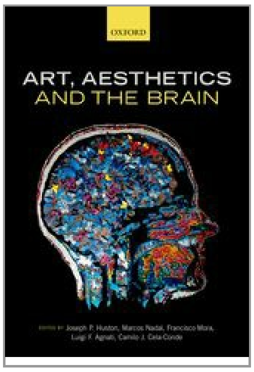

Art, Aesthetics, and the Brain

Joseph P. Huston, Marcos Nadal, Francisco Mora, Luigi F. Agnati, and Camilo José Cela Conde

Print publication date: 2015
Print ISBN-13: 9780199670000
Published to Oxford Scholarship Online: August 2015
DOI: 10.1093/acprof:oso/9780199670000.001.0001

Contextual bias and insulation against bias during aesthetic rating: The roles of VMPFC and DLPFC in neural valuation

Ulrich Kirk
David Freedberg

DOI:10.1093/acprof:oso/9780199670000.003.0008

[−] Abstract and Keywords

The scientific study of aesthetic experience through the examination of the neural correlates of sensory and motor responses works of art and to other visual images has thrived during the last decade. The neural substrate of embodied responses to works of art, and to visual images more generally, has been the object of much attention. This research, however, has tended to sidestep the question of aesthetic preference and rating, and the neural correlates of contextual influences on such ratings. Responses in the domain of perception–action coupling have provided useful and important evidence for the role of somatic and emotional responses in viewers’ engagement with works of art. Nevertheless, the degree to which they form the basis of evaluation, ranking, and even judgment remains unclear. In this chapter we concentrate on the respective roles of the ventromedial prefrontal cortex (VMPFC) and the dorsolateral prefrontal cortex (DLPFC) during aesthetic evaluation, particularly the aesthetic evaluation of visual works of art. Activity in these areas is modulated by external contextual pressures on viewing. The roles of ACC, hippocampal and striatal connections in the process of rating and evaluating works of visual art, and the relationship between expert and non-expert responses, are also discussed.

Keywords: visual art, aesthetic evaluation, context, influence, ventromedial prefrontal cortex, dorsolateral prefrontal cortex, embodiment

8.1 Neural aesthetic valuation

In this chapter we concentrate on the respective roles of the ventromedial prefrontal cortex (VMPFC) and the dorsolateral prefrontal cortex (DLPFC) during aesthetic evaluation, particularly the aesthetic evaluation of visual works of art. Activation of these areas has been shown to be modulated by external contextual pressures on viewing (Kirk 2008; Kirk et al. 2009a; Kirk et al. 2011). We also discuss the roles of ACC, hippocampal, and striatal connections in the process of rating and evaluating works of visual art.

One way of considering aesthetic experience is through the examination of the neural correlates of sensory and motor responses works of art and to other visual images. Much attention has already been devoted to the neural substrate of embodied responses to works of art, and to visual images more generally (Freedberg 1989; Freedberg and Gallese 2007; see also Astafiev et al. 2004, and Downing et al. 2006 on responses in extrastriate body area (EBA), and De Gelder 2006 on emotional body language (EBL)). The role of mirror neurons in the felt simulation of action and implied action has played a central role in these discussions (Rizzolatti et al. 1996; Rizzolatti et al. 2001; Freedberg and Gallese 2007; Di Dio et al. 2007). Since such accounts, and all accounts of common coding and shared representation (Prinz 1997; Decety and Sommerville 2003), emphasize not only perception and action coupling but also the links between sensory and motor responses, mirror activations in motor and premotor cortices, as well as in the somatosensory cortices, have been examined at some length (for the visual perception of touch in art, see Keysers et al. 2004; Freedberg and Gallese 2007; for motor responses to art, see also Calvo-Merino 2005; Battaglia et al. 2011). Felt simulatory responses to visual images have become a staple of studies of embodied simulation as well as of empathic responses to images (Gallese et al. 2004; Freedberg 2007, 2009). These have provided a neural account for the kinds of embodied and motor responses to paintings and sculptures described in the work of the French phenomenologist Maurice Merleau Ponty and his predecessors, including the pioneers of empathy theory, such as Robert Vischer and Theodor Lipps, for whom the **(p.159)** notion of *Einfühlung* was a fundamental aspect of aesthetic response (e.g. Merleau Ponty 1945; Vischer 1873; Lipps 1903a, 1903b). The connection between movement and emotion as described by Henry James has had a significant revival in the work of Antonio Damasio and others (James 1890; Damasio 1994). The trend towards linking bodily and emotional responses has led to a slew of analyses of the role of amygdalic (LeDoux 1992, 1996; Adolphs et al. 1995; Adolphs 1999) and insular activations in responses to artistic representation (Di Dio et al. 2007; for earlier studies of emotional responses to images, see also the very many studies by Lane and Lang, including Lane 1997; Lang et al. 1993, as well as the wide range of material currently available for the relationship between feelings of disgust and activation of anterior insula). We are now in possession of abundant research on the neural substrates underlying both sensory and affective engagement with works of art (e.g. Freedberg and Gallese 2007). A considerable amount of attention has been paid to the ways in which motor simulation, or a sense of motor simulation of action and movements seen, evokes emotions in the viewer that accord with those intended by the artist (Freedberg 2007). More recently, attention has also been paid to the movements implied by the marks—in other words the traces of the painter's or sculptor's hand—on a painting or sculpture, thus expanding the notion of simulation well beyond figurative art to more abstract forms (and to calligraphy as well) (Umiltà et al. 2012).

Little of this research, however, provides access to the question of aesthetic preference and rating, and even less to understanding the neural correlates of contextual influences on such ratings. While responses in the domain of perception–action coupling provide useful and important evidence of the role of somatic and emotional responses in viewers' engagement with works of art, the degree to which they form the basis of evaluation, ranking, and even judgment is moot. Recent economic and decision-making theory suggests a number of possibilities for the understanding of the neural substrate underlying the (subjective) evaluation of works of art, of the impact of context on hedonic value, of the varieties of insulation against such contextual influences, and of the impact of domain expertise on such insulation (Montague and Berns 2002). Here we set out the role of prefrontal interactions, most notably between VMPFC and DLPFC in the processes of evaluation, and the relationship between expert and non-expert responses.

