The Art of Gerard Caris and the Brain's Search for Knowledge

I.

I have long maintained that artists are neurobiologists who explore the functions and functioning of the brain, though with techniques that are unique to them[1]. This may seem strange. We are accustomed to thinking of neurobiologists as belonging in the world of science and of artists in the world of art. Scientific studies, we are taught, are steeped in rational argumentation, experimentation and deduction whereas art is intuitive and emanates from a creative faculty that resists a detailed explanation. Moreover scientific studies use detailed measurement, something that we do not traditionally associate with art, at least not superficially. As well, the technology associated with science, especially in the recent fifty years, has become extremely sophisticated and requires many resources, while art can make do with simpler techniques. For these reasons alone the idea that artists are also scientists is one that many, especially in the world of art, resist. The work of Gerard Caris provides fertile ground for considering the truth of my statement, that artists explore the potentials and capacities of the brain and thus give us insights into how it functions. I shall do so here with reference to his work and to the organization of the visual brain, emphasizing in particular what lessons the neurobiologist of vision can learn from this work and how it can be exploited in scientific studies of the brain.

There is, however, an additional reason why some, and perhaps even many, question and fear what they consider to be a scientific intrusion into the world of art. For them, the supposition that artists are also unravelling scientific truths about the way in which nature and our brains are organized carries with it the implication that the power and grandeur of art can be reduced to simple, reductionist, scientific formulations. This horrifies many who believe instead that art is a subjective experience that derives its power from the different way in which it moves, arouses and disturbs different individuals. Probing scientifically into the world of art, as they suppose, will ultimately lead to a world where we would all be mentally naked together in an art gallery, in the sense that each one of us would know what is happening in every other spectator's brain. While understanding this fear, I also find it irrational. The work of Gerard Caris provides, again, an admirable terrain for allaying these fears and bringing out the admirable qualities of his creations, not only in terms of understanding the functioning of the brain but also in revealing unsuspected features of form in our natural world. This discussion will show, I hope, that the aesthetic element will remain resistantly in his work, however much we understand the way the brain operates or whatever knowledge we obtain.

II.

Visual art is expressed through the visual brain, without which there would be neither vision nor visual art. We tend to accept vision as a blessing that nature has given us, without enquiring into what it is given for. Why do we need to see at all? The answer to that question is fundamental to understanding both the functions of the visual brain and the biology of art.

There are many answers that one could give. But an answer that subsumes all the more specific ones is the following: that we see in order to be able to acquire knowledge about the world. This constitutes the single most important function of the visual brain.

Vision is of course not the only means of acquiring that knowledge; one could acquire knowledge through other senses, for example the sense of touch or smell. But, reflecting the relatively large amount of brain that is devoted to the visual sense, vision just happens to be the most efficient way of acquiring that knowledge and there are certain kinds of knowledge, such as the colour of a surface or the expression on a face, which can only be acquired through the sense of vision.

There are three aspects to this knowledge, all of which are worth considering in the context of Caris' work. The first relates to certain knowledge, the second to uncertain knowledge and the third to the creation of knowledge.

In general, the brain is only interested in acquiring knowledge about the constant, essential and immutable properties of objects and surfaces in the visual world. But the information reaching the brain is never the same from moment to moment. An object, for example, may be viewed in different lighting conditions, from different distances and points of view, and yet it maintains its identity. The brain, in its search for such constancies, has developed a highly efficient and stable system whose characteristic is a remarkable ability to discount the changes that could impede it in acquiring knowledge about the permanent properties of objects and surfaces in this world. Colour vision, discussed briefly below, constitutes an excellent example. But there are also conditions in which there is more than one essential characteristic; in such instances, if the brain were capable of only one interpretation, it could be at a disadvantage. It has therefore developed a system for confronting situations where there is no correct answer, where the knowledge that it acquires must remain ambiguous and uncertain, since it must allow for alternative interpretations. I believe that these almost contradictory approaches to knowledge acquisition are well illustrated by an examination of Caris' creations which, let me emphasize, are a creation of his brain.

Given that the visual brain is the neural vehicle for visual art, it is perhaps not surprising that the acquisition of knowledge is a function that can also be attributed to visual art[2]. A portrait, if great, is not only a portrait of an individual but also the portrayal of a character; it gives knowledge about a particular kind of character or personality. Equally, Michelangelo's great *Pietà* in Rome gives much knowledge not only about physical and spiritual beauty but also about the pathos, the suffering and the final triumph of the spirit. But to do so it, like the great portraits of Titian or Velasquez, must be steeped in detailed measurement of a sort that is not usually thought of as measurement at all but as artistic license. Whatever one might choose to call it, it would be highly unlikely that these works of art have the effects that they produce had it not been that many of their features target and trigger strong and optimal responses in the visual and emotional brain. That the features that have such strong effects on the brain are not easily quantifiable mathematically or communicable through language does not mean that the *Pietà* does not have at its basis a profound degree of detailed measurement but only that we cannot conceive of these measurements in mathematical terms, as presently instituted. And why should it be so hard to communicate the knowledge and the intense feeling that it communicates through language or mathematics? Because the visual brain has taken billions of years to develop, whereas the linguistic ability developed at most one million years ago and is therefore relatively new.

