Understanding Creativity

Understanding Creativity:

A Cross-Disciplinary Adventure

By

Francis Pratt

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For my two children
Thomas and Katherine
Both of whom are
So very creative

There is no learning without feeling
There is no freedom without constraint
There is no creativity in the absence of
These four essential ingredients.

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PREFACE

This is a book by an artist (myself) who became an experimental scientist, amongst scientists, for twelve years (1975-1987).[1] *My research project started as an investigation into how artists use their eyes when drawing and painting. Later it was to morph into a more general enquiry into how brains mediate artistic (and other) skills and how these are used to enable creativity.*

Along the way, I co-authored journal publications, gave seminars in top universities, gave presentations to international conferences and helped in the founding of the University of Stirling Vision Group, an interdisciplinary collection of researchers interested in using ideas from the psychology of perception and neurophysiology to inform computer modelling of eye/brain systems.[2]

This meant that I was able to pursue my objectives in cooperation with experts whose interests had more in common with mine than I could have imagined. The availability of these colleagues provided an opportunity to delve deeper into a number of issues that I had brought with me from my life as a practising artist. Without them, I would never have arrived at such comprehensive and exciting results.

It was in this context that my perspective as an artist enabled me to contribute to critical steps in the evolution of a model whose title gives some idea of the extent of our ambition. It is "Operational principles used by the eye-brain-body when coding and making practical use of the ever-changing arrays of information provided by the light entering the eye."[3]

However, maybe because I was still an outsider coming into a scientific environment, I was wary of experimental results obtained under

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[1] Cottrell Memorial Fellow, University of Stirling, Scotland and Senior Research Fellow, Department of Psychology, University of Stirling, Scotland.
[2] From which sprang the new Centre of Cognitive and Computational Neuroscience.
[3] Unpublished working paper for the University of Stirling Vision Group, written jointly by me, Dr Alistair Watson (from the Department of Environmental Science) and Dr Leslie Smith (from the Department of Computing Science).

unnaturally constrained conditions. This was why, encouraged by J. J. Gibson's influential attack on traditional laboratory experiments,[4] *I concluded that I needed to test mine out in real-life conditions.*

Thus, it was in a state of eager anticipation, tinged with doubts, that I had the idea of founding the Painting School of Montmiral, where I planned to teach painting and drawing courses, to students of all levels, the contents of which would owe their originality to my scientific adventure. My hope was that, as well as helping the students to develop their creativity, I could both confirm and build upon the findings from my university research.

Luckily, my gamble paid off. Not only has the school prospered for over thirty years, but, more importantly from my point of view, the interaction with the students proved to be a long-drawn-out, ever-exciting learning experience. One result was that the scope of my understandings was to expand well beyond my wildest expectations. What I mean by this is made clear in Chapters Two and Three and evidenced throughout this book.

Starting places

When I was only ten years old, I told myself that I wanted to be an artist (which, for me, at the time, meant being a painter like Van Gogh, Gauguin, Cézanne, Paul Klee or Botticelli)[5]*. While never quite abandoning this narrow goal, at sometime during my later adolescent years, I found myself broadening my focus to more universal issues and in particular, to the subject of creativity. Accordingly, in my own mind, when, halfway through my twenties, I decided to dedicate myself to painting, I was also committing myself to wider horizons.*

This volume is the fruit of the lifetime's quest for insights into the nature of creativity that ensued. Although, on my journey, I used experiences of painting and drawing as the entry point, I was also much influenced by interaction with other disciplines.

[4] Gibson, J. J., 1979, *The ecological approach to visual perception*, Houghton Mifflin.
[5] My father had hung framed prints of works by these artists around the house.

Of particular importance was my teenage friendship with a teacher of singing[6] *and his pupils of many levels of attainment, including beginners and professional madrigal and opera singers. His teaching combined not only rigorous emphases on voice-production and musicality, but also on states of mind, as he understood the subject from a wide reading of philosophical and religious texts. When he had finished a book, he passed it on to me. From this starting point I found myself reading more widely, including books with the word "creativity" in their titles. I discovered that many of these focused on "scientific creativity". From these, I concluded that artistic and scientific creativity have much in common.*

To a significant extent, the perception of this commonality explains why I responded positively when, many years later, an opportunity arose to engage in scientific experiment. This came about as a result of my appointment to two consecutive posts at the University of Stirling in Scotland. The first involved making paintings. The second involved scientific experiment.

