The nature of perception and emotion in aesthetic appreciation: A response to Makin's challenge to Empirical Aesthetics

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Abstract

Alexis Makin argued in a recent paper that Empirical Aesthetics is unable to properly advance our understanding of the mechanisms involved in aesthetic experience. The reason for this predicament, he claims, is an inability of current research methods to capture the psychological properties that truly characterize aesthetic experience, especially the unique perceptual and emotional processes involved in the aesthetic experience. We show that Makin's argument rests on assumptions that are at odds with scientific knowledge of the neurobiological mechanisms involved in the appreciation of sensory objects. We thereafter show that such mechanisms are rooted in shared neurobiological systems, and operate according to computational principles that are common to many domains of

experience. This casts doubt on the notion that aesthetic experiences constitute a distinct kind of experiences that can be defined according to a set of special and unique qualities. Finally, we discuss how attributing this specialness to "aesthetic" experiences leads Empirical Aesthetics astray from mainstream psychology and neuroscience.

Alexis Makin (2017) recently issued a rousing challenge to contemporary Empirical Aesthetics. Makin argues that empirical aesthetics cannot, *as a matter of principle*, grasp its very object of inquiry: Aesthetic experience. The reason for this claim is that the psychophysical method commonly employed by empirical aesthetics is unable to fathom the proper nature of the aesthetic experience. The psychological states or processes that psychophysics *is* able to study are not those that truly define aesthetic experience: "aesthetic experience is fundamentally about hot emotional reactions to wholes, but empirical aesthetics is stuck measuring cold evaluation of parts" (Makin, 2017, p. 208).

This is a deeply problematic situation if Makin is right. Empirical Aesthetics, as currently practiced, would fundamentally be a futile enterprise—or at least in need of a radical methodological overhaul. Moreover, Makin is far from the only who harbors doubts about the fate of the field. Other researchers have voiced similar misgivings, questioning the ability of Empirical Aesthetics to probe those aspects of the aesthetic experience that truly define it (e.g., Carbon, 2018; Christensen, 2017; Menninghaus et al., 2017: Menninghaus et al., 2019; Pelowski et al., 2017a, 2017b; Sherman & Morrissey, 2017). This widespread concern appears founded on the belief that aesthetic experiences have special psychological properties, which elude experimental methods as currently practiced. In turn, this putative specialness is related to two deep-seated assumptions: (*1*) that certain objects—particular those called "art"—are ontologically special and able to provoke special experiential states, characterized by special psychological processes (Pelowski, 2017a, 2017b; Menninghaus et al., 2017), and (*2*) that the emotions elicited by the "appreciation" of such objects are unique, both in terms of their phenomenological feeling and their physiological nature (Carbon, 2018; Christensen, 2017; Menninghaus et al., 2019; Skov, Vartanian, & Nadal, 2019). Conventional experimental laboratory methods are considered to be inadequate to capture these special processes (Carbon, 2018; Pelowski et al., 2017b; Sherman & Morrissey, 2017). As we have tried to show elsewhere, these assumptions are not backed by experimental evidence. They are, in fact, directly contradicted by empirical research (Nadal & Skov, 2017, 2018; Skov & Nadal, 2017, 2018; Nadal, Vartanian, & Skov, 2017).

Makin bases his argument against the ability of Empirical Aesthetics to understand "proper" aesthetic experience on both of these assumptions. Our aim in this paper is to show that the empirical evidence of the neurobiological processes associated with appreciation of sensory objects, including works of art, paints a radically different picture from the one suggested by the assumptions informing Makin's argument. Furthermore, we discuss how Makin's use of unsupported assumptions to establish "aesthetic" experiences as a *sui generis* category, possibly unfathomable, is just one example of a much broader trend in Empirical Aesthetics seeking to imbue "aesthetic" objects and "aesthetic" processes with special qualities that do not conform to the general understanding of how the human brain works.

Makin's argument and its underlying assumptions

In Makin's analysis, Empirical Aesthetics can be described as the study of how object properties elicit subjective preference responses. Employing the psychophysical methods developed by Fechner, Empirical Aesthetics maps how much a given property is liked or disliked, hoping to establish general laws explaining why certain properties—objective or subjective—are liked and others are disliked (Figure 1). Makin's own studies, where degree of symmetry is related to differences in preference response (e.g., Makin, Pecchineda, & Bertami, 2012a, 2012b; Makin et al., 2012) are a good example of this type of approach. Empirical Aesthetics also seeks to establish lawful relations between subjective dimensions, like arousal or familiarity, and preference. But, as Makin states, the problem here is the same: the manipulation of a single dimension in isolation.

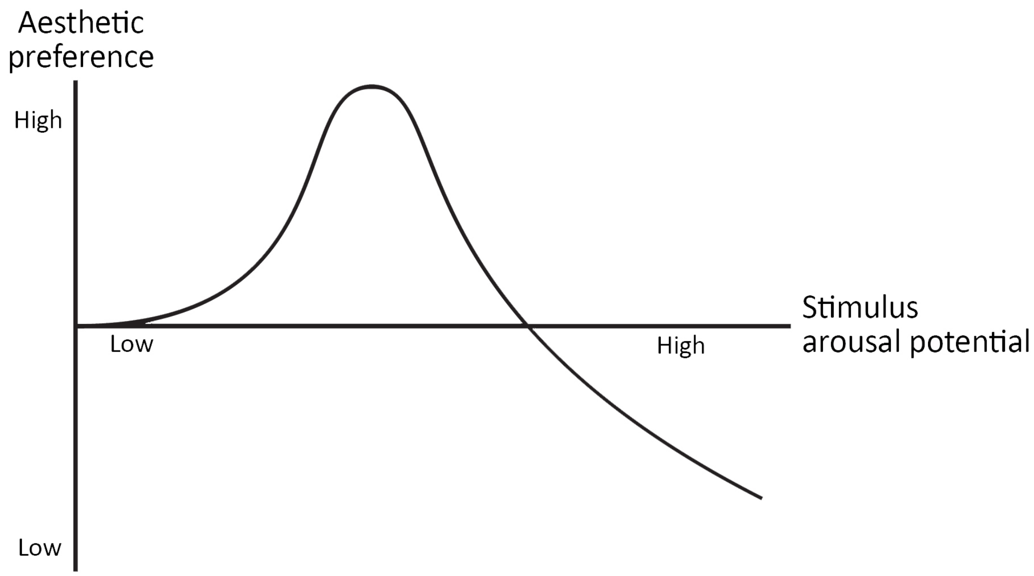

Figure 1. Berlyne's (1971) theory of "arousal potential" is a paradigmatic example of the kind of lawful relations between stimulus properties and aesthetic preference proposed in Empirical Aesthetics. Berlyne hypothesized that stimuli with intermediate levels of collative properties, such as complexity, elicit positive hedonic responses, such as aesthetic liking. He sought to prove this law, for instance, by varying levels of complexity in visual objects and comparing their effects on preference and liking.

