The Woodhull Lecture 1995
Visual Art and the Visual Brain

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Introduction

There are certain truths about art and the visual brain that are so self-evident that we may accept them as being largely axiomatic. Chief among these is that we do not see with our eyes but with our brains, the eyes being nothing more than an essential filter and conduit of visual signals to what is known as the primary visual cortex, area VI (Fig. 1), of the brain which itself redistributes the visual signals to yet further visual areas which we have discovered only in the past twenty years or so. No visual art is therefore possible without the visual brain, from which it follows that all art, whether in conception, in execution, or in appreciation, must obey the laws of the brain.

The law of functional specialization

The first of these laws is the law of functional specialization (1), by which I mean that different attributes of the visual scene, such as form, colour, and motion, are processed in geographically separate parts of the visual brain. Experimental evidence has shown that cells in the visual brain are remarkably selective; first they respond to stimulation of only a small part of the field of view, known as their receptive fields, and secondly they are selectively responsive to only some kinds of stimuli falling in their receptive fields. Some, for example, respond specifically to light of certain wavelengths and not to other wavelengths or to white light, others respond to lines of specific orientation and not to other orientations, and yet others respond to motion in one direction and not to motion in other directions (Fig. 2). Cells that are selective for a certain attribute are
**Fig. 1** The visual pathways leading from the eye to the brain. e, eye; on, optic nerve; oc, optic chiasm; ot, optic tract; lgb, lateral geniculate body; or, optic radiation; sc, superior colliculus; str, striate cortex.

**Fig. 2** This cell responds only when a bar is moved within its receptive field (dotted outline), and further, it responds when that motion is in one direction only (towards 1 o'clock).
grouped together in particular areas of the cerebral cortex, thus conferring their specialization on the areas.

A simple way of demonstrating this in the human brain is to let humans look at particular types of visual stimuli, in which particular attributes such as motion or colour are emphasized, and measure the change in the cerebral blood flow, itself indicative of an increase in activity in specific parts of the brain (Fig. 3). When one does so, and examines horizontal slices through the brain in which areas of highest activity are shown in white, one finds that looking at an abstract multicoloured scene with no recognizable objects activates not only area V1, through which visual signals enter the brain, but another area, the 'colour centre', located in the

Fig. 3 A subject is placed in a Positron Emission Tomography (PET) scanner, which detects increases in cerebral blood flow. Whilst in the scanner the subject is shown a static multicoloured display, and increased activity is detected in an area known as V4 (left). If the subject is shown a pattern of moving dots, activity is detected in another area, known as human V5 (right). In both these conditions, areas V1 and V2 are active (centre). (After Zeki S., *La Recherche*, 1990; 21, 712-721).
cortex surrounding area V1, to which we refer as area V4. On the other hand, when one stimulates with a pattern of small black and white squares that move in different directions, one finds that this time, in addition to the activity in V1, there is another area in the visual brain outside V1, quite separate from the colour centre, which becomes active, an area which we refer to as the 'motion centre' or area V5(2).

A second law follows from this demonstration, namely that the brain assigns special areas to the processing of those visual features that are of particular significance to the organism. Colour, form, motion, faces, facial expressions, and even body language fall into this category and all have their separate representational seats in the cortex. I put forward the seemingly obvious proposition that it is those attributes that are separately mapped in the visual brain that have primacy in art. I do not mean to imply that the aesthetic effects of colour depend uniquely upon the area of the visual brain which is specialized for colour but only that that area is necessary for any colour experience at all and that without it no aesthetic experience of colour is possible. Consider this: when the colour centre is damaged as a consequence of a stroke, the result is cerebral achromatopsia or an inability to see the world in colour(3). Patients with such a lesion uniformly describe the world as consisting of dirty shades of grey. They are no longer able to obtain one particular type of knowledge about the world. Colour perception is not possible for an achromatopsic patient and he can therefore have no aesthetic experience in that domain. It is little use asking such a patient to admire the subtleties of fauvist art or to appreciate the mature poésie of Titian, expressed in colour. Indeed, one of the achromatopsic patients that I examined, the patient of Oliver Sacks, was himself an artist, and a great admirer of Impressionist art as well as the art of Vermeer. He told me that since becoming achromatopsic, he could no longer bear to go to an art gallery.

Or consider portrait painting, which has been a dominant feature of Western art, as another example. One function of portrait painting, especially in the days before photography, was to acquaint or to remind men and women of what their loved ones or future spouses look like, because the recognition of individuals is most often and most easily done through their faces. It is because of this that the brain has devoted an entire area to the recognition of faces, which in turn explains why portrait painting has been such a dominant feature in our art.

Perhaps the first thing to notice about a portrait is that the face usually dominates the painting even if it does not constitute the predominant part in terms of size or luminosity. There are many examples of this; especially prominent among these are many of Rembrandt's portraits as
well as those of his contemporaries, where the intensity of light reflected from the then fashionable collars is much greater than that reflected from the face, which is in fact sometimes half obscured. Apparently, the brain is much more interested in focusing and concentrating on the face - because it yields a good deal more information. The rest of the painting is a sort of prop, enhancing aesthetically the portrait but not necessary to it - the face can survive on its own. The area of the brain that is critical for the recognition of familiar faces lies ventrally in the occipital lobe, close to the colour centre (Fig. 4, arrowed region), and damage to it leads to the condition of prosopagnosia, or the inability to recognize familiar faces. In this condition, the brain is no longer able to obtain visual knowledge about a particular person through the face. It is in many ways an extraordinary syndrome, when the subject can recognize the details of a face, the eyes, the nose, the mouth, and so on but cannot put all these details together to recognize a particular face\(^4\). There is one extraordinary and somewhat frightening description of a patient who suffered a stroke that struck the relevant area while he was with his physiotherapist. "What is happening, Mademoiselle," he said, "is that I can no longer recognize your face", even though he knew perfectly well who she was\(^5\). Such patients often have to use other features, such as the voice,
to recognize familiar faces. Again, I do not maintain that the aesthetic quality of a portrait is uniquely dependent upon the relevant area in the fusiform gyrus, but only that the recognition of familiar faces, and therefore one of the aims of portrait painting, is not possible without this area, from which it follows that there can be no aesthetic quality associated with a particular face when a portrait is viewed by a prosopagnosic patient.