Hence knowledge that is so easy to communicate visually is very hard to impart linguistically.

A task for visual neurobiologists is to understand higher cognitive functions as an expression of neural activity. It is almost an article of faith that the reason why a work such as the *Pietà* of Michelangelo is capable of arousing such strong responses in so many viewers is that its creator reached conclusions about the brain intuitively. In that intuition one includes innumerable calculations of proportion, of curvature, of distance and much else besides which it is almost impossible to write about (because only instinctive). Thus describing the work in neural terms is, in the current state of our knowledge, extremely difficult and would in any case be highly incomplete. The work of Caris offers strong advantages for conveying what I mean by the acquisition of knowledge through art. The absence of a narrative element in it allows an analysis to concentrate on other and simpler aspects. These nevertheless also constitute a search for, and acquisition of, knowledge. Of course it is understood that the knowledge that I am speaking of is in part knowledge acquired by Caris (or rather his brain) through his explorations, the knowledge that is then transferred to works of art through which it is finally communicated to the viewer.

III

It is perhaps best to begin by outlining broad steps in the acquisition of knowledge. The first step is, of course, abstraction, by which I mean the emphasis on the general at the expense of the particular or, if one puts it in more exalted terms, the emphasis on the universal as opposed to the particular[2]. This is a process undertaken continually by the brain. And in art, the abstraction developed by the brain is translated into a work of art. In the process, what art depicts becomes a universal example. The term abstraction has come to have a somewhat specific meaning in art, referring to particular schools and periods. In fact, at the most elemental level, all art is abstraction, an idea well conveyed by Constable when he wrote: "The whole beauty and grandeur of Art consists in being able to get above all singular forms, local customs, peculiarities of every kind....[The painter] makes out an abstract idea of their forms more perfect than any one original"[3]. Consider for a moment the enormous difficulty of achieving this - the form created by the artist must be representative of all forms of its kind that the artist has experienced visually, even though it is only a particular form. The artist has therefore the enormous task of abstracting the essentials from all the particulars that he or she has experienced, and putting this cumulative synthetic experience into a particular painting. Plato's condemnation of art in *The Republic*, as an exercise that could only represent one aspect of one particular form and could therefore not represent the universal form, almost certainly failed to take into account the abstractive and synthetic power of the brain in formulating a work of art, itself a manifestation of the abstractive powers of the brain in acquiring knowledge.

Perhaps the most extraordinary answer, in neurobiological terms, to the criticism levelled at art by Plato came over two millennia later, in the early phase of Cubism, known as Analytic Cubism. This was described by Juan Gris as "a sort of analysis", a static representation of the result of "moving around an object to seize several successive appearances, which, fused in a single image, reconstitute it in time"[4], in other words a reconstitution in which the particular point of view and the particular lighting conditions no longer matter. A form must maintain its identity regardless of the point of view, the ambient illumination, the viewing distance. The brain achieves this easily, in the sense that it is easy to recognize a particular form, for example a car, regardless of the point of view, the viewing distance or the colour. No one understands today how the brain achieves this remarkable feat, but it is clear that to do so requires a machinery of extraordinary complexity. Without reference to the brain or its functions, Cubists tried to achieve on a two dimensional surface what the brain achieves so easily, that is making the point of view and much else irrelevant in identifying an object. This led the French literary and art critic, Jacques Rivière, to think of Cubism as being destined "to give back to painting its true aims, which is to represent objects...as they are"[5], in other words differently from the way in which we see them at any particular moment or in any particular context. But Cubism developed in a strange way in this regard. It ended up with paintings that were not easily recognizable except with the aid of a title, as many of Picasso's works, eg *Man with a Violin*, testify (Figure 1).