A number of behavioral studies have shown how information such as titles, labels, texts, and other forms of cognitive supplementation can affect the evaluation of a work of art (e.g. Cupchik et al. 2009; Leder et al. 2004; Russell 2003; Kirk et al. 2008). The neural correlates of aesthetic evaluation began to become clearer with the examination of responses to musical (Blood and Zatorre 2001; Baumgarten 1986/1750) and pictorial stimuli (Cela-Conde et al. 2004). Subjective pleasantness ratings of musical sequences have been shown to correlate with activity in the striatum, amygdala, parahippocampal gyrus, insula, orbitofrontal cortex (OFC), and anterior cingulate cortex (ACC) (Blood and Zatorre 2001; Brown et al. 2004; Menon and Levitin 2005; Koelsch et al. 2006). Similar findings were reported in two studies using paintings as stimuli, where subjective appreciation of works recruited the caudate, ACC, and OFC (Kawabata and Zeki 2004; Vartanian and Goel 2004; Kirk et al. 2008). In a study comparing the networks recruited during aesthetic rating **(p.160)** as compared to symmetry judgments, Jacobsen and colleagues found enhanced activity in frontomedian cortex, lateral OFC, inferior frontal gyrus, posterior cingulate, temporal pole, and temporal-parietal junction (Jacobsen et al. 2006). Each of these studies provided significant clues to components of the neural networks underlying aesthetic rating. Kawabata and Zeki's (2004) breakdown of the elements of appreciation into comparatives (determined by a rigorous analysis of behavioral ratings) produced a set of suggestive, if not conclusive, results: when stimuli rated as beautiful versus neutral were compared, activity in medial orbitofrontal cortex (OFC), ACC, and left parietal cortex correlated with such ratings; when stimuli rated as ugly versus beautiful were contrasted, primary motor cortex was activated; when ugly versus neutral stimuli were compared, no activation was observed. In the case of the rating of beautiful versus ugly, medial OFC seemed to be elevated (Kawabata and Zeki 2004). While the sample size here was small and rather vaguely defined (five male and five female students "with no special experience in painting or art theory"), the finding of activity in medial OFC during aesthetic evaluation of beautiful paintings (as rated by subjects) was suggestive enough to use as a base for further experiments that merge with findings from the area of decision making.

Early on, Damasio and colleagues had shown that lesions in medial OFC/VMPFC often lead to decision-making deficits (Bechara et al. 2000; Damasio 1994). The role of VMPFC in emotional appraisal, as in the case of valuation of emotional valence of facial expressions (e.g. Aharon et al. 2001; Winston et al. 2007) also proves to be critical for further understanding of the subjective neural processes involved in decision making—as well, it turns out, for the understanding of the processes underlying the rating of visual works of art and the pressures and biases involved in doing so.

8.2 Ventromedial prefrontal cortex involvement in evaluation

In this section we describe a group of experiments arising out of recent interest in understanding the subjective processes involved in decision making (Montague and Berns 2002). These experiments are unified by the theme of hedonic or affective components in the aesthetic rating of a visual work of art.

Kawabata and Zeki's research showing that the recruitment of medial OFC in the rating of works as beautiful as opposed to ugly (Kawabata and Zeki 2004) suggested the possibility of examining the question of how preference ratings of works of art are modulated by semantic information presented alongside them. Then Kirk and colleagues designed an fMRI study to measure the influence of cognitive information on the modulation of subjective preference for visual works of art (Kirk et al. 2009a). In this study, chromatic reproductions of paintings from the Louisiana Museum of Modern Art in Copenhagen were shown to fourteen subjects with no formal training in any area of art. They were accompanied by labels below each of them, with half identified as from the Louisiana Museum ("gallery" label) and half as computer-generated by the experimenter ("computer" label). Pre-screening ensured that no subject had any familiarity with the paintings shown. Using this experimental design, the aim was to determine whether the contextual information **(p.161)** supplied would affect the aesthetic evaluation and the subjective preference associated with it, either in terms of the behavioral ratings or of the neural processing underlying them. It was assumed that the gallery label would induce a higher expectation of reward than the computer label, and that this would be reflected both in the behavioral ratings and in the neural activity engaged in the processing of reward. The question was the degree to which subjective preference might be altered and modulated by framing its status as artistic or as merely computer generated. Whatever the direct sensory appeal of a work, the possibility remained that top-down influences would influence coherent behavioral preferences and recruit a specific neural network that differed from those involved in such appeal. The hypothesis was that one's concept of the status of the art object, rather than its sensory properties, would be the underlying determinant of one's subjective preference for one rather the other.

This, of course, would be consistent with the now long-standing claim in philosophical aesthetics that there are no inherent properties of an object that constitute it as art, and that its very constitution as art is predicated either on its institutional context or its philosophical status (which in many cases, particularly these days, merge) (Danto 1964). Often these are the only criteria, beyond general acclaim, by which works are defined as art or non-art. One might further maintain, consistently with the positions of many contemporary conceptual artists, that it is the labeling of works of art as art that enables them to be experienced as such, precisely as this experiment may seem to suggest. The neural data the experiment provides thus reinforce a central aspect of the new debate around the issue of how art is constituted.

What emerges clearly from this study is the influence of explicit contextual information on neural activity in the VMPFC. Given the role of the VMPFC in value computations and in experienced pleasure during experiential tasks (e.g. Anderson et al. 2003; O'Doherty et al. 2003; Rolls et al. 2003), it is perhaps not so surprising that it should be modulated by contextual information (Plassmann et al. 2008; McClure et al. 2004; de Araujo et al. 2005). Research in the field of neuromarketing and marketing actions further clarifies VMPFC activation during decision making. Moreover, the fact that activity in this area is modulated by contextual information also emerges, for example, in experiments in which subjects evaluate their preference for liquids or odors. One study (de Araujo et al. 2005) showed that subjects rated a test odor as significantly more pleasant when paired with a pleasant verbal descriptor than with an unpleasant one, and that this correlated with activity in the VMPFC. High-level cognitive input such as word labels clearly influence brain activity in the VMPFC, which plays a critical role in experienced pleasantness. Another study (McClure et al. 2004) investigated the neural systems involved in generating preferences produced by two different brands of soft drinks. They found that the rated preferences for unlabeled drinks (i.e. without cognitive influences but based only on sensory information) correlated consistently with VMPFC activation, while brand knowledge produced a strong influence both on expressed ratings and on measured responses in hippocampus (as one might expect), midbrain, and DLPFC. We shall examine the implications of such DLPFC activation later in this chapter. On the other hand, Plassmann and **(p.162)** colleagues recently showed, predictably, that wine ratings are higher when the monetary value of a wine is known than when it is unknown, and that there is a neural correlate of this effect in medial OFC/VMPFC (Plassmann et al. 2008).