This methodological approach suffers from two critical problems in Makin's view. The first problem concerns the *kind* of responses that psychophysical methods are able to measure. Makin argues that the "reductive quasi-psychophysical approach" cannot capture the type of psychological processes and states that actually characterize aesthetic experience. What are these? The examples Makin mentions include *rapture*, *flow experience*, *mindfulness* (Makin 2017, p. 187), and intense "rare and special aesthetic emotions" (Makin 2017, p. 189). Psychophysical methods measure, instead, what he calls "cold evaluations or preferences" (Makin 2017, p. 191).

The second problem concerns the fact that the psychophysical method only studies single object properties in isolation. As Makin observes, this is a major flaw because any object property or subjective dimension is rarely, if ever, experienced on its own, but almost always as a part of a whole. Makin calls this "the Gestalt nightmare" (Makin 2017, p.192) and describes the problem as follows: "The reductive psychophysical approach assumes that there are many stimulus dimensions which alter preference in a lawful way. We can do experiments to discover these laws.

However, the approach tacitly assumes *that all these dimensions are orthogonal, and all effects on preference are independent*. This second assumption is totally unrealistic. It is more likely that stimulus-preference laws are modulated, turned, and twisted whenever another dimension is added to the stimuli" (Makin, 2017, p. 193, italics in original).

Together, these two problems doom experimental research in Empirical Aesthetics, and thus threaten it as a scientific enterprise: "We are like scientists who would love to measure a very rare whirlpool in a chaotic system, but cannot reliably recreate it in an artificial fluid tank" (p. 210).

At first glance, these might seem to be devastating problems. But they are problems only if certain tacit assumptions are left unquestioned and taken for granted. These assumptions are not addressed or substantiated in Makin's paper. His first claim, that "it is very difficult to evoke either special aesthetic emotions or *hot* emotions" (p. 191, italics in original) in lab experiments using psychophysics, stands or falls with the assumption that the aesthetic experience is defined by *specific* and *special* experiential states (*aesthetic rapture*, *intense fascination*, *transcendence*, *flow experience*, *mindfulness*, etc.). But the proposition that aesthetic experience is defined by specific and special experiential states is not a factual proposition; it is a speculative one. There is no empirical evidence that aesthetic experiences specifically entail such "special" states, or even that they constitute a distinct class of psychological or neurobiological events. Makin writes that "it is uncontroversial to say aesthetic rapture cannot be studied with the reductive quasi-psychophysical approach" (pp. 187-188). But the truth of this assertion depends on the truth of three premises that actually *are* controversial: (*i*) that "aesthetic rapture" exist as a discrete psychological category; (*ii*) that we know how to identify its neurobiological elements (i.e., that we know what to study and, thus, what cannot be studied by Empirical Aesthetics); and (*iii*) that we have compelling evidence that rapture forms a characteristic part of aesthetic experiences. None of these premises are backed by facts. As far as we know, there is no empirical evidence that describes how often, or to what degree, humans experience "rapture" during aesthetic experiences. Nor do we know of any accepted psychological theory that explains what an "aesthetic rapture" is, or how such a theory fits in with available neuroscientific facts about emotion.

Likewise, Makin's second problem, that the Gestalt nightmare prevents Empirical Aesthetics from formulating "lawful functions relating stimulus properties to subjective preferences" (p.186), only holds if aesthetic preferences are thought to be driven entirely by object properties. The Gestalt nightmare can only be a nightmare if we expect an outcome to *follow* from the presence of a given stimulus property. But to assume that aesthetic responses are *elicited* by object properties is also to assume the truth of two propositions about the psychological and neurobiological system instantiating these responses. The first of these is that aesthetic responses are driven by bottom-up perceptual processes, and are insulated from regulatory top-down processes. The second is that perceptual processing involved in computing aesthetic responses is *reflexive*, law-like, such that the perceptual system must invariably respond in a certain computational manner when confronted with a given object property. Neither of these assumptions, as we will show, fits well with the current understanding of human perception or aesthetic appreciation.

In sum, unless aesthetic responses are triggered solely by object properties, and take the form of a set of special experiential states—"intensely hot emotions"—Makin's argument loses its traction. It only poses a challenge for Empirical Aesthetics if we accept Makin's characterization of the *true* object of inquiry as "hot emotional reactions to wholes". However, Makin does not explain why we should accept this view, nor does he justify it by appealing to facts about how "perception" and "emotion" interact to construct "aesthetic" responses to sensory objects. This is perhaps not surprising, given that the current understanding of human neurobiology does not support the idea that aesthetic experiences are triggered by object properties, nor that they constitute a special class of emotional states.

What neuroscience tells us about aesthetic appreciation

When Makin describes Empirical Aesthetics as the psychophysical study of "stimulus-preference laws" he is both right and wrong. It is true that most studies in Empirical Aesthetics report experiments where object conditions are manipulated, and behavioral preference responses are measured. It is also true that the field continues to be dominated by this approach. However, for at least 20 years psychophysics has not been the only methodological tool available to Empirical Aesthetics. With advances in non-invasive neuroimaging, it has also become possible to probe the neural mechanisms underlying aesthetic appreciation, and in this way open the black box of neurobiological mechanisms long inaccessible to Empirical Aesthetics research—what Fechner coveted as a future "inner psychophysics" (Fechner, 1876; Figure 2). This influx of neuroscientific data has fermented a revolution in our understanding of aesthetic appreciation, allowing us to go beyond a mere description of "stimulus-preference laws" and study the actual functional machinery involved in aesthetic appreciation (Skov, 2019a). This revolution has also paved the way for innovative behavioral studies investigating such mechanisms independent of stimulus properties (e.g., Brielmann & Pelli, 2017; Graf & Landwehr, 2017; Huang et al., 2018).