People of course change and die and memories of what they looked like soon fade away. The fact that the art of portrait painting outlives the person portrayed derives from the fact that portraits tell us a good deal more than what a person looked like, and a glance at a portrait may tell us whether the person portrayed is sad or happy, arrogant or humble, and much else besides. Portraits are therefore a way of giving the spectator knowledge about the personality of someone, even someone whom we have never met. Titian's portrait at the National Gallery, said to be of himself, is that of a man recognizable at a glance as being somewhat arrogant and disdainful. To that extent, it is representative of a host of such faces and therefore of such people and to that extent there is a constancy about it since it captures the essential ingredients of what the brain interprets as that type. Artists have developed a great many tricks to communicate to us, visually and through our brains, the characteristics that mark a person. In his portrait Titian uses the device of the twisted view, apparently then common in Italy\(^6\), to enhance the effects of self-assuredness, his subject looking at us with his eyes only, his head being only partially turned in our direction. There are many other examples one could give but perhaps the above suffices to make the point that small and subtle changes, especially in the eyes, can make a big difference to the brain's perception of faces and its ability to acquire knowledge about them.

The fact that my brain as well as yours can categorize at a glance the Titian portrait as that of a haughty and self-confident person effectively means that Titian (or his brain) managed to capture on canvas an essential feature which gives immediate knowledge about that person.

Whether the portrait itself bears any likeness to Titian or not is immaterial, except perhaps to Titian himself and to those who knew him well. Perhaps Michelangelo was right when, reproved because his sculptures for the Medici tombs in Florence bore little resemblance to the Medicis buried inside, he replied, 'In a thousand years, who will remember what the Medicis looked like'.

Now it is, to me at any rate, an astonishing fact about the organization of our visual brain that it is capable of separating recognition of a face from the expression on a face\(^7\). If you take a prosopagnosic patient, one
who can no longer recognize familiar faces, and ask him to describe whether the expression on a familiar face that he is no longer able to recognize, is that of a sad or happy person, he can do so with accuracy. It is only when lesions extend more anteriorly in the fusiform gyrus that the perception of a face and of the expression on it are abolished. One is led to the perhaps surprising conclusion that, because of the important knowledge that both the face and the expression on it can give, separately, the brain has allocated separate areas for each.

**Functional specialization in visual aesthetics**

We can now ask whether, in neurological terms, there is a single unified sense of aesthetics or whether there are many different aesthetics, each one linked to a separate system. Whatever the philosophical or artistic answer to that question, there seems little neurological doubt that there are many different aesthetics within the domain of vision, attached to say colour, or to expressions, or to movements, or to forms, that each is tied to a separate set of cortical areas, and that the destruction of one need not entail the destruction of all. I am tempted to generalize and say that there is a functional specialization in aesthetics, which does not exclude the fact that all of these separate aesthetic systems may both interact with one another and also lead to a higher aesthetic which neurology has not even begun to investigate. In the same way, the fact of functional specialization does not imply that the different systems do not interact with each other and lead to the final image in the brain, which is a synthesis of all the different attributes, undertaken by the brain in a way that we still do not understand.

**The law of constancy**

The third law is perhaps the most fundamental of all the laws regarding the visual brain and it is in it that I find a direct link between the functions of art and the functions of the brain. I will call it the law of constancy and both its significance and its relation to art will become clearer if one were to ask the most fundamental of all questions regarding the visual brain, surprisingly a question that is never asked in practice: why do we need to see at all? Different people would probably have different answers to that question; few, I imagine, would believe that we see in order to be able to appreciate art. Most would perhaps give answers such as: in order to be able to recognize people, or to find your way about, or to acquire food, or to read. Yet none of these answers is satisfactory,
because none is broad enough. Many animals, among them mice and moles, have very rudimentary vision, if indeed they have any at all, and are yet fairly successful in negotiating their way about their environment and generally in undertaking such activities which have allowed them to survive successfully. The answer to our question is, I believe, much simpler and more profound—we see in order to be able to acquire knowledge about this world.

Vision is not of course the only sense through which we can acquire that knowledge. Other senses do just the same thing. Vision just happens to be the most efficient way of acquiring knowledge, which is perhaps one reason why so large a part of our brains, amounting to perhaps one-quarter of the total, is devoted to vision. Moreover, there are certain kinds of knowledge, such as the colour of a surface or the expression on a face, that can only be acquired through vision.

Such a definition of vision is not one voiced by neurologists and I have never encountered it among artists, though I may of course be ignorant of much that they have said. Yet it is perhaps the only definition that unites neurology and art, that finds a common thread linking the functioning of the visual brain to the function of visual art, which is itself one of the products of the brain. It is, at any rate, a definition worth exploring, because in it I find a general and unifying theory of visual aesthetics, one that encompasses the views of Plato and Michelangelo, of Schopenhauer and Heidegger, no less than those of Cezanne, Braque, and Mondrian, but one which, unlike theirs, is based on the functions and functioning of the visual brain.

It requires little to realize that the acquisition of knowledge by the visual brain cannot be an easy matter. Our visual environment is in a continual state of flux and objects and surfaces are viewed from different angles and distances, and in different lighting conditions. But the brain is only interested in the permanent properties of objects and surfaces. Vision is, therefore, a search for essentials. To extract those essentials from the ever-changing information reaching it, the brain must undertake three interdependent processes: it must discount and discard much of the information that reaches it, it must select from that information only that which is necessary for acquiring knowledge about the permanent, constant, and essential properties of objects, and, finally, it must compare the selected information with its stored record and hence identify and categorize an object as belonging to one or another group of objects. One can see that the first law, of functional specialization, is intimately connected to the third, the law of constancy, because the kind of information that the brain has to discard to get at one attribute of the visual scene, say its colour, is very greatly different from the kind of information that it has to
discard to get at another attribute, say the size; in the former, the brain has to discount the illuminant in which a colour is viewed and in the latter the viewing distance. Hence the brain has dedicated special areas for extracting the constants related to different attributes.

