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Neuroaesthetics and landscape appreciation

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ABSTRACT

This article is a critical review of some aspects of theories of landscape appreciation in the light of the findings of neuroscience. Four propositions that have been employed in appraisal theory, and which can potentially be informed by these findings, are selected. An introduction is given on the scope of neuroscience and its models of aesthetic experience followed by reviews of objectivism, preferences from adaptation, the objective assessor, and direct perception. The conclusions of neuroaestheticians, even in their preliminary present state, offer the potential for clarifying these, and perhaps further, aspects of the theory of landscape assessment.

KEYWORDS

Neuroaesthetics; landscape theory; environmental aesthetics; evolutionary aesthetics; landscape evaluation; landscape assessment; landscape appreciation; perception; aesthetic experience; natural beauty

Introduction

Reviews of the state of landscape assessment invariably emphasise the range of possible approaches and methods. Perhaps this is not surprising in view of the several lines of enquiry on 'landscape value' (a term that has recently broadened to include non-aesthetic forms of value, and the meaning of which is now generally conveyed by 'landscape aesthetics'). These approaches were not just the neo-Platonic quantitative methods of the 1970s, but evolutionary aesthetics from biologists, ecological psychology from sociologists, ecological aesthetics from deep ecology, and environmental aesthetics from philosophers.

Attempts to find common ground have been advocated and attempted, but much contradiction and confusion reigns in the world of landscape appraisal. One thorough review (Ward-Thompson & Travlou, 2009, p. 31) of practice stressed the desirability of sound theory as the basis of the design and method of assessment studies. It went on to observe that:

It is noticeable that many practical landscape assessment tools and guides are only poorly related to aesthetic and perception theory. This is a weakness that should be remedied to ensure landscape planning policies are not founded in assumptions about the mechanisms behind environmental perception and response that lack any empirical foundation.

Whilst differences between approaches may be understandable for ontological reasons, in that there are different conceptions of the subject across disciplines and cultures, it must also be asked whether the underlying assumptions of each are soundly based, or just ideological preferences. If the latter, they may be queried and perhaps some confusion can be dispelled.

Within the last decade the subfield of 'neuroaesthetics' has emerged. The implications of neurological experiments carried out in the late 2000s and early 2010s have been digested, and there is now a growing consensus from that community on matters of perception and on neurological mechanisms for beauty.

Neuroaesthetics has hitherto developed mainly in relation to fine art, though also has the potential to contribute to the fundamentals of landscape appreciation, especially in explanations

of the processes of perception and of how it is that the human can sense beauty. Over other matters, such as the making of aesthetic judgements and other high-level functions of the mind, it has less scope.

This paper, in pursuit of more robust theoretical foundations, suggests how neuroaesthetics can clarify some points. First, it identifies some propositions amongst theories of landscape appreciation that remain contentious. Neuroaesthetics is then examined as a topic so that its scope and potential can be appreciated. Arising from these two strands, a short list is made of the topics to be examined in more detail.

Theories of landscape appreciation

A short and selective account of landscape aesthetics is here given in order to explain different approaches and identify some theoretical underpinnings that could be tested. Following the formalist models of the 1970s, several other approaches were followed. Each line of enquiry has a distinctive approach, and each has different implications for landscape assessment.

The mathematical modelling in the 1970s was premised on three particular propositions, (1) that beauty is inherent in the landscape, (2) that humans are automatic observers of this beauty, and (3) that trained professionals could accurately provide objective evaluations. By about 1980 serious misgivings were being expressed about the shaky justifications for these propositions and the assumption that there could be consensus around professionals' evaluations. This modelling was generally abandoned in the 1980s in favour of 'multi-criteria judgements', and within a few years Landscape Character assessment was being developed. Although helpful in many ways this method was based on geographical and archaeological analysis and was not designed for, and does not offer, insights on the question of public or professional preferences.