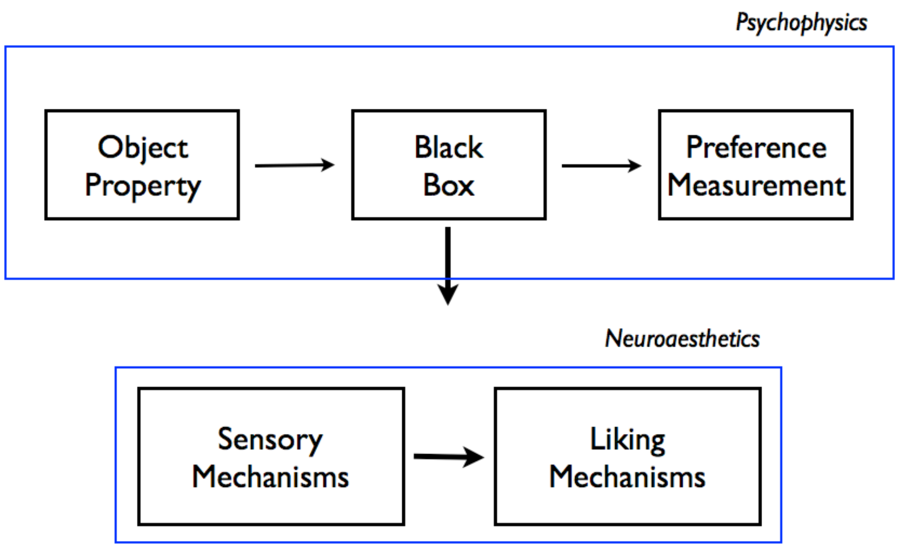

Figure 2. In his pioneering book *Vorschule der Ästhetik,* Fechner suggested that aesthetic appreciation could be studied experimentally by scaling the magnitude of a sensory stimulus and relating individual stimulus properties to behavioral responses (Fechner, 1876). This was an application of his groundbreaking psychophysical method. Fechner, though, only thought of such stimulus-behavior relations as an "outer psychophysics", expecting that an "inner psychophysics", explaining sensation in terms of neurobiological mechanisms, would one day become possible. Since the 1990s neuroimaging has finally allowed aesthetics researchers to investigate how neural activity unfolds *in vivo* while human subjects engage in aesthetics experiences, effectively opening the black box of neural processing that translates a sensory stimulus into hedonic liking (Pearce et al., 2016; Skov, 2019a).

Thus, to portray Empirical Aesthetics as solely the collector of preference responses to object manipulation is rather misleading. Indeed, neuroscientific research into aesthetic appreciation has unearthed the specific neural circuitry computing hedonic responses to sensory input, investigated its function and relationship to other neural systems, and detailed how different factors modulate the way sensory processing and hedonic computation interact (for reviews of this literature, see Getov & Winston, 2015; Berridge & Kringelbach, 2015; Brattico & Pearce, 2013; Salimpoor & Zatorre, 2013; Sachs, Habibi & Damasio, 2018; Skov, 2019b). At least three of these findings are of direct relevance to the assessment of Makin's argument.

1. The reward system. The first of these findings is that the hedonic response to a sensory object—the experience of how much we like or dislike it—is computed by a distinct neural circuit: The reward system. This finding is of consequence because it shows that the hedonic value of a stimulus is not inherent to its perceptual properties, but is tacked on as an affective "gloss" by the reward circuit (Rolls, 2005; Berridge & Kringelbach, 2015; Ellingsen, Leknes & Kringelbach, 2015). There are a number of ways this dissociation between perceptual representation and hedonic gloss has been proven. One is that it is possible to experimentally modulate the hedonic value of a stimulus through electrophysiological or pharmacological manipulation of neurons in parts of the reward circuit, even when the sensory stimulus remains the same (Peciña, Smith, & Berridge, 2006). Another way is to experimentally stimulate reward neurons in the absence of sensory input, thus "artificially" inducing an experience of pleasure or disgust without sensory involvement (Peng et al., 2015). Finally, some patient groups exhibit a lack of access from a specific perceptual system to the reward circuit, even when both systems are themselves intact, affecting their ability to tag inputs from this sensory system hedonically. This is the case, for example, with people who suffer from specific musical anhedonia (SMA). These people experience a reduced pleasure response to music, despite having a normal ability to represent music perceptually, and a preserved ability to feel pleasure for non-music input, such as visual art and monetary rewards (Mas-Herrero et al., 2014, 2018). This difference in hedonic response to music and other stimuli owes to a difference in nucleus accumbens activity (Martínez-Molina, et al., 2016), caused by reduced white matter connectivity between the auditory areas responsible for representing music and this part of the reward circuit (Sachs et al. 2016). Indeed, individual variability in connectivity between auditory cortex and the reward circuit also predicts individual differences in experience of musical pleasure in people without SMA (Loui et al., 2017).

Thus, there are very convincing reasons to believe that neurons in the reward circuit are the actual *cause* of the hedonic response associated with aesthetic appreciation, that is to say, the affective state of pleasure-displeasure, liking, or preference. Sensory information accesses this system, but does not in itself *determine* how the neurons computing this response act. Indeed, afferents from the reward circuit reflecting the hedonic value associated with a stimulus often influence how the stimulus is represented perceptually, as discussed below. The implication for the discussion here is straightforward: empirical evidence strongly suggests that aesthetic appreciation is not about "laws" coupling stimuli and preferences. Aesthetic appreciation, rather, is about an unfolding *interaction* between sensory processing and neural activity in the reward circuit.

2. Common currency. The second important finding to come out of neuroscientific research into aesthetic appreciation is the observation, repeated across many hundreds of experiments now, that hedonic responses are computed by the same network of neurons, irrespective of sensory modality or the specific object category being assessed.[1] Thus, the brain has not evolved one system to ascertain how much we like a Rembrandt, and another to decide how pleasurable a slice of cheesecake is. This common currency hypothesis (Levy & Glimcher, 2012; Berridge & Kringelbach 2015) is of specific importance to empirical aesthetics: the class of objects we categorize as art engages a neurobiological system that did not evolve specifically to perform this job.

3. Contextual regulation. Finally, the third crucial finding to emerge from recent neuroscientific research is the realization that the neurobiological system computing hedonic responses for sensory objects is highly influenced by contextual factors. As noted, the way the reward circuit responds to a given object is not just determined by the perceptual input. It is strongly regulated by the internal homeostatic state of the organism, and the behavioral goals the organism is currently engaged in (Figure 3; for

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[1] A number of statistical meta-analyses have examined these neuroimaging studies and found that neurons located in the striatum (especially the ventral striatum and parts of the pallidum), orbitofrontal cortex (OFC), the anterior cingulate (ACC), insula, and amygdala, consistently code for how positive or negative a sensory input is experienced to be (Bzdok et al. 2010; Brown et al., 2011; Kühn & Gallinat, 2012, Sescousse et al., 2013; Bartra et al., 2013; Zou et al., 2016).

further discussion see Skov, 2019b). For instance, the way neurons in the orbitofrontal cortex fire during ingestion of chocolate is modulated by state of satiety, changing how pleasurable people find the chocolate to be relative to homeostatic needs (Small et al., 2001; Kringelbach et al., 2003). Similarly, when people are tasked to explicitly assess the attractiveness of a face, neurons in striatum and orbitofrontal cortex exhibit a different response profile than when they are tasked with assessing the face's geometric shape, leading to different hedonic experiences of the same face (Kim et al., 2007; Chatterjee et al., 2009). This computational set-up makes a lot of evolutionary sense: It is highly advantageous for an organism to be able to assign hedonic value to sensory input depending on contextual factors, such as the relevance of the input for its current physiological needs and behavioral goals. This contextual regulation of the reward system allows the organism to compute motivational values, even when behavioral and environmental circumstances change, as they do constantly (Coppin & Sander, 2012; Warren, McMcGraw, & Van Boven, 2011).