The involvement with science started as a sideline, when I was still working as an artist. The first of what turned out to be sixteen experiments was initiated when I first entered the coffee room of the Department of Psychology and met Dr Bill Phillips, whose research at the time centred on short-term visual memory. Claiming not to know anything about art, he resorted to telling me about the currently fashionable theory of intellectual realism, which he explained in terms of the aphorism that "children draw what they know, and adults draw what they see".

My astonished reaction to this derived from what I had learnt during my first ever teaching appointment, which was at Isleworth Polytechnic, where I had taught drawing and painting from observation to non-vocational adults of all levels of attainment. This made it clear to me that there was something fundamentally wrong with the know/see dichotomy. My certainty concerning this matter provoked Bill to suggest that we do some experiments to prove me right or wrong. For Bill, the objective of these was to insert a question mark into a flourishing field of research. For me, it was to find out more about the role of knowledge in guiding, not only children, but also adults, of all levels of achievement, when making drawings from observation.

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[6] Norman Lilly: Director of London Singers (a madrigals) and London Opera Group. My music teacher at school was "the best tenor in England".

Our experiments started by confirming that children, when drawing familiar objects such as a cube-shaped children's building block, did indeed produce the kind of knowledge-driven drawings that had inspired the theory. However, when confronted by unfamiliar abstract patterns, it was evident that, at least according to the definition of the word used by the theorists, the same children did a lot of "seeing."

Thus, when drawing a cube, our eight-year-old experimental subjects looked at it only once and then produced, from memory, the kind of drawing that had inspired the theory. The explanation we gave for this was that what at first sight seemed to be bizarre features of their drawings were based on knowledge coming from touch information, gained when the children had been playing with their toy building bricks. In contrast, when drawing abstract patterns, the same children were clearly including information that could only have come from visually mediated processes. These interpretations were supported by the fact that when drawing the cubes (and other familiar objects) the children typically looked only once (enough to enable recognition and no more), whereas when they drew abstract patterns, they looked multiple times (necessary for visual analysis).

The next steps

From this starting point, encouraged by Bill and colleagues from the Psychology Department and, later, from various other departments, my interest was to broaden out into asking questions about the acquisition and use of knowledge, not only in the context of drawing and painting, but also in that of all skilled activity. Being surrounded by experts capable of answering the bulk of my naive science related questions, I was well placed to go more deeply into the matter. What surprised me was the level of interest shown by my new associates, such that, in the course of time, my little project blossomed into a multidisciplinary initiative. It was their interest that led to my appointment as a Senior Research Fellow in the Department of Psychology and my participation in the setting up of the aforementioned University of Stirling Vision Group.

My focus was now on the subject of how all people, when developing any visually mediated skill whatsoever, use their eye/brain, first, to make sense of the patterns of light that enter the eyes and then, to make use of the *information acquired. The interest of my colleagues was less specific. For them it meant anything to do with the eye/brain function, a subject broad enough to cover their many different individual interests, including those of computer scientists interested in modelling eye/brain processes.*

Broadening the focus

This combination of art and science was to be the context within which this book and the ideas and speculations within it were born. As they grew to maturity, they became progressively inclusive of other manifestations of creativity. Important amongst these is the Big Bang, to which science tells us, we owe everything in our universe down to the last speck of dust. But also, our species' obsession with creation and afterlife myths which, before scientists came along, seemed to necessitate the imagining of supernatural beings. Whether you are a believer in the existence of any such thing, it can be argued that two of the most powerful sources of creative speculation known to the human mind have been the concept of some kind of deity and some form of afterlife. Indeed, this had much to do with the journey of science that has currently reached as far as the Big Bang hypothesis.

Armchair science

These days science is almost exclusively done in universities and in groups. I get the impression that the community of scientists has concluded that the days of the armchair scientist are numbered.