Vision is not, therefore, the passive process that we have for so long supposed it to be, but an active one in which the brain constructs the visual image and that final visual image depends as much upon the external physical reality as it does upon the operations of the brain. Consider colour: the brain is able to assign the colour 'green' to a leaf whether the leaf is viewed at noon on a cloudy or sunny day or at dawn or dusk. If one were to measure the wavelength composition of the light reflected from the green surface objectively one would find considerable variations, including at times an excess of long-wave (red) light—it is as if the apparent, objectively measured, 'truth' tells us that the surface is not always green. Yet, by comparing the wavelength composition of the light reflected from the leaf with that which is reflected from the surround, the brain is somehow able to discount the objective measure and to assign a constant colour, green, to the surface. The ability of the brain to assign a constant colour to a surface, in spite of wide-ranging differences in the illumination conditions under which that surface is viewed, is one that Helmholtz called the process of 'discounting the illuminant' and thought that it is done by an unconscious inference by the brain in its desire to get to the essence of things; today we call it 'colour constancy' and know that it is the product of neural interactions within the colour centre. Gleizes and Metzinger, in their book on Cubism, wrote of the necessity for an artist to 'sacrifice a thousand apparent truths' to get to the essence of things, a statement remarkably similar to that of Helmholtz. A physiologist, in describing the functions and functioning of the visual brain, could hardly improve on that statement. The final visual image in the brain is thus dependent upon both the external, physical, reality and on the rules and activities of the brain.

This analysis of the functions of the visual brain not only illustrates why there is a law of constancy, but also provides us, I think, with the beginnings of what I shall call a general constancy theory of visual art. Such a theory would define art as an extension, or a manifestation, of the functions of the brain in the quest for constancies and therefore for essentials.

The neurology of the Platonic ideal

In Athens, some two and a half thousand years ago, the circle of Plato talked about these problems, and summarized the problem of painting as
they saw it. Consider the following lines, taken from Book X of Plato's *Republic*:

Does a couch differ from itself according as you view it from the side or the front or any other way? Or does it differ not at all in fact though it appears different, and so of other things?

That is the way of it, he said. It appears other but differs not at all.

Consider then this very point. To which is painting directed in every case, to the imitation of reality as it is or of appearance as it appears? Is it an imitation of a phantasm or of the truth?

Of a phantasm, he said.

Then the mimetic art is far removed from the truth.

Yes, he said, the appearance of form, but not the reality and the truth

(from ref. 11)

To Plato, then, painting was a relatively low art, a mimetic art, one that could only represent one aspect of a particular example of a more general category of object. Indeed, given a chance he would have banished all painters from his millenial Republic since they could only capture one facet of the truth. To him, and to the ancient Greeks in general, there was the general ideal, the ideal couch in this instance, which was the embodiment of all couches; then there was a particular couch which was but one example of the more general, 'universal', couch; and, finally, there was painting, which captured but one facet, one image, of one particular couch. 'The Greeks', Sir Herbert Read(12) tells us, 'with more reason, regarded the ideal as the real, and representational art as merely an imitation of an imitation of the real'.

The example that Plato gives above, that of a couch, is an interesting one in that a couch is not necessarily associated in most minds with great beauty or aesthetic appeal. This choice is probably deliberate, for the view expressed in the passage is only one example of a more general theory of form. If we ask what is a couch, we do not ask about a particular couch but instead enquire into what all couches have in common, in other words we ask about that property which enables us to categorize them as couches. The common elements identify them. So what Plato was really saying was that a single view or image of a particular couch, depicted in a painting, could not be representative of all couches and could not therefore give knowledge of all couches. Without saying so explicitly, and almost certainly without realizing it, he was really comparing the 'phantasm' of painting with the reality of perception, a func-
tion of the brain, where there is no problem with a particular facet or view, because the brain usually has many views of the same object and is able to combine all the views to acquire knowledge about an object. Plato therefore implied that painting should strive to expand and possibly change direction in such a way that, by viewing one painting alone, we should be able to acquire knowledge about all objects of that category represented in the painting. What he only implied, Schopenhauer made explicit many centuries later, when he wrote that painting should strive 'to obtain knowledge of an object, not as a particular thing but as Platonic Ideal, that is the enduring form of this whole species of things' (13), a statement that a modern neurobiologist could easily accommodate in describing the functions of the visual brain. Painting, in other words, should be the representation of the constant elements, of the essentials that would give knowledge of all couches; it should, in brief, represent constancies. As John Constable put it in his Discourses (14) '... the whole beauty and grandeur of Art consists ... in being able to get above all singular forms, local customs, particularities of every kind... [The painter] makes out an abstract idea of their forms more perfect than any one original, the 'abstract idea' being presumably Constable's term for the Platonic Ideal.

It is not difficult to see that, in the opinion of Plato and other like-minded philosophers, painting could be described in neurobiological terms as a search for constancies, a means of getting above all, 'singular forms [and] particularities of every kind', in fact of achieving precisely what the brain does so effortlessly. The brain is interested in particularities, but only with the broader aim of categorizing a particularity into a more general scheme. For the brain, a couch is categorized immediately as something that you lie down on or sleep in, provided it is given a sufficient amount of information to identify it as such. This identification is dependent upon the brain's stored memory of couches in general, and is not therefore dependent upon any given view because the brain has already been exposed to many different views of many different couches; any one of these is sufficient to allow it to classify a couch as a couch. As Gertrude Stein might have said, for the brain, a couch is a couch is a couch, just as a rose is a rose is a rose.

In neurological terms, therefore, the Platonic Ideal is nothing more than the brain's stored representation of the essential features of all the couches that it has seen and from which, in its search for constancies, it has already selected those features that are common to all couches. We know a little, but not much, about the brain's stored visual memory system for objects. We know that it must involve the inferior convolution of the temporal lobes because damage here causes severe problems in
object recognition. Although very much in their infancy, recent physiological studies\(^{(15)}\) have started to give us some insights into the more detailed physiological mechanisms involved. When a monkey, an animal that is closely related to humans, is exposed to different views of objects that it has never encountered before (objects generated on a television screen), one can record from single cells in the inferior temporal cortex to learn how they respond when these same objects are shown on the television screen again. Most cells discharge in response to one view only, and their response declines as the object is rotated in such a way as to present increasingly less familiar views. A minority of cells respond to only two views but only a very small proportion, amounting to less than 1 per cent, respond in a view-invariant manner. Whether they respond to one or more views, the actual size of the stimulus or the precise position in the field of view in which they appear makes little difference to the responses of the cell. On the other hand, no cells have ever been found that are responsive to views with which the animal has not been familiarized; hence exposure to the stimulus is necessary, from which it follows that the cells may be plastic enough to be 'tuned' to one or more views of an object. In summary, many cells, each one responsive to one view only, may be involved during recognition of an object, the whole group acting as an ensemble.