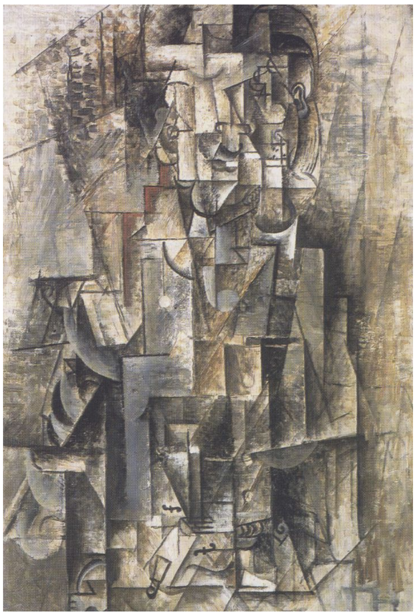

Figure 1: *Man with a Violin*
Pablo Picasso 1912
Philadelphia Museum of Art

The so-called "simultaneous vision" of Cubism, resulting from looking at an object from many different angles and points of view, had therefore a strange result. Far from getting to the essentials of a form, it made its recognition more difficult. In that sense, Cubism, or at least the early Analytical Cubism, must be regarded as something of a failure, at least in neurological terms and in terms of acquiring knowledge about forms regardless of the point of view, which is not to say that its creations do not have considerable aesthetic merit. This is a view that irritates some when it comes from a neurobiologist. They might perhaps find it a little less irritating and more convincing when it comes from an artist. Mondriaan, who flirted with Cubism in his early phase, 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"[6] and Art, he believed, "shows us that there are also constant truths concerning forms". Hence Mondriaan's disappointment with Analytical Cubism is easy to understand, given that he was searching for the constant elements that constitute all forms and could therefore be said to be the abstract representation of form. Instead of pursuing this aim, Analytic Cubism changed course and gave way to Synthetic Cubism, much to Mondriaan's dismay. Mondriaan, I feel, would have been much happier with the approach of Caris. As I argue below, it is precisely the search for "constant truths concerning forms" that may be taken as the motive for Caris' work and, in addition to their aesthetic value, his work has led not only to creations of much scientific interest but has also revealed new and unsuspected features of form that may be taken to have universal validity.

The kind of abstraction that Mondriaan was searching for – constant elements that are the constituents or the building blocks of all forms – is writ large in Caris' work. This search led Mondriaan, many years before physiologists began studying the properties of single cells in the visual brain, to suppose that the elemental building block of form was the oriented straight line (Figure 2). It is not uninteresting to reflect that physiologists came to much the same conclusion many years later, with the discovery in 1959 that there are many cells in particular areas of the visual brain that are extremely specific in their responses. These cells give their optimal reaction to lines of one orientation and respond less vigorously as one departs from their optimal orientation until, at an orientation that is orthogonal to their optimal orientation, they become totally unresponsive. Physiologists have considered such cells to be the "building blocks" of form. This is a formulation that is almost identical to the one reached by Mondriaan although, significantly, no physiologist has been able to produce a plausible hypothesis as to how these orientation selective cells act to construct forms in the brain. Mondriaan went even further. He developed an abhorrence for the diagonal line and preferred to think and paint in terms of vertical and horizontal lines. Indeed, he disliked seeing diagonal lines in nature. The late French painter Balthus recounted to me how he, Mondriaan and Picasso were enjoying a drink in Picasso's studio in Paris, and Picasso remarked on how beautiful the trees and the plants looked. Mondriaan, horrified by so many lines that were not strictly vertical and horizontal, drew the curtains together and said, "Je ne veux plus voir cela"! This emphasis on the vertical and the horizontal has an interesting perceptual, if not physiological, parallel. Human subjects detect vertical and horizontal lines more readily than they detect oblique lines, but whether this is due to a preponderance of cells in the brain that are specific for these two orientations remains unknown. At any rate, Mondriaan's discoveries led him to define form as "the plurality of straight lines in rectangular opposition" (Figure 2).