If so, you should hesitate before reading this book because, except for my time in the University of Stirling, I have been a loner: someone who, for the last 35 years, has been carrying on my research and my battles with ideas, tucked away in South West France, where I have had minimal contact with other researchers, except by reading some of their books.

However, this relative isolation has freed me to indulge in a great deal of fun with the subject of creativity. Chapter Nine takes you with me on one of my, often slightly frivolous, but always deadly serious, mind-game journeys. It is, by far, the longest chapter in the book.

But creativity is far from always fun. It cannot be so because every advance requires battling with the unknown and, accordingly, living with uncertainty. One of the most important moments of my life came with *reading the book called "The Wisdom of Uncertainty". It may sometimes be a difficult companion but, without a prelude of uncertainty, creativity cannot happen. It will make life much easier, if those that aspire to creative journeys, can make it a friend.*

The purpose of this book is to share the rich personal rewards that this combination of fun and struggle has given me.

Chapter One

A Lucky Life

Five encounters have played a critical role in the fusion of ideas that gave me the courage to write this book. All of them came quite unexpectedly. So much so, that I feel they illustrate one of the themes of this book, namely the creative role of chance, and, consequently, the need for humility in the development of ideas.

First encounter

In 1963, after obtaining a degree in history, I needed to resolve the problem of choosing a career. I decided that, before I opted for a conventional pathway,[7] I would give myself a year to test out my childhood dream of becoming a painter.

While seeking a solution, I had a rendezvous with an artist in another artist's studio. He had offered help with a possible part-time teaching opportunity in Italy. I went up to London to meet him, but he never turned up.

Instead, I found myself stranded at the door of Marian Bohusz-Szyszko, whom I was later to discover to be a professor of painting at the Academic Community of the Wilno University in London. Taking pity on me, he invited me into his studio and after some talk, offered to tell me what he asserted to be "*all you need to know about painting*". He then shared with me what I decided to call his "five dogmas". These are:

- All good painting is based on colour.
- All good colour is based on colour in nature.
- There is only one thing you need to know about nature, namely that colours never repeat (the proof he gave, related to the physics of

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[7] I was offered an opportunity to embark on a research degree by my tutor, K. B. MacFarlane: https://archive-cat.magd.ox.ac.uk/records/GPD/26.

reflecting and inter-reflecting surfaces).

- Accordingly, there should be no repetition of colour in paintings.
- All colours in paintings should be mixtures containing a proportion, however small, of complementary colour.

My first response to them was positive, for I could immediately see that they would provide some good starting points. I also thought they seemed to be just the sort of thing that must be being taught in all art schools. However, sixty years and more than a thousand students later, I have not yet encountered anyone who has come across them.

Later, when I researched the origins of the dogmas, I found them to be a synthesis of ideas coming from nineteenth-century scientists and artists and, especially, from Chevreul, James Clerk-Maxwell, Ogden Rood, Seurat, Cézanne, and Bonnard. I could not help wondering how it had come to pass that they had so completely disappeared down the plughole of history.

By dint of four years of testing these dogmas in the context of my own paintings, I concluded that, even if they were not quite "*all you need to know about painting*", they were certainly worth knowing. Their value was and is that they reliably produce an enhanced sense of illusory pictorial-space, infused with its own sense of light. Also, they guarantee what Cézanne described as "*a harmony that runs parallel to nature*".

While exploring these qualities in my own painting, I could not help wondering why the professor's rules worked so well.

To complicate matters, it was not long before I realised that there was what I saw as an obvious theoretical *non sequitur* in the professor's recipe for "*all good painting*". It was the search for an explanation of this "fly in the ointment" that was later to lead to experiments and hypotheses that were to provide a key piece of the jigsaw of ideas that underpin this book.