Proposition (2), regarding the automatic observation of beauty, was subsequently provided with an additional explanation from evolutionary theory. Preferences for landscapes were thought to be 'hard-wired' into the human brain through adaptation. This hypothesis was first promoted through Jay Appleton's 'Habitat Theory' and 'Prospect-Refuge Theory' based on his reading of animal behaviourists like Konrad Lorenz and Desmond Morris (Appleton, 1975, pp. 65 & 69–71). Hunting habitats that had enabled the human success story came to be appreciated, he wrote, and as the dependence on hunting declined, the appreciations did not disappear but sublimated into the perception of beauty. These assertions were noted by Stephen Bourassa (1991, pp. 1–2) as bypassing many of the issues in landscape aesthetics and being uninformed by its literature, but they encouraged Gordon Orians who promoted his own 'savannah hypothesis' (Orians & Heerwagen, 1992, p. 556; Balling & Falk, 1982).

The psychologists Stephen and Rachel Kaplan undertook studies for the United States Forestry Service from 1970 on public preferences for landscapes. Their analysis was based on conventional information-processing, and allowed them to nominate the qualities of landscapes that were most enjoyed (Kaplan & Kaplan, 1989, p. 63). Perhaps feeling that their empirical findings would benefit from being allied to current theoretical fashion, they somewhat paradoxically declared for evolutionary aesthetics and also for the hypothesis of 'ecological perception' being promoted by James Gibson (1979). This proposition (4) was that human perception of the environment was 'direct', without cognitive thought intervening, and that the environment was appreciated for the 'affordances' it offered.

At that time there was a tradition, in which Yi-Fu Tuan and David Lowenthal were prominent, of descriptive landscape appreciation by cultural geographers that concentrated not so much on what was out there but on how places had meaning and thereby stirred emotions. The landscapes of nature were thus just the trigger for the much more interesting landscapes of the mind. Predominantly the discussion in humanist aesthetics has concerned the swirl of memories, associations, imagination and emotions that will clarify in the formation of a judgement assembled in the light of preparedness, expertise and social context, and may be flexible over time. Such

counterarguments to Proposition (2) were sometimes pungently expressed. Alarmed by the popularisation of the evolutionary arguments by Stephen Pinker (1997), some of those who opposed them devised an anthology of criticism (Rose & Rose, 2000) containing chapters by Stephen Jay Gould, Tim Ingold and Charles Jenks. There were also popular works that presented landscape as cultural experience, for example, by Schama (1995), Roger (1997), and continuing with Macfarlane (2012).

The two recent decades of environmental aesthetics by philosophers have re-run some of the arguments above in picking over the definition of 'the aesthetic attitude' by the art critic, Stolnitz (1960, pp. 35, 390), as a 'disinterested and sympathetic attention to and contemplation of any object of awareness whatever, for its own sake alone'. Concerning Proposition (1), that beauty is 'out there', he contrasted 'objectivism' and 'subjectivism'. That debate was continued in slightly altered form by Allen Carlson (2000, p. 6), who argued that knowledge of the landscape itself was the wellspring of informed appreciation; others opposed what they called his 'cognitive' approach, usually coupling their position with adherence to Proposition (4), 'direct' or 'non-cognitive' perception. Brady (2003, pp. 206–11) re-invoked Proposition (3) that 'disinterested' assessors could exclude mere preference and provide objective assessments.

The scope of neuroaesthetics

In introducing neuroaesthetics, it is important first to grasp the nature of the topic, so that its scope and application may be understood. It is a subfield within cognitive neuroscience that is concerned with understanding the mental bases of aesthetic experiences, whether they be in landscape, art, music, dance, mathematics or any activity that can give rise to aesthetic judgement. The term 'neuroaesthetics' was coined by Semir Zeki, of University College London, who viewed it as 'a neurology of aesthetics' that provides 'an understanding of the biological basis of aesthetic experience' (Zeki, 1999, p. 2).

The primary aim in neuroscience has been to map the brain, to discover the functions of all its many areas. Access to functional magnetic resonance imaging (fMRI) and other types of scanning has allowed neural activation within the brain to be detected non-invasively. Although called 'neuroaesthetics', implying work on the brain itself, that branch of the subject remains closely woven together with conventional experimental psychology using questionnaires and noting physiological responses (eye movement, etc.).