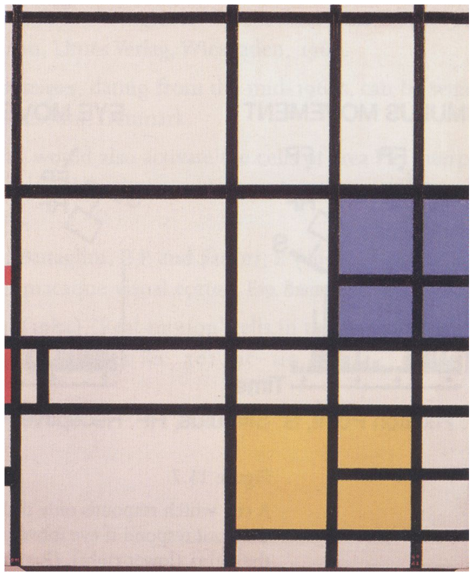

Figure 2: *Composition London*
Piet Mondriaan 1940-42
Albright-Knox Art Gallery

Mondriaan's definition of form is neurobiologically interesting, in that the cells of the visual brain do not respond to light as such, but to light that has a particular configuration, for example a line of specific orientation, and then only when it appears in a specific part of the field of view, known as the *receptive field*. Receptive fields are usually square and rectangular in shape, and I have wondered whether it is entirely fortuitous that so many artists should have emphasized the square and the rectangle in their work, in addition to the straight line. Kazimir Malevich, the Suprematist artist, declared that the "artist has no further need for the object as such"[7], and emphasized the supremacy of the mind in creating works of art (a statement, incidentally, that is particularly apt in considering the work of Caris, who really seems to have reached a stage where he has no "further need for the object as such"). He and his successors emphasized the line, the square and the rectangle in various configurations (Figure 3). Examples abound, from the work of Malevich (Figure 3) to that of Russian constructivists like Olga Rozanova, to Ben Nicholson and Hans Hoffman. Even Cézanne, in pursuing abstraction in his portrayal of the Montagne Sainte Victoire (Figure 4) ended by using squares, a feature that can be seen more generally in his later works.

Figure 3: *Suprematism (Supremus #58)*
Kazimir Malevich 1916
State Russian Museum, St Petersburg

Figure 4: *Montagne Sainte Victoire*
Paul Cezanne 1905
Philadelphia Museum of Art

Given the strong emphasis on squares and rectangles, and given that most receptive fields of visual cells in the brain are square and rectangular in shape, I have referred to this art as *the art of the receptive field*.

We may obtain a glimpse into abstraction as displayed in works of art in neurological terms by examining the activity in the brain of humans when they view abstract paintings as well as other kinds of paintings, for example portraits, landscapes or still life. A fundamental property of the visual brain is its functional specialization[8], by which I mean that different attributes of the visual world, such as form, colour, motion, faces, places, and objects are processed in geographically distinct areas of the visual brain. Thus, when subjects view coloured paintings (as opposed to paintings that are in black, white and grey), the activity in the brain is restricted to the colour centre, area V4. When they view portrait paintings, the activity is in a part of the visual brain known as the fusiform face area, while when they view landscapes it is in another part known as the place areas (Figure 5). By contrast, when they view abstract paintings, the activity seems to be very widely distributed presumably because abstract works contain elements that are common to all other areas[9].

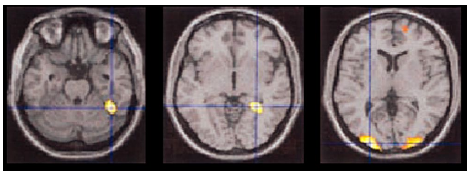

Figure 5: Brain activity (shown in red and yellow) produced in different parts of the brain when humans view different categories of paintings. To the left activity produced by viewing portraits, in the centre activity produced by landscapes and to the right activity produced by still life.

IV.

As I argue below, it is precisely the search for constant truths concerning forms" that may be taken as the motive for Caris' work and, to the neurobiologist at least, there is a straight link between the work of the Cubists, Mondriaan (and other artists) and the work of Caris. Indeed, in many of the comments that I have read about Caris' work, allusion has been made to the work of Mondriaan. This is not surprising. Caris' formal realism constitutes, in neurobiological terms, an extension of the search for the elemental constituents of all forms. To a large extent, Caris' work can be said to be an exploration of the fundamental constituents of all forms, just as Mondriaan's work was; it constitutes in other words a means of acquiring knowledge about form through art and the visual sense. At one level, he appears to have reached much the same conclusions as his predecessors, although of course he presents his findings in new and original ways.

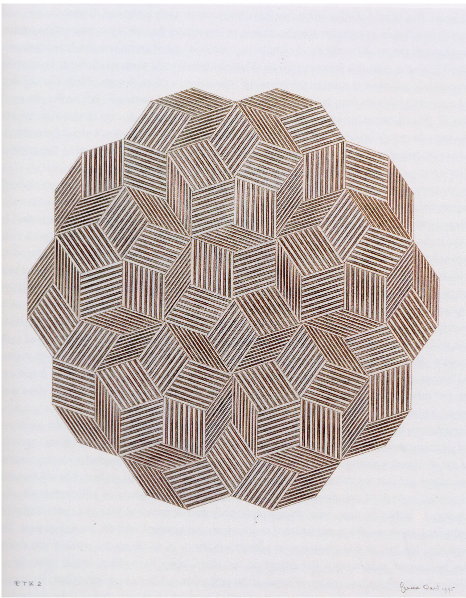

Figure 6: *ETX2*
Gerard Caris 1995
Collection of the artist

There is, as in the work of earlier artists, a strong emphasis on lines (Figure 6), and on apparently simple geometrical shapes which may be inferred to be, for him, the universal constituents of all forms. The lines are sometimes of short segments and parts seemingly of a more complex structure (Figure 6 & 7).