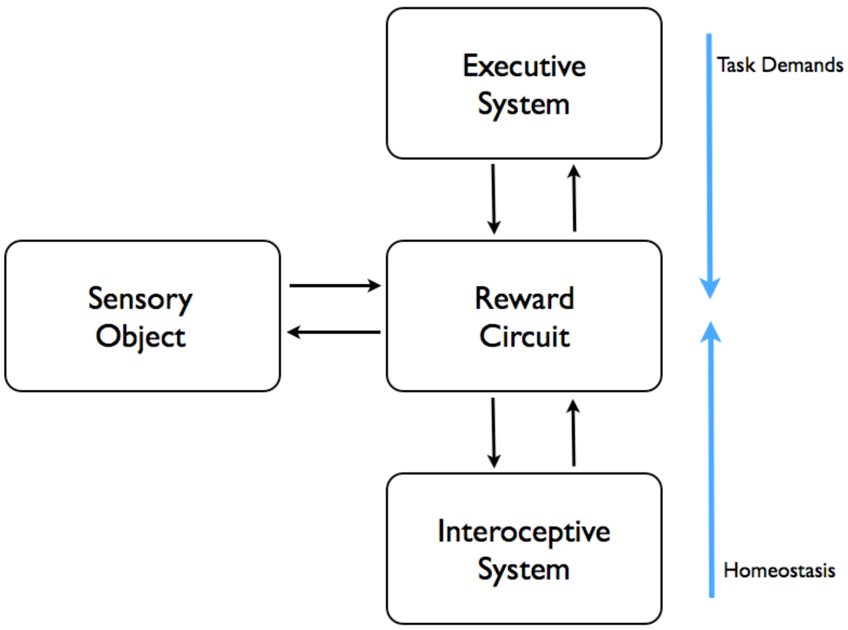

Figure 3. A model of the key functional nodes involved in the computation of sensory valuation, and how they are modulated by known factors (Skov, 2019b). The model posits that sensory valuation occurs when perceptual information gains access to the reward circuit, where value mechanisms assess the hedonic value of the stimulus relative to regulatory concerns and behavioral task demands. These factors are represented by interoceptive and executive signals that innervate the neurons in the reward circuit, modulating activation prompted by perceptual signaling.

To sum up, aesthetic appreciation involves the transfer of perceptual information from any of the brain's sensory systems to the reward circuit where neurons also receive contextually relevant projections from interoceptive and executive systems. Based on these sources of information, the reward circuit computes a hedonic value that reflects how rewarding or punishing the sensory object is considered to be relative to homeostatic needs and behavioral objectives. The hedonic value produced by the appreciation event takes the form of an affective response somewhere on the pleasure-displeasure continuum. Thus, in contrast to Makin's portrayal of aesthetic appreciation, neuroscientific evidence does *not* confirm a simple model where positive or negative emotional responses are triggered by sensory stimuli. Rather, currently available evidence reveals aesthetic preferences to be flexible outcomes of a complex computational chain of processing steps that involve several different neurobiological systems, all of which project information back and forth while appreciation unfolds in a situational context.

Where does this neuroscientific evidence leave the assumptions built into Makin and others' critique of Empirical Aesthetics? As is probably already clear, neither the assumption that proper aesthetic responses involve special intense emotional states, not the assumption that they are driven by object properties, fit well with it. It is worth examining this discrepancy in greater detail.

Emotional responses in aesthetic appreciation

The key issue raised by Makin and other critics is the charge that Empirical Aesthetics, as currently practiced, is not actually studying the experiential qualities that define aesthetic experience. Aesthetic experiences, in Makin and others' view, consist of "intense hot emotions", not merely "cold preferences". What does the neuroscientific evidence tell us about the possible emotional response inherent to aesthetic appreciation?

As already discussed, liking responses to sensory stimuli—do I like or dislike this object?—are *generated* by neural processes located in the reward circuit. Empirical evidence shows that manipulation of neurons located in structures like nucleus accumbens, ventral pallidum, and the orbitofrontal cortex, affects liking responses, even when sensory information remains unchanged (Smith, Mahler, Peciña & Berridge, 2010; Castro, Terry & Berridge, 2017). Blocking mu-opioid receptors in this system with opioid antagonists, such as naltrexone or naloxone, strongly attenuates experienced pleasure for, and preference responses to, a host of sensory objects, including food and music (Yeomans & Gray, 1996; Fantino, Hosotte, & Apfelbaum, 1986; Mallik, Chandra, & Levitin, 2017). In many cases, blocking opioid receptors leads to a generalized reduction in emotional responsiveness (Wardle, Bershad, & de Wit, 2015).

This fact suggests that the basis of aesthetic appreciation is affective tagging of the sensory object being perceived. As with emotions in general (Damasio & Carvalho, 2013; Adolphs & Andler, 2018; Barrett, 2017), we have yet to fully understand the nature of this affective response, but most researchers agree that liking something is associated with some form of pleasure response, whereas disliking is associated with forms of displeasure, in extreme cases even states of disgust. Not surprisingly, liking and disliking reports are associated with changes to physiological and somatic states, a hallmark of the functional role of emotions (Adolphs & Andler, 2018). For example, studies consistently find different preferences for sensory objects to correlates with variation in heart rate, pulse, arousal, as well as endocrinological function (Salimpoor et al., 2009; Skov, 2019b). How much a sensory object is liked and disliked also influences behavioral responses toward it, including how motivated one is to either work to procure or avoid the object, again a defining feature of emotional processes (Berridge, 2018; Rangel, Camerer & Montague, 2008).