Interesting though such cells are, they cannot present the entire physiological background to object recognition. We know that this is a property that must be very widely distributed in the brain, a supposition that follows directly from the functional specialization of the many, widely distributed, visual areas. That it must be very widely distributed and require the co-operation of several areas is also shown by the fact that, except for lesions of V1, which lead to total blindness, there is no known example of a lesion restricted to the cortex surrounding V1 which disrupts recognition of all aspects of the visual world or indeed of all shapes and objects. We also know that the cerebral mechanism for eliciting different visual memories may in fact differ. We know, finally, that the temporal lobe and structures in its vicinity, such as the hippocampus, are involved, partly because electrical stimulation of these regions reawakens long-forgotten memories and partly because damage to them, and especially the hippocampus, leads to severe problems of memory. But of the detailed mechanisms we are more or less ignorant.

We can now begin to see that there is a straightforward relationship between the Platonic Ideal and the brain-based concept of constancies. A couch may be said to have certain constant features, no matter what angle one views it from, and it is these constant features, the ones that it shares with all couches, that are represented in the brain. Likewise the
Platonic Ideal of a couch is what is common to all couches; it is in fact the brain's stored record.

**The aims of Cubism**

It was Cubism that set out to address that deep paradox between reality and appearance in representational art and its absence in ordinary visual perception that Plato had alluded to. Cubism was inaugurated by Picasso and Braque as one of the most radical departures in Western art since Paolo Ucello and Piero della Francesca introduced perspective into painting. The precursor of this style is generally accepted to be Picasso's *Les Demoiselles d'Avignon* (Fig. 5) where the beginnings of the effort to eliminate both perspective and the point of view are evident. Especially notable is the figure to the bottom right, who could be sitting sideways, or facing us, or facing away from us and, to a lesser degree, there is also an ambiguity in her face. That ambiguity is taken to greater lengths in *Portrait of a Woman* (Fig. 6) and heightened further in later representative

![Les Demoiselles d'Avignon](image)

**Fig. 5** *Les Demoiselles d'Avignon* by Pablo Picasso. (The Museum of Modern Art, New York.)
paintings such as the *The Violin Player*, where Picasso approached the naturalistic image from so many different viewing angles and combined these views onto canvas (attempting in a way to represent the real violin player, not a particular violin player) that the final product is barely recognizable as a violinist, save through its title. Hence Picasso and Braque were trying to achieve a sort of constancy—the major attribute of the visual brain. And here you begin to see the limitations of art when compared with the infinite capacities of the brain. The brain can unite these separate views into one, and the result is not the unrecognizable image that Picasso’s painting presents.

![Fig. 6 Portrait of a Woman by Pablo Picasso.](image-url)
The aims of Cubist painting were stated at the beginning of this century by Jacques Riviere\(^{(16)}\). Without referring to Plato, what he wrote is almost identical to what Plato had said some two thousand years before, and like Plato, made without reference to the brain, though it is doubtful if a neurologist could find more adequate words to describe the operations and functions of the brain:

> The Cubists are destined to give back to painting its true aims, which is to reproduce objects as they are. But, to achieve this, lighting must be eliminated because it is the sign of a particular instant. If, therefore, the plastic image is to reveal the essence and permanence of things, it must be free of lighting effects. It can therefore be said that lighting prevents things from appearing as they are ... Contrary to what is usually believed, sight is a successive sense; we have to combine many of its perceptions before we can know a single object well. But the painted image is fixed. Perspective must also be eliminated because it is as accidental a thing as lighting. It is the sign, not of a particular moment in time, but of a particular position in space. It indicates not the situation of objects but the situation of a spectator. Perspective is also the sign of an instant, of the instant when a certain man is at a certain point.

But that is precisely what the brain does—to reproduce objects as they are, no matter what angle they are viewed from.

Given this very close similarity between the aims of the visual brain and the aims of art, one may indeed regard the aim of the latter as being nothing less than an extension of the aim of the former. And given this similarity, it is surprising that the connection between the two has never been made before. The reason for this is simple. It is only in the past few years that we have begun to understand that vision is not a passive process but an active search for essentials. Previous to that, we commonly thought of vision as being nothing more than a simple photographic process, with an image of the visual world, in all its forms, colours, and movements, being impressed on the retina and then transmitted to be received, passively, by the visual receiving area, V1, in the cortex. The image thus received would be interpreted by the cortex surrounding V1, called the visuo-psychic cortex, thus leading to the understanding of what was seen. Vision was therefore conceived of as a dual process, of seeing and understanding, with each faculty having a separate cortical seat. That view has its basis in a simple and powerful anatomical fact, namely the nature of the connections between retina and cortex and the consequences of damage to these connections or to the visual receptive cortex. For it was, until very recently, one of the best established facts about the visual brain that the retina connects with V1 only, with
adjacent points on the retina connecting to adjacent points on V1, thus recreating a map of the retina on the cortex (Figure 1). The consequence of damage to this pathway, or to the visual receptive cortex (V1), is blindness. The extent and position of the blindness is proportional to the extent and position of the damage: the blindness is total if the whole of V1 is damaged and sub-total if the damage is only partial. The cortex surrounding V1 was thought not to receive an input from the retina, but to receive its visual input from V1 instead. It is no wonder, therefore, that the founding fathers of our subject considered that seeing consists of a passive process, that it is with our V1 that we see and that it is with the vaguely defined cortex surrounding it that we understand what we see, without realizing that seeing is, in a sense, understanding and that the two processes are not easily separable.

Our new concept of the functions of the visual brain allows us better to consider art as being an extension of the functions of the brain in its search for essentials. And great art can thus be defined, in neurological terms, as that which comes closest to showing as many facets of the reality, rather than the appearance, as possible and thus to satisfying the brain in its quest for essentials.

A neurological excursion into the art of Vermeer and Michelangelo

With that thought in mind, it is perhaps interesting to consider Jan Vermeer's Man and Woman at the Virginal, now in Her Majesty's collection, I thought that I ought not to pass judgement on any painting. Who am I, after all, to pronounce on the quality of these works? But in the end the judgement cannot be avoided, although I do so with diffidence and humility and then only as a neurobiologist. The painting, I believe, derives its grandeur and unique position not only from its technical virtuosity but also from its ambiguity, by which I mean its ability to represent simultaneously, on the same canvas, not one but several truths, each one of which has equal validity with the others. These several truths revolve around the relationship between the man and the woman. She could be his sister, his pupil, his wife, or his lover; he could be just listening to her playing, or announcing a separation or a reconciliation. All these scenarios have equal validity in this painting which can thus satisfy several 'ideals' simultaneously—the brain can recognize this and categorize it as representative of a happy or sad event. This gives ambiguity—which is a characteristic of all great art—almost a different, and neurological, definition, not the vagueness or uncertainty found in
the dictionaries, but on the contrary, certainty; the certainty of many different, and essential, conditions, each of which is equal to the others, all expressed in a single profound painting, profound because it is so faithfully representative of so much.

