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The Art of Seeing and the Seeing of Art

5th - 7th December 2001
ANU Canberra Australia

A conference exploring how normal and abnormal visual processes influence the interpretation of art

Conference sponsored by the
Centre for Visual Sciences
Research School of Biological Sciences
Australian National University

The Art of Seeing and the Seeing of Art

Wednesday December 5

At the Robertson Theatre, RSBS

8.00 – 9.00	Registration
9.00 – 9.10	Welcome: John Hearn, Deputy Vice Chancellor for Research, ANU
9.10 – 10.00	Opening address: Howard Morphy, (Canberra) Seeing indigenous Australian art
10.00 – 10.40	Plenary address: Liam Burke (Sydney) An introduction to the visual brain
10.40 – 11.10	Morning tea

Session 1: Community beliefs & their influence on art

Caroline Turner (Canberra): Chairperson

11.10 – 11.35	Simon Grose (Canberra) The artistic impact of images from science
11.35 – 12.00	Yutaka Fukuda (Japan) Is Japanese art unique in its rendition of nature?
12.00 – 12.30	Cobie Brinkman (Canberra) Non-hairy, but not non-human primates can paint: the neuroethology of art. (Keynote lecture)
12.30 – 1.30	Lunch

Session 2: Looking at the world with the painter's eye

Helen Musa (Canberra): Chairperson

1.30 - 1.55	Jon Nathan (Melbourne) The painter and handicapped vision
1.55 – 2.20	Betty Snowden (Canberra) Degas's impaired vision: did it compromise his art or was it a vehicle for his remarkable visual inventiveness?
2.20 – 2.45	Ruth Waller (Canberra) Van Eyck to virtual
2.45 - 3.10	Peter Ellis (Melbourne) Teenage lightning in the floorboards: Automatism, chance and visual associations in a surrealist context
3.10 – 3.40	Jack Pettigrew (Brisbane) Science, art and ambiguity: Dali & Leonardo from a neuroscientist's point of view (Plenary lecture)
3.40 – 4.20	Afternoon tea
4.20 – 5.00	**Panel and audience discussion**: Does surrealism really portray the workings of the subconscious mind? Jack Pettigrew (chairperson) & Peter Ellis
7.00 for 7.30	**Conference dinner - Vivaldi's restaurant**

Guest speaker: Andrew Sayers, Director National Portrait Gallery

The Art of Seeing and the Seeing of Art

Thursday December 6

At the Robertson theatre, RSBS

Session 3:	**Fantasy, hallucinations and psychedelic art**
	Rebecca Scott Chairperson
9.00 – 9.25	Barb. Smith (Canberra) &Annette Iggulden (Melbourne) Dealing with visual flaws: the artist's response
9.25 – 9.50	Gert van Tonder (Japan) Making & breaking of Gestalt in traditional Zen landscapes
9.50 – 10.15	Mark Pennings (Brisbane) The rebellious psychedelic consciousness
10.15 – 10.40	Jeff Ward (Canberra) Intoxicated vision: Hallucinations, the visual system and psychedelic art (Keynote lecture)
10.40 – 11.10	Morning tea
Session 4:	**Playing with vision: the artist's box of tricks**
	Srini Srinvasan (Canberra): Chairperson
11.10 – 11.35	Tim Miller (Bathurst) Colour thresholds and painting
11.35 – 12.00	Mark McCourt (USA) Brightness illusions in visual art and seeing
12.00 – 12.25	John Jupe (UK) Inside visual perception
12. 25 – 1.25	Lunch
Session 5:	**Depth & movement on a flat, static surface**
	Michael Cook (Canberra): Chairperson
1.25 – 1.50	Nicola Watts (Sydney) An oblique effect in aesthetics revisited
1.50 – 2.15	Johannes Zanker (UK) Motion in art – Art in motion
2.15 – 2.40	Ian Thornton (Germany) What can implied dynamics tell us about the brain?
2.40 – 3.20	Christopher Tyler (USA) A controversial history of depth representation From Greece to Magritte (Plenary lecture)
3.20 – 3.50	Afternoon tea
	Invited Lecture
	Nigel Lendon (chairperson):
3.50 – 4.50	Djon Mundine (Canberra) Yolngu science
7.00 – 9.00	**Public lectures - Academy of Science.**
	Chairperson: John Gibson, Acting Director, RSBS
	Jerry Jacobs (USA) Out of the darkness: the evolutionary journey to human colour vision
	Brian Kennedy (Canberra) An Irish joke; a Dublin Caravaggio

The Art of Seeing and the Seeing of Art

Friday December 7

At the National Gallery of Australia (Bus leaves RSBS for NGA at 8.15am)

9.00 – 9.10	**Welcome** Brian Kennedy, Director National Gallery of Australia
Session 6:	**'My heart leaps up when I behold a rainbow in the sky'**
	Ann Sefton (Sydney): Chairperson
9.10 – 9.35	Paul Martin (Sydney) Structure & evolution of brain pathways for colour vision
9.35 – 10.00	Barry Cole (Melbourne) The artfulness of the colour-blind artist
10.00 –10.25	Bob Rodieck (USA) Colour gamuts and colour spaces
10.25 – 10.50	David Nash (Canberra) Warlpiri terminology for colour
10.50 – 11.15	Morning tea
Session 7:	**Shapes and form; who has had the greatest impact - Mondrian, Jackson Pollock or Lucian Freud?**
	Anna Gray (Canberra): Chairperson
11.15 – 11.40	Miranda Grounds (Perth) SymbioticA: Crossing boundaries
11.40 – 12.05	Richard Taylor (USA) Fractals: A resonance between art & nature
12.05 – 12.30	Alan Lee (Adelaide) Piet Mondrian: Buridan's ass & aesthetic decision
12.30 – 1.00	Sasha Grishin (Canberra) Lucian Freud: Form, sight & heavy metal (Keynote lecture)
1.00 – 2.00	Lunch
Session 8:	**How patterns guide the artist's fancy**
	Mark Rowe (Sydney) Chairperson
2.00 – 2.25	Kevin Murray (Melbourne) When things pick up: the process of partitioning in the construction of an exhibition
2.25 – 2.50	Branka Spehar (Sydney) Aesthetic preference among simple visual patterns
2.50 – 3.15	Lothar Spillmann (FRG) Neon colour and water colour spreading - presented by Ted Maddess (Canberra)
3.15 – 3.40	Laurence Garey (UAE) Reconstructing Rembrandt: Where art & science compete for effect
Session 9:	**Closing Address**
	Chairperson: Bogdan Dreher (Sydney)
3.40 – 4.10	John Gage (UK) On not talking much about colour
4.10 – 4.45	**Farewell** Geoff Henry (Canberra): **Drinks in the Gallery Foyer**
5.00 - 5.30	**Unveiling of sculpture , New Sculpture Garden, ANU**

