

Defining aesthetics in this restricted way has two consequences for empirical aesthetics and neuroaesthetics. First of all, by limiting what counts as aesthetics to a special variant of sensory taste responses, demarcated by the kind of sensory objects and hedonic responses involved, is to detach aesthetics from other branches of psychology and neuroscience that investigate sensory valuation. As a result, research conducted in empirical aesthetics or neuroaesthetics becomes divorced from research on, say, gustatory and olfactory taste responses, or valuation events that involve sex, social interactions, or money. Consequently, insights gained in these branches of psychology and neuroscience may be deemed irrelevant to aesthetics, and vice versa. A bibliometric analysis of research papers published in English since 1972 suggests...
that, in fact, what is published under the auspices of aesthetics has little or no contact to other fields studying hedonic taste in humans and animals (Anglada-Tort & Skov, 2019). For instance, an analysis of the distribution of keywords associated with publications tagged as aesthetics reveals five clusters of research communities, centered on Art and Culture, Philosophy, Empirical Aesthetics, Environmental Aesthetics, and Reconstructive Surgery (Figure 1). In contrast, research centered on food consumption, sexual selection, or economic behavior does not come up at all as a part of the study of aesthetics, suggesting that these forms of sensory valuation are not considered aesthetic in nature, and that knowledge gained from their study play no part in how research unfolds in the self-defined aesthetic research clusters.

*Figure 1*. Map showing the connection between the most frequent keywords associated with self-designated aesthetics research, 1970-2018. Clustering of keywords suggests that published research on aesthetics coalesce around five main “branches”. Data taken from Anglada-Tort & Skov (2019).
The second consequence is that empirical aesthetics and neuroaesthetics come to posit the existence of special, distinctive, psychological and neuroscientific states and mechanisms associated with instances of “non-ordinary” hedonic appreciation (Nadal & Skov, 2018; Skov, 2019a; Skov & Nadal, 2018, 2019). What does this purported aesthetic specialness amount to? It appears to be defined by two main components: (1) “aesthetic” hedonic values are believed to be elicited by certain specific object categories; hedonic responses that (2) in contrast to “adaptive” or “ordinary” hedonic responses are thought to consist of distinct patterns of engagement of the reward circuit, characterized by predominantly positively valenced affective states. When these putative “aesthetic” responses occur, prompted by “aesthetic” objects, we have an instance of “aesthetic” appreciation, and an “aesthetic” experience. The implication, of course, is that there are many objects that do not qualify as “aesthetic”, stimuli that are not considered capable of prompting the proper kind of “aesthetic” response believed to exist. This idea separates “aesthetic” hedonics from “non-aesthetic” hedonics (as illustrated by our examples above). Consequently, the bulk of what we have learned about the function of the reward circuit’s value signals is dismissed as irrelevant to the study of aesthetics. For example, negative hedonic values are neglected or directly rejected as irrelevant to aesthetics. (Do pain or disgust qualify as aesthetic hedonic states?) Instead, researchers in empirical aesthetics and neuroaesthetics hold untested assumptions about the supposed nature of the positive affective states “aesthetic” events are thought to elicit, characterizing them as especially intense or moving (Makin, 2017; Menninghaus et al., 2019), able to afford pleasure, but without negative addictive consequences (Christensen, 2017), or “disinterested” in that they lack a motivational component (Chatterjee, 2013, 2014).
Obviously, none of these consequences would constitute a problem if it were true that aesthetic experiences designate a distinct psychological phenomenon, where objects with special attributes conjure special states of hedonic affect—responses that can be distinguished from other forms of “adaptive” sensory valuation. However, there is little evidence supporting this claim (Nadal & Skov, 2017, 2018; Nadal, Vartanian & Skov, 2017; Skov, 2019a, 2019b; Skov & Nadal, 2017, 2018, 2019). Rather, what the empirical evidence shows is that (1) the neurobiological processes engaged when people form pleasure and displeasure responses for works of art overlap with those engaged by non-art stimuli (Bartra et al., 2013; Brown et al., 2011; Sescousse et al., 2013; Skov, 2019a, 2019b); (2) most of the computational principles that determine how “ordinary” or “adaptive” hedonic appreciation unfolds also apply to “aesthetic” hedonic appreciation. There has yet to emerge any convincing evidence that art produces unique hedonic states that differ from hedonic states produced by non-art stimuli because it is able to elicit especially moving or intense states of pleasure, or because it is able to elicit pleasure that is not accompanied by the activation of motivational drive. Indeed, studies examining highly intense pleasure states elicited by music, characterized by elevated neural activity in nucleus accumbens (NAcc) and orbitofrontal cortex (OFC) (Salimpoor et al., 2011, 2013), and markedly increased autonomic states (Grewe et al., 2007; Grewe, Kopiez & Altenmüller, 2009; Salimpoor et al., 2009), has found comparable patterns of activity when states of intense pleasure are triggered by visual, gustatory and tactile nonartistic stimuli (Grewe et al., 2010). Similarly, there is robust evidence that works of art elicit reward predictions (Gold et al., 2019; Hansen, Dietz & Vuust, 2017; Salimpoor, 2013; Steinbeis, Koelsch & Sloboda, 2006;), lead to prediction errors when expectations are not met (Kobayashi & Schutz, 2014; Salimpoor et al., 2015),
modulate saliency of perceptual objects, influence decision-making and behavior (Kim, Ko & Lee, 2012), and in many other ways engage processes associated with implementing the motivational impact of hedonic valuation (Vartanian et al., 2013).