In their examination of the neural correlates of contextual modulation of subjective preference for paintings, Kirk and colleagues found that aesthetic ratings were significantly higher for pictures labeled "gallery" than those labeled "computer" (Kirk et al. 2009a). This correlated with greater activation of VMPFC under the gallery than under the computer condition. Given the now well-established role of this area in the representation of experienced pleasure (e.g. Anderson et al. 2003; O'Doherty et al. 2003; Rolls et al. 2003), this is hardly surprising. The correlation of VMPFC activation with the higher aesthetic rating assigned to works under the gallery rather than the computer label coincides with current evidence that VMPFC activation represents the subjective preference response involved in the assignment of aesthetic preference to one stimulus over another. The results derived from this experiment also provide evidence that this representation holds even when the attributed preference ratings are modulated by cognitive and semantic input. Taken together, these findings showing modulation of VMPFC by contextual information suggests an interaction between sensory processes and top-down information in this region.

On the other hand, consideration of the neural effects of paintings in the gallery versus computer conditions regardless of aesthetic rating showed increased activation of bilateral parahippocampal gyrus, visual cortex, and bilateral temporal pole. The distinction between these two very different categories of areas of activation calls for comment. Some of the reasons for this difference are clear; others possibly less so. They turn out to be critical for the understanding not just of the cognitive modulation of aesthetic evaluation but also of the role of expertise in suppressing context-induced bias during aesthetic rating.

The study by de Araujo and colleagues of cognitive influences on odor preference showed greater activation in VMPFC when subjects made preference ratings of a set of odors manipulated with a positive word label rather than a negative one. Psychophysical studies had long established the relative inefficiency of olfactory discrimination in humans, to the extent that successful odor identification was known to be highly susceptible to factors such as familiarity and to the semantic connection between an odor and its name (Cain 1979). It is thus hardly surprising that de Araujo and colleagues should have found that verbal or semantic information had a strong influence on both perception and rating of odor attributes. That semantic labels can influence aesthetic and hedonic ratings of works of art is less well documented, however. Russell found that the introduction of title and artist's name upon second ratings of individual abstract and semi-abstract artworks produced an increase in hedonic value (Russell 2003). Kirk and colleagues' research extended this observation by showing that semantic labels (prestigious gallery versus computer generated) influenced subjective preference, even when there was no difference in the stimulus material (Kirk et al. 2009a). Here too they found a neural correlate in VMPFC for the behavioral evidence, just as De Araujo and colleagues had found (de Araujo et al. 2005).

Other studies have shown modulation of VMPC in response to objects of varying reward value. Erk and colleagues found that cultural objects such as sports cars versus small **(p.163)** cars modulate reward circuits in male subjects—not only the dopaminergic reward circuitry in ventral striatum, but also in anterior cingulate and in median orbitofrontal cortex (in the usual regions overlapping with VMPFC) (Erk et al. 2002). VMPFC is strongly implicated in signaling basic appetitive aspects of reward. Blood oxygen-level-dependent (BOLD) signal changes in this region correlate with reward value (O'Doherty et al. 2003). VMPFC has also been implicated in emotional processing with increased responses to rewarding outcomes (Lane 1997). The likelihood that it is engaged under conditions that require behavioral decision-making is consistent with its involvement in the integration of reward feedback for affective decision-making (Kringelbach et al. 2003; O'Doherty et al. 2003).

This is all very well, but how are these VMPFC results to be interpreted in relation to the question of the neural mechanisms involved in the aesthetic evaluation of visual images, and of art in particular?

McClure and colleagues' study showed that brand knowledge of soft drinks influenced activations in hippocampus, primary visual cortex, and dorsolateral prefrontal cortex, areas that have traditionally been regarded as having strong cognitive rather than flavor-related functionality (McClure et al. 2004). In 2009, Kirk and colleagues demonstrated bilateral activation of the entorhinal cortex in the gallery versus computer condition, irrespective of the actual aesthetic rating (Kirk et al. 2009a). This much stands to reason. The entorhinal cortex adjoins and is interconnected with the hippocampus and is activated in trials in which subjects correctly recollect contextual information compared to trials in which they do not (Cansino et al. 2002). Other findings suggest that midbrain dopaminergic systems involved in reward expectation directly modulate declarative memory formation in the hippocampus. This evidence is consistent with our initial hypothesis that it is the subject's conception of the image, rather than its sensory properties, that primarily/also determine its hedonic value.

This effect might arise from subjects' differing prior expectations of future reward—and thus of hedonic value—as evoked by the stimulus labels. One could thus account for two possible factors in the gallery versus computer-generated experiment. The first would loosely have to do with relative difference in prestige. Despite recent developments in all forms of computer-generated and cyber-art, by and large art galleries remain a more prestigious context both for the display of and as a source of artworks than the Internet. In this case, expectation or prediction of reward arises from a social prior. The more prestigious the gallery, the more competition to display works in it, and a sense of the artist's success may well be correlated with a higher degree of reward expectation. A second, closely related factor might be the greater monetary value attached to showing in a more prestigious than a less prestigious gallery—let alone the monetary value attached to a work that is merely said to be computer-generated, but is in fact a reproduction of a real painting (and not displayed in a more or less prestigious gallery). In many cases—especially outside the rarefied contexts of analysis by students of the history of art and critics—a simple social prior is that the more expensive the artwork, the greater the likelihood that it will have a higher hedonic value.