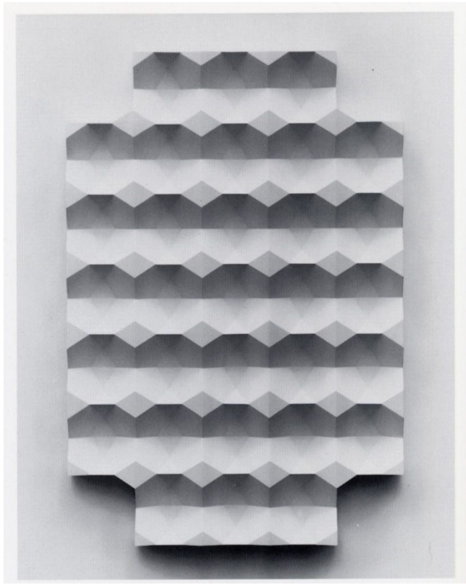

Figure 7: *Reliefstructure 2G1*
Gerard Caris 1992
Collection of the artist

They not only enclose and define self-contained shapes, but these shapes themselves lead to the emergence of imposing lines cutting diagonally across the reliefstructure (Figure 8).

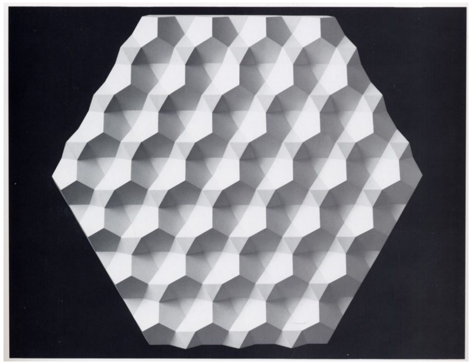

Figure 8: *Reliefstructure 1D-3*
Gerard Caris 1985
Van Abbemuseum, Eindhoven

There is moreover a strong de-emphasis of colour. Colour, form and motion are represented largely separately in the visual brain[10] and it is not surprising that, in important artistic explorations of any one of these attributes, the other two have often (though not always) been de-emphasized or at least much reduced in importance. The palette is much restricted, for example, in the work of Cubists. Mondriaan eschewed most colours save for blue, red and yellow (his refusal to use green was based more on doubtful theosophical arguments). Similarly, both colour and form are de-emphasized or rendered meaningless in artistic creations such as those of Alexander Calder and Jean Tinguely, where the emphasis was on motion. Hence, at one level of observation, one can say that Caris is a natural successor to the Cubists and to Mondriaan.

But, in addition to these common approaches which are, in my view, intuitively dictated more by the organization of the visual brain than by any artistic need, Caris' approach to the fundamental constituents of form is perhaps more compelling in terms of the representation of the properties of all forms, because there is, in his work, a strong emphasis on depth and solidity, on instability and on a stable ambiguity.

V.

Depth and solidity are obviously important constituents of form. This is exemplified neurobiologically by cells in the visual brain which are specific for depths. There are several kinds of depth detecting cells in the visual brain, and here I emphasize three only, those that are optimally driven by objects or surfaces that fall away from the plane of fixation, those that respond to stimuli in front of the plane of fixation and those that respond when a stimulus appears at the plane of fixation. Underlying the highly specific response of these cells is an extraordinary precision in connections. This is because the distance away or from the plane of fixation that yields a maximal response from a cell is very finely tuned and specific for each cell, the tuning being dependent upon highly precise anatomical connections and physiological properties. It is a mathematical miracle, though expressed in neural terms. It may seem strange to say so for works of art, but the creations of Caris are undoubtedly also based on a mathematical precision that is intuitively reached and that is dependent upon the sort of computation that the brain makes in endowing cells with such precise properties for detecting depths – cells upon which we ultimately depend for perceiving the works here displayed.