If Vermeer achieved his effect in a finished painting, another, who has a place among the highest, at times tried to achieve the same multi-representation in exactly the opposite way. It is well known that Michelangelo spent much time and effort trying to portray not only physical beauty but also spiritual beauty and divine love, particularly in relation to the Descent from the Cross. It is equally well known that he often left his sculptures unfinished. Perhaps the most famous among these are his two sculptures, the San Matteo and the Rondanini Pieta, but there are others. By deliberately leaving them unfinished, he allowed the viewer to become imaginatively involved and perhaps see many possible, equally valid, designs and forms, not one. As Gleizes and Metzinger were to say much later in their book On Cubism, 'Some forms must remain implicit, so that the mind of the spectator is the concrete place of their birth'.

To best appreciate Michelangelo's aims and approach, it is as well to look at his Sonnets, where he best expressed his theory of art and beauty. In one of them, The Lover and the Sculptor, dedicated to Vittoria Colonna, he tries to tell us that the artist experiments to discover what the brain can really see. He wrote:

\[
\text{The best of artists have no thought to show}
\]
\[
\text{That which the rough stone in its superfluous shell}
\]
\[
\text{Does not include: to break the marble spell}
\]
\[
\text{Is all that the hand that serves the brain can do}^\dagger
\]

**The pathology of aesthetics**

But, Plotinus, another Neo-Platonist and one whose writings Michelangelo was surely acquainted with, had said many centuries before him, 'the form is in the designer long before it ever enters the stone'. It is, of course, in the viewer as well, which is precisely why forms can remain implicit. But if the form is in the designer before it ever enters the stone, then it is just possible that the artist needs no external scene to inspire his art. This is, in fact, the starting point of the non-objective art of the

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^\dagger I have used the translation by Symonds; other translations do not use the word 'brain'. The actual word used in the original is *intelletto*. In Latin, *intellectus* meant perception or 'a perceiving' and Symonds has, astutely in my view, rendered this as 'brain'.

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Russian Suprematist, Malevich, who wrote that 'Art wants nothing further to do with the object as such'. I do not know what Malevich meant by 'as such', but I am pleased that he used the word 'further' in that statement, because vision, and in consequence art, cannot be divorced from the objects in the world, a fact which also gives the lie to the Platonic Ideal of an abstract form, existent in the world outside, independent of a perceiving brain. For we know that people born blind because of a congenital cataract, and to whom vision is later restored, find very great difficulty in seeing. One of the first such operations was performed by a French ophthalmologist on an eight year old boy. The ophthalmologist had anticipated the return of vision with much pride and enthusiasm. 'But', he wrote, 'the deception was great'. It took many months of training to teach his patient to recognize only a few objects by sight and these he had forgotten within two years. Von Senden, who perfected the operation in Germany, tells us that many such patients are not even delighted with the return of vision, if such it can be described, preferring to use the sense of touch to recognize objects. We now know that although the connections from the eye to the brain are genetically determined, they nevertheless atrophy and die if the visual system is not nourished during a critical period after birth. The consequence is that the cells in the visual brain of an individual deprived of vision during the critical period are either not visually responsive or respond in a vague and unpredictable manner, quite unlike the vigorous and selective responses of the cells in the visual brain of a healthy individual. People deprived of their vision have no Platonic Ideal of a couch or of anything else. Hence the use of the word 'further' by Malevich at least implies that at one point the artist did need the object, which is correct neurologically. So the non-objective sensation and non-objective art of Malevich and his followers is in fact the introspective art of a brain already well acquainted with the visual world, with the objective world. It has a Platonic Ideal; it has already selected all the essential information that is necessary for it to identify and categorize objects. And true to its aims, of being a search for essentials and constants, we find that as art developed more and more in the modern era, it became better and better tailored to the physiology of the areas of the brain that I have mentioned, and specifically to the physiology of the single cells in them, because the physiology of these areas is itself tailored for extracting the essential information in the visual environment. That is the beginning of the art of Malevich, which is the precursor of much else in relatively modern art and which has, without acknowledging its motives, tried best to explore this developed inner neurological world, and has therefore tried to understand the workings of the brain in a relatively simple and comprehensible way.
Not everyone, even among artists, admires modern art or some of the works I shall describe. John Ruskin, in his Friday evening Discourse given at the Royal Institution in February 1867, interestingly thought that the relatively modern art of the time was an expression of isolation of individuals in an alienated society. Other artists thought that such simplification debased art itself. Gustave Moreau, in whose studio Matisse worked, once told Matisse 'Vous voulez simplifier la peinture', disapprovingly according to some and approvingly according to others. But Matisse, in a different context and time, replied:

Underlying this succession of moments which constitutes the superficial existence of things and beings, and which is continually modifying and transforming them, one can search for a truer, more essential character, which the artist will seize so that he may give to reality a more lasting interpretation (my emphasis). 

No neurobiologist of vision could improve on this statement, save only to substitute the word 'brain' for the word 'artist'.

The art of the receptive field

What was the result of the so-called non-objective art of Malevich? A striking feature is the use of lines or bars of various shapes and widths and also of squares and rectangles (Fig. 7). In this he was followed by the Russian Constructivists, who also emphasized lines, as can be readily seen when one surveys the achievements of Russian artists of that period. They were not alone in this. Mondrian too ended by emphasizing the line but reached that end from a different beginning and with a different approach. He had started with naturalistic painting and had been much attracted to Cubism. But he had been disappointed with the development of Cubism, which had failed to get to the essence of form and had abandoned the quest, or so he believed. Instead it had developed in a different direction, characteristic of the later Synthetic Cubism, in which the emphasis was on the creation of new forms. Mondrian wrote that '... Cubism did not accept the logical consequences of its own discoveries; it was not developing abstraction towards its ultimate goal, the expression of pure reality ... To create pure reality plastically it is necessary to reduce natural forms to the constant elements' (original emphasis). 'Art', he thought, 'has two main human inclinations ... One aims at the direct creation of universal beauty, the other at the aesthetic expression of oneself' (original emphasis). The first is more or less objective, the latter subjective. The first had to be objective because 'Since
art is in essence universal, its expression cannot rest on a subjective view', even if 'our human capacities do not allow of a perfectly objective view'. Art, he believed, 'shows us that there are also constant truths concerning forms' and it was the aim of objective art, as he saw it, to reduce all complex forms in this world to one or a few universal forms, the constant elements which would be the constituent of all forms, to '... discover consciously or unconsciously the fundamental laws hidden in reality' (my emphasis). This led him to pure abstract art, 'the art that is concerned with the basic elements of form'\(^{(25)}\) and the search, through that art, led to the vertical and horizontal lines, or so he believed. These '... exist everywhere and dominate everything'. Moreover, the straight line, '... is a stronger and more profound expression than the curve'\(^{(24)}\) because '... all curvature resolves into the straight, no place remains for the curved'\(^{(26)}\). He sought, in other words, the Platonic Ideal for form (though he did not describe it in
these terms). He wrote, 'Among the different forms, we may consider those as being neutral which have neither the complexity nor the particularities possessed by natural forms or abstract forms in general'\(^{(24)}\). In this search, Mondrian settled on simple vertical and horizontal lines.