(p.164) Cognitive inputs such as semantic word labels clearly have a profound influence on aesthetic rating. The data summarized above suggest that the entorhinal cortex and temporal pole are engaged during recollection of art-related and cultural information that may influence aesthetic preference during gallery conditions, while VMPFC is more involved in the generation of preference computations. These two systems do not appear to function independently of each other, but are interdependently modulated in such a way as to generate aesthetic preferences as induced by semantic context.

8.3 Neural correlates of aesthetic expertise

A related question is that of the degree to which aesthetic expertise modulates aesthetic evaluation. Many recent studies have demonstrated substantial and deep differences between experts and non-experts in their assessment of works of art, as well as in the neural substrates that underlie their preferences and evaluations (Calvo-Merino et al. 2005; Hekkert et al. 1996a, 1996b). In 1966, McWhinnie showed that subjects without art training generally prefer simple and symmetric visual elements, whereas those with training or a background in art tend to favor complex and asymmetric visual elements (McWhinnie 1966). In 1990, Smith and Melara concluded (with equal predictability) that music novices show a greater preference for syntactically prototypical chord progressions than do experts (Smith and Melara 1990). Forms of training (not always adequately specified) and degree of expertise are generally said to contribute to these differential preferences. One could always say—as is often claimed—that training in a particular art, and deeper knowledge, familiarity, and experience, enrich its perceived meaning, and it is usually held that experts incline to respond to aesthetic values (broadly taken) over purely sensory ones. One of the difficulties in the literature so far is that expertise is never clearly defined, nor is it clearly established in exactly what expertise is supposed to consist. Often the rather general supposition is made that experts are more likely than novices to take into consideration concepts of aesthetic value, or the concepts and ideas on which the work is based, or on the supposed (or prevailing) norms of good and bad taste (Smith and Melara 1990; Bourdieu 1979). Preferences expressed by experts are often thought to reflect a disposition for distancing oneself from popular taste (as exemplified by non-expert viewers). Often it is believed that aesthetic experience involves the processing, recognition, and broad understanding of an individual style. Some form of stylistic awareness, analysis, and recognition then becomes a critical marker of aesthetic expertise. As is well-known, “even highly abstract paintings can be constrained by rules, although the underlying principles are not immediately evident to those outside the artist’s circle” (Cupchik and Laszlo 1992). There is no question that critics and art historians are frequently more aware of the preferred techniques and rules that distinguish one style from another, however, and that this affects their evaluation of the work under consideration.

An abundance of evidence points to direct expertise effects in the brain, especially in structures related to memory and perception—even on the macro-anatomical scale. In a striking voxel-based morphometric analysis, Maguire and colleagues found that **(p.165)** gray-matter volume in the posterior hippocampus of London taxi drivers was greater than in age-matched controls, and seemed to increase correlatively with time spent taxi-driving (Maguire et al. 2000). Increasing numbers of studies have been devoted to the role of expertise effects in responses to music. In their fMRI study of 2006, Bangert and colleagues compared brain activity in groups of musicians and non-musicians as they listened passively to a piano sequence, and found elevated levels of activity in the musicians' brains in regions of the temporal lobe associated with auditory processing, as well as in frontal regions associated with motor control (Bangert et al. 2006). More recently, Jacobsen and others have taken a different approach to comparing aesthetic responses in experts and laypersons in analysing ERP effects in the course of auditory and cognitive processing of chord sequences (Brattico and Jacobsen 2009; cf. also Bigand and Poulin-Charronat 2006).

As already mentioned, a number of fMRI studies have identified cortical areas recruited during the aesthetic evaluation of pictures (Kawabata and Zeki 2004; Jacobsen et al. 2006; Kirk et al. 2008). The results suggest that the computation of preferences largely relies on areas implicated in the processing of reward, especially VMPFC and ACC. To what degree are these reward-related areas modulated by expertise? VMPFC has been found to correlate with subjective preference ratings, and to be involved in coding stimulus value from a variety of sensory modalities (Knutson et al. 2003; O'Doherty et al. 2003; Rolls et al. 2003; McClure et al. 2004; Plassmann et al. 2008). It serves as a critical center both for the tracking of reward value of different stimuli independent of their sensory modality (i.e. taste, smell, etc.), and for relating this value to hedonic experience.

Although it could be argued that the "rules" of art (say of twentieth- and twenty-first-century abstract art) are not effectively equivalent to the technical rules of art or architecture, a further neuroimaging study sought to investigate the extent to which the neural correlates of aesthetic evaluation vary as a function of expertise in architecture (Kirk et al. 2009b). This fMRI study cast considerable light on (1) the question of the impact of expertise on aesthetic preferences, and (2) how differences in assessment strategies between experts and non-experts can be tracked as differences in neural activity. The subjects here consisted of one group professing to have no great interest or expertise in art or architecture, and another group of experts, consisting of graduate students in architecture and professional architects. Each group was asked to rate the aesthetic value of a series of images of architecture (divided between modernist and pre-modernist, public and private) and faces. Aesthetic value was rated on a scale of 1 (very unappealing) to 5 (very appealing) (Kirk et al. 2009b). It was hypothesized that the expert-specific condition (architectural images) would significantly affect both aesthetic ratings and neural activity differentially. Since earlier psychometric studies had found that people in different cultures and of both sexes tend to agree as to which faces were attractive (Langlois et al. 2000), it was predicted that there would be little if any significant differentiation between the two groups' aesthetic ratings of faces and the neural processing underlying such ratings. In other words, it seemed likely that an expertise effect on the neural structures underlying the formation of an aesthetic judgment would be evident when architects rated the buildings, but not when judging faces.

(p.166) The behavioral responses (i.e. the aesthetic ratings) for both categories of images revealed no significant differences between the two groups. To test whether architectural expertise modulated brain activity underlying aesthetic preference, an analysis was made of those regions where the difference between the responses for the two stimulus conditions varied across the two subject groups. Significant activations were found in VMPFC and bilateral ACC, but were greater in the case of experts' preference ratings of buildings, while remaining essentially balanced across the two groups in the case of face stimuli. The observed effect clearly related to acquired expertise in architecture. Nucleus accumbens (NAcc) showed the same level of response in both groups and to both sets of stimuli, regardless of expertise level. This finding thus replicated previous findings that VPMFC and striatal regions, including the NAcc, play different functional roles in reward processing (Knutson et al. 2001; O'Doherty et al. 2003). A plausible conclusion would be that VMPFC processes evaluation of stimuli, whereas the nucleus accumbens is more involved in prediction of reward and reward expectancy, as has often been shown (Montague et al. 2004).