Consider first a work such as *Reliefstructure 1c3-4* (Figure 9),

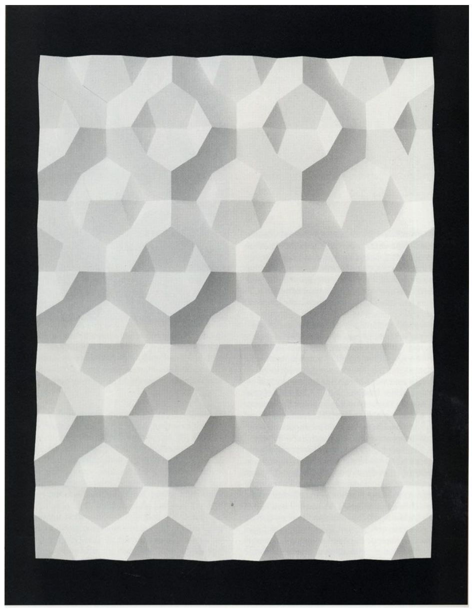

Figure 9: *Reliefstructure 1c3-4*
Gerard Caris 1985
Collection of the artist

which is representative of other works of Caris. There are two features that are prominent here, apart of course from the lines that define the forms. The structure of the relief introduces differential shading as a result of light falling on it. This in turn introduces a strong perception of depth. So strong is this depth effect that even when the work is reproduced on a flat two-dimensional sheet (as in Figure 9) the effect persists. The differential shading which in this work is actually introduced merely by light falling on the work from an angle thus endows this work with depth effects that are more accentuated than in the work itself. The juxtaposition of light and shade must, one presumes, be a strong stimulus for activating cells that signal depth, though no one has used such an artistic medium to explore the properties of the depth detecting cells in the brain. The depth introduced is of two kinds, bi-stable or meta-stable. The former is to be found in a single juxtaposition of two surfaces, the latter in a juxtaposition that involves three or more surfaces. In the former, the edge between the two surfaces can be in one of two recessional planes, either towards or away from the observer; in the latter the metastability is *obligate*, the shift forward of one border being accompanied by a mandatory shift away of the other borders.

Such instabilities are interesting for two reasons. First they are dependent upon a precise arrangement of the contiguous parts. In thus arranging the parts, the artist must obviously use intuitively the mathematics of the brain, its capacity to accept certain arrangements as enabling meta-stability while rejecting others. There must be certain configurations that excite one group of cells and inhibit others. For example, when a border in the work reproduced in Figure 6 or Figure 8 is perceived to be towards us, the two other borders are away from us, presumably because at any given time, one set of cells (the “near cells”) registering activity in a given part of the field of view are excited while the “far” cells, registering activity in nearby parts of the field of view are simultaneously excited. This is followed by a sudden change, when two different groups of reciprocally active cells register far and near activity in the same parts of the field of view. Presumably, activation of one set of cells must be accompanied by inhibition of the reciprocal ones, and vice versa, but what neural rules determine this reciprocity is a problem that has yet to be explored. The creations of Caris would provide admirable stimuli for studying the brain organization that is at the basis of this metastability.

Equally problematical is the extent of the visual field over which this meta-stability functions. In casual experiments, I have tried to enlarge the size of the rectangles and the squares so that they cover ever larger parts of the field of view, and have not been quite able to abolish it. On the other hand, contiguity is critical, which implies that common and neighbouring cells that interact must be activated. Thus, if one were to use Caris’ works in a serious exploration of how the visual brain functions, one might obtain a great deal of important information. I can think of no better stimuli for undertaking this kind of work than the creations of Caris and other artists, which is why I have been pleading that the work of artists must be used in a serious way to study the visual brain. After all, Caris and other artists do not achieve their results by some sort of magic but by using the potentials of the brain, without necessarily knowing, or indeed having to know, anything about the brain or its organization. This does not make their creations any less forceful instruments for studying the brain and its organization.

The creations seen in this exhibition provide another strong stimulus for studying the organization of the brain. This is the problem of integration, of how the brain unites certain elements and distinguishes them from others. This problem arises in viewing all works of art and indeed during natural viewing conditions, but a work such as that shown in Figure 6 is especially interesting for conducting such a study. For here, the lines are grouped into self-contained entities that bear a definite (unstable) spatial relationship to one another. But together they constitute a larger form. The task for the neurobiologist is to understand how the brain groups stimuli together and distinguishes from one another, and how it groups the smaller elements into a larger unit. That this is not a trivial problem can be easily confirmed by the fact that some quarter of a century of extensive brain studies have not given us any definitive conclusions regarding this remarkable capacity of the brain.

VI.

The meta-stability that I have referred to above implies a certain degree of ambiguity, in that any segment of the work cannot be said to be definitely in one state or another during any given viewing, but alternates between one and the other. The fact that the size and extent of the forms constituting many of Caris' compositions can be changed so extensively without in any way diminishing the inherent meta-stability (or bi-stability), and therefore the inherent ambiguity, implies that *the meta-stability and the ambiguity are themselves stable*. It is not, in other words, easy to rid oneself perceptually of this ambiguity. The importance of this property of stability, in a context which implies instability, is interesting to explore in terms of the functions and functioning of the brain.