Crucially, experimental evidence makes it clear that assessing to what degree a sensory object is liked or disliked is not equivalent to constructing simple, conscious feelings. Rather, sensory valuation intersects with, and modulates, a host of cognitive, physiological and somatic systems. Thus, far from being experiential "endpoints", sensory preferences sit atop a multitude of non-conscious emotional processes triggered during aesthetic appreciation events—what Damasio and Cavalho (2013) refer to as “action programs”[2]. To disregard this is to disregard the functional role sensory values play within the larger context of human brain function. The biological purpose of aesthetic appreciation is *not* to produce self-contained feelings for the objects we see, hear, or taste, but to assess how rewarding or punishing interaction with these objects is for the organism. For instance, will eating a particular food item provide molecules necessary for maintaining physiological parameters crucial to survival? Or will it allow the entry of pathogens or other pernicious agents? Aesthetic appreciation attempts to answer such questions by “rewarding” the first type of behavior with positive hedonic responses (liking), and “punishing” the latter with negative hedonic responses (disliking/disgust) (Swanson, 2000; Berridge, 2004; Rossi & Stuber, 2016).

Because appreciation events—assigning an affective or hedonic value to a sensory input—unfold as a function of a fundamental reward-behavior cycle (Berridge & Kringelbach, 2015; Kringelbach & Berridge, 2017), they really encompass a number of dissociable value mechanisms. For instance, parts of the appreciation event involve value mechanisms that specifically signal expected reward value, helping the organism prompt goal-directed behavior (Alcaro, Huber & Panksepp, 2007; Berridge, Robinson & Aldridge, 2009; Knutson & Karmakar, 2014; Knutson & Genevsky, 2018). Other value mechanisms compute and implement reward outcomes through integration of both expected reward signals and contextual information (Kringelbach, 2005; Grabenhorst & Rolls, 2011; Rolls, 2016; Knutson & Genevsky, 2018), thus producing value information tailored specifically to ongoing situational demands. A third set of reward processes transform value signals into choice comparisons, allowing the organism to decide between behavioral options when different options compete for attention (Padoa-Schioppa & Assad, 2006; Rangel & Hare, 2010; Rangel, Camerer, & Montague, 2008; O’Doherty, Cockburn, & Pauli, 2017). This diverse set of value mechanisms, including others not discussed here, shows that the affective machinery for hedonic tagging of sensory inputs did not evolve to produce certain phenomenological experiences, but to participate in the regulation of behavioral action. Furthermore, it also shows that to conceive the affective processing associated

[2] Damasio and Carvalho describe action programs as “innate, programmed physiological actions aimed at addressing the detected changes [to the internal environment of the organism] and thereby maintaining or restoring homeostatic balance” (Damasio & Carvalho, 2013, p. 144).

with sensory valuation in terms of a simple emotional state underlying preference "outputs" is profoundly misleading.

Where does this leave us with regard to Makin's view of aesthetic experience as defined by the feeling of "hot emotions"? Makin does not specify what these hot emotions are: he does not indicate the psychological or neurobiological processes that initiate, maintain, regulate, or end them. From his discussion we can infer that they must take the form of certain conscious feelings: emotions with a special phenomenological quality that we feel when we appreciate objects with certain features. We can perhaps distill this view into three principles: (*1*) Aesthetic experiences—in Makin and others' conception—embody specific conscious feelings; (*2*) These feelings are unique to aesthetic experiences, and are consequently only elicited by certain stimuli; (*3*) Their nature is of such a disposition that lab experiments cannot grasp them, at least with the psychophysical methods commonly used in empirical aesthetics (Carbon, 2018, 2019; Muth et al., 2019). As our examination of experimental inquiry into the neurobiology of sensory appreciation shows, empirical evidence points to a very different nature. Specifically:

> (*a*) The process of assessing the hedonic value of a sensory object should not be viewed as the handmaiden of creating conscious feelings, but as an evaluative mechanism producing emotional programs signaling the motivational value of the object being valued relative to the homeostatic state and behavioral goal-setting of the organism. Conscious representation of these emotional programs in the form of feelings is a byproduct of the more fundamental neurobiological changes taking place, but far from the most important aspect of the phenomenon of sensory valuation.
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> (*b*) The hedonic value signals produced by an appreciation event is common to all of our sensory experiences (and thus sensory objects belonging to different ontological categories). Hence, there is currently no experimental evidence that supports the idea that some object properties, in contrast to others, provoke special feelings when we appreciate them.
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> (*c*) Not only can affective states associated with hedonic values very easily be elicited during experimental tasks, they are also routinely being examined in neuroimaging studies and other experimental paradigms. Indeed, the very idea

that humans in some circumstances can assess the aesthetic value of an object *without* invoking affective brain states and emotional action programs—as suggested by Makin's notion of "cold preferences"—is a misnomer that contradicts what we know about the neurobiology of reward and preference in general, and of aesthetic appreciation in particular.

Hedonic values are not (only) object derived

Makin's second charge, his "Gestalt nightmare", invokes another prevalent assumption, namely that aesthetic values are determined primarily, if not solely, by the perceptual information received from the sensory stimulus (Skov, 2019a). How does this assumption fare when confronted with empirical evidence? Not well. If anything, it is an assumption that is based on an outdated and over-simplified model of perception. If we assume that aesthetic values are the result of "stimulus-preference laws", the brain's representation of the stimulus must be both faithful and reflexive, driven by bottom-up projections from node to node in a perceptual network (say from receptors in the retina, to LGN, to V1, to V2, to V4, and so on). When perceptual processing has determined what stimulus properties are being encountered, other systems, including the reward circuit, can respond to this information. However, this model of perception—sometimes referred to as "pure vision" (Churchland, Ramachandran & Sejnowski, 1994) or "naïve realism" (Varela, Thompson & Rosch, 1991)—does not adequately explain how sensory information is processed. The evidence shows that perception is not a passive and automatic recording of an object's properties. Rather, perceptual systems predict what information is to be expected, based on previous experience, knowledge, task demands, and context, and use these predictions to influence how sensory information is processed (e.g., Bar, 2004; Murray, Schrater, & Kesten, 2004; Olivia & Torralba, 2007; Alink et al., 2010; Engel et al., 2013; Egner, Monti, & Summerfield, 2010). Thus, at every node in a perceptual network, even at the earliest stages, activity is modulated by projections from other systems, including top-down executive networks. Consequently, perceptual systems attend to, and allocate computational resources to, different aspects of the available sensory information from situation to situation. For an example of how this happens, in a recent fMRI experiment Hjortkjær and colleagues had subjects categorize the same set of simple sounds either with respect to what action or what material they represent (Hjortkjær et al., 2018). Multivariate analysis revealed that in these two task contexts *the same* auditory stimulus is represented by different patterns of activity, even in early auditory cortex (Figure 4), a fact that can be attributed to the auditory system attending to different aspects of its spectral and temporal cues during the two categorization tasks (Hjortkjær & McAdams, 2016).