Nevertheless the fact that the VMPFC is sensitive to the magnitude of aesthetic value accords with recent studies showing that the relative reward value of stimuli is reflected by the amplitude of neural activity in this region, whereby we mean that activity in the VMPFC increases linearly with aesthetic ratings. These studies have also indicated that this region codes the reward-related rather than the sensory aspects of a stimulus (Kringelbach et al. 2003).

One may go a step further. The data from the study of architectural experts versus novices in rating buildings and faces shows that architectural expertise modulates the neural response to buildings even in the absence of any differences in aesthetic rating between experts and non-experts. This further confirms what may seem obvious; namely, that the expertise effect is specific to the domain of expertise.

In conclusion, the results of Kirk and colleagues' study of architectural expertise showed that VMPFC and ACC are differentially engaged as a function of expertise, but that NAcc is equally activated in both experts and non-experts.

8.4 The influence of favors on valuation and decision making

For some time it has been known that decision making can be biased by the offering of favors, or by particular social gestures (Loewenstein et al. 1993). The tendency to be influenced by biases may be rooted in biological mechanisms that subvert cognitive control. In real-life scenarios such biases occur where social gestures from a sender to a receiver encourage some equivalent behavior in return, even if the agreement is not explicit. This feature of response is known as reciprocity. It is clear that in many cases open-ended gestures may be made without any explicit expectation of reciprocity (for recent discussions of the neural mechanisms of reciprocity-eliciting gestures; see Rilling et al. 2002; King-Casas et al. 2005; Li et al. 2009), and it is in this domain that the whole question of how social gestures may manipulate value judgments arises. So too does the still broader question of how "open-loop" favors, in which there is no possibility of reciprocating interactions **(p.167)** between sender and receiver, affect decision making and therefore preference judgments. Such cases would seem to be particularly relevant to the case of abstract rewards such as might arise from preference judgments for one painting over another.

The use of monetary favors to influence preference offers particularly striking real-world examples of the manipulation of value judgment by perceived external social value. The media often alleges manipulation of drug choice by monetary favors (cf. also Wazan 2000; Dana and Loewenstein 2003). Harvey and colleagues hypothesized that a monetary favor would affect subjects' preference ratings of works of art (Harvey et al. 2010). It may seem that this sort of favor is a specific and exceptional instance of the external motivation of valuation judgments and rating, but in fact it offers an interesting and critical test case where there is no objectively correct answer, and where the favor is entirely of the "open loop" kind, with no possibility of a reciprocal interaction between sender and receiver. Harvey and colleagues' experiment also makes clear not just that monetary favor biases judgment in domains unrelated to the favor, but also that the neural substrate of the brain modulations induced by monetary favor is not separate from the networks activated by preference judgments more generally.

Furthermore, while monetary favors may not be thought to be particularly relevant to the case of art, in the present art world it very clearly is (and may always have been). The offer of monetary favors stands as exemplary for a wide range of potential biasing factors in judgments about and ratings of works of art. The case seems particularly applicable to the operations of the art market, but in fact could be seen to apply to any other form of social gesture that elicits reciprocity—for example, the use of pictures as forms of marriage solicitations or proposals (a phenomenon that has a long history), or any other such reciprocal arrangement involving supposed beauty or social benefit. Recent experiments have begun to shed light on the neural mechanisms of reciprocity-eliciting gestures (King-Casas et al. 2005; Rilling et al. 2002; Li et al. 2009; van den Bos et al. 2009), but almost nothing is known about the influence of an "open-loop" favor where there is no possibility of reciprocal interactions between the sender and the receiver, or in which one agent makes a gesture or offers a gift without any explicit expectation of reciprocity.

Harvey and colleagues hypothesized that the offer of social favors would bias subjective preferences, even for objects unrelated to the favor itself (as in the case of works of art). They addressed this hypothesis by employing a series of monetary favor and preference experiments, in which a total of 151 subjects participated. Before scanning subjects were told that that they would be sponsored for their participation by one of two companies. At the beginning of the fMRI task they were shown two company logos followed by a screen showing which of the companies would be sponsoring them, as well as the amount of compensation ($30, $100, or $300). During scanning, subjects passively viewed 60 reproductions of paintings, each paired with either a sponsor logo or a non-sponsor logo. After scanning they provided preference ratings for all the pictures they viewed.

In other words, in this experiment a monetary favor was sent from an agent to a subject and the influence of this favor on subjects' preferences for one image over another was tested. This is a domain in which there are no objectively "correct" answers for such **(p.168)** preferences, and there is no economic relationship between the favor and the preference judgments. What was striking about this set of experiments is that the mere offer of a favor was able to influence subjective decision making, even without actually paying the favor out. Responses both in VMPFC and posterior cingulate correlated linearly with the behavioral change across the three offer conditions (Harvey et al. 2010).

The behavioral results showed that preference for paintings paired with the sponsoring company's logo was higher than those paired with the non-sponsor logo. The functional imaging results revealed that activity in the VMPFC tracked the value signals of the paintings belonging to the sponsorship category to a higher degree than those that did not thus belong. This really was the first imaging study to indicate that a monetary favor could transfer value to a proxy, and could influence preference judgment of objects that were placed next to the sponsorship logo, with corresponding changes in neural activity. Moreover, the experiment was designed with no reciprocal interaction between the company and the receiver, suggesting that the favor could influence behavior even when the receiver had no explicit expectation of reward in the outcome of the interaction.

What is critical about these results is that they show that the sponsorship effects described do not possess a special and separate network of brain responses but instead modulate responses in neural networks normally activated by a wide range of preference judgments. VMPFC encodes for revealed preference across a whole variety of sensory modalities (Knutson et al. 2003; O'Doherty et al. 2003; Rolls et al. 2003; McClure et al. 2004; Plassman et al. 2008; Kirk et al. 2009a). Activity within VMPFC suggested that the neural networks normally activated by a wide range of preference judgments are also modulated by the strong effect of sponsorship. The effect is so robust that it is not sensitive to changes such as logo size or distance from the stimuli themselves. The results raise the important possibility that monetary favors bias judgments by acting through existing valuation mechanisms, and that individuals may therefore have difficulty detecting the gesture's influence over their subjective preferences—even for objects seemingly unrelated to the favor.