The brain is in general only interested in obtaining knowledge about the permanent, essential and constant properties of objects and surfaces, when the information coming from them is never constant from moment to moment. It has therefore developed a system for discounting ephemeral changes and registering the constant property only. A good example is provided by colour vision. The fundamental property of a surface in terms of colour is its reflectance, that is the amount of light of any waveband reflected from a surface in relation to the amount of light of the same waveband that is incident on it. This property never changes, although the actual amount incident on a surface changes from moment to moment, as when a surface is viewed in daylight at noon or at dusk or in tungsten or fluorescent light. The way that the brain has solved this problem is by acquiring a stable system to gauge the amount of light of different wavelengths reflected from a surface and from it surrounds, taking a ratio between the two for each waveband. These ratios always remain the same and the brain is therefore able to discount the changes that occur continuously[11]. This means, essentially, that the brain can give one interpretation and one alone to a surface that reflects more long-wave (red) light and less short- and middle-wave (blue and green, respectively) light than its surrounds, namely red. *As long as the brain is functioning normally, this is the only possible interpretation.*

But what is the brain to do when some property can be interpreted in more than one way because of an inherent instability in nature. In a way, the work of Caris' addresses this question with interesting results. For the brain must then also allow for more than one possible interpretation because if it allows for one interpretation only and that interpretation turns out to be the wrong one, it might end up in a perilous state. This means essentially that the brain has to use a system that is unstable, in that it can signal one aspect or another (but not the two at the same time), just as in the meta-stable constructions of Caris. But once the brain has allowed, in its physiological wiring, for more than one interpretation, it is not possible to force it into a state where it can only give a single interpretation. Hence the instability in the responses of the brain are a device for acquiring knowledge, when the knowledge is uncertain. It seems to me that this property of the brain is brought into admirable focus in the work of Caris, which thus represents the two general modes of operation of the brain in the acquisition of knowledge. On the one hand is a stable system, exemplified by the lines that are the constituents of most if not all forms, as well as the stable and relatively simple shapes that they enclose and define. From these together emerge the simple and repetitively occuring shapes, the polygonal structures which, though themselves stable, are capable of being configured or combined in an almost infinite variety of ways. In these combinations, the total picture is never completely stable but shifts from one perceptual configuration to another. The unstable system is thus now exemplified by the unstable relationships between adjacent polygonal structures in his work[12]. It is as if important properties of the brain's knowledge acquiring system brought into focus in Caris' work. But, naturally, the instability and the metastability are not chaotic or random. Instead, as mentioned above, they follow definitive rules. It is the task of the neurobiologist to determine what these rules are in neurophysiological terms. These rules are embedded in the works of Caris, who presumably arrived at them by some sort of perceptual intuition whose basis is the response of cells in the brain. The compositions provide therefore an admirable way of beginning to study the important property of meta-stability in the brain.

There is of course another feature to the instability and the meta-stability that is of artistic interest. Relationships that remain forever fixed and do not undergo changes become inherently boring. The reason for this might be sought, conjecturally, in the fact that the cells of the visual brain are well known to adapt with prolonged exposure to the same stimulus, in other words that their responses diminish in vigour. But the incessant change and the inability to give a correct interpretation endows the work of art with even greater interest. It leads to an ambiguity. I have elsewhere[2] given a neurobiological definition of ambiguity that is somewhat different from the standard dictionary definition, which defines ambiguity as uncertainty or vagueness. I propose instead to define it as the *certainty of many interpretations*, each one of which has equal validity with the others and there is therefore no correct answer. This feature which, I believe, enhances immeasurably the value of a work of art, can be found in the works of many artists, amongst whom one could number Jan Vermeer and Michelangelo. But in the works of Caris, the ambiguity takes on a form that is much more accessible to biological experimentation.

VII

Caris' explorations of form have, then, led to certain conclusions about all forms and their characteristics, conclusions which his work shares with that of other artists. Paul Klee once wrote that "art does not reproduce the visible; it makes things visible"[13]. It is perhaps here that one finds the most interesting aspect of Caris' work.

It is an extraordinary fact that through his artistic exploration of form, Caris has hit upon one of the Platonic solids, the "new" form, the pentagonal dodecahedron, consisting of twelve regular pentagons. One virtue of the pentagonal dodecahedron is that, in addition to incorporating lines and spaces, they have a perceptual solidity owing to the fact that they are solid themselves but also because, due to differential shading (even when uniformly coloured), they impart a sense of depth. These, when combined, can give rise to a great number of more complex forms. Yet many of these apparently complex forms have a basic and disarming simplicity in them. Assembled together, they can constitute what can be interpreted as a helix, or a building, or even a poodle (Figures 10, 11 & 12).