This use of scanners gave rise to a wave of neuroscientific studies designed to address aesthetic appreciation from 2004 as it opened the possibility of finding 'neural correlates' to judgements of beauty. These studies included one by Zeki and a colleague. They found that evaluations of paintings as 'ugly' or 'beautiful' tallied with activity in different parts of the medial orbitofrontal cortex (OFC), an area just above the eyes, and other parts of the brain, and were thus able to suggest areas involved in deciding on 'beautiful', as distinct from 'ugly' (Kawabata & Zeki, 2004).

The number of researchers and theoreticians interested in neuroaesthetics expanded greatly from that time, resulting in many articles and a slew of books on the subject. First after Zeki's *Splendours and Miseries of the Brain* (Zeki, 2009) was Gabrielle Starr, who specialised in eighteenth-century British literature and aesthetics, but who had taken part in neurological experiments by Edward Vessel, her colleague at New York University. They found that when particularly moving artwork was shown to participants, a network in the frontal region of the brain was activated. They went on to suggest that aesthetic experience involves the combining of sensory and emotional reactions, and that its heightening was a product of the emotional relevance to the individual. That could explain the great variability between individual preferences for art images (Vessel et al., 2012). This exercise, together with her considerable knowledge on her specialist subject, enabled her to compose *Feeling Beauty* (Starr, 2013).

Meanwhile Anjan Chatterjee had been preparing *The Aesthetic Brain* (2014), a tripartite examination of the concepts of beauty, pleasure and art, informed by his knowledge of neuroscientific work

undertaken by himself and others. The same year an anthology of ten pieces came out as *An Introduction to Neuroaesthetics* (2014), edited by Jon Luring from the neuroscience department of the University of Copenhagen. The following year Oxford University Press brought out another anthology of 25 papers as *Art, Aesthetics, and the Brain* (2015), edited by Joseph P. Huston of the University of Dusseldorf, Marcos Nadal of the University of the Balearic Islands and others. These were followed by *The Arts and The Brain* (Christiansen & Gomila, 2018), edited by Julia Christensen, a psychologist from City University, London, and Antoni Gomila, also from the Balearic Islands, and which ranged widely over bioaesthetics, cultural inheritance, creativity, emotional responses, music, dance, and many other topics.

This cascade of books, papers and blogs was weighted towards the aesthetic experience of artworks, and the presumed evolved preferences for faces and human beauty. Almost no attention was given to landscape appreciation, or gardens and designed landscapes. It would be mistaken to conclude that neuroaesthetics does not apply to landscape, though, as many general points about brain processes are worth noting. The origin of the field as specifically the counterpart to art appreciation, and also the practical difficulties of devising neurological experiments in the outdoors, have perhaps militated against its application to landscape to date.

Art critics that were uncomfortable with, as they saw it, the intrusion of science into what should be humanist study reacted against the more ambitious claims of the scientists. Some psychologists (Conway & Rehding, 2013, p. 4; Roald & K ppe, 2015, p. 21) have agreed that any science is reductionist by nature, and that the appreciation of art is of its phenomenological totality, including its meaning in its historical and social context. Zeki (2012) denied that his discipline was seeking 'explanatory power' for aesthetic judgements:

far from trying to "explain" a work of art or a literary masterpiece, neuroaesthetics only tries to gain insights from them to try and learn something about the brain ... it is not the aim or mission of neuroaesthetics to explain works of art. On the contrary, neuroaesthetics is inspired by works of art and debates in the humanities to learn something about the brain.

Essentially, then, neuroscience was not trying to supplant art history, nor to solve philosophical aesthetic questions. Its practitioners were interested primarily in mapping brain functions and discovering the correlates to external events, and in noting how the differing functions of the brain (the senses, emotions, memory, etc.) would be coordinated in such types of experience.