NON-HAIRY, BUT NOT NON-HUMAN, PRIMATES, CAN PAINT:
THE NEURO-ETHOLOGY OF ART
Cobie Brinkman

Almost 50 years ago, Desmond Morris published "The Biology of Art: A Study of the Picture-Making Behaviour of the Great Apes and its Relationship to Art" (Methuen & Co, 1962), summarising what was known of painting apes (gorillas and chimpanzees, but also *Cebus* monkeys) and describing his 'experimental' approach to ape painting. Comparing apes' works with contemporary non-representational art, and with children's drawings, Morris identified six "biological principles of picture making," and expressed the hope that working with "carefully selected teams of apes and monkeys" "a great deal more about the mystery of the process of artistic creation could be unraveled". However, Morris' hoped for Institute for the Study of the Biology of Art was never built, although apes have continued to paint (eg, at Perth Zoo); moreover, non-primates have taken up brushes - Sydney's Museum of Contemporary Art will shortly host paintings by Thai elephants- and monkeys, "sculpture" - *Cebus* monkeys modify clay shapes and may use tools, or paint, to mark them (Westergaard and Suomi, 1997). But are apes' artistic efforts merely evidence of Morris' first principle of Self-rewarding Activation (what might, to-day, be called "environmental enrichment"), or do any or all of his other principles also apply? Lenain (1990/1997; 1995), using the tools of the art critic and historian, concluded "a monkey painting is not a work of art". At best, only Morris' first principle applies; studies of ape painting are useful only to describe "the evolutionary gap between animal behaviour and human culture". However, at the same time, the increased biological and behavioural knowledge about apes and humans appears to indicate that this evolutionary gap may be very small: eg, the often quoted evidence of chimpanzees and humans sharing almost 99% of DNA. As a consequence, humans have been described as the "third (species of) chimpanzee" (Diamond, 1991), and some consider ape/human differences as so minimal that apes should be given "personhood", sharing with humans a common charter of rights (Cavalieri and Singer, 1993). Chimpanzees share with humans culture, tool manufacture and use, a sense of morals, self-awareness, some ability for language, and highly evolved social skills including, possibly, "mind-reading" (knowing what another person's point of view is) skills (De Waal, 2001). Why, then, should they not paint like humans? An answer to this question may be found using neuro-ethological principles, comparing the brains, and the behaviours they produce, of chimpanzees and humans. If painting is, at base, a neural visuomotor transformation, there are few if any differences between the visual and motor systems of the two species. However, there is, in humans, an enormous increase in size in the prefrontal and parietal association cortex (Deacon, 1997). It is that cortex which gives modern humans their large brain size and is involved in abstract and symbolic thinking and planning, and in executive functions. The likely relationship of this cortex to the planning, execution and appreciation of art works would explain the emergence of art with the advent of modern humans (Mithen, 1996; Tomasello, 1999), support Lenain's (1990/1995) conclusions, and go against Morris (1962) idea of a comparative biology of art. In fact, a re-examination of Morris data suggests that ape art may indeed obey only the first principle and only be an exciting (and for the institution, well-paying) form of environmental enrichment

AN INTRODUCTION TO THE VISUAL BRAIN
Liam Burke

Should artists know anything about the anatomy and physiology of vision? Should visual anatomists and physiologists try to understand art? Geoff Henry thinks the answer in both cases is: yes!

This talk will attempt to describe the essential features of the visual brain. The basic anatomy will first be described, detailing the pathways from retina, through thalamus, on to the cerebral cortex. I will then try to answer some 'frequently asked questions.'

The image of the world is inverted and reversed on the retina, as it is on the film in a camera. Why don't we see the world inverted and reversed?

There are three major groupings of nerve fibres in the optic nerve – magnocellular, parvocellular and koniocellular. What is the function of these different groups?

Our visual acuity is similar to that of the monkey but much better than that of cats and dogs. What determines our acuity?

Why do we have two eyes? How are the pathways from the two eyes distributed within the brain? Why is our view of the world seamless? What is the basis for stereoscopic vision? What other clues do we have for depth perception?

Why are there so many separate visual areas in the cerebral cortex (over thirty and still counting)? What are the properties of these areas and how are they connected?

Why don't we see our blind spot (optic disc) or small lesions in the retina? What happens to our vision if our cerebral cortex is injured?

Where are our visual memories stored? What parts of the brain are involved in our visual dreams? Where do hallucinations occur? Where do illusions occur?

Is our visual environment important as we grow up? What happens if we grow up with a cataract or a squint? . In the child the brain is moulded by the environment and, in turn, the brain shapes the environment.

Our brains are very visual brains with one million nerve fibres in each optic nerve and about half of the cerebral cortex devoted to vision. From this cornucopia of neurons the artistic brain assembles shapes and colours to give delight and inspire contemplation. This is not a mere reproduction of the external world but a re-interpretation. Our attempts to understand the workings of the visual brain may not have revealed the neural basis of this aesthetic sensibility but they have established how some of the elementary perceptions are created.

THE ARTFULNESS OF THE COLOUR BLIND ARTIST
Barry L Cole

There has been discussion about colour-blind artists for over 100 years, even an exhibition of their work in Naples in 1908. However, Marmor and Lanthony (2001) state that no "major" painter is know to have defective colour vision and while that may be true a number of lesser painters do.

What we would expect of them? Red-green dichromats lack one colour receptor and their coloured world is reduced to the perception of yellow, blue and white. They have good colour discrimination for blues and blue greens but see them all as blues varying in purity. Reds, yellows and yellow-greens all look the same colour but vary in brightness, so red looks like a dark yellow compared to the brightness of yellow. Perhaps colour-deficient artists limit their palette to blues and yellow since these are the colours they perceive?

Paris artist, Jens Johannsen, seems to have adopted this strategy. Charles Meryon, a significant 19th C artist, also seems to have preferred blue and yellow, but gradually gave up painting in favour of etching, which may have been a smart career move.

A keen amateur artist with the common but mild colour vision defect of deuteranomaly, brought to the attention of the author by his optometrist, says he always paints at one siting because he knows he cannot match the colours when he attempts to refine a painting at a later date.

A very keen amateur artist known to the author also has deuteranomaly and he too has trouble with colour discrimination. He often knows that a colour is not right but has no idea of what colours to add to get the colour right. He lays out numerous of blobs of white on his palette and takes care to use separate blobs for each different colour he uses because he knows he cannot always detect contamination of his white by unwanted colours. He says he limits the number of tubes of paint he uses to the ones he is confident with, but when he opens his paint box there are two dozen tubes, all well used.

Much of his work is maritime scenes using blues, blue greys and white, which he might be expected to use because these are the colours he can perceive and feels confident with, but he surprises us by other work using red, oranges and yellows. He can name these colours provided they are large areas, but not when they are small patches and flecks. His trick is to lay on the bigger areas of red, yellow and orange colour and then put in the flecks and small patches using the colour mix he used for the larger areas.

All artists trick our perceptions both visually and emotionally, so why should not the colour-defective artist be equally artful to produce something that pleases both him and the colour-normal public. It is interesting to reflect on the recent study of 3124 high school boys that included 82 dichomats, who have a severe loss of colour perception. It was found the dichromats had significantly lower school achievement in all subjects except art!

TEENAGE LIGHTNING IN THE FLOORBOARDS: AUTOMATISM, CHANCE AND VISUAL ASSOCIATIONS IN A SURREALIST CONTEXT
Peter Ellis

Lecture will explore automatic and chance associations in literature and image making within the context of surrealism.