Second encounter

In 1964, I was appointed to teach a figure drawing and painting class at Isleworth Polytechnic. The luck here was that I turned up in the office of the Head of the Art Department, ten minutes after the woman, who had been teaching the Tuesday evening figure painting and drawing classes, had decided to withdraw from them. I can only speculate that, even though I lacked any relevant qualifications, the Head of Department who interviewed me saw an opportunity to save himself from the trouble of finding a substitute.[8]

One advantage of my lack of qualifications was that I felt an urgent need to do research into existing methods. I was not long in coming to realise that neither the currently available "how-to-do-it books" on drawing, nor the existing publications on the psychology of perception, though, of course, helpful in many ways, were able to provide either practical or theoretical solutions to a number of teaching problems that I was encountering.

During my research into current teaching methods, I discovered that many had their origin in the Italian Renaissance. These were almost exclusively concerned with achieving literal accuracy in drawing buildings and human bodies. They all used methods that involved the constraint of information. These included:

- Making tracings of mirror images of objects seen through glass and of images created with the help of a camera obscura.
- Using perspective frame grids to divide the task into easy-to-cope-with small rectangles. These not only provide perpendicular and horizontal references but also transform the task from one of representing familiar objects to one of representing abstract elements.
- Anatomy, including standard proportions, skeletal and muscle structure.

Other teaching methods owed their origins to nineteenth-century ideas about the nature of what we now know as visual perception. These included, analysing in terms of negative shapes, contour drawing (continuously looking at the model while drawing it) and copying upside-down images.

Years later, I was to come across the more than one-hundred-and-fifty-year-old "*methods of training the memory*" taught by Horace Lecoq de Boisbaudran,[9] that were to give important support to my theorising and play a pivotal role in the elaboration of the ideas presented in this book.

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[8] I kept the job until 1967, when I eventually decided to go to Art School, to get myself a proper qualification.

[9] *Éducation de la mémoire pittoresque*, Paris, 1848. *Éducation de la mémoire pittoresque, application aux arts du dessin*, 2e éd. augmentée", Paris, France, 1862. *Lettres à un jeune professeur* , Paris, Morel, 1876.

Third encounter

When I decided to go to Art School in 1967, upon the advice of artist friends, I chose the Bath Academy. The life-changing luck I had there was that the introductory class on colour-contrast effects was given by Michael Kidner, who was later to become a friend and to play a key role in the development of my ideas on creativity.

I felt that the subject matter of the class had already been so thoroughly explored, both in theory and in practice, that there would be nothing to add to it. How wrong I was. My change of stance came at the end of a class that Michael gave on local contrast effects. When he asked us students which colour pairings worked best, there were significant variations in opinion. My efforts to explain these differences, was eventually to prepare the way for my two appointments at the University of Stirling, Scotland, the publication of two research papers[10,11] and the uniting of ideas from my interests in painting and graphic skills, that is key to the contents of this book.

Fourth encounter

Very early in my time at Stirling, when taking up my post as an artist,[12] I found that the nearest coffee room was in the Psychology Department. When I timidly entered it for the first time, a little man with black hair and a beard was seated near the door.[13] On seeing me hesitating on the threshold, he invited me to join him in a cup of coffee. Feeling the need to say something, he started by telling me that he didn't know anything about painting and very little about drawing. Indeed, he told me that the only thing he knew about either subject was the theory of intellectual realism, which he proceeded to explain to me. My response was one of astonishment. To me, it was obvious that it was wrong-headed. When I told him my reasons,

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[10] Pratt, Francis and MacDonald, Ranald R., 1981, "Effects of distance on heterochromatic matching". *Perceptual and Motor Skills*, Vol. 50, 1127-1138.
[11] MacDonald, Ranald R., Pratt, Francis and Beattie, Martin E., 1982, "Effects of viewing distance on metameric matches". *Perceptual and Motor Skills*, Vol. 54, 119-126.
[12] Tom Cottrell Memorial Fellow.
[13] Dr Bill Phillips.

he suggested that we should do a research project together.[14] The outcome was to support my scepticism and to lead to a publication. This, and other cooperations with my newfound colleagues, went so well that Bill and others persuaded me to apply for a research grant to study graphic skills. Becoming a senior research fellow can be seen as an official recognition of my temporary transformation into being a scientist.