This dialogue leads to some observations. First, neuroaesthetics can be most helpful in sorting out the confusions amongst the rival theories of perceptual analysis, and in the automatic functions of the brain generally. As one practitioner wrote:

philosophical aesthetics could benefit from cooperation with neuroscience, by ensuring that certain aspects of our aesthetic engagement in the arts can be extracted empirically. That is, neuroscientific findings could then be incorporated in philosophical aesthetics to confirm existing models and theories about art appreciation, as well as in the formation of new models and theories, thus substantiated by empirical data. (Luring, 2014, p. 104)

Second, neuroscience does not pretend to explain the outcomes of brain processes dependant on memory or affect, which are personal to the individual, such as conscious thought, imagination, or aesthetic judgement, even though it may be able to suggest where they take place. One should not expect neuroaesthetics to address matters such as the healing and restorative quality of the landscape as proposed by the Kaplans, or the ideological basis of ecological aesthetics.

Neurological models of the aesthetic experience

There have been numerous neurological experiments on aesthetic preferences, and much theory in trying to make sense of the outcomes. There is an area of the brain (the parahippocampal place area, or PPA) that helps in developing mental maps, for both natural and human-made environments. These could be landscapes, cityscapes, or room interiors (Yue et al., 2007). An adjacent area is part of a mechanism to recover any memories of the scene. One study concluded that the PPA responded

more vigorously to scenes that people said they liked better than others. Seemingly it was coordinating its activity with other areas, including the OFC that deals with pleasure and rewards, implying that this area is involved in both classification and evaluation of scenes.

Unconscious emotions are quickly developed as part of the early stages of sensory processing into our feelings or emotions as the process turns to judgement. These thoughts, both pleasurable and unpleasurable, pass to the base of the limbic region of the brain where they are rewarded (or punished) by the release of chemicals (Chatterjee, 2014, p. 30). However, this is part of a loop, because the memory logs this reward or punishment and its associated circumstances. Hence the capacity to learn is very much part of the reward system. A continuing or fresh neural event, whether via the senses or originating as an idea in the mind, is interpreted and maybe adjusted in the light of memory and understanding to be passed down to the reward centre, which releases chemicals, and so on. Hence memory has a large effect on reward, and reward colours our memories.

Neuroaesthetics cannot help with meanings and judgements, art object by art object—that remains firmly in the sphere of the art critic—but it can seek out the neural networks and the processes that enable human experience. Chatterjee summarises this:

this is what happens when we look at aesthetically pleasing objects. Information comes in from our eyes to the occipital lobes. This information is processed in different parts of the occipital lobe, which interact with our emotions in the limbic areas. When we like what we see, the pleasure or reward centers of our limbic areas are turned on. When we think about the meaning of what we are looking at, the temporal lobes are engaged. When we draw on our personal memories and experiences in aesthetic encounters, the inside of the temporal lobe comes online. As beautiful things engage us and capture our attention and we respond to them, we activate our parietal and frontal lobes (Chatterjee, 2014, p. 30).

For information, the parietal lobe organises the ways we think about space, whilst our frontal lobe prepares us to act in the world and is where our sense of personality comes from.

Chatterjee was the first to offer a general neurological model for aesthetic experience with a simple flow chart. External stimuli act on the areas of vision, which seek to characterise the image and interacted with ‘attention’ and ‘representational domain’. The outputs were ‘emotional response’ and ‘decision’ (Chatterjee, 2003). Before long, Helmut Leder and his colleagues from the Free University in Berlin produced a more complicated chart. The input was processed through ‘perceptual analysis’, ‘implicit memory integration’ and ‘explicit classification’, before engaging expertise, knowledge, interest and taste in ‘cognitive mastering’ and ‘evaluation’ stages. The outputs, ‘aesthetic judgement’ and ‘aesthetic emotion’ emphasised meaning (Leder et al., 2004). Another variant was essentially a combination of these two models (Vartanian & Nadal, 2007).

A summary of this process leading to beauty has been offered thus:

In the brain, the experience of beauty arises from how we process the sensory properties of objects, the meanings we associate with those objects, and the objects’ interactions with our emotions and reward systems. (Chatterjee, 2014, p. 65)

Many aspects of the brain—memory, attention, reward—can be attributed to known neural areas, but this is not so for pleasures, including beauties, which surf along the other waves of emotion: ‘our subjective experience is cobbled together from bits and pieces of the brain that are used to do other things ...’ (Chatterjee, 2014, p. 68). For this reason, a single understanding of ‘beauty’ is impossible:

Beauty is a mongrel. It is a collection of different properties that engage different parts of the brain. Beauty produces different responses and evolved within us for different reasons. Beauty engages our sensations, emotions, and meaning flexibly.