Examining the use of technologies, mechanisms, techniques and media to produce images. Photography, painting, drawing, film, the object.

The science of the "Marvellous", hidden meanings, and the inner world made visible.

An illustrated lecture featuring pre and post surrealist images, including examples of the artist's work.

IS JAPANESE ART UNIQUE IN ITS REPRESENTATION OF THE WORLD?
Yutaka Fukuda

It is well known that the perspective of the Japanese art is quite different from that of the Western art especially since the time of renaissance in Europe. Of course the western art itself has significantly changed from the end of 19 century to 20 century thorough various movements of impressionism, cubism, and fauvism and so on. Furthermore, in the United States even the abstractionism, superrealism and action painting have also emerged. Every new movement has also changed Japanese arts. Thus the difference between the Japanese art and western art has been diminished. In spite of this, I believe that the Japanese art is still unique in representing the world.
In the present talk, I will discuss how unique the Japanese paintings are in their representation of the world by taking some examples from the classical Japanese paintings such as Genjimonogatari-emaki, Shigisanengi-emaki, to modern Japanese paintings such as the works done by Jirou Yoshihara, Kazuo Shiraga, Kunitarou Suda and Heihachiro Fukuda. Deep appreciations of these paintings in terms of the subject drawn, the way of painting and the unique perspective will tell us, I hope, how the Japanese mind went into action in common in understanding the surrounding environment and creating the art works through their specific perceptions and skills.

On not talking much about colour
John Gage

The world 'out there' is colourless and yet for most of us it is endowed with a fullness of colour. Yet, although animals and insects have special reasons for identifying colours, our human needs are unspecialised and, it seems, we do it rather badly. So it is fortunate that - at least for men - a monochromatic image of the world is adequate for most of our purposes. So why is colour so important, if it is? This paper looks at art, and particularly Australian art, in order to throw some light on these questions, which involve linguistics as well as aesthetics, and cultural practices of many kinds.

Reconstructing Rembrandt: where art and science compete for effect
Laurence Garey, Mei Guan, William Schupbach

An often-asked question by artists and scientists is: what is going on in Rembrandt's painting "The Anatomy of Dr Deijman"? Commissioned in 1656, it was fifth in a series of group portraits of public dissections. It was recently on display in London in an exhibition of Art and Science of the Human Body, and shows a cadaver, with the brain and abdominal cavity dissected, an assistant holding the skullcap, and the hands and trunk of the anatomist, Johan Deijman. The rest, showing Deijman's head and several other spectators, was destroyed by fire in 1723. The anatomist is apparently pulling something out of the skull cavity. What is being dissected in the painting, and what is the objective of portraying such a gruesome subject? Purely a scientific record, or something more? To help answer the first question, we performed a reconstruction of the dissection. The findings were surprising, revealing points that have not hitherto been recognised. The structure being held by Deijman is the falx, the crescent-shaped segment of dura mater that lines the longitudinal fissure between the cerebral hemispheres. The dissection also showed what liberties the painter has taken. Deijman has already cut the falx out of the fissure in which it sits and turned it through 90 degrees to show its crescent shape side-on, but is holding it to give the impression that he is just lifting it out. Not until we actually tried to do this did we discover that it is not possible to turn the still attached falx sideways. Rembrandt's artistic licence has been even more unscrupulous: the soles of the feet imply a low viewpoint, but the brain is also depicted in detail. Again, only by trying to repeat the manoeuvre did we discover that a low-angle view of the body was not compatible with the painted view of the brain. In order to depict both, the artist had to paint a "double" view, one from low down, and the other from a much higher position, and much closer. We had to photograph the subject twice, once from floor level for the body, and then from some two metres higher for the brain. In order to foreshorten the cadaver, Rembrandt has eliminated a cubic metre of Amsterdam airspace between the subject's head and feet. Why emphasise the dissection of the falx, a tissue of little obvious importance, for such an important commission? A reason emerges when we consider the painting as one in a series, including Rembrandt's earlier, and more famous, "Anatomy of Dr Tulp", which aimed to communicate a suitable public image for the Amsterdam Corporation of Surgeons. The surgeons presented themselves as craftsmen whose working material was the human body. One of the lessons they taught was the fragility of life. *Falx* is Latin for scythe, and the scythe is the instrument with which Death, the grim reaper, harvests his human crop. Rembrandt used this imagery in one of his etchings, so he might well have appreciated the opportunity to depict the anatomical scythe deep within ourselves. Rembrandt's "Anatomy of Dr Deijman" was a scientific impossibility, a work of fiction largely created in the artist's head. However, it is not a scientific work. Its greatness is that is looks totally natural, but is not. Rembrandt used subtle creative licence to show the feet and brain in the same dimensional image. He first created the work in his head in two halves. He did not respect perspective, but preferred to distort his image to obtain the desired effect. The "Anatomy of Dr Deijman", like other paintings in the series, is intended to have a strong moralising influence, and was more concerned with educating the public about how fragile life is than representing scientific reality. Rembrandt's distortions have the effect of emphasising the difference between life and death, and they may add a sense of humiliation to the dead figure.

LUCIAN FREUD: FORM, SIGHT AND HEAVY METAL
Dr Sasha Grishin

Earlier this year the National Gallery of Australia in Canberra acquired a huge painting for a huge price. It was Lucian Freud's *After Cézanne*, which measures over two metres square, which the gallery purchased for the record price of $AUD 7.4 million. Almost overnight, Lucian Freud, a painter of whom few Australians had ever heard of, became a household name and his painting stood at the centre of a raging controversy.

This paper explores the reading of this painting from three distinct, yet interrelated perspectives. The first is within an art historical context, where the painting is examined within the conventions of portraiture, still life and genre painting. Freud borrows from each of these traditions without locating the work within any one of them. The *After Cézanne* canvas is also considered within Freud's oeuvre as well as within the conventions of history painting and the art of the religious altarpiece.

Secondly, the painting is considered in terms of the different formal strategies employed by Freud and their implications for the viewing of the work. Both through the perspectival structures and the manipulation of the colour and texture, Freud creates a series of visual tensions and an arena for desire. His use of certain visual strategies subvert many of the anticipated emotional responses implicit in the subject matter. Ambiguity in the beholder's relationship to the work is one of the key features in our inability to establish a satisfactory viewing distance.

Thirdly, through the use of heavy metal pigment for the areas of flesh, the painting has a physical relief quality which in some ways contradicts the implied illusionism in the construction of the picture space. The sublimation of flesh through paint carries with it major implications for the perception of the work.

THE ARTISTIC IMAGES FROM SCIENCE
Simon Grose

Many images and objects generated by scientists have aesthetic qualities that evoke responses within the range that we readily associate with 'art'.

SYMBIOTICA: CROSSING BOUNDARIES.