8.5 Mitigation of the effects of favors by domain expertise

In follow-up experiments to those of Harvey and colleagues, the same team examined whether the biasing effects of social gestures on valuation judgments could be mitigated (Kirk et al. 2011). In the case of medical professionals, for example, biases from monetary gifts or other favors from pharmaceutical companies are thought to be mitigated by a variety of mechanisms, including disclosure of potential conflicts of interest, not accepting large gifts or favors, and oversight from institutions regarding biases in prescribing behavior. In addition, the fact that medical professionals have expertise in their domain of decision-making is taken as an argument that they should be more objective in their judgments than laypersons making similar decisions. The obvious question for the field of art is the degree to which expertise and experience in art insulates against judgment bias. To test this directly, a group of participants with expertise in the domain of art were recruited **(p.169)** to perform the favor task outlined in the previous section. Expertise criteria included a formal education in a visual art-related area and a minimum of five years of experience working in visual art-related areas. The hypothesis was that training in assessing art would insulate such subjects against the biasing gesture of the sponsoring company, and that if this were indeed the case, there would be neurobiological correlates corresponding to the differences in behavior between art experts and non-experts.

The group of experts was asked to undergo an fMRI scan while viewing images of the artwork, paired either with a sponsor company logo or another non-sponsor company logo. After the fMRI session, each subject rated his or her preference for the art displayed in the scanner. The set-up was identical to the previously discussed experiments, except that student art was used rather than well-known paintings, to eliminate the possibility that differences in results between art experts and non-experts were solely a result of familiarity with the paintings. In the behavioral results, there was no difference between experts' preference for sponsored paintings versus non-sponsored paintings, in contrast to the control subjects who showed a significantly higher preference for sponsored paintings. It was hypothesized that if the experts did not show an effect of sponsorship on preference ratings for paintings, BOLD activity in the VMPFC would also not be sensitive to sponsorship in the way it was in the control subjects (whose behavior reflected the bias towards sponsor-related paintings).

This turned out to be the case: while both the control group and the art experts showed activity in the VMPFC correlating linearly with painting preference for all paintings, the experts did not show differential activity in this region for sponsored compared to non-sponsored paintings. However, if the group of art experts showed no effect of sponsorship either on their behavior or on activity in the VMPFC, what region of the brain was involved in the mitigation of this effect?

To explore this further, activity in the dorsolateral prefrontal cortex (DLPFC) was analysed. DLPFC is known to be involved in executive control (Wagner et al. 2001) and in modulation of valuation (in experiments on goal values and the influence of instruction on reward learning) (Hare et al. 2009; Li et al. 2011). The results showed that relative to the control group, viewing artworks elevated activity in the DLPFC, whereas the control group did not show activity in this region. These results indicate that in the expert group, DLPFC was continuously engaged in the regulation of bias susceptibility. In subsequent analyses, right DLPFC turned out to be functionally connected to the VMPFC, and the coupling of these two regions was stronger during presentation of sponsored paintings than during presentation of non-sponsored paintings.

As recent studies of the neurobiology of self-control have also shown, VMPFC may indeed be modulated by areas of the DLPFC, especially in instances of self-censorship (Hare et al. 2009). It is clear that DLPFC plays a critical role in self-censoring modulations of neural valuation mechanisms such as the VMPFC. It also serves as a more general mechanism by which a person may be insulated from bias and from biasing maneuvers, rather than being specific to individuals with domain expertise, whether in art or in any other field. What does emerge, however, is that in experts or in those with training in art, DLPFC **(p.170)** more strongly modulates VMPFC activation in such a way as to insulate them from the kinds of biases that are generated by contextual information and by reward prospects, whether financial or sensory, or by any other of the kinds of elements that attract both non-experts and experts to a work in the first place. The importance of such results for the ways in which experts are insulated from biasing effects (such as those of possible financial gain, or even of prestige effects) cannot be overestimated.

References

Bibliography references:

Adolphs, R. (1999). The human amygdala and emotion. *Neuroscientist* **5**, 125–37.

Adolphs, R., Tranel, D., Damasio, H., et al. (1995). Fear and the human amygdala. *Journal of Neuroscience* **15**, 5879–91.

Aharon, I., Etcoff, N., Ariely, D., et al. (2001). Beautiful faces have variable reward value: fMRI and behavioural evidence. *Neuron* **32**, 537–51.

Anderson, A.K., Christoff, K., Stappen, I., et al. (2003). Dissociated neural representations of intensity and valence in human olfaction. *Nature Neuroscience* **6**, 196–202.

Astafiev, S.V., Stanley, C.M., Shulman, G.L., et al. (2004). Extrastriate body area in human occipital cortex responds to the performance of motor actions. *Nature Neuroscience* **7**, 542–8.

Bangert, M., Peschel, T., Schlaug, G., et al. (2006). Shared network for auditory and motor processing in professional pianists: evidence from fMRI conjunction. *Neuroimage* **15**, 917–26.

Battaglia, F., Lisanby, S., and Freedberg, D. (2011). Corticomotor excitability during observation and imagination of a work of art. *Frontiers in Neuroscience* **5**, 1–6.

Baumgarten, A.G. (1986/1750). *Aesthetica*. Hildesheim: Olms.

Bechara, A., Damasio, H., and Damasio, A.R. (2000). Descision making and the orbitalfrontal cortex. *Cerebral Cortex* **10**, 295–307.

Bigand, E. and Poulin-Charronat, B. (2006). Are we “experienced listeners”? A review of musical capacities that do not depend on formal musical training. *Cognition* **100**, 100–30.

Blood, A.J. and Zatorre, R.J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences of the USA* **98**, 11818–23.

Bourdieu, P. (1979). *Distinction: A social critique of the judgment of taste*. Cambridge, MA: Harvard University Press.