This model for the pleasures may give the impression of the smooth progression of processes towards our judgements, but neuroscientists look at the brain as a generality, not into an individual’s subjective responses. It looks like the involvement of the cognitive functions of the brain (memory, understanding and imagination) makes processing anything but predictable (Chatterjee, 2014,

p. 183). Hence neuroscientists are ready to acknowledge that in any specific case aesthetic judgements can be highly variable person to person:

Aesthetic experiences flexibly engage neural ensembles of sensory, emotional, and cognitive systems. This flexibility built into the ensembles is part of what makes art and aesthetic experiences varied and unpredictable.

The following discussion brings a neuroaesthetics perspective to the four propositions described above.

Objectivism

Is beauty a property of an object, or is it generated in the mind of the subject? The 1970s methods of landscape assessment presumed that it was an inherent quality of the landscape itself, and that the observer was just that (Ramsay, 2017, p. 25; Jacques, 2019, pp. 46–8, 186).

More recently, Emily Brady (2003, pp. 18–9, 22) has seen aesthetic appreciation as the outcome of the intrinsic aesthetic qualities of nature having passed through the human mind:

We bring our experience and aesthetic sensitivity to bear on base properties perceived in the environment, our experience combines with what we perceive, and aesthetic appreciation emerges.

She likened aesthetic judgements to colour judgements in that both, she claimed, are in the same perceptual class. Although acknowledging that a cultural overlay would affect the aesthetic sense, she warned that this ‘should not lead one to assume that aesthetic qualities are subjective projections.’

The feasibility of some form of beauty signal emanating from an object would be denied by the assumptions of modern psychology: beauty is inherently a matter for the observer’s mind. The models of aesthetic experience by Chatterjee and Leder, mentioned above, both commence with the initially meaningless stimuli from the senses, and a person’s or a place’s qualities are assessed thereafter with increasing input from attention, affective evaluation and memory.

Preferences determined by evolved adaptations

Evolutionary aesthetics is neo-Darwinian in flavour, referring either to sexual selection in the case of beauty in faces and bodies, or natural selection with regard to preferred environments (Chatterjee, 2014, pp. 38–9). Many psychologists suppose, in the light of claims for inborn preferences for beauty in faces and body proportions, that there will be such ‘hardwiring’ in the case of places as well.

If it is considered that all human traits and customs are evolved adaptations the experience of beauty in landscape must derive from the visual preferences of *Homo sapiens* which favoured survival and reproductive success. A professor of ornithology from Yale University, Richard Prum (2013), has described ‘standard’ evolutionary aesthetics in these terms, and analysed the artworld in this way. According to him, appreciation of artworks depends on universal human psychological characteristics. However, he acknowledged that in recent history artists have produced works for intellectual reasons, to be judged as ‘art’ rather than by their beauty, and with no advantage or meaning in evolutionary terms. Art has thus become a mix of evolutionary and artistic impulses. He terms this phenomenon ‘co-evolutionary aesthetics’.

Westphal-Fitch and Fitch (2018, pp. 3, 7–8), though regarding the human race as essentially biological in behaviour, had a more nuanced position thus: ‘humans possess culturally coevolved aesthetics, which helps explain the unusual variability of aesthetic domains across human cultures.’ They defined ‘cultural evolution’ as:

the more rapid change that can occur without any changes in gene frequency, often within the span of a single generation, for example, in dialects, fashions, or styles ... in cultural evolution learning underlies information transfer, potentially from any member of the population to another.

In other words, culture is something that changes through learning, not evolutionary adaptation.