Miranda D Grounds

The Department of Anatomy & Human Biology at the University of Western Australia has had a long-standing interest and activity in promoting Art in Science and Medicine. Over recent years there has been additional activity that is rapidly opening up many new developments, and public reaction to the unusual art practices has been particularly favourable. Art can be a means to introduce many people to the excitement of Science and Medicine and we would particularly like to extend this opportunity to indigenous people. There have always been strong links between artists and anatomy and we welcome the opportunity to share our specialised materials and sophisticated equipment with artists. Hans Arkeveld has worked with anatomical material in the Department for over 30 years to produce his amazing sculptures. In 1998, we organised with the Lawrence Wilson Art Gallery at UWA an exhibition of greatly enlarged microscopic images entitled Art in Science: essentially designed to 'turn people on to the wonder of the microscopic world'. Since 1996, several artists, in particular Oron Catt, Ionat Zurr and Guy Ben-Ary in collaboration with Dr Stuart Bunt, have been working in our Department on tissue culture and tissue engineering as a medium for artistic/scientific expression. Their innovative work has attracted much international interest (see www sites below). This collaborative research is a powerful stimulus for critical debate of ethical and other issues. The unique facilities and range of expertise within our Department presents a rare opportunity to bring together the different disciplines of art and science/medicine within Australia. To this end we have recently constructed a dedicated Research Studio for Art & Science in our Department called SymbioticA, which was completed in 2000. This unique facility is already attracting much attention and we are almost overwhelmed by the number and diversity of leading researchers in the areas of Art, Biology and Biotechnology who wish to come and work at SymbioticA. This dynamic enterprise has already opened up many fascinating collaborations and new possibilities for all concerned.

Some WWW sites of interest.

SymbioticA	http://www.symbiotica.uwa.edu.au
Exhibition of Art & Science	http://www.iaaf.uwa.edu.au/art-in-science/
Tissue Culture & Art work	http://www.tca.uwa.edu.au/
Fish & Chips	http://www.fishandchips.uwa.edu.au

NOTEBOOK OF A PHANTASMOGORIC JOURNEY
Annette Iggulden

Following the diagnosis of "Right Anterior Ischemic Optic Neuropathy" I experienced symptoms of Charles Bonnett Syndrome. These are hallucinatory images triggered by a sudden loss of vision; compensatory of that loss yet specific to one's own 'image-repertoire' (Barthes; 1978). My responses to this and the likelihood of total loss of vision within five years were many and varied.

Beset by unasked-for images invading my 'vision' and the experience of many emotions, some delightful, some horrifying, but all fascinating, my recollections are drawn from memory and "diaristic" drawings of 1991. Their significance continues to quietly reverberate today with on-going questions of 'vision' and what these images were all about. Images that appeared to reside *inside* my head, *outside*, in the envelope of space my body inhabits, and *in-between*, on the transparent 'screen' or surface of my eye. Where did they all come from? From images already stored in my brain, as from some archaic unconscious reservoir? From an accumulation of images, imagined, dreamt, seen or created? And, the lingering question, how these images are 'shaped' by one's state of mind, internal and external stimuli?

Fear, fury, frustration and fascination accompanied my immediate and short-term responses to what impact this "visual flaw" might have on my work as an artist. Longer term responses that have become an integral though not overt part of my art-work, have been an acute awareness of my human vulnerability; of gratitude for the faculty of sight; and a wonder at the hyper-reality of interior vision and 'tricks' of the imagination.

THE EVOLUTIONARY JOURNEY TO HUMAN COLOR VISION
Gerald H. Jacobs

It is estimated that the human eye can distinguish more than two million different surface colors. How did we gain such remarkable ability? Until relatively recently the origins of our color vision were matters for speculation. Research conducted over the past two decades has revealed a good deal about the nature of color vision and its biological basis in a wide array of different animals. From these results, and particularly from comparative studies of color vision in our fellow primates, one can discern some likely evolutionary pathways to human color vision.

Short Biography

Gerald H. Jacobs is Professor of Biopsychology and a member of the Neuroscience Research Institute at the University of California, Santa Barbara.

Professor Jacobs received the Ph. D. degree at Indiana University. He served for several years as a member of the faculty at the University of Texas, Austin before taking up his present post at UCSB.

Dr. Jacobs' research has dealt broadly with the biology of mammalian color vision, a topic his laboratory has studied with a range of behavioral, electrophysiological and molecular genetic approaches. He has been particularly interested in understanding the nature of primate color vision, but has made observations about vision on animals ranging from pocket mice to elephant seals.

INSIDE VISUAL PERCEPTION
John Jupe

It is clear to me through my work as an artist and through applying my ideas to the work of others, that our sense of vision is compiled from two distinct image types and not just two images. I maintain that both these image types are required for us to accurately locate "objects in space". Where vision scientists have identified a "what and where" categorisation, artists have recorded evidence to suggest that there are physical reasons why this categorisation is required. I would suggest that the constant "duality" of function and physiology so apparent in vision science reflects a physical reality of image production dependent on the dual characteristics of light.

Traditionally vision scientists have probed visual perception through third party responses to stimuli. Embodied in the scientific approach lies an assumption - that our eyes function much like a camera. Artists use their powers of visual perception directly. It is the direct link between the observation and the hand making the record that is so important and so revealing. Through the controlled investigation of "still life" subject matter, the great artists of the last century reveal that our sense of vision is composite and "projectionistic". By concentrating on the information received as opposed to the picture the brain composes with the information, artists operate "inside visual perception" and their veridical records can be understood and analysed.

I maintain that our eyes are sensitive to the reception of these two image types and that it is the inclusion of the additional dynamic of the second image type that sets the eye apart from the camera and the intuitive painting apart from the photograph. Having codified these image types, I am able to work with them to create a new form of illusionary space on the canvas.

Vision scientists do not use their sense of visual perception directly to investigate their environment. I believe this to be significant. This form of investigation has been the exclusive domain of the artist and I would suggest that this situation is an historic by-product of the art/ science split that occurred in the Renaissance. The schism has created conditions for pathways of intellectual pursuit, a by product of which, is mutual exclusion, where lateral connections are rarely made. While Artists have observed the phenomenon and explored it to some considerable detail, they have failed to conceptualise about what they recorded and so failed to fully manipulate and disseminate the knowledge available to them.

I maintain that the detection and processing of this "physical" condition has been a strong influence on the evolution and structure of the brain. I also maintain that the issue of the conscious appreciation of image types, characterises a new conceptual overview for vision science. The work of artists is probably the most accessible and rich source of "new" information regarding visual perception available to vision scientists. Perspective may interact with the tool box of our sense of visual perception, but it has little to do with our perception of the real world. This is why artists to not adhere to the disciple. Vision Scientists need to get "inside visual perception". To do this they must use there sense of visual perception directly and learn to see what the artist sees.

CARAVAGGIO IN DUBLIN: AN IRISH JOKE?
Brian Kennedy

When word first reached the media that a major work by the celebrated baroque artist, Caravaggio, had been discovered in Ireland, many thought it must be a great Irish joke. But the story turned out to be true, and the discovery of the painting, and the investigations by Sergio Benedetti, a senior restorer at the National Gallery of Ireland, which led to the painting's authentication, is one of the great art-historical detective sagas of recent times. Caravaggio painted *The Taking of Christ* in 1602, and he was paid 125 scudi for it on 2 January 1603 by the Mattei family in Rome. The companion pieces for *The Taking of Christ* were *The Supper at Emmaus*, now in the National Gallery, London, and the *Saint John the Baptist*, now in the Pinacoteca Capitolina in Rome.