Fifth encounter

One day, I found on my desk, without any accompanying message, a copy of an article in *Scientific American* entitled "The Retinex Theory of Color Vision".[15] (I never found out who was the donor.) This article included both a powerful demonstration of the phenomenon of colour constancy and a hypothetical explanation of it. I soon realised that, if it were to be neurophysiologically plausible, it might well resolve the theoretical problem I had with the rules of Professor Bohusz-Szyszko. However, by this time I had already learnt enough about neural system processing, to realise that it was not any such thing.

During the next five years I devoted much spare time fruitlessly turning over ideas in search of a more neurophysiologically plausible hypothesis. It was not until 1984 that I took a computer question to my ever helpful colleague Ranald McDonald. He suggested that I share my predicament with Dr. Alistair Watson, who was working in the Department of Environmental Science, on the interpretation of satellite imagery.

At our first meeting we got onto the subject of colour constancy. Much to my surprise, when I shared the confusion of ideas I had developed on the subject, his eyes lit up and he proclaimed that I had solved his current problem. More importantly for me, he asserted that the solution solved my problem as well. By the next day, he had come up with what we called our neurophysiologically plausible colour constancy algorithm, which worked a treat. We later learned that this was a version of what Anya Hurlbert

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[14] Phillips, Hobbs and Pratt, 1979, "Intellectual realism in children's drawings of cubes", *Cognition*, plus presentations at international conferences, talks and seminars given at Oxford, Cambridge, Edinburgh and others, plus several publications in review books.

[15] Edwin Land, 1977, "The Retinex Theory of Color Vision", *Scientific American*.

described as a lightness algorithm.[16]

Following this, Alistair and I spent much time in follow-up discussions, a process that led to a classification algorithm based on the power of multimodal processing.

Both these algorithms were based on ideas concerning neural processing that were to become central to the arguments about the nature of creativity presented in this book.

[16] Anya Hurlbert, 1986, "Formal connections between lightness algorithms", *J Opt Soc Am A.*, Vol. 3.

CHAPTER TWO

STATEMENT OF FUNDAMENTALS

Before going any further, I think it will help to give context to what follows in this book. Now that I am eighty-five years old, I find that I have come to a stance on a number of fundamentals. I feel that making a list of these will provide a helpful perspective on the chapter-by-chapter synthesis, which follows.

- Human creativity can be taking place in any domain of activity whatsoever, whether it be in the arts, the sciences (including mathematics), product design, sport, gardening, carpentry, cooking, children's play and, indeed, any other skilled activity of any kind. In all these spheres it entails, first, going beyond the known into the unknown and then, making use of what is found, either on arrival in this unpredictable territory or in the process of getting there.
- As far as brain processing is concerned, there is no difference between creativity and learning. Certainly, learning fits my definition above, of creativity. The only difference is that:
- In the case of learning, there are other people (for example, parents, teachers, or books) that claim to be familiar with the particular variety of sense being made.
- In the case of creativity, there is a belief that it is necessary to go beyond previous experience into everybody's unknown. In my view, if someone has achieved a creative outcome, without awareness of others who have come to it before him or her, then he or she is equally as creative as these people.
- No matter what modality we are talking about, the unknown has no boundaries. The many scientists who have talked of standing on the edge of the infinite expanse of "the sea of knowledge", clearly agree. Mathematically speaking, navigating these unbounded expanses provides the same dimension of challenge to top scientists, as it does

to five-year-olds, eighty-five-year-olds, high-achieving schoolchildren or badly educated ones.

Nor is it only status and age that can be considered in this way. The same is true of physical capacity. Indeed, there is an abundance of evidence that physical limitations can help creativity. For example, if we narrow matters down to the role that vision plays in artistic creativity, we find that there is both advantage and disadvantage for people with so-called normal vision, relative to people who are short-sighted, long-sighted, colour-blind (anomalous colour vision of any of its manifestations), dyslexic, autistic, or schizophrenic. On the contrary, each of these conditions provides a different normality. For example, what we describe as anomalously red/green colour-blind, other people experience as normal. Likewise, what we experience as normal, they would consider to be anomalous. For schizophrenics, it is the way that non-schizophrenics experience the world that is anomalous.