In sum, there is no evidence supporting the notion that “aesthetic” experiences—aesthetic pleasure, aesthetic emotions, aesthetic objects, etc.—exist in the nineteenth century sense of the word. In fact, the argument for accepting aesthetics as a specialty study of a particular kind of hedonic appreciation, distinguishable from other, “ordinary” kinds of hedonic appreciation, is entirely circular: it is assumed that such a phenomenon exists, and because it is assumed that “aesthetic” appreciation exists as a sui genesis phenomenon, it is rarely considered necessary to concretely define exactly what is meant by this notion, or to explain how a concept of “aesthetic” appreciation fits with a broader concept of hedonic appreciation.

A Place for Aesthetics in Psychology and Neuroscience

If the nineteenth century-based notions of art and aesthetic experience prove at odds with a modern understanding of how the human brain works, does the concept of “aesthetics” have a place in contemporary behavioral and brain sciences? We believe that it does. Aesthetics can be used to describe a precisely defined topic in psychology and neuroscience, with a productive relation to other contemporary fields of inquiry.

In modern neuroscience, hedonic liking is conceived of as a process where sensory information is imbued with hedonic value. Evidence from both animal and human studies supports the idea that hedonic value is computed by a distributed
system of nuclei in the mesocorticolimbic reward circuit, (Bartra et al., 2013; Becker et al., 2019; Berridge & Kringelbach, 2015; Brown et al., 2011; Sescousse et al., 2013; Skov, 2019b). The process of assigning a hedonic value to a sensory stimulus is highly flexible, varying both between individuals and, over time, within the same person. It is determined not only by the object’s perceptual properties, but also by several endogenous and contextual factors (Skov, 2019b; Skov & Nadal, 2019; Figure 2).

Figure 2. A graphic depiction of neurobiological systems involved in computing hedonic liking for sensory objects. Hedonic values are generated by distributed nuclei in the reward circuit when perceptual information gains access to them. The response of these value signals to projections from sensory systems is modulated by input to the reward circuit from interoceptive and executive systems, signaling homeostatic state and on-going task demands of relevance to the specific valuation event. Figure reprinted from Skov (2019a).
Together, these findings suggest that hedonic appreciation—i.e., determining if the sensory object is liked or disliked—can be described as a process where information gains access to, and is assessed by, the reward circuit. A recent body of research that exemplifies this principle is the work on specific musical anhedonia (SMA). People who experience no pleasure for music—people with SMA—have reduced activity in NAcc, despite being fully able to represent music perceptually (Martínez-Molina, 2016; Mas-Herrero et al., 2014, 2018). This diminished capacity for musical pleasure contrasts with their intact ability to experience pleasure induced by visual art and money, both of which do engage NAcc in people with SMA (Martínez-Molina, 2016; Mas-Herrero et al., 2014, 2018). This dissociation suggests that stimuli that fail to engage nuclei in the reward circuit cannot acquire a positive hedonic value. Recent tractography studies confirm this principle. Thus, Sachs and colleagues (2016) used diffusion tensor imaging to show that people with SMA have diminished white matter connectivity between auditory areas and NAcc (Sachs et al. 2016). Even in people with no SMA, individual sensitivity to musical pleasure correlates with differences in connectivity between auditory cortex and the reward circuit (Loui et al., 2017; Martínez-Molina et al., 2019).