The Taking of Christ next surfaced in Scotland, where it was taken by Hamilton Nisbet, who had purchased it from the Mattei family. The painting was reframed, and carried the label of another baroque artist, Honthorst. It was with this label that the painting was offered at auction in Edinburgh in 1921 for the sum of £6.6.0. The picture was bought in at the auction, but some time later came into the possession of a noted Dublin paediatrician, Dr Marie Lea Wilson. She gave the painting to the Jesuit Fathers in a House of Studies in Dublin some time in the 1930s. For decades, the Jesuit Fathers dined under the shadow of the great painting by Caravaggio, which everyone assumed was a copy. In 1989, shortly after Dr Brian Kennedy became Assistant Director of the National Gallery of Ireland, he was contacted by the Jesuit Fathers to see if the National Gallery would be interested in cleaning some of their paintings. So it was that Dr Kennedy went to visit the Jesuit Fathers in the company of Sergio Benedetti.

The lecture will explain the story of how the painting was uncovered as the original among a dozen known copies. It is a fascinating story, and one which takes us inside the artistic mind and painterly technique of Caravaggio.

PIET MONDRIAN: BURIDAN'S ASS AND AESTHETIC DECISIONS
Alan Lee

In the early years of the 20th century Piet Mondrian's art developed through stages of increasing abstraction, until in about 1918 he arrived at the austere non-representational elements of his mature Neo-Plastic style. From the time of this pioneering development until his death in 1944 he produced a body of paintings that has come to hold a prominent place in the story of modern art. His work is regarded as a paradigm of geometrical abstraction, unequivocally demonstrating the potential for meaningful artistic expression with such simple means. Contrary to the most widely accepted view of his artistic achievements, I shall argue that Mondrian's paintings are largely devoid of the aesthetic qualities attributed to them. In making his pictures, he was not meaningfully engaged with the perfected essence of abstract composition; rather he was, in effect, fruitlessly engaged with the problem of choice without preference (i.e. the problem of Buridan's Ass). The Development of his style had involved the elimination from his repertoire of everything that could make aesthetic choice meaningful. The difficulty he found in his work was not due to its profundity, but to the aesthetic indifference of all the choices open to him. In arguing my case I shall draw upon empirical evidence that derives from my 'Mondrian Tests'. The results of testing both ordinary people, no less than those who might be held to have expert appreciation of modern painting, strongly suggests that the design of a Mondrian paintings is not distinguishable from randomly generated configurations of the same design elements. I will urge that, limited as these tests may be, they trump the most widely held beliefs about Mondrian's work, just because such beliefs are sustained by the same kinds of 'evidence' as sustains belief in such things as astrology and numerology.

PATTERN STRUCTURE AND BRAIN REGIONS THAT UNDESTAND IT

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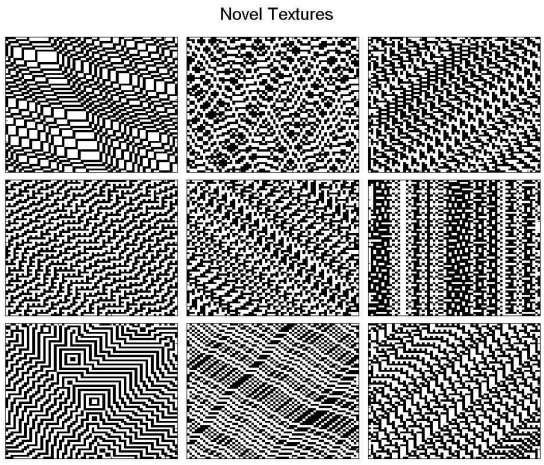
A fundamental question in Vision and Art is how do we obtain an understanding of the internal structure of objects and also of the structure produced by the relative position of objects?

One approach to this problem has been the study of our ability to recognise or discriminate different types of two-dimensional textured patterns. A somewhat prosaic approach is to classify patterns according to the types of mathematical correlations between points, or pixels, in texture patterns. Image structure can be mathematically represented by the average correlation between sets of pixels, such as every possible triplet, or quadruplet of pixels. Of particular interest are sets of textures that have equal average triple-correlations but which are easily discriminable by humans (and bees!). These patterns are called *isotrigon* textures. Many of these patterns appear highly structured to human observers.



Taking the above information together means that to discern pattern structure we must be sensitive to correlations between, at least, *quadruplets* of pixels in images. A surprising outcome of our recent experiments is that we can predict human texture discrimination for a wide variety of patterns assuming nothing more than sensitivity to quadruple correlations computed over quite small numbers of picture elements of the test patterns. Our visual machinery scales the analysis depending on the scale of the pictures viewed. Thus, if pictures are composed of large block pixels, like Mondrian patterns, these mathematical relationships are applied between quadruplets of the large blocks. A similar number of picture elements are *compared* when the elements are small. Thus, a degree of sophistication is introduced by repeating the same *local* analysis at several scales.

The above text sets out the scientific framework of our knowledge of texture recognition. The talk to be presented will begin with a pictorial introduction to the above, followed by discussion of recent evidence about what parts of the brain are sensitive to, or learn about, quadruple correlations within textures. We have also developed methods for producing new texture patterns having statistical properties not previously considered. Many of these patterns are visually interesting. Some provide illusions of depth, rugosity and tilt. Also found amongst these machine-generated patterns are examples of things such as the jazzing effects found in OP art.

STRUCTURE AND EVOLUTION OF BRAIN PATHWAYS FOR COLOUR VISION.
Paul R. Martin, Ulrike Grünert and Samuel G. Solomon

Colour vision in the majority of humans is trichromatic, relying on a comparison of the Quantal absorption in three different types of cone photoreceptors: short-wavelength sensitive ("blue-cones"), medium-wavelength sensitive ("green-cones") and long-wavelength-sensitive ("red-cones") to discriminate the spectral reflectance of objects in the visual field. Many non-human primates, and the minority of humans with severe red-green colour vision deficiency, express only two cone photoreceptor types (for example, only blue-cones and red-cones) and thus are dichromatic. Several lines of evidence suggest that red-green colour vision is a relatively recent addition to the sensory discrimination capacity of primates. We here review studies in which we compared the anatomical and functional properties of the subcortical visual system in primates with dichromatic and trichromatic vision, using anatomical and electrophysiological techniques. The following general conclusions can be drawn. First, no anatomical differences are apparent in the synaptic connnectivity, immunoreactivity or numbers of neurones when the visual systems of dichromatic and trichromatic animals are compared. Second, a distinct circuit devoted to processing blue-cone signals in the retina and subcortical visual system of both dichromatic and trichromatic primates. Third, the connectivity and colour-selective properties of cells which serve high-resolution (foveal) vision are consistent with the proposal that colour-selective responses could arise as a natural consequence of one-to-one connectivity of the fovea. The results are consistent with earlier proposals that red-green colour vision evolved together with, or subsequent to, high-spatial resolution in primates, and that the blue-yellow dimension of colour vision is a relatively ancient feature of the primate visual system.