For Prum and other evolutionists preferences were seen as a legacy of the long habitation of *Homo sapiens* on the African plains. That assumption is not necessarily valid. First, the climate in Africa was radically affected by the Ice Ages and the gaps between, not necessarily leaving enough time for irreversible adaptation. Second, even if it is true that there are inherited preferences for facial form, the same does not necessarily apply to landscape form. Chatterjee (2014, p. 66) thought that ‘faces and landscapes are very different from each other and are processed in different parts of the brain.’ Third, there is the question of the very wide range of appreciations which we customarily say give us the sensation of ‘beauty’. There are sensual and musical pleasures, and even mathematicians who find beauty in elegant theorems. So pleasures need not be just from satisfying physical appetites; they can be from ideas. One can generalise about the neural network for beauty, but not about what stimulates it.

Chatterjee queried the supposed causal link between usefulness and visual satisfaction:

Why should something useful be regarded as beautiful? And how does that knowledge insert itself into the brain? The argument that something that is useful is also beautiful is too neat and logical ... Evolutionary usefulness accompanies beautiful objects but does not cause their beauty ... (Chatterjee, 2014, p. 30)

Similarly, in his *Introduction to Neuroaesthetics*, Lauring pointed out that the evolutionary case was far from secure:

Hypotheses on the evolution of behaviour in relation to aesthetics and the arts are inherently speculative ... most hypotheses lack empirical support and hence are, at this point, difficult, if not impossible, to verify, let alone capable of meeting the Popperian standard of falsifiability ... It is difficult to demonstrate that aesthetic and “artifying” behaviour actually provided survival and reproductive advantages in Pleistocene times. Moreover, ... correlation with the presence and expression of an underlying gene or gene complex still remains to be shown. (Lauring, 2014, p. 91)

The compulsion amongst evolutionists to characterise every human trait as a consequence of adaptation would appear to be the principal reason for the claims for an evolutionary reason for the experience of beauty. However neurological reasoning does not require an adaptive reason for beauty—it just happens, as with other pleasures, as the reward system carries out its duties when required. One could suggest that aesthetic experience is made possible by the modern human’s greatly increased mental capacities for memory and imagination. There is clearly a huge involvement of these functions in the reward and learning loop, and standardising it with fixed adapted responses would be counterproductive, as that would reduce its flexibility and variety.

One feasible position is that we cannot pin down the pleasures tightly—they are inherently ephemeral; we have a reward system responding to the particular wants and likes of the person concerned at that moment. We must look to within our own cognitive systems for a large part of landscape appreciation.

The objective assessor

The landscape assessment methods of the 1970s, in the desire for ‘normal’ or ‘standard’ responses, went to great pains to iron out variations in judgement arising from subjectivity. The aim was to derive ‘objective’ assessments from qualified and sensitised professionals who could set personal preferences aside (Jacques, 2019, pp. 43–5). In this century Brady (2003, p. 191) has opened the matter once more: ‘In this chapter I set out to establish the objectivity of aesthetic judgements of nature’.

Like the earlier theorists, Brady (2003, p. 192) seeks to suppress the variability of assessments by using only ‘competent’ assessors. They would be able to overcome factors like familiarity and personal preference and follow a standard of ‘practical objectivity’. If the variability and unpredictability of judgement emphasised by modern neuroaesthetics is accepted, it is difficult to see how any

theory that presupposes that an observer's judgement can be objective, standard and replicable can be reconciled to it.

The philosopher and the planner may desire human beings to be all of the same mind, but those irrational and irritating deviations called preferences have to be acknowledged.

Direct perception

There has been a longstanding hypothesis from Gibson (1979) that perception should be treated as instantaneous 'direct perception' (Jacques, 2019, pp. 100, 145 & 283). Whereas in standard cognitive theory the brain actively seeks to make sense of the external world, and stimuli from it are processed using pre-learned knowledge until a satisfactory situation report is reached, in 'direct perception' the world is understood without cognition. The changing shapes of objects, and invariables like the horizon, as the observer moves through it, give the mind sufficient information. A further aspect of this theory is that objects are automatically analysed by their 'affordances'—what uses or benefits they may afford the observer. Gibson called his model 'ecological psychology' because he thought it more credibly described how animals and early hominids behaved in their environments.