**Malevich**

Are these the intellectual wanderings of painters or were they really using non-objective sensation and experimenting with the capacities of the brain? I leave it to you to decide whether it was an accident, a mere coincidence, that the very elements, the lines, that Malevich thought represented non-objective art and that Mondrian thought represented the essentials of form and which both therefore emphasized so much in their work, are the very stimuli to which so many of the cells in specific areas of the visual brain are selectively responsive. These so-called orientation-selective cells, cells that respond to lines of certain orientation and not as well or not at all to lines of other orientations, are considered by physiologists to be the neural 'building blocks', or the essentials, of form perception (Fig. 8). Thus, in their separate searches, the different artists came to put on canvas the basic building block that the brain uses to represent forms. It is for this reason that I shall refer to this art, and to other kinds of art which can be related directly to the responses of single cells in the visual cortex, as *the art of the receptive field*.

**The Métamalevich and the activation of V3**

Cells that are specifically responsive to lines of particular orientation presented in their receptive fields are widely distributed in the visual brain. In some areas, like areas V3 and V3A, the cells respond best to lines of specific orientation if these lines are not held stationary within their receptive fields but actually move back and forth in a direction that is orthogonal to their preferred axis. It is perhaps this latter property that Gabo, Tinguely, and, more recently, Hugo DeMarco, have exploited in their work, though of course without reference to the brain. Jean Tinguely conceived of the neurologically interesting idea of setting the work of Malevich, dominated by oriented lines, into motion and calling the new creation the *Métamalevich* (or the *Métakandinsky* or *Métamatiqques*). The prevalence of straight lines in motion would ensure that the *Métamalevich* is a strong stimulus for the cells of area V3 and V3A. It is interesting to note that the cells of both the latter areas are indifferent to colour, that is to say that they respond to lines of their preferred orientation irrespective of the colour of the oriented line; perhaps correspond-
ingly, Tinguely de-emphasized colour in his work, restricting himself to the use of blacks, whites, and greys; others, like Gabo in his *Kinetic Sculpture* and Hugo DeMarco in his *Série Relations* have done much the same. In fact, a very substantial restriction of the palette is very characteristic of kinetic art in general.

It is hard to think of visual stimuli that are better suited to activating the cells of the V3 complex (V3 and V3A) than the creations of Malevich and his successors and the extension of this work into the *Métamalevichs of Tinguely*. But the shift from a Malevich to a *Métamalevich* involves more than a shift in artistic form or emphasis. It actually involves the stimulation of a separate group of cells in the brain, and specifically in areas V3 and V3A. In both these visual areas, there are two groups of orientation-selective cells. One responds to oriented lines that are statically presented within their receptive fields, even in spite of the fact that the eye is continually moving back and forth in scanning.

![Diagram](image.png)

**Fig. 8** This cell responds best to lines of a specific orientation, and responds less to other orientations.
them and thus generating a sort of passive motion of the stimulus. The cells of the other group can discount the displacement, and hence the movement, that is due to the eyes; its cells only respond if the oriented line itself is in actual motion, in other words it only responds to real motion\(^{(27)}\).

Oriented lines also enclose squares and rectangles and both were considered to be basic forms by Mondrian-'the plurality of straight lines in rectangular opposition' as he called it. They were especially so considered by Malevich and Kandinsky, who thought that the square and the rectangle constituted the two most important elements of non-objective art. Many other artists, including Joseph Albers and the contemporary American artist Ellsworth Kelly as well as Ben Nicholson, emphasized these simple shapes in their paintings. Again, is it purely accidental that so many of the receptive fields of single cells are rectangular or square in shape? Take the receptive field of a single cell in area V4; this cell responds best to a blue patch against a white background (Plate 1) and does not respond much against a black background which in fact suppresses somewhat the cell's response. The resultant configuration of what this cell responds to best is not vastly different from a Malevich square (Plate 2). Is this a pure coincidence, or did Malevich and the others uncover a neurological secret? I leave this for you to decide.

**Colour is a creation of the brain**

There is a reason why the cell illustrated above, and others like it, have receptive fields with such sharp boundaries, and the reason is physiological, not artistic. This is perhaps best addressed by looking at the colour system, where the presence of a surround is critical in the determination of the colour of a given patch. Not surprisingly, it is a characteristic of area V4 that the cells in it have strong surrounds to their receptive fields, which influence their responses\(^{(28-31)}\). This is no doubt partly a reflection of the fact that the brain determines the colour of a surface by gauging the wavelength composition of the light reflected from it and comparing it with the wavelength composition of the light reflected from the surround. It is through this comparison that the brain is able to assign a colour to an area. This can be demonstrated by a simple experiment, which we owe to Edwin Land\(^{(31)}\), but which is essentially a formal demonstration of what each one of us experiences many times during the day. It well illustrates the fundamental law of constancy, as applied to colour. If you were to arrange it so that one surface of a multicoloured abstract display containing no recognizable objects,
say the green one, reflects a given amount of red, green, and blue light, say 30, 60, and 10 units respectively, and switch on all three projectors, you will perceive the colour of the green surface to be green. Hardly surprising, you may say, since in this condition the green patch reflects a lot more green light and the surround a lot less. But now if you arrange the same green surface to reflect 60, 30, and 10 units of red, green, and blue light respectively, that is twice the amount of red than of green light, and switch on all three projectors, the green area will still appear green. This is because, with the change from one illuminant to the other, the areas surrounding the green surface will reflect less green light and more red light and, since the brain is not interested in absolute energies but only relative values, it is able to take the ratio of the red and green light reflected from the centre and the surround and thus make itself independent of the absolute amounts. The same procedure applies to all the other squares of different colour.