BRIGHTNESS AND LIGHTNESS ILLUSIONS IN VISUAL ART AND SCIENCE
Mark E. McCourt and Barbara Blakeslee

Brightness is a fundamental quality of human vision. A central problem in the study of brightness perception is understanding how and when the visual system is able to separate the physically invariant reflectances of surfaces from their potentially changing illumination. Reflectance and illumination are confounded since their product determines luminance, the amount of light reaching the eye from a particular surface. Regardless of whether veridical surface perception (lightness constancy) is actually achieved through the successful separation of reflectance and illumination or is, under conditions of ambiguous illumination, only approximated based on the sensory qualities of brightness and brightness contrast, we know that these dimensions of achromatic perceptions and/or judgments result from the interaction of information derived from multiple surfaces in the field of view. Physiologically this must be accomplished through lateral spatial interactions between receptive fields and/or by temporal interactions within receptive fields. In addition, such interactions may occur at one site or at multiple sites with a parallel and/or hierarchical organization. Perceptual illusions are potentially informative regarding the mechanisms underlying normal visual perception, including that of brightness and lightness, and their study has historically been and continues to be a productive topic of research. While a large and growing number of intriguing (and oft-times beautiful) brightness illusions have been introduced, a survey of the literature reveals that the number of proposed explanations for these illusions is cumbersome. In addition, although phenomenal brightness "demonstrations" are often exploited to support various theories or proposed mechanisms of brightness coding, far too few quantitative data are actually offered in support of these claims. The goal of our presentation will be to summarize our recent research efforts, which have aimed to remedy these deficiencies by investigating and modeling the spatial interactions between different areas of the visual field through the quantitative study of brightness illusions. The collection of quantitative psychophysical data on brightness effects enlarges the quantitative database and critically tests various theories of brightness perception. In addition, these data inform the continued development of a mechanistic model of brightness perception, the Oriented Difference Of Gaussians (ODOG) model of Blakeslee & McCourt (1999). This model has, in our view, been extremely successful in simplifying our understanding of the mechanisms underlying brightness perception by simultaneously encompassing a large number of seemingly diverse brightness phenomena with a history of different explanations.

COLOUR THRESHOLDS AND PAINTING
Tim J. Miller

Have you ever wondered why it is difficult to see the colour of an object at low light levels, or why twilight has another dimension or feeling? Why you can name the colour of an object in window light the same way you would name it in sunlight? How can an approaching storm look dark, richly coloured and moody, but as the storm arrives all seems grey?

These questions are the ones I have posed in an exhibition of paintings of the Abercrombie, Borenore, Jenolan, Wellington and Wombeyan Caves – the areas of vision I am investigating to answer these questions are:

- Adaptation to photopic and/or scotopic vision (both, as at twilight)
- Simultaneous contrasts and after-imaging
- Colour constancy
- Diffraction

My current explorations of light thresholds, colour constancy simultaneous contrasts and diffraction in the cave's environment will be illustrated with on-site studies in charcoal, pastel and watercolour. Slides of these studies and finished paintings will be used to describe my progress and conclusions. An underlying aim of my study of light thresholds, colour constancy and simultaneous contrasts is to see how these biological phenomena correlate with the concept of "unity" (ie., composition).

My work is mostly representational. I intend to expand or utilise the works of Cezanne, the Bauhaus and colour field painters. While some of the visual scientists (artists) whose ideas I will explore during this process will be Ralph Evans, Faber Birren, R.W. Rodieck etc.

This collection of paintings is for exhibition at Bathurst Regional Art Gallery in February 2002 and will form the basis of a travelling exhibition beginning in July 2002.

SEEING INDIGENOUS AUSTRALIAN ART
Howard Morphy

How should we look at Aboriginal art to see it as its practitioners do? In a Western context how Aboriginal art is seen has been entangled with the history of how European art has been seen. An assumption underlying much Western art history is that art is a mediating process intervening between vision and the outside world. In a naieve formulation of this assumption art is thought to capture images of the world and carry them across space and time. In more sophisticated formulations, art is said to analyse what is there to be seen and reveal it to us, showing us how to look at the world. More radically, art challenges the vanity of its own systems of representation and joins science in an exploration of the ways in which we see, interrogating the components of vision. Does Aboriginal art with its separate histories provide different ways of seeing the world, and are there parallels to the interrogation of vision that has been undertaken by European artists? The analogies that are happily drawn between different Aboriginal art styles and styles of Western art might suggest that this is the case, but such analogies may be merely illusory, encouraging us to see Aboriginal art as if it were European art. Is Aboriginal art even concerned with seeing the outside world, as opposed to conceptualising it? I will argue that in Aboriginal art there is close relationship between the conceptual and the visual as ways of communicating understandings of the world, and that this is revealed in particular in the relationship between abstraction and figuration, and in the creation of visual puns, as well as in powerful symbolic forms. In making ideas visible, human beings have to interrogate ways of seeing: seeing and art-making overlap as human activities, and as a consequence have the potentiality to reveal something of their own nature through the analysis of their interactions.

YOLNGU SCIENCE
Djon Mundine

Djon Mundine O.A.M., of the Bandjalang People, is a distinguished curator and writer. He has held a number of key positions over his twenty-five year career including Senior Curator, Gallery of Aboriginal Australia, National Museum of Australia, Canberra and Senior Curator of Aboriginal and Torres Strait Islander Programs at the Museum of Contemporary Art, Sydney. For over twelve years he was the Art Adviser for the Ramingining Community of Central Arnhem Land, N.T., and he has also held that position at the communities of Milingimbi and Maningrida. Perhaps the best known of his many major projects is the 'Aboriginal Memorial' installation of hollow log bone coffins first exhibited in 1988 and now on permanent display at the National Gallery of Australia. He is the principal author of the book 'The Native Born: Objects and representations from Ramingining, Arnhem Land', Museum of Contemporary Art, Sydney 2000, and he has published many exhibition catalogue essays and journal and magazine articles. He was awarded an Order of Australia Medal for services to the visual arts in 1993. He is currently based in Canberra, working as a freelance writer and curator.

The sculpture details are as follows:

The work is titled Ngaraka: Shrine for the Unknown Koori

a work by Djon Mundine and Fiona Foley. It has been donated by the artists to the Australian National University as part of the ANU's International Sculpture Park. It is located in front of the lawn at Old Canberra House. The work will be launched with the participation of local Indigenous representatives. This is planned for 5.00pm on December 7th.

When things pick-up: the process of partitioning in the construction of an exhibition
Kevin Murray

The figure-ground relationship has been the focus of much Gestalt psychology. How do we make the distinction between the focal element in a scene and its background? Researchers in ecological perception, such as J.J. Gibson, attempted to examine this process in a dynamic situation that reflects our active engagement in the word. More recently, this process has been studies as a form of perceptual 'partitioning' that affects our broad understanding of the world. This object-based framework provides a particularly relevant way of understanding of how craft-based exhibitions work in a gallery space.