Normality

More generally speaking, the meaning of the word "normality" is a moving feast in all domains where physical differences of any kind exist. Every so-called disadvantage is a potential advantage in the sense that it opens different ways of looking at problems and, hence, different routes to creativity. A quotation near the end of this book is,

> *… they will be alright as long as they realise that their weaknesses are their strengths and that their strengths are not such a bad thing, as long as they don't get too uppity about them.*

Indeed, if we put these thoughts into a larger perspective, we find that it is important to realise that genetic diversity is a major necessity for the evolution of civilisations. This is because every member of our species has a unique, genetically rooted and experientially elaborated way of experiencing his or her world so that all individuals have the potential for expanding the experience of others.

Starting points

As suggested in the Introduction, the efficient functioning of our brain can be described as being "dependent upon a hierarchy of backup systems". Each one works best in a different situation. For example:

- The usefulness of recognition depends on the relevance of the information stocked in the long-term memory (LTM). A six-year-old child starts with less knowledge than a fifty-year-old adult but has just as much potential for creativity. Different knowledge bases, like the different visual capacities, offer different opportunities and different limitations. It is true that the most creative seven-year-old is unlikely to win a Nobel Prize. However, it is unlikely that any Nobel Prize winner could match the creativity of vast numbers of (perhaps all) six-year-olds. Take the example of children's drawings and paintings. Pablo Picasso and Paul Klee both admitted the failure of their attempts to see and do with the eyes and minds of young children. Paul Klee also found that there was a lot to learn from the psychotic patients, whose work he saw in the collection of Dr Hans Prinzhorn. Clearly, in these painters' minds (and mine), being a child or being "mad" was seen as a platform for unique creativity. As has just been implied, the same is true of individual uniqueness: each of us embodies a unique launching pad for creativity.
- The same is true of people living in groups. The larger they are the more complicated is the situation, but studies of small groups have shown that they tend to organise themselves in regular ways. In all cases, they make use of different talents. For example, I am told that they all tend to have a leader, a henchman and a deviant. If, for any reason, a person holding any these roles should leave the group, a replacement will be found from within the group. If it is the deviant, another deviant will emerge from amongst the existing, non-deviant members of the group. If it is the leader who departs, the norm is that he or she will be replaced by the deviant (that is to say, a person with different ways of looking at matters). If they are large groups or civilisations, there will be a need for many talented people, possessing between them a good helping of genetic variability, which is capable of seeding a healthy variety of different perspectives that will

inevitably encourage a potential for group creativity.

- Creative journeys always involve an accumulation of many little steps, rather than giant leaps of the imagination. The neurophysiology of the situation means that this is the only possibility. If we ask what little steps can achieve, the answer is that they can be used, brick by brick, to build unique infrastructures incrementally. The last little step in this process can appear to others and even to oneself as having been a giant leap.
- Each step is taken in the context provided by the sum of previous steps. Russian dolls come to mind, with each new step providing a context for the next and, in this way, progressing incrementally from the general to the particular. The result is edifices of different complexity. Each skill requires a different edifice and the greater the skill-level, the larger is the edifice.

As explained in many places, the step-by-step progress depends on the use of same/difference judgements (enabled by lateral inhibition). At each level of processing, the "sames" create an array of mosaics of neural activity that form a component of a description, while the "differences" trigger a higher-level mosaic that can provide refinements of them. It is the accumulation of these layers that provides the descriptions. The building process stops either (a) when the edifice of descriptions in the LTM triggers action-instructions, or (b) when a level is reached at which there are no more mosaics of "sames" to find.

It is perhaps helpful to consider approaching matters in this way, as being an incremental process of making it possible to find sense in the senseless. At each level, the separate context-refining mosaics can be described as "independently varying modalities of vague information".

Elsewhere, I explained why the cross-correlation between ambiguous entities must be a necessity, if single cells are to be integrated into the complex neural-processing systems that are necessary for the evolution of human skills. For example, consider the skilled use of the analytic-looking cycle when drawing and painting from observation. As must be evident to all who read my writings, one of the leitmotifs is that the first stage of the analytic-looking cycle is, always and necessarily, that of enabling recognition.