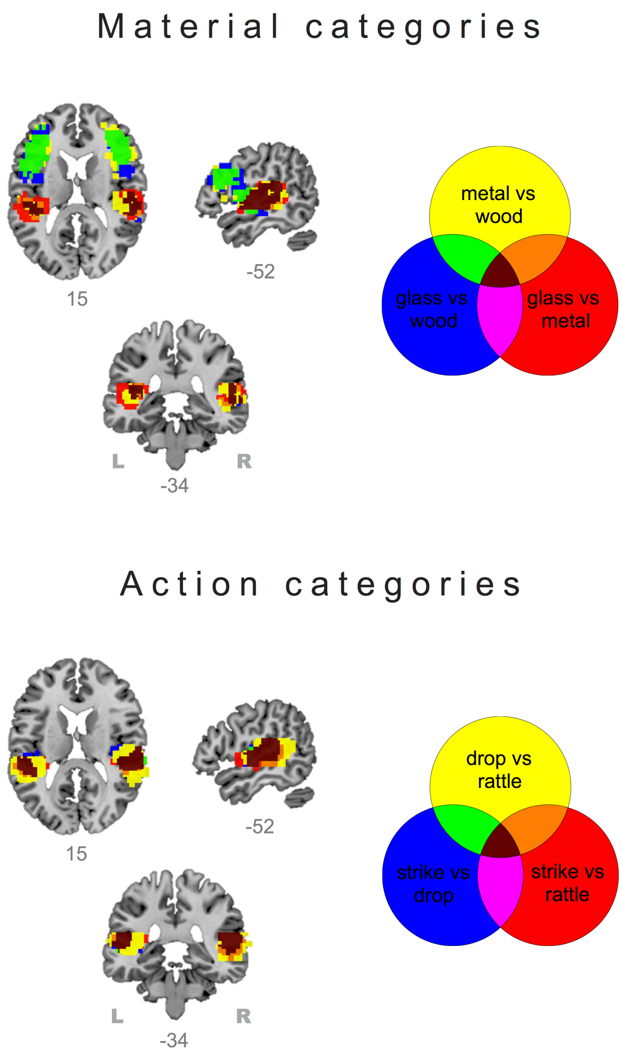

Figure 4. Example of how task demands modulate perceptual representation. Identical sounds were categorized in two different task contexts, either as actions (below) or materials (above). Group-level discriminative maps obtained with a multivoxel classification searchlight demonstrate how cortical regions involved in auditory representation discriminate between different combinations of action and material categories during these two task events ($p<0.05$, FWE corrected). Figure reprinted from Hjortkjær et al. (2018), under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/).

The discovery of this predictive nature of perception has failed to make an impact on research into aesthetic appreciation. Instead, the assumption inherent to Makin's argument, that aesthetic values arise as responses to "pure" perceptual representations of the stimulus being perceived, is widespread. It would not be unfair to characterize most of Empirical Aesthetics research as occupied with plotting aesthetic judgments *to* changing object manipulations, ignoring the way circumstances related to the assessment process itself influence how stimulus information is processed (Skov, 2019a). Yet, there is now abundant evidence that processes related to interoceptive signaling, homeostatic state, expectations, decision-making, and task demands, all modulate the way the *identical* stimuli are being represented during appreciation events. At least three lines of research demonstrate that the brain does not merely extract perceptual information from a sensory object and assign a hedonic value to it.

(*1*) The first example comes from studies of the effect of satiation on hedonic valuation. Neurons in the reward circuit are highly affected by projections from chemosensory receptors located in various internal organs, via brainstem and hypothalamic structures (Saper, Shou, & Elmquist, 2002; Cassidy & Tong, 2017; Zimmerman, Leib, & Knight, 2017; Rossi & Stuber, 2017). This regulatory arrangement calibrates ingestion of food and drink to match the physiological needs of the organism. In essence, the state of molecules necessary for energy metabolism is signaled to the reward circuit such that foraging for, and intake of, required nutrients, etc., are promoted when states are low, and inhibited when high. In consequence, foodstuff becomes increasingly rewarding when hunger is high, and increasingly aversive when satiety is high (Rolls, 2005; Rolls, 2016; Coppin & Sander, 2012). This sensitivity to variations in homeostasis changes how neurons in the reward system fire for a given tastant. Neural activity in nucleus accumbens, pallidum, amygdala, or orbitofrontal cortex, vary dependent upon levels of deprivation or satiation (Small et al., 2001; Kringelbach et al., 2003; Führer, Zysset, & Stumvoll, 2008; Siep et al., 2009; Katsuura, Heckmann, Taha, 2011; Thomas et al., 2015). The result is fluctuations in experienced hedonic value. These fluctuations, prompted by changes in homeostatic state, can make a "sweet" object such as chocolate taste disgusting (when eaten to satiety), or a "noxious" object such as salt taste pleasurable, for instance when ingested in a sodium depleted stated (Tindell et al., 2006). In each circumstance an identical percept is represented differently, and assigned differently valenced hedonic values, to reflect its importance to the organism relative to the organism's physiological needs.

(*2*) The second example is derived from research on the role of expectations in the formation of hedonic values for sensory objects. Expectations emerge from a range of different conditions, some related to how perceptually expected a stimulus is to the organism (Herry et al., 2007; Ramsøy et al., 2012), others to the individual knowledge associated with the stimulus (Huron, 2006), or expectations generated from previous experiences (Summerfield & de Lange, 2014). The specific line of inquiry we will highlight here is often referred to as the framing effect (Okamoto & Dan, 2013). Framing is a catchall term for a number of different ways whereby object-extrinsic cues and information can bias the way a sensory object is processed and valuated. Thus, the framing effect demonstrates another way whereby a stimulus may lead to different neural representations during appreciation events, this time because preceding cues and information alter the expectations it is met with by the organism assessing its value.

A range of different cues of types of information can work as frames. Semantic labels, naming, titles, or information about providence, origin, and price, will all influence hedonic valuation of an object, but so will packaging design, images, brands, colors, or other forms of sensory cues (see Krishna, 2012; Okamoto & Dan, 2013; Fernqvist & Ekelund, 2014; Piqueras-Fiszman & Spence, 2018 for reviews of the literature). All sensory modalities are susceptible to the framing effect, just as any object category imaginable has been found vulnerable: food, odors, products, cultural artifacts, faces, paintings, music, etc.