WARLPIRI TERMINOLOGY FOR COLOUR
David Nash

The language of the Warlpiri people of central Australia has been studied in detail over the last several decades, and Warlpiri was one of four Australian languages included in the World Color Survey (WCS). The unpublished 1978 data from the WCS is brought together with unpublished 1936 data from HK Fry, and over 100,000 lines of Warlpiri text to analyse the Warlpiri vocabulary referring to colour and how it is deployed. I discuss the role of reduplication in forming colour words, and the ways colour words are used descriptively. The paper also considers the extent to which Warlpiri fits the generalisations of Berlin & Kay. For instance, after 'black' and 'white' terms, the best established colour words mean 'red', fitting global generalisations of Berlin & Kay. The word *tirirtiri* 'red' has a variant *tiri*, rarer now than in the 1936 data, which also occurs in lexical items *tiri-pardu* ‘joey’, *tiri-nji* ‘sponger’ and *milpa-tiri* ‘hare wallaby sp., lit. eye-red’. Another common term for 'red' is *yalyu-yalyu*, formed from *yalyu* 'blood'. Less expected, from the Berlin & Kay point of view, is the range of the Warlpiri term *walya-walya*, a word used to describe the colour of snakes, for instance, and formed from *walya* 'soil, dirt, ground' -- the colour of the soil in Warlpiri country is notably called 'red' in English in the Red Centre.

THE PAINTER AND HANDICAPPED VISION
Jonathan Nathan

A painter is normally seeking to transform a three dimensional stereoscopic image on to a two dimensional surface utilising one or more of the familiar cues to distance including linear and aerial perspective, relative size, overlap, tonal variation and use of colour.
This process is potentially jeopardised by a number of commonly occurring inherited and acquired vision problems, in particular errors of refraction, maculopathies, cataract, binocular vision disorders and colour vision defects. The ability for a painter to adapt to these anomalies is discussed from the viewpoint of an ophthalmic practitioner and long time painter of pictures.

THE REBELLIOUS PSYCHEDELIC CONSCIOUSNESS
Mark Pennings

The paper will consider the influence of hallucinatgenic drugs on the development of radical thinking about a new consciousness during the immediate postwar period. Under the influence of Freud, radical humanist thinkers understood consciousness as a largely unexplored geographical site. They argued that hallucinogens like LSD expanded consciousness by facilitating access to parts of the mind that exceeded rational analysis and control. The primary means of this psychic transgression was predicated on the experience that could transcend capitalist instrumentaliseation, but there were others who claimed that such states were a symptom of a broader social pathology instituted by capitalist consumer culture. The paper will consider the ideas of thinkers like Aldous Huxley, R.D. Laing, counter-cultural radicals, and postmodern theorists including Fredric Jameson and Jean Baudrillard.

Science, Art and Ambiguity: Dali and Leonardo from a Neuroscientist's Viewpoint.
John D. Pettigrew

Science and art are both creative human endeavours with empirical approaches in common that seek to understand rules in Nature. A major difference is their orientation, with science looking outwardly in an attempt to understand the world, while art looks more inwardly in an effort to understand the observer. Neuroscience stands at the interface and has the unique potential to help to illuminate the mutual relation between art and science. In this presentation I will present recent work from visual neuroscience on Bonneh's illusion and oscillatory perceptual phenomena (rivalry) which show dramatic variation between individual observers and which are challenging traditional views of their origin and role. Perceptual oscillation may be a strategy by the two cerebral hemispheres to deal with inherent ambiguities in the sensory input. Dali and Leonardo appeared to have a deep appreciation of the perceptual phenomena of oscillation and ambiguity, which were incorporated into their works evidence that they were good visual neuroscientists. In addition, their appreciation of perceptual oscillation suggests that these two great artists may also have been at the slow extreme of the human spectrum of oscillation rate.

NEON COLOR AND WATERCOLOR SPREADING: NEW PRINCIPLES IN SURFACE PERCEPTION AND FIGURE-GROUND ORGANIZATION

Baingio Pinna and Lothar Spillmann

Two phenomena that combine a delicate beauty with a profound significance for understanding visual perception will be described: (1) The *neon-color effect*, a subtle glow of color that escapes the boundaries of a real figure and fills the surrounding area until it is halted by the boundaries of an illusory figure. This effect will be discussed with regard to assimilation, transparency, motion, and texture. Neon color spreading has implications for the way in which our visual system uses seemingly incomplete stimuli to generate percepts, segregate objects from their backgrounds, and provide them with color and depth. (2) The *watercolor effect* which is elicited when a purple contour tracing out an area is accompanied by a lighter orange edge. Under these conditions the entire enclosed area will appear to be subtly colored in the hue of the edge. We found that the colored flanking line accompanying the darker border assimilated its color onto the enclosed area over distances of up to 45 deg. This coloration was uniform and complete within 100 ms. Thin, winding inducing lines were generally more effective than thick and straight lines. Blue and red contours produced the strongest effects, but watercolor spreading could also be seen with green and yellow. Weaker or no color spreading was perceived when a narrow white zone (gap) was inserted in between the two inducing lines. However, chains of colored dots instead of continuous lines sufficed to produce spreading. This watercolor effect is superior to the classical *Gestalt* factors of proximity, good continuation, closure, symmetry, convexity, past experience, and amodal completion and thus may be considered a new factor determining figure-ground organization. Both phenomena point towards long-distance mechanisms of assimilative color spreading that may have evolved to support surface perception. Although the psychophysical conditions for the occurrence of these effects are known, the neural bases as well as their computational modelling are still largely lacking.

COLOR GAMUTS AND COLOR SPACES
Bob Rodieck

Attempts to portray color gamuts have a long history, but before about 1900, these gamuts were qualitative. Alfred Munsell, a teacher at the Massachusetts Normal Art School in Boston around 1905, was interested in color and how it should be taught. His aim was to allow artists, working in any medium to grasp both the three-dimensional nature of pigmented colors, and the gamut of their enclosing surface. He developed a quantitative model, based upon just noticeable differences. Although this scheme continues to be used, it has been supplanted by a continuous solid, cast into various abstract color spaces. Now that we better understand the physiological basis of color, it has become possible to create a new standard for color specification, based upon the absorbance spectra of the visual pigment contained in each of the three cone types, together with spectral transmittance of the ocular media. This approach can better deal with variations in normal color vision within the population than can earlier methods of color specification.

Artists want strongly saturated colors, at least on their palette, and the development of the aniline dye industry in the late Nineteenth Century greatly expanded the range of pigments available. But was there a theoretical limit to the saturation of reflected colors? Yes, the theorist Erwin Schrödinger took time off from quantum physics to show what that limit it was. Colors that lie at or near this limit are termed optimal colors. From this theory, we may deduce that, at least over the red-green range, all species share the same set of optimal spectral reflectances. Hence spectral reflectances that produce large differences in the relative stimulation of the different photoreceptor types in one species generally do so as well for other species.