Thus, hedonic appreciation unfolds as a neurobiological process where sensory information is projected to nuclei in the reward circuit, generating levels of pleasure or displeasure. An important consequence of this computational setup is that, although the perceptual representation of an object is obviously important to how it is appreciated, its hedonic impact is not inherent to this perceptual representation. Rather, hedonic values must be understood as a “gloss” that is applied onto sensation by the mesocorticolimbic system (Ellingsen, Leknes & Kringelbach, 2015). This is an important insight, because the way the reward system responds to sensory input is not
just determined by the input it receives from perceptual systems, but also by projections from other systems (Figure 2). For instance, interoceptive signals project to nuclei in the striatum, via brainstem structures and the hypothalamus, modulating activity relative to the homeostatic state of the organism (Morville et al., 2019). Similarly, prefrontal structures project to several nuclei in the reward circuit, including the orbitofrontal cortex, allowing the executive system to influence valuation according to behavioral task demands and goals (Aydogan et al., 2018). As a result, hedonic appreciation events always unfold in a contextually flexible manner, with the experienced hedonic impact determined not just by stimulus properties but also by ongoing regulatory processes (Skov, 2019b; Skov & Nadal, 2019).

How can we define the study of aesthetics within this framework of modern neuroscience? From the perspective of psychology and neuroscience, aesthetics can be viewed as the study of why a specific sensory stimulus results in a specific hedonic value. This definition assigns all questions related to the understanding of how hedonic values are computed for sensory objects to the Cognitive Neuroscience of Aesthetics, and distinguishes this problem from that of understanding what hedonic valuation is in itself (hedonics), and from that of understanding how hedonic values are integrated into decision-making and behavioral control (neuroeconomics) (Figure 3). Of course, these distinctions are mainly for convenience, given that they aim to distinguish neurobiological mechanisms and computational components that almost always function together: Organisms assess the hedonic value of sensory objects with the functional goal of motivating behavioral interaction with them. Nonetheless, from the point of view of scientific disciplines, there is some sense in these distinctions. Research on hedonics is usually concerned with understanding the neural underpinnings of pleasure and displeasure regardless of why a given stimulus elicits
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either. Neuroeconomics, in contrast, focuses on determining the computational factors that determine value-based decision-making, with little regard for what a hedonic value is *per se*, or why perceptual information triggers a given hedonic response. By charting and understanding the specific psychological and neurobiological mechanisms by which hedonic values are computed for sensory objects, aesthetics becomes the study of a well-defined scientific problem, and also gains a well-defined position with respect to other psychological and neuroscientific subdisciplines.

*Figure 3.* Aesthetics as a scientific problem can be defined as the aspect of sensory valuation that refers specifically to understanding *how* and *why* perceptual representation of a sensory stimulus leads to a given hedonic value. By defining aesthetics in this sense, empirical aesthetics and neuroaesthetics have a meaningful place in the context of modern psychology and neuroscience.
Furthermore, a *Cognitive Science of Aesthetics*, defined in this precise way, allows us to spell out what would count as specific aesthetic problems in psychological and neuroscientific research. We suggest that three sets of problems will constitute the core concerns of a scientific study of aesthetics:

**Question 1**

What are the factors that determine individual outcomes of an aesthetic appreciation event? By “factor” we broadly mean any kind of behavioral, psychological or neurobiological feature or process that modulates how a stimulus comes to acquire a specific hedonic value. Experiments have revealed numerous such factors, across all the sensory modalities, including factors that derive from (1) the physical properties of sensory objects, such as the symmetry or regularity of objects (Friedenberg, 2018), or how “sweet” a gustatory object is (Peng et al., 2015), (2) the way object features are represented by perceptual-cognitive systems (e.g., predictability, Egermann et al., 2017, or familiarity, Mastrandea & Crano, 2019), and (3) the contextual circumstances, including the external context (Grüner, Specker & Leder, 2019), the internal homeostatic states (Zimmerman et al., 2016), and top-down expectations (Kirk et al., 2009). However, neuroscience is far from being able to explain *how* these factors work, and *why* they influence a given appreciation event in the manner they do. What has proved especially challenging to the study of aesthetics is coming up with actual computational models that predict how information flow will be affected by any individual factor. Furthermore, much work is still required to explain why such factors modulate appreciation events differently in different individuals, leading to considerable variation in aesthetic sensitivity (Corradi et al., 2019a, 2019b).
Question 2