The change in expectations engendered by exposure to frame information modulates activity both in the perceptual system and in the reward circuit (e.g., McClure et al., 2004; Plassmann et al., 2008; Kirk et al., 2009). The details of this process still need to be fleshed out. But it has been suggested that the frame information shifts attention to elements in the objects aligned with, or relevant to, the frame, an idea that seems in accordance with eye-tracking experiments measuring shifts in visual attention (DeAngelus & Pelz, 2009; Castelhano, Mack, & Henderson, 2009; Park, Yun, & Jeong, 2015), or priming studies (Bargh, 2006; Kouider & Dehaene, 2007), and obviously conforms to the general notion of predictive perception discussed above. As for the reward circuit, neuroscientists have suggested that top-down signals regulate activity in reward structures such that value signals are either made to conform to, or contrast with, the frame information (De Martino, Camerer & Adolphs, 2010; Schmidt et al., 2017; Tymula & Plassmann, 2016), an idea that chimes with the observation that people are more or less susceptible to framing, with people less prone seen to recruit increased regulatory activity in the executive network (Aydogan et al., 2017).

Together, satiation and the framing effect demonstrate that both endogenous and external conditions influence how the brain represents an object during appreciation events. More specifically, they show that hedonic valuation is far from determined by the sensory object's perceptual features. Rather, aesthetic appreciation takes into account a host of contextual factors that modulate neural activity in both perceptual systems and the reward circuit, leading identical percepts to be represented in different manners in different circumstances.

(*3*) Even more problematic for the idea that preferences are derived automatically and directly from object properties is the highly robust finding that perceptual representation is modulated by projections from the reward circuit. In fact, Empirical Aesthetics has contributed important studies that help us understand how the subjective hedonic value assigned to an object, or objects in a perceptual scene, influence what aspects of it we attend to and allot computational resources to processing. For example, numerous studies have found that objects deemed more pleasurable are attended to more than less desirable objects (e.g., di Pelligrino, Margarelli, & Mengarelli, 2011; Valuch et al., 2015; Leder, Mitrovic, & Goller, 2016), even when they are experienced subliminally (McDonald, Slater, & Longmore, 2008; Sui & Liu, 2009; Hung, Nieh, & Hsieh, 2016). Thus, hedonic value helps exploration when an organism is confronted with a crowded perceptual environment, biasing its computational resources towards the parts considered important, either because of its putatively positive or negative consequences for the organism (Chen, Liu, & Nakabayashi, 2016; Li, Oksama, & Hyönä, 2016; Ritchie, Palermo, & Rhodes, 2017). Some studies even suggest that hedonic value impacts perceptual mechanisms promoting percepts to conscious awareness, facilitating the recognition of highly pleasurable and unpleasant objects (Ramsøy & Skov, 2014; Marx & Einhäuser, 2015; Nakamura & Kawabata, 2018).

At the neural level, reward and punishment expectations, based on the reward history of an object, profoundly alter neural activity in perceptual structures, even in the earliest parts where projections from the thalamus terminates (e.g., Hikosaka, Nakamura, & Nakahara, 2006; Serences, 2008; Summerfield & de Lange, 2014). Electrophysiological studies of neural populations in V1 or V4 have found that, as a visual cue becomes associated with reward value, activity in a subset of neurons change firing to reflect value attribution (Shuler & Bear, 2006; Gavornik et al., 2009; Baruni, Lau & Salzman, 2015; Zold & Shuler, 2015; Goltstein, Meijer & Pennartz, 2018). This modulation of spiking patterns may be regulated by specific projections from forebrain structures to V1 (e.g., Chubykin et al., 2013), although the exact mechanisms controlling the way reward value influences perceptual activity remain elusive. In any case, it has become clear that primary visual cortex is not an insulated feature detector, or that sensory processing follows strictly step-wise projections, where hedonic value is only assigned to an object after initial, object derived, perceptual processing has taken place.

The assumption that aesthetic preferences should be related to stimulus properties by universal laws massively underestimates how intimately perception and reward processing are intertwined, and the way valuation itself affects perceptual representation. This is a crucial flaw, given that the vast majority of behavioral studies on aesthetic appreciation are built around two main components, (*a*) eliciting preference ratings and (*b*) manipulating objects, often tacitly ignoring the neurobiological black box that "mediates" between the latter and the former (Figure 2). Moreover, this way of organizing experiments can impose an erroneous conception of how stimuli and aesthetic judgments are related: *first* you are exposed to a stimulus, *then* you compute its features, and *finally,* as an end-point, you assess your emotional response to these. This simplistic model is far from how appreciation of a sensory object's hedonic value actually unfolds in real life situations. As the evidence discussed above shows, information flows back and forth between structures, setting up predictions, integrating interoceptive and cognitive information, prompting physiological actions, modulating perceptual activity to reflect salience and relevance of certain parts of the stimulus, all as an on-going, evolving temporal event with no clear start and end.

Is "Aesthetic experience" special?

Makin's conception of an aesthetic experience implies that "aesthetic" perception and emotion have special properties that distinguish them from "non-aesthetic" kinds of perception and emotion. For instance, aesthetic emotions are thought to have certain phenomenological and physiological qualities ("hot", "intense"), while aesthetic perception is assumed to entail the recognition of certain object properties, projecting this information to the emotional processes tasked with producing the particular aesthetic responses. Crucial to this argument is the assumption that these unique "aesthetic" processes can be distinguished from other non-aesthetic perceptual and emotional processes.

As we have noted, Makin is far from alone in entertaining these ideas. Indeed, attributing special traits and qualities to experiences classified as "aesthetic" can be viewed as one of the fundamental myths of Empirical Aesthetics. We have shown that when is comes to the role played by perceptual and emotional processes in appreciation of sensory objects, this myth is contradicted by empirical findings. In fact, a vast body of experimental research has revealed that the affective processes that generate hedonic values for sensory information—physiological, behavioral, phenomenological—are not unique to certain classes of objects or appreciation situations. Rather, the human brain seems to have evolved *one* general system for assessing the hedonic value of many kinds of sensory objects, including human cultural creations. Critically, this neural system is regulated by the very basic adaptive concern of assessing a sensory stimulus' potential positive and negative consequences for the organism, and is not set up to evoke special, self-contained hedonic experiences. As a consequence of this functional organization, aesthetic appreciation events cannot be said to produce hedonic values by reacting *to* sensory inputs. They, instead, compute how valuable a stimulus is relative to the organism's homeostatic needs, expectations, and behavioral concerns.

Thus, an inspection of what is known empirically about the psychological and neurobiological mechanisms thought to underlie sensory valuation does not support the notion that there is a special "aesthetic" version hereof, characterized by a unique set of functional process, or neurophysiological properties. But this is exactly the mirage that looms behind Makin's (2017) argument, as well as much other historical and current thinking in empirical aesthetics: A deep-seated conviction that such special psychological and neurobiological processes exist, defining a unique category of experience—the "aesthetic" experience. Empirical Aesthetics has been haunted by this category, generating a flurry of hypotheses and theories as to what makes it unique and distinct. At this point, with knowledge on how the human brain works questioning the myth of aesthetic specialness, we issue a challenge of our own: If "aesthetic" is taken to signify a special domain—special experiences, emotional states, and perceptual processing, etc.—proponents of this idea must spell out what this specialness consists of—in concrete terms. As a field, we must work together to go beyond theories and ideas that are primarily based upon unfounded assumptions and personal intuitions. We note three issues in particular need of clarity.