Colour is therefore a comparison. That comparison is undertaken by the brain, not the world outside, and the result of that comparison belongs to the brain, not the world outside. It is one that is determined by the functional logic of the brain, nothing else. This leads me to agree with André Malraux when, in his book *Les Voix du Silence*, he qualifies as 'cette phrase maladroite' Cézanne's saying that 'Il y a une logique colorée; le peintre ne doit obéissance qu’à elle, jamais á la logique du cerveau' ('There is logic to colour; the painter must obey this, never the logic of the brain'). In fact, the construction of colour by the cerebral cortex is an example of the brain going beyond the information given according to its own rules and logic. It was Newton who said that 'the Rays to speak properly have no Colour; in them there is nothing else than a certain power and disposition to stir up a sensation of this Colour or that'. The stirring up of that sensation requires the brain to undertake an operation—and thus go beyond the information provided by the physical environment.

**The liberation of colour**

Note that, to construct colour, the comparison that the brain undertakes is in the wavelength composition of the light reflected from one surface and the wavelength composition of the light reflected from surrounding surfaces. But the surrounding surfaces have a border with the surface in question, and the border has a shape. Hence the impossibility of separating colour from form. This, one is sometimes told, is what the fauvists tried to do. It is no wonder that none succeeded, because they tried something that is physiologically impossible. In the end, they opted for a different solution, which was to highlight the colour in a painting by
attaching it to a form with which it is not normally associated, for example a red sea, or a green sun, and so on. Other artists who tried to highlight colour have also found it difficult to liberate it from form. The artistically uneducated brain could say with much validity that Rothko's creations consist very much of rectangles; the achromatopsic patient who cannot see colours will nevertheless still see the rectangles of Rothko, even though there is an attempt by Rothko to render form insignificant by repeating the same rectangle in different colours. The same is true of the creations of Robert and Sonia Delaunay; they may indeed be colourful but can equally be said to be composed of many rectangles and squares and simple shapes of various kinds. Hence, the simple shapes in the compositions of these painters can be differentiated because of colour or because of shape and in practice because of both. Perhaps the easiest way of emphasizing colour is to remove the simple shapes which are so essential a part of the brain's physiology, as Malevich instinctively understood, and create a garble of nonsense in colour, depriving the painting of even a title, and hence of a cognitive element. The man, I believe, who came closer to achieving this is Willem de Kooning, and it is noteworthy that a significant number of his later, form-wise nonsensical paintings are untitled. And just as Sartre praised the mobiles of Calder for signifying nothing, so the lack of a discernible shape in de Kooning's paintings means that they signify nothing and emphasize colour because of that.

Kinetic art and the physiology of area V5

It is interesting to consider further the relationship of single-cell physiology to visual art and the assumption that I have made that artists are, unknowingly, exploring the organization of the visual brain, though with techniques unique to them. Kinetic art provides fertile ground for doing so. This is an art in which actual motion is an integral part of the work. It started as a dissatisfaction with an art that seemed to exclude movement, or what Naum Gabo called the 'fourth dimension'. The first steps taken to remedy this were hesitant and consisted of representing motion statically. They are well exemplified in the works of Marcel Duchamp (whom Etienne described as the 'Frenchman who engages himself in dissecting sensations and sentiments'). There is little doubt that Duchamp's creations were strongly influenced by the chronophotography of Jules-Étienne Marey in France (Fig. 9) and Edward Muybridge in England. A succession of paintings, like Dulcinea and Nu descendant l'Escalier II (Fig. 10) are strongly suggestive of movement and show
Marey's influence. Of the latter, Duchamp wrote that it 'was the convergence in my mind of various interests amongst which the cinema, still in its infancy, and the separation of static positions in the photo-chronographs of Marey ... the anatomical nude does not exist, or at least cannot be seen since I discarded completely the naturalistic appearance, keeping only the abstract lines of some twenty different static positions in the successive act of descending'\(^{(34)}\). A similar influence had taken hold among the Futurists in Italy, who had declared the importance of speed in their *Manifesto of Futurism*. But, here again, for all its declared importance, motion was represented statically in the paintings of Boccioni, Balla, and Russolo. Some, like Ettore Bugatti, disappointed by the lack of motion in works of art, abandoned painting altogether and took refuge in designing fast cars, themselves often works of considerable beauty.

This static representation of motion was soon changed by the work, not of those who proclaimed its importance, but of one who was fascinated by seeing motion. It was the Swiss artist Jean Tinguely who became much intrigued with motion at an early stage in his career, ever since he saw Georges Mathieu paint. He tells us that his fascination was not with the finished product but with the movement while Mathieu was executing the painting. He thus decided to make movement an integral part of the work of art. In his *Méta-malevichs* and *Méta-matiques* (Fig. 11) he had simplified forms and greatly restricted his palette, even eliminating colour altogether, while highlighting motion; he thus produced paintings which are wonderful stimuli for the cells of areas V3 and V3A. But there is another area in the visual brain, area V5, whose cells are even more selective for motion. Most of these are directionally selective, that is to say responsive to motion in one direction but not in the opposite direc-

**Fig. 9** Long-jumper by Julés Etienne Marey. (By permission of the Musée Marey, Beaune.)
tion (Fig. 2), and they respond best to spots rather than to lines moving in the appropriate direction (Fig. 12). Like the cells of V3, those of area V5 are indifferent to the colour of the stimulus, responding to their preferred direction irrespective of the colour; they are mostly indifferent to the form of the stimulus too. V5 is, therefore, an area in which motion is...
emphasized and both colour and form are de-emphasized or rendered irrelevant\(^{(35)}\).

Given its specialization, it is not surprising to find that when V5 is destroyed by a lesion, the patient is not able to see objects when in

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**Fig. 11** *Metamecanique* by Jean Tinguely.

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**Fig. 12:** This cell responds more vigorously to spots than to bars passing through its receptive field. (From Zeki, S., J. Physiol., 1974; 236, 549-73.)
motion but only when they are stationary\textsuperscript{(36-38)}. Such a patient has difficulty in seeing cars in motion, or seeing tea being poured because of the inability of seeing the level rise, or indeed to carry on a conversation with the same ease as normals because of an incapacity to see lips move. She is, of course, also unable to appreciate kinetic art. This is not to imply that the aesthetics of kinetic art is mediated through area V5, but only that V5 is necessary to it.