Brattico, E. and Jacobsen, T. (2009). Subjective appraisal of music: neuoimaging evidence. *Annals of the New York Academy of Sciences* **1169**, 308–17.

Brown, S., Martinez, M.J., and Parsons, L.M. (2004). Passive music listening spontaneously engages limbic and paralimbic systems. *NeuroReport* **15**, 2033–7.

Cain, W.S. (1979). To know with the nose: keys to odor identification. *Science* **203**, 467–70.

Calvo-Merino, B., Glaser, D.E., Grèzes, J., et al. (2005). Action observation and acquired motor skills: an fMRI study with expert dancers. *Cerebral Cortex* Aug **15**(8), 1243–9.

Cansino, S., Maquet, P., Dolan, R.J., et al. (2002). Brain activity underlying encoding and retrieval of source memory. *Cerebral Cortex* **12**, 1048–56.

Cela-Conde, C.J. Marty, G., Maestú, F., et al. (2004). Activation of the prefrontal cortex in the human visual aesthetic perception. *Proceedings of the National Academy of Sciences of the USA* **101**, 6321–5.

Cupchik, G. and Laszlo, J. (1992). *Emerging visions of the aesthetic process: Psychology, semiology, and philosophy*. New York, NY: Cambridge University Press.

Cupchik, G., Vartanian, O., Crawley, A., et al. (2009). Viewing artworks: contributions of cognitive control and perceptual facilitation to aesthetic experience. *Brain Cognition* **70**, 84–91.

Damasio, A. (1994). *Descartes' Error: Emotion, Reason and the Human Brain*. New York, NY: G.P. Putnam.

Dana, J. and Loewenstein, G. (2003). A social science perspective on gifts to physicians from industry. *JAMA* **290**, 252–5.

Danto, A. (1964). The Artworld. *Journal of Philosophy* **61**, 571–84.

de Araujo, I.E., Rolls, E.T., Velazco, M.I., et al. (2005). Cognitive modulation of olfactory processing. *Neuron* **46**, 671–9.

De Gelder, B. (2006). Toward the neurobiology of emotional body language. *Nature Reviews Neuroscience* **7**, 242–9.

Decety, J. and Sommerville, J. (2003). Shared representations between self and other: a social cognitive neuroscience view. *Trends in Cognitive Sciences* **7**, 527–32.

Di Dio, C., Macaluso, E., and Rizzolatti, G. (2007). The golden beauty: brain response to classical and renaissance sculptures. *PLoS One* **2(11)**, 2–27.

Downing, P.E., Peelen, M.V., Wiggett, A.J., et al. (2006). The role of the extrastriate body area in action perception. *Society for Neuroscience* **1**, 52–62.

Erk, S., Spitzer, M., Wunderlich, A.P., et al. (2002). Cultural objects modulate reward circuitry. *Neuroreport* **13**, 2499–503.

Freedberg, D. (1989). *The Power of Images. Studies in the History and Theory of Response*. Chicago, IL: Chicago University Press.

Freedberg, D. (2007). Empathy, motion and emotion. In K. Herding and A. Kraus-Wahl (eds), *Wie die Gefühle Ausdruck verschaffen*: Emotionen in Nahsicht. Berlin: Driesen, pp. 17–51.

Freedberg, D. (2009). Choirs of Praise: Some Aspects of Action Understanding in Fifteenth Century Painting and Sculpture. In D. Levine and J. Freiberg (eds), *Medieval Renaissance Baroque: A Cat's Cradle for Marilyn Aronberg Lavin.* New York, NY: Italica Press, pp. 65–81.

Freedberg, D. and Gallese, V. (2007). Motion, emotion and empathy in aesthetic experience. *Trends in Cognitive Sciences* **11**, 197–203.

Gallese, V., Keysers, C., and Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in Cognitive Sciences* **8**, 396–403.

Hare, T.A., Camerer, C.F., and Rangel, A. (2009). Self-control in decision-making involves modulation of the VMPFC valuation system. *Science* **324**, 646–8.

Harvey, A.H., Kirk, U., Denfield, G.H., et al. (2010). Monetary favors and their influence on neural responses and revealed preference. *Journal of Neuroscience* **30**, 9597–602.

Hekkert, P. and van Wieringen, P.C.W. (1996a). The impact of level of expertise on the evaluation of original and altered versions of post-impressionistic paintings. *Acta Psychologia* **94**, 117–31.

Hekkert, P. and van Wieringen, P.C.W. (1996b). Beauty in the eye of expert and nonexpert beholders: a study in the appraisal of art. *American Journal of Psychology* **109**, 389–407.

Jacobsen, T., Schubotz, R.I., Höfel, L., et al. (2006). Brain correlates of aesthetic judgment of beauty. *Neuroimage* **29**, 276–85.

James, W. (1890). *The Principles of Psychology*. New York, NY: H. Holt.

Kawabata, H. and Zeki, S. (2004). Neural correlates of beauty. *Journal of Neurophysiology* **91**, 1699–705.

Keysers, C., Wicker, B., Gazzola, V., et al. (2004). A touching sight: SII/PV activation during the observation and experience of touch. *Neuron* **42**, 335–46.

King-Casas, B., Tomlin, D.A., Anen, C., et al. (2005). Getting to know you: reputation and trust in a two-person economic exchange. *Science* **308**, 78–83.

Kirk, U. (2008). The neural basis of object-context relationships on aesthetic judgment. *PLoS One* **3**, 11.

Kirk, U., Harvey, A.H., and Montague, P.R. (2011). Domain expertise insulates against judgment bias by monetary favors through a modulation of ventromedial prefrontal cortex. *Proceedings of the National Academy of Sciences* **108**, 10332–6.

Kirk, U., Skov, M., Hulme, O., et al. (2009a). Modulation of aesthetic value by semantic context: an fMRI study. *Neuroimage* **44**, 1125–32.

Kirk, U., Skov, M., Nygaard, N., et al. (2009b). Brain correlates of aesthetic expertise: a parametric fMRI study. *Brain and Cognition* **69**, 306–15.