1. "Aesthetic" objects. The assumption that aesthetic experiences are special is very much related to the idea that certain objects are "aesthetic"—different in some respect from non-aesthetic objects. Indeed, the reason empirical aesthetics has adopted the tacit assumption that aesthetic experiences are characterized by special psychological and neurobiological processes seems very much to be a commonly adopted conviction that "aesthetic" objects possess special properties. But what defines this putative object category? Many theories have attempted to solve it by suggesting features that describe the specialness of art objects, often hypothesizing these special features to have associated psychological effects. For example, Russian Formalism and structural semiotics suggested that, while literature and other forms of linguistic expressions employ the same language system, they embody different functions. Literary utterances are distinguished by the use of certain language forms ("devices" in the Formalist parlance), and organization of the parts also used by other types of expressions in specific ways (i.e., foregrounding). As hypothesized by Viktor Shklovsky, experiencing such devices leads to "defamiliarization", experiencing the well known in a novel way (Erlich, 1981).

Yet, unfortunately, none of these theories have been able to withstand counterexamples. For every special “function”, “device”, trait, or other type of property, proposed to distinguish an art (or aesthetic) object from other kinds of objects it has always proved possible to find it instantiated by non-art objects. Indeed, in wake of Duchamp’s ready-mades, it has become clear to philosophers that trying to define what art is by listing the essential parts that ontologically constitutes an object as art is a fool’s game (Danto, 1983). Perhaps no object is inherently an art object. This observation should not only matter to art philosophers. It matters also to psychologists who insist on studying “aesthetic” experiences as special experiences. If we cannot define with precision what perceptual features specifically constitute an aesthetic object, the assumption that such objects exist—and that the brain uses specific psychological and neurobiological processes to represent them—becomes a circular fallacy. What, then, characterizes an aesthetic stimulus? More than a circular definition is needed.

2. “Aesthetic” mechanisms. There is little that suggests the reward circuit employs different value signals—and related affective processes—for different sensory modalities or object categories. This is an example of a recurring problem in Empirical Aesthetics: that, when studying the neurobiological mechanisms associated with putatively “aesthetic” experiential states, we find that the mechanisms we unearth are shared with a range of other states we do not consider aesthetic in nature. If one inspects the most authoritative models the fields has produced, summarizing the psychological and neurobiological processes thought to be involved in art and aesthetic experiences (Leder et al., 2004; Chatterjee, 2003; Chatterjee & Vartanian, 2014, 2016), in reality none of these processes are unique to “aesthetic” experiences. “Perceptual analysis”, “memory integration”, “conceptual associations”, “meaning making”, “reward”, “emotion”, or “motor action”, are all functions involved in representing non-aesthetic and non-art objects. So what makes a neurobiological mechanism count as aesthetic? As a field we need a much more concise conception of how “aesthetic” psychology and neuroscience relate to non-aesthetic research programs.

3. “Aesthetic” animals. Finally, attribution of a special quality to the notions of art and aesthetics has played a fundamental role in forming our self-image as an animal set apart from other species. For most of the 20th century the emergence of anatomically modern humans, *Homo sapiens*, was thought to be intrinsically associated with the appearance of art behavior in the natural record. Not only was art thought to be the province solely of the human species, but even for prominent biologists it also counted as one of our species’ defining traits (Dobzhansky 1962; Washburn, 1970). Human art behavior was believed to be the result of a “cognitive revolution” (Klein, 2002), novel abilities acquired through gradual tinkering with the hominin nervous systems. Thus, in scientific disciplines such as archeology, paleontology, and evolutionary psychology, art has been seen as unique forms of artifacts and behavior, just as the brain of *Homo sapiens* was assumed to contain special traits that allowed us, alone amongst all known biological organism, to create these unique entities.

As with the evidence for special aesthetic experiences, none of these beliefs and assumptions has fared well as more and more archeological, paleontological, and comparative research has accumulated. Not only has it been hard for psychologists and neuroscientists to pinpoint processes that are specifically dedicated to “art” or “aesthetic” behavior—as discussed here—but many of the neurobiological mechanisms we use to use to experience “aesthetic” objects appear to have deep evolutionary roots. For instance, many of the anatomical structures, and neurochemical processes, involved in constructing hedonic values are found in most mammalian brains. Some of the specific functions that determine human appreciation, including the framing effect we reviewed above, are found even in distant evolutionary ancestors (Lakshminarayanam, Chen, & Santos, 2010; Santos & Rosati, 2015). Moreover, recent archeological findings cast doubt on the idea that *Homo sapiens* has been the only, or indeed the first, species to invent art behavior (Hoffman et al., 2018). The notions that art is special, and that we have evolved special cognitive and emotional abilities to enable this special type of behavior, are not as well supported as they were once thought to be.

The conviction that aesthetic objects are special, and that the aesthetic experiences they give rise to also are special too, rooted in special psychological and neurobiological processes, runs through aesthetic science and thinking as a deep, unexamined current. It is an idea that holds enormous sway in the way experiments are conceived, and theories constructed, in Empirical Aesthetics. Yet, as we have argued, there is little that, at the end of the day, actually supports this deep-seated conviction (see also Skov & Nadal, 2018). It is *assumed* to be true that art is special, that some objects (and the experiences they engender) have an intrinsic and distinctive aesthetic nature, but the scientific effort to identify these defining constitutive elements have so far come up short. What shall we, as a field, do with this contradiction between assumptions and empirical evidence?

To us the solution is not to abandon Empirical Aesthetics as a scientific field. We do not even believe that the failure to make good on its most cherished assumptions means Empirical Aesthetics has not contributed anything to our understanding of psychology or neuroscience. In fact, as attested by our review of research into the computation of hedonic valuation, there has been tremendous progress on certain topics falling under the auspices of Empirical Aesthetics. We do believe, however, that Empirical Aesthetics must become mindful of the many speculative assumptions that inform ideas that continue to prevail, and the way they lead research astray. What we call for is a psychological and neuroscientific study of how the human brain instantiates art behavior and the hedonic appreciation of sensory objects, without this study being bogged down by unsupported assumptions that have, by now, been discounted. It is time to reclaim "aesthetic" as the description of a set of general, and ordinary, neurobiological phenomena.

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