The role of recognition is to provide a pathway to the LTM and, by doing so, to make available the information residing in it to generate appropriate action-instructions.

If we now turn our attention to the origins of the store of action-instructions residing in the LTM, we realise that each one of them must have been constructed of a lifelong accumulation of small, context-dependent steps, involving the cross-correlation between ambiguous entities.

Likewise, the evolution of our species must have been the outcome of the long sequence of similar cross-correlations.

It is also important to realise that the only plausible way in which this could have happened is by means of the cross-correlation of information provided by a number of different sensory systems, each drawing information from multiple sources of sensory input.

In all this, a question arises as to how the eye/brain copes when it is confronted by the visual analysis of unfamiliar objects. As it can only start visual processing with recognition, we have to conclude that it has the capacity to find familiarity in what we would describe as unfamiliarity. This must involve going down the levels of description, via objects, to object parts, shapes, contours, colour etc. If, at any level, the system comes across the information that is needed for realising the current objectives (almost certainly or always with the help of inputs to other sensory systems), it can stop the descent. Equally clearly, it cannot go on down until it runs out of road. The system would grind to a halt if it found itself at a level where there is no mosaic of neural activity left to compare.

Luckily, evolution has arranged that this cannot happen. The reason is that all objects, once separated from their backgrounds, have a common property, namely that of being incoherent, meaningless lumps. Unless recognition occurs, the eye/brain system will continue down until it reaches the incoherent lump stage. At this point, since figure/field separation is the first stage of processing for absolutely all objects, this has the counter-intuitive property of being the most familiar object of all.

Accordingly, the visual system will trigger the action-instructions in the LTM for starting from scratch.

As suggested above, there are two kinds of creativity. These are:

- Producing something beyond current experience.
- Finding a new way of achieving a preset goal.

In both manifestations, it is necessary to make value judgements:

- In the case of producing something beyond current experience, value judgements are necessary for deciding whether the result is good or bad, and this decision depends on the criteria that are being used. Clearly, artists such as Van Gogh, Matisse and Mondrian were using different criteria to Piero della Francesca, Titian and Rembrandt. Equally clearly, all these painters were basing their value judgements on culturally influenced and personalised criteria. History would later decide if they were also in accord with large group criteria.
- In the case of finding a new way of achieving a preset goal, value judgements are required for deciding whether matters are going in the desired direction. This is not necessarily easy. There are many examples of scientists who have sought to model how the eye/brain arrives at a known phenomenon and have got coherent conclusions that prove to be incorrect. For example, this was the case with Edwin Land's retinex theory of colour vision, which he claimed to explain the phenomenon of colour constancy. The problem was that his solution required the eye/brain's early processing systems to use ratios, which is something that they cannot do. Nevertheless, even though not neurophysiologically plausible, Land's finding was an example of creativity. The fact that it was deeply flawed did not stop it being a good story based on the facts as Land knew them.

Luckily, the shortcomings of the retinex theory were soon enough evident to neurophysiologists and others (including myself). However, as with many negative results, it energised a search for a more neurophysiologically plausible alternative. As a result, a cluster of independently arrived at lightness algorithms (including Alistair's and mine) appeared soon after.

Anyone who is intent upon opening up worthwhile new ways of doing things, will be confronted with value judgements. One of the core issues explored by the Early Modernist painters was the good/bad criteria. For example, Toulouse Lautrec and Henri Matisse were pioneers in making drawings or paintings that deliberately questioned previously accepted criteria. Toulouse Lautrec included deliberately bad drawing in a poster submission and, when it was rejected for its sloppiness, defended it vigorously by printing out the poster one hundred times. Also, he both challenged the rule that, to be called "finished", a painting must cover the whole canvas and explored the use of minimal cues. Apparently, Shukin, the Russian collector of the paintings of Matisse, only bought the ones that he did not like. The reason for this seemingly bizarre behaviour was that he trusted Matisse to have gone into new territory and to have discovered new criteria for what could be evaluated as good. Shukin's idea was to find his own new goods by following the trail of Matisse. The fact that he kept coming back to buy more paintings, indicates his belief in the success of his policy.