Knutson, B., Fong, G.W., Bennett, S.M., et al. (2003). A region of mesial prefrontal cortex tracks monetarily rewarding outcomes: characterization with rapid event-related fMRI. *Neuroimage* **18**, 263–72.

Koelsch, S., Fritz, T., von Cramon, D.Y., et al. (2006). Investigating emotion with music: an fMRI study. *Human Brain Mapping* **27**, 239–50.

Kringelbach, M.L., O'Doherty, J.P., Rolls, E.T., et al. (2003). Activation of the human orbitofrontal cortex to a liquid food stimulus is correlated with its subjective pleasantness. *Cerebral Cortex* **13**, 1064–71.

Lane, R.D. (1997). Neuroanatomical correlates of pleasant and unpleasant emotion. *Neuropsychologia* **35**, 1437–44.

Lang, P.J., Greenwald, M.K., Bradley, M.M., et al. (1993). Looking at pictures: affective, facial, visceral, and behavioral reactions. *Psychophysiology* **30**, 261–73.

Langlois, J.H., Rubenstein, A.J., Larson, A., et al. (2000). Maxims or myths of beauty? A meta-analytic and theoretical review. *Psychological Bulletin* **126**, 390–423.

LeDoux, J. (1992). Emotion and the Amygdala. In J.P. Aggleton (ed.), *The Amygdala: Neurobiological Aspects of Emotion, Memory and Mental Dysfunction*. New York, NY: Wylie Liss, pp. 339–51.

LeDoux, J.E. (1996). *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*. New York, NY: Simon & Schuster.

Leder, H., Belke, B., Oeberst, A., et al. (2004). A model of aesthetic appreciation and aesthetic judgments. *British Journal of Psychology* **95**, 489–508.

Li, J., Delgado, M.R., and Phelps, E.A. (2011). How instructed knowledge modulates the neural systems of reward learning. *Proceedings of the National Academy of Sciences of the USA* **108**, 55–60.

Li, J., Xiao, E., Houser, D., et al. (2009). Neural responses to sanction threats in two party economic exchange. *Proceedings of the National Academy of Sciences of the USA* 16835–40.

Lipps, T. (1903a). Einfühlung, innere Nachahmung und Organenempfindungen. *Archiv für die Gesamte Psychologie, I* **2–3**, 185–204.

Lipps, T. (1903b). *Aesthetik: Psychologie des Schönen und der Kunst*. Hamburg and Leipzig: L. Voss.

Loewenstein, G., Issacharoff, S., Camerer, C., et al. (1993). Self-serving assessments of fairness and pretrial bargaining. *Journal of Legal Studies* **22**, 135–59.

Maguire, E.A., Gadian, D.G., Johnsrude, I.S., et al. (2000). Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Sciences of the USA* **97**, 4414–16.

McClure, S.M., Li, J., Tomlin, D., et al. (2004). Neural correlates of behavioural preference for culturally familiar drinks. *Neuron* **44**, 379–87.

McWhinnie, H.J. (1966). Effects of a learning experience on preference for complexity and asymmetry. *Perceptual and Motor Skills* **23**, 119–22.

Menon, V. and Levitin, D.J. (2005). The rewards of music listening: response and physiological connectivity of the mesolimbic system. *Neuroimage* **28**, 175–84.

Merleau Ponty, M. (1945). *Phénoménologie de la perception*. Paris: Gallimard.

Montague, P.R. and Berns, G.S. (2002). Neural economics and the biological substrates of valuation. *Neuron* **36**, 265–84.

Montague, P.R., Hyman, S., and Cohen, J.D. (2004). Computational roles for dopamine in behavioural control. *Nature* **431**, 760–7.

O'Doherty, J.P., Critchley, H., Deichmann, R., et al. (2003). Dissociating valence of outcome from behavioral control in human orbital and ventral prefrontal cortices. *Journal of Neuroscience* **23**, 7931–39.

Plassmann, H.O., Doherty, J., Shiv, B., et al. (2008). Marketing actions can modulate neural representations of experienced pleasantness. *Proceedings of the National Academy of Sciences* **105**, 1050–54.

Prinz, W. (1997). Perception and action planning. *European Journal of Cognitive Psychology* **9**, 129–54.

Rilling, J.K., Gutman, D.A., Zeh, T.R., et al. (2002). A neural basis for social cooperation. *Neuron* **35**, 395–405.

Rizzolatti, G., Fadiga, L., Gallese, V., et al. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research* **3**, 131–41.

Rizzolatti, G., Fogassi, L., and Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews Neuroscience* **2**, 661–70.

Rolls, E.T., Kringelbach, M.L., and de Araujo, I.T. (2003). Different representations of pleasant and unpleasant odours in the human brain. *European Journal of Neuroscience* **18**, 695–703.

Russell, P.A. (2003). Effort after meaning and the hedonic value of paintings. *British Journal of Psychology* **94**, 99–110.

Smith, J.D. and Melara, R.J. (1990). Aesthetic preference and syntactic prototypicality in music. *Cognition* **34**, 279–98.

Umiltà, M.A., Berchio, C., Sestito, M., et al. (2012). Cortical motor activation evoked by static images of abstract art: An EEG study. *Frontiers in Human Neuroscience* **6(311)**, 1–9.

van den Bos, W., van Dijk, E., Westenberg, M., et al. (2009). What motivates repayment? Neural correlates of reciprocity in the Trust Game. *Social Cognitive and Affective Neuroscience* **4**, 294–304.

Vartanian, O. and Goel, V. (2004). Neuroanatomical correlates of aesthetic preference for paintings. *NeuroReport* **15**, 893–7.

Vischer, R. (1873). *Ueber das optische Formgefühl; ein Beitrag zur Aesthetik*. Leipzig: H. Credner.

Wagner, A.D., Maril, A., Bjork, R.A., et al. (2001). Prefrontal contributions to executive control: fMRI evidence for functional distinctions within lateral prefrontal cortex. *Neuroimage* **14**, 1337–47.

Wazana, A. (2000). Physicians and the pharmaceutical industry: is a gift ever just a gift? *JAMA* **283**, 373–80.

Winston, J.S., O'Doherty, J., Kilner, J.M., et al. (2007). Brain systems for assessing facial attractiveness. *Neuropsychologia* **45**, 195–206.