To best tailor a stimulus to the physiology of area V5, the emphasis had to be on motion, with both form and colour de-emphasized, or rendered meaningless. It was Alexander Calder who came closest to achieving this, by inventing his mobiles (Fig. 13), which represent the high point of kinetic art. Calder apparently hit upon the idea after visiting Mondrian's studio. This is surprising because the nearest Mondrian ever got to putting motion in his paintings was in his static \textit{Broadway Boogie-Woogies}, where the motion is only suggested by the name, not much else. However that may be, Calder genuinely hit on the idea of the mobile, small roundish objects that move in different directions. As seen from a distance, these are remarkably effective stimuli for the cells of area V5. Remember that the cells of area V5 are indifferent to colour, that is to say that they will respond to a stimulus in motion regardless of its colour. In the laboratory, we usually stimulate the cells of area V5 with white spots against a black background or the reverse. And Calder, just

![White Mobile with 24 Pieces by Alexander Calder.](Private Collection, France.)
like Tinguely before him, began to make his mobiles achromatic, that is to say in black and white. He considered that the other colours, with the possible exception of red, 'confused' the clarity of the mobiles. What does 'confusing' the clarity of mobiles mean in neurological terms? We have found that, in general, when we stimulate with colour, activity in area V4, specialized for colour, goes up and activity in area V5, specialized for motion, goes down (Fig. 14). So maybe, without realizing it, Calder was uttering a neurological fact about the brain, which we have just begun to discover with neurological tools.

Area V5 is situated laterally and ventrally in the human brain. It provides fertile ground for testing the proposition that the brain actively generates percepts and is not a mere passive chronicler of outside events. It is interesting to see what happens when we perceive something in a work of art which is not objectively there, using V5. An example is to be found in the work of the contemporary French physiological artist, Isia Leviant. In his Enigma, some (though not all) of you will perceive rapid motion confined to the rings. If we were to ask subjects who can see the motion in the rings to look at Enigma and then measure the activity in their brains (Fig. 15), we shall find that it is largely confined to area V5. When the same subjects look at objective motion, we find that there is activity in both V5 and V1. Hence it is as if activity in V5 is imposing certain properties on Enigma, properties which are not objectively there. The brain thus goes beyond the information given, and constructs the image according to its own rules.

I have tried to show you that we have gained sufficient knowledge about the visual brain in the past twenty-five years to be able to say something both useful and interesting about what happens in the brain when we look at works of art and to consider visual art as an extension of the functions of the visual brain. That function is the acquisition of knowledge and the self-confessed aim of art, from artists and philosophers, is also the acquisition of knowledge. We may therefore regard the aim of art as nothing more nor less than an extension of the aims of the visual brain. There are of course many areas that we have not even started to explore yet: the powers of art to disturb and arouse, the role of the imagination in generating new works of art and the relationship of all art, since it is a self-reproductive process, to the atavistic impulses of sexuality. As well, we have no idea of why some works of art are more appealing aesthetically to some people than to others or why different painters are drawn to executing different kinds of work.

To many the notion of talking about art in the relatively elementary and yet precise terms of what happens physiologically in the brain may seem a somewhat dangerous thing to do. It implies that what happens in
the brain of one perceiver is very much the same as what happens in the brain of another. Art, they might argue, is an aesthetic experience whose basis remains opaque and mysterious, unqualified by scientific experimentation and dissection, and indeed should continue to remain so; physiology, they might argue, should above all not assault the closeted secrets of fantasy. To reduce art thus to a physiological formula etiolates
arouses and disturbs different individuals. The supposition of a basic similarity between different individuals in so subjective an area, and the profaning of the secrets of the brain in this way may, they fear, lead to a world where none would be allowed the privileges of concealment and privacy and subtlety, where we would all be mentally naked together since we would all be aware of what happens in one another's brains.

Fig. 15 When most people view the figure on the left, they see an enigmatic, circular motion in the grey rings. This illusion can be destroyed by making the spokes intersect the rings. This can provide a stimulus for a PET scanner. When subjects placed in the scanner are shown the two images, and the activity pattern of the control is subtracted, increased activity is detected in an area very close to the area V5 detected using moving dots. (Results from Zeki, S. et al., Proc. R. Soc. Lond. Biol., 1993; 252, 215-222.)
I would argue precisely the opposite. It is true that, to a large extent and perhaps at an elementary level, what happens in one brain is very similar to what happens in another, which is one reason why we can talk about art and communicate through it and why such works as Michelangelo's *Pieta* or Botticelli's *Primavera* have had such a universal appeal. Nor does knowledge about what happens in the visual brain threaten the aesthetic sense. Just as knowledge of the fact that the motion in the rings of the *Enigma* illusion is a product of activity in a highly specific area of the visual brain does not in any way interfere with the perception of that motion, so no physiological or anatomical dissection of the brain, no profound knowledge of it, can take away our perception of the resentment at failing powers in Rembrandt's later self-portraits, or of our perception of the world of loneliness and misery and pain that Edvard Munch captured in *The Scream*, or the world of isolation and depravity that Degas portrayed in *Absinthe*, or of our perception of the serenity in the face of Michelangelo's Christ, after the supreme doubt expressed in the last seven words from the Cross. The evocative power of these paintings is prodigious, being itself the product of the prodigious powers of the brain. Indeed, because of their almost infinite variety, the imagination of the brain, the painter's as well as ours, is impossible to capture in a single painting or indeed many single paintings. I think that the mighty Michelangelo, who tried so hard to portray the spiritual beauty of Christ, especially in his last moments, realized this instinctively towards the end of his life and, embittered, understood the limits of what painting and visual art could achieve in comparison with the seemingly effortless and instantaneous power and success of the brain. It is perhaps for this reason, among others that art historians ascribe to it, that in one of his last and most pathetically beautiful sonnets, dedicated to Giorgio Vasari, he wrote:

> I now know how fraught with error was  
> the fond imagination which made  
> Art my idol and my king  
> No brush, no chisel, will quieten the soul  
> Once it is turned to the divine love of Him who, upon the Cross,  
> outstretched His arms to take us unto Himself

And no knowledge of the brain and its intricate operations can quieten the soul when it begins to contemplate how the many billions of neurons that constitute it work in unison to create works of such infinite beauty but whose beauty pales into insignificance compared with the immense beauty of the brain itself.
References


Plate 1 The responses of a cell in area V4. This cell responds best to a blue square on a white background.

Plate 2 Red Square by Kazemir Malevich