CHAPTER THREE

SPECULATIONS ON THE EVOLUTION AND NATURE OF BRAIN FUNCTION

This chapter consists of speculations that are influenced by my interest in the evolution of the earliest living things on our Earth and the first stages in the life of an infant and young child. They can be divided into four headings:

Transformation of inert matter into living matter

According to scientists, the Big Bang was responsible for the creation of the world. For a few billion years this meant lots of water and many minerals. Then, chemical reactions between some of these occurred, that gave life to the formerly inert matter. During the next few billions of years, primitive forms of life evolved and took the form of bacteria, archaea, and viruses.

Two known properties of bacteria are that they were complex organisms and that they were sensitive to light.

From bacteria and archaea, to eucaryotes

Speculation concerning a hypothetical, multilayered cluster of light-sensitive, single-cell organisms suggests that it would automatically develop both feed-through and intercellular interactions that depended on neural nets, receptive-fields, and levels of processing. In particular, it would enable lateral inhibition and, accordingly, develop the capacity for making the same/difference judgements that can be described as the "workhorse of neural processing at all levels".

The above speculations can be related to the claim that some billions of years ago a bacterium and an archaeon fused to become the eucaryote that was to be the common ancestor of all living things (except, of course, bacteria, archaea, and viruses), thereby producing a multilayered cluster and, accordingly, placing same/difference judgements at the core of all neural processing.

Evolution of the species

My next speculation concerns the evolution of brains within life forms. Of particular interest are:

- The bottom-up nature of a process that can be conceived as an accumulation of add-ons.
- The range and functionality of the capacities of different organisms as they evolved over time, from simpler to more complex.
- The evolution of mammalian brains, starting with old brain capacities and, only at the last stages, developing new brain capacities.
- The example of a rat which, despite having a relatively small new brain has a memory.
- The ability to recognise, recall and both organise and implement actions.
- Internal mapping capacities capable of locating targets, both in the world outside and within the brain (this is the reason why the hippocampus is necessary for memory).
- The ability to have both positive and negative feelings (desire and fear).
- The ability to decide between the relative value of different outcomes (good and bad).
- The ability to receive and make sense of information from a range of sensory receptor-types found throughout the body allowing it to hear, smell, taste, see and feel (in various ways: all well adapted for multimodal processing which is necessary for initial classification and recognition by means of any combination of modalities).

The need for a new brain

The last of these three speculations is that, if the old brain has all these capacities, why is the new brain needed at all? To answer this question, one obvious starting place is a closer look at new brain structures. If we do this, we find that, like the old brain, all play a part in extending the usefulness of the five main stages of visual processing, namely (1) isolating objects from their context, (2) classification, (3) recognition, (4) recall, and (5) the organisation and implementation of actions (the basis of all habits and skills). Another important role is providing the back-up systems that enable the brain to function more efficiently in a variety of contingencies.

However, all this extra processing capacity should not blind us to the fact that the new brain is indeed an add-on. Nor should it be a surprise to find that the new brain would not be able to mediate any of the above stages without the ongoing and continuous help of old brain processes. All the explanations in my books on drawing, painting and creativity depend on the assumption that the new brain is regularly and crucially dependent on old brain inputs.

Summary of the evolutionary perspective presented above

The discussion above centres on how the evolutionary processes that produced *Homo sapiens* gave priority to processes that occur outside the neocortex, including outside the five regions known as the visual cortex. It emphasises the fact that all visual experience is rooted in such non-visual considerations as the sense of place and the feeling's history. It also emphasises that the inclusion of old brain processes means that there is a highly significant increase in the number of modalities available for boosting the efficiency of the multimodal processes that enable recognition (there will be more on multimodal processing in a separate section below). One of the advantages of this is the possibility that a number of these modalities may remain unchanged even when visual input is fluctuating, thereby creating a more stable context for the visual aspects of the recognition processes.

Developmental considerations relating to the earliest stages of learning

A similar message can be derived from an analysis of the processes that enable visually mediated aspects of learning. This is best illustrated by starting at the beginning, with the baby still inside its mother's womb, where there is no light. However, there is sound and there are other sensory inputs.