How does sensory information come to activate processes in the reward circuit? As explained above, sensory objects are imbued with positive or negative hedonic values when perceptual information is relayed to the mesocorticolimbic reward circuit. But how does this happen precisely? What are the concrete computational principles that lead a pattern of activity in a perceptual-cognitive system to engage valuation mechanisms in the reward circuit? While some headway has been made in describing such computational principles for some sensory systems, especially the gustatory system (Rossi & Stuber, 2018), there are very few answers to this fundamental question for other systems. For example, visual studies show that objects with a symmetrical organization of stimulus properties have a strong—albeit not universal (Leder et al., 2019)—tendency to elicit pleasurable responses. Experiments suggest that degree of visual symmetry is perceptually represented by a distributed network of neurons in extrastriate cortex that include the areas V3A, V4d/v, V7, and the lateral occipital complex (Bertamini & Makin, 2014; Sasaki et al., 2005). To this day, though, it remains unclear precisely what kind of perceptual activity excites the reward neurons that generate pleasure. Neuroaesthetics is still far from describing such computational interactions between sensory systems and the reward circuit, although a current thrust to give connectivity studies a greater prominence in aesthetic research will likely change this situation.

Question 3

Finally, what are the computational mechanisms that make up the reward circuit? Work in the adjacent fields of hedonics and neuroeconomics has revealed that
the reward circuit contains several different sub-systems involved in different functions. For example, while nuclei distributed across the ventral striatum, pallidum, and ventral prefrontal cortex appear specialized for the generation of pleasure or displeasure *per se* (Becker et al., 2019; Berridge, 2018; Smith et al., 2010), dissociable populations of neurons in other parts of the reward circuit seem dedicated to the production of motivational drive, facilitating approach and avoidance behavior. Strong evidence suggests that neurons in NAcc are critical to conditioned learning, associating specific sensory cues with a predicted hedonic response (Talmi et al., 2009). A central component of this subsystem is the computation of prediction errors, carried out by neurons that signal that an expected reward did not materialize, or that a reward did unexpectedly occur (Kobayashi & Schultz, 2014; Schultz, 2016). In contrast, neurons located in ventromedial prefrontal cortex, especially the orbitofrontal cortex, appear to integrate information from different sources, calculating hedonic outcomes that reflect the specific current appreciation context (Knutson & Genevsky, 2018).

These findings suggest that, during appreciation events, sensory information engages processes in the reward circuit in a multitude of different functional ways. In some circumstances hedonic liking is determined by stored cue-reward associations, in others by consideration of novel information. Appreciation events vary in how they unfold, depending on whether or not they are explicit or implicit to a behavioral task. For instance, the explicit assessment of a face for its attractiveness recruits value signals in the OFC that are not taken into account when the same face is inspected with respect to other task demands (Chatterjee et al., 2009; Kim et al., 2007). One of the most crucial undertakings of aesthetics is to map the different ways the reward
circuit’s value mechanisms can be triggered by projections from the brain’s sensory systems, creating different types of appreciation events.

**Conclusion: Exorcising Art from the Study of Aesthetics**

Much research in empirical aesthetics and neuroaesthetics rests on ideas about art and aesthetic experience that were developed more than two centuries ago. These ideas linger today in the form of assumptions, such as that art designates ontologically special objects, the experience of which entails special mental states. By adopting this view, current work in empirical aesthetics and neuroaesthetics envisions “aesthetic” psychological and neurobiological processes and mechanisms as distinct mental phenomena, entirely separate from, and uninformed by, phenomena studied by other branches in psychology and neuroscience.

Progress in empirical aesthetics and neuroaesthetics requires separating art from the study of aesthetics. Aesthetics must be clearly set out as a general study of how sensory information acquires hedonic value, with art objects only one small subset of sensory stimuli that falls under its purview. This is not to say that art does not merit scientific research, or that it should be beyond the scope of the behavioral and brain sciences. The creation and appreciation of art are interesting topics of scientific research, and we expect they will also thrive at a greater pace once they are disentangled from the topic of sensory valuation.

Only by divorcing scientific aesthetics from the special assumptions associated with art, will it be possible to define aesthetics in a precise way that turns it into a central topic in psychology and neuroscience. As we have suggested, when
viewed in this general way, aesthetics can be defined as the study of how and why a specific sensory stimulus acquires a specific hedonic value. Furthermore, by adhering to this definition, it also becomes possible to assign aesthetics a precise and integrated place within the broader scope of psychology and neuroscience. Indeed, aesthetics has the potential to link studies of hedonics and neuroeconomics by specifically investigating how the neural systems underlying perception and hedonics combine to form appreciation events, i.e., situations where stimuli are attributed with a degree of pleasure or displeasure. As we have noted, this overarching problem can be further sub-divided into concrete empirical questions, such as how perceptual information come to engage value signals in the reward circuit, or why different psychological and neurobiological factors elicit different appreciation events for identical sensory objects. By adopting this approach, aesthetics gains a well-defined and central place in the broader enterprise of contemporary psychology and neuroscience.
References


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