Gibson's conception of perception derived from his days assessing the ability of aircraft pilots in flying and landing by assessing the apparent 'flow' of fixed objects around the observer as motion was maintained. It is clearly a useful way of thinking about vision when the brain's autonomous perceptual processes are at work, and demands on cognition are minimal. However, it does not explain vision in the case of reading books or computer screens, for example. It is regrettable that he was determined that his theory should occupy the whole of visual perception theory, instead of being content that he had expanded ideas on the early stages of perception by the mind.

Neuroscience helps to deconstruct Gibson's argument. All accounts of perception, including those from enactivism and embodied cognition, start with the senses delivering raw information to associated parts of the brain. Visual information is passed to the occipital lobe at the back of the brain. The lobe is itself subdivided into areas that handle the various aspects of vision—for example, colour, shape, contrast and movement. That stage of visual processing is autonomous; afterwards we become more conscious of it. Emotions will influence the process, directing our attention, and determining how we experience the scene. The early results are recombined into more complex messages handled in specialised areas that call up the memory and seek the recognition of faces, bodies and places (Chatterjee, 2014, p. 25).

Thus Chatterjee (2014, p. 112) states: 'aesthetic pleasures are influenced profoundly by our cognitive systems'. So, too, Leder et al. (2004, p. 493) saw that:

an aesthetic experience is a cognitive process accompanied by continuously upgrading affective states that vice versa are appraised, resulting in an (aesthetic) emotion.

Their models are 'cognitive' in nature, meaning that the mind employs functions of the brain including attention, memory and judgement to process new information and generate new knowledge. They are thus an outgrowth of cognitive psychology as expounded, for example, by Gregory (1977) in his *Eye and Brain*. Zeki (1999, p. 4), citing Gregory, asked: 'What is the visual brain there for? ... The answer is *we see in order to acquire knowledge about this world*'. This is the classic description of the cognitive process, and neuroscientists refer to their subject as 'cognitive neuroscience'.

Zeki (1998) has promoted the concept of 'constancy' which is an obvious parallel to ecological psychology's concept of objects and invariables during movement. He defined it as: 'having a knowledge of constant and essential properties of an object and ability to discard irrelevant dynamic properties'. Other researchers have measured cognitive processing speed in humans. Its decline with age would suggest that perception cannot be instantaneous, a conclusion that is problematic for the theory of direct perception.

The idea of 'affordances' has had its loyal adherents, especially amongst admirers of abstract artists like Jackson Pollock, for example, Starr (2013, pp. 80, 87), and amongst those designers seeking solutions that would be understood intuitively. The term became used variously to explain people's relationships to technologies. The concept was reviewed by Oliver (2005, pp. 404–5, 412), an educationalist specialising in the use of technology, who concluded by writing: 'This article calls into question whether the concept of "affordance" has any analytic merit for researchers or designers.'

A fundamental problem for the concept is that the possibilities that objects may afford can be known only through past experience or the imagination, whereas Gibson was at pains to deny this. He saw them as psychic linkages between the observer and the environment, forged through long contact in animal and human prehistory. That perspective lessened their application, though, for they could have little relevance to the moment-to-moment interactions of an individual using a modern artefact in the twenty-first century. The concept was not sustainable philosophically, but was perpetuated by architectural theorists who, however, adjusted the original meaning. To them Oliver had a message: 'We should just avoid calling what we study "affordances".'

Some preferences and tastes

Neuroscience is predicated on all members of *Homo sapiens* having standard brain architecture, and thus a uniformity of the autonomous processes. However, that should not be confused with consensus in appreciation taking place in a context of cultural conventions and accepted standards. Whilst culture invests the collective judgement with considerable momentum, it cannot be assumed that aesthetic judgements can be 'normal' (Jacques, 2019, p. 185).

The cognition leading up to appreciation ensures that opinions on landscape and garden beauty can be wildly different from person to person. The cultural background of each individual and the meanings of places for people interact with social and contextual factors in the generation of aesthetic pleasure. Psychologists have made observations on the role of appraisal theory, familiarity and expertise.