The recent techological shift from 'Print and Distribute' to 'Distribute and (maybe) print', has been invigorating for graphic artists and photographers. But it has created difficulties for them as well, since they no longer have control of the manner in which a colored image will be rendered, either when printed or viewed. In effect, they can no longer 'proof by eye'. There are methods for dealing with these issues, which involve transformations to various color spaces such as XYZ and L*a*b*. But if professionals are going to proof in this new world , then they need to understand these color spaces and the various color gamuts they display. One means of doing so is to follow Alfred Munsell's instinct, but make use of current technologies to make it easy toobserve and manipulate color gamuts in three dimensions rather than two.

Vitreous Detachment - Work in Progress
Barb Smith

Unexpected loss of sight, whether temporary or permanent, is always traumatic. This illustrated presentation is a personal account of what can happen when the patient in question is an artist. It documents changes in perception caused by the onset, treatment and recovery from a posterior vitreous detachment and retinal tear in the right eye.

Attempts to continue this documentation during the subsequent growth of post-operative cataracts may eventually lead to a significant directional shift in future art practice.

DEGAS'S IMPAIRED VISION: DID IT COMPROMISE HIS ART OR WAS IT A VEHICLE FOR HIS REMARKABLE VISUAL INVENTIVENESS?

Betty Snowden

It is little known that the French Impressionist artist Edgar Degas (1834-1917) had monocular vision throughout his life as well as impaired vision in his 'better' eye from 1870, leading to almost full impairment in his last years. An undetected squint at birth caused laziness in his right eye, and eventually amblyopia (virtual loss of sight). Unknown causes of damage, which can be dated from 1870, resulted in impairment of the left eye. In his left eye Degas suffered cumulatively myopia, presbyopia, photophobia (intolerance of bright light) and 'blind spot'. In a series of early self-portraits the asymmetrical position of his eyes (one centrally positioned, the other diverging from the central axis), clearly shows his amblyobia (squint), and in later self-portraits his heavy-lidded eyes suggest the severe photophobia that he suffered from about 1870.

There are numerous references to his state of 'seeing' and his fear of impending blindness in his letters and in the writings of those who knew him well. A note in his diary of August 1889 tells of an appointment with the oculist Landolt, a highly regarded eye doctor, who prescribed glasses for the treatment of his eye defects. Degas rarely bothered to wear these since they could only correct one aspect of his eye problems at a time. There is an extant photograph of him wearing tinted glasses to protect his eyes from bright daylight.

His circumvention of traditional methods of presenting his subjects and his deliberate use of some clearly defined and finished sections with other areas less defined and often blurred show a specific way of seeing. His preference for working in his dark studio using models and props where the motif would not alter between bouts of working contrasted markedly with his Impressionist peers Monet, Sisley and Pissarro who worked in 'plein air' and where the situation of their motifs changed hourly and daily. Degas's was a calculated art, both of composition and of what he wanted his viewer to see. Charles Stuckey describes it as 'the fundamental theme of Degas's art taken as a whole - an analysis of the act of looking and its consequences.'[C.F. Stuckey 'Degas as an Artist; Revised and Still Unfinished' in *Degas: form and space*, ed. J. and M. Guillaud, Paris [1984], p. 14]. Degas was extraordinarily sensitive to, and aware of, the vicissitudes of sight and rather than being compromised by his severe defects worked these to advantage with the highly inventive manner in which he structured and manipulated his compositions. He was one of the most 'modern' of nineteenth century French artists. In the earlier stages of his career there are indications of his distinctive awareness of the process of perception and the manner in which he manipulates his art according to this consciousness of the act of seeing.

There is a significant group of works by the artist in which vision itself becomes the subject of his art, for example several images of women and men looking through binoculars at the races or at the opera, and images of men and women examining a painting or object. In his later years when his sight was severely limited his earlier experiments in cropping and fragmenting the observed images became even more marked leading to the bold visual devices of this period. The unpredictable nature of perception and the artificial nature of art are motifs that constantly pervade his work. Degas himself said 'One sees as one wishes to see. It's false; and it is that falsity that constitutes art.'[D. Halevy *Degas parle*, Paris [1960] p. 69]

AESTHETIC PREFERENCE AMONG SIMPLE VISUAL PATTERNS
Branka Spehar *and Colin Clifford*

Recently, Taylor *et al.* (2001) reported that subjects show a consistent aesthetic preference for fractal patterns with a fractal dimension in the range 1.3-1.5, regardless of the origin of those patterns. The patterns made by clouds and many other natural objects have fractal dimensions in this range, and it has been suggested that people's aesthetic preference may be set through continuous visual exposure to patterns characterized by this value (Aks & Sprott, 1996). It has been suggested that the sensitivity of our visual systems is similarly tuned to the structure of our environment. Thus, we might expect people to show an aesthetic preference for patterns to which they are the most sensitive and are most effectively processed by our visual systems (Zeki, 1999). To test this hypothesis, we asked subjects to make aesthetic judgements between a set of grating patterns of different spatial frequencies. We found aesthetic preference to be a band-pass function of grating spatial frequency, similar in form to the human contrast sensitivity function. This finding supports the hypothesis that aesthetic preference and visual sensitivity are moulded by similar elements.

FRACTALS: A RESONANCE BETWEEN ART AND NATURE?
Richard P. Taylor, Ben R. Newell, Branka Speha[3] and Colin W. G. Clifford

Fractal geometry has experienced spectacular success in quantifying the complex structure exhibited by many natural patterns, including coastlines, trees and clouds (1). In contrast to the simplicity of Euclidean shapes, the complexity of fractal patterns results from the recurrence of patterns at finer and finer scales. Here we show that humans display a consistent aesthetic preference for a particular from of fractal image, regardless of whether this image is generated by nature's processes, by mathematics, or by humans (2). We discuss the implications of this result for the artist Jackson Pollock, whose drip paintings we recently showed to be fractal (3).

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2. R.P. Taylor, *Nature*, **410**, 2001, 18.
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WHAT CAN IMPLIED DYNAMICS TELL US ABOUT THE BRAIN?
Ian M. Thornton,

A painting or a photograph presents us with a single moment, frozen in time. Many artists and photographers, however, can still capture subtle hints of movement or change, often, just barely reflected traces of real-world dynamics, despite the constraints imposed by "static" media. How are such implied dynamics achieved? Where do they come from? Are they predominantly in the hand of the artist or in the eye, or rather, the brain of the observer? Can we isolate and measure specific neural and behavioural consequences in human observers? In this talk I will first attempt illustrate the notion of implied dynamics with a few (hopefully!) well chosen examples. Next, I will review a variety of perceptual studies which show how such implied dynamics can directly affect the way we mentally represent the world. Finally, I will discuss recent neuroimaging studies that provide the first clues to how and where such effects occur in the brain. Together, studies of implied dynamics suggest that our visual system actively seeks out clues to potential movement or change in the environment, possibly to help anticipate the behaviour of other animate beings and to plan and coordinate our own actions. Clearly, such active perceptual mechanisms would be ideal targets for those wishing to exploit the aesthetic potential of our visual system.

MAKING AND BREAKING OF GESTALT IN TRADITIONAL ZEN LANDSCAPES
Gert J. van Tonder, Michael Lyons and Yoshimichi Ejima

Looking at masterfully sculpted Zen gardens in Kyoto, Japan, the authors were