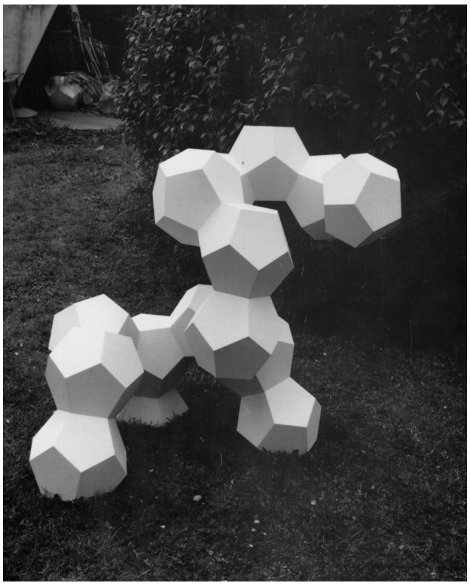

Figure 12: *Helix 1*
Gerard Caris 1991
Collection of the artist

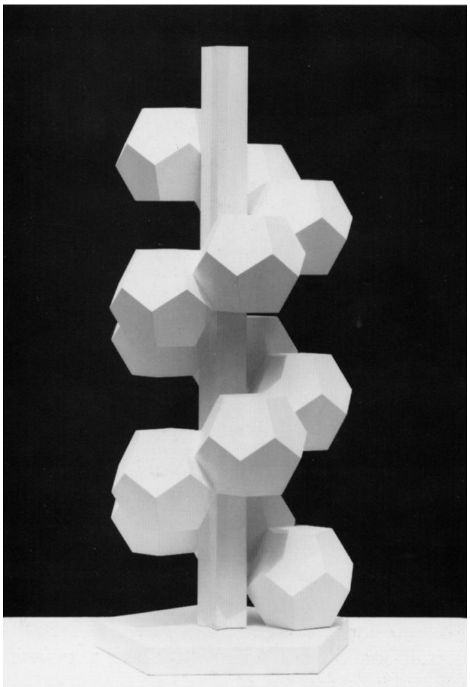

Figure 10: *Helix 4*
Gerard Caris 1993
Collection of the artist

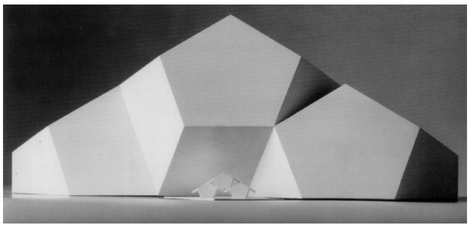

Figure 11: *Reliefstructure 1S1 & Model S Structure*
Gerard Caris 1993
Collection of the artist

The multiplicity of interpretations that we (or our brains) can give to these assemblages testifies to the fact that the ambiguity inherent in the more simple examples of Caris' work is not lost in the more complex ones, but rather incorporated into them. By endowing these works with such ambiguity, their merit is immeasurably increased. Such regular pentagonal assemblages may not occur in nature; the nearest example (pyrite), is quite irregular. Yet, years after Caris' discoveries, scientists produced a similar form "artificially" and thus hesitated to call it a crystal (a natural form). Instead they called it a “pseudo” crystal, especially since the pentagonal element does not repeat regularly.

That an artist should have hit upon a natural structure before scientists should have discovered it may seem surprising. But it should only be surprising to those who believe that artistic and scientific minds are radically, or at least substantially, different and that art and science pursue different aims. In the context of my definition, they do not, because they both constitute a search for knowledge. In that search the artist, just as much as the scientist, can work up "new" knowledge. In the case of Caris' discoveries concerning the polygonal dodecahedron, one might well ask whether what has led him is simple artistic curiosity and experimentation alone, or whether such an exploration had to be the product of a brain structure and organization that, in its exploration of form, would inevitably lead to such a formulation. I could frame the question somewhat differently and with reference to a similar example but one taken from what most would regard as being strictly the world of science, namely string theory, which constitutes an attempt to quantize gravity. To do so, one needs to construct an abstract space with 26 dimensions, which can then be collapsed into 10 and subsequently into 4, giving the conventional space-time dimensions. As I understand it, there is no sound experimental evidence yet for string theory. This leads me to enquire whether mathematicians and physicists would ever have come up with such a theory had they not had the brain structure that they have. In the same way, is it entirely by chance that Caris has hit upon a form that can be a constituent of so many more complex forms and which, though not found in nature, can be produced when manganese-aluminium alloy is rapidly cooled?

VIII

It is thus not difficult to see that, in Caris' work at least, the separation of art and science would be highly artificial. His work not only explores form in terms that are highly interesting for brain scientists but also creates new forms and thus new knowledge. These new forms can themselves be combined to form other forms. Malevich once wrote that "For an artist like Picasso objective nature is merely *the starting point – the motivation – for the creation of new forms*, so that the objects themselves can scarcely, if at all, be recognized in the pictures" (original emphasis). The statement could be applied to Caris by a little re-writing: "For an artist like Caris, the pentagonal dodecahedron is merely the starting point – the motivation – for the creation of new forms".

In surveying Caris' work and its development, can anyone doubt that it has to do with the acquisition of knowledge? And, by extension, can anyone doubt that one of the functions of visual art is the acquisition of knowledge and, indeed, the creation of new knowledge?

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