Appraisal theory

Psychologists have postulated an 'appraisal theory of emotions' (Roseman & Evdokas, 2004). According to this, we interpret objects and events in the world in the light of our own goals and desires. Thus an evaluation produces a feeling of attraction or aversion. When a situation seems to run counter to one's goals or expectations, it elicits a negative emotion, such as anger or regret. And vice-versa for a feeling of satisfaction.

This is very relevant to the appreciation of landscapes, as people imbue them with cherished notions of identity and sometimes (in the case of 'sacred' landscapes) spirituality. Even if change is overdue or happening in a landscape, we will probably hold it in the mind's eye as it once was and appreciate its seemingly permanent state as representing our values. This is as true for the idea of wilderness as it is for the humanised landscapes of mountain, moor, fields and lanes.

Familiarity

The Kaplans' experimental work included 'preference studies', several of which pointed to the observation that 'familiarity enhances preference to some degree' (Kaplan & Kaplan, 1989, p. 91).

Leder's model of aesthetic experience explicitly included 'familiarity' amongst the factors in the 'implicit memory integration' stage of sensory processing, which is prior to our becoming conscious of it. Some experimental evidence for neural activity connected to familiarity has been reported, seemingly related to the recovery of memory of places. This affects aesthetic preferences (Leder et al., 2004, p. 496).

An increase in preferences merely because of familiarity can be found through experiment, but a definite explanation is uncertain. One might be that recovery of memories brings with it associations and past pleasures. Another is that repetition appears to reinforce positive experiences and sets up a prototypical representation. Once recognised again it can be processed more fluently and with less effort, and be appreciated on that account (Chatterjee, 2014, p. 51).

Expertise

Understanding shapes visual experiences. This has been appreciated ever since a study in 1987 found that preferences of professionals such as architects, landscape architects, and range managers can vary significantly from those of the public (Buhyoff et al., 1978).

Allen Carlson (2000, pp. 6, 50), the environmental aesthetician, recommended that appreciation of landscape should be in the light of knowledge provided by the natural sciences, especially the environmental sciences. In his view, 'The naturalist and the ecologist are well equipped to aesthetically appreciate nature'. Experimental evidence indicates that experts in their fields showed more neural activity in areas of the brain including the reward system, as compared to non-experts, perhaps because their memories were being activated (Chatterjee, 2014, p. 141).

This is hardly an unexpected conclusion: experts frequently differ in opinion from laypeople, and the reasons can easily be seen in terms of greater knowledge of the object and its context, greater familiarity with the questions raised by the object and the possible answers and hence experience in the making of judgements, and often an enhanced sensitivity to the aesthetic qualities (Nadal & Skov, 2015, p. 660). In these ways, an expert's way of thinking about an object will likely differ from a popular one, and so also in their aesthetic experience.

Conclusion

Neuroaesthetics has made significant advances since 2010, as neuroimaging provides understandings about the mental processes involved in aesthetic experience that go well beyond those provided by behavioural studies alone.

The topic has to date concentrated principally upon aesthetic preferences for art objects, and there has still, unfortunately, been little attention given to landscape appreciation. Yet there appears to be no theoretical obstacle to the entry of the findings of neuroaesthetics into the landscape arena. Should this come about, the same demarcation seen in the case of neuroaesthetics and art criticism would apply, with the former illuminating brain mechanisms and the latter informing aesthetic judgement.

Neuroaesthetics appears likely to be helpful to the theory of landscape assessment, principally in pulling at the shaky metaphysical underpinnings so often found. The propositions (1) to (4) discussed above have concerned objectivism, evolutionary preferences, the objective assessor, and direct perception. All have been found to be questionable, and their opposites have in most cases been more plausible. In a general way, the neuroaesthetic approach provides guidance and may help to improve other bases of appraisal theory.

As neuroaesthetics expands its understanding of the mechanisms of perception and preferences, let us hope that it does not overlook landscape.

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David Jacques is a landscape historian and conservationist. He was the Inspector of Historic Parks and Gardens at English Heritage before teaching at the University of York and the Architectural Association. In the early 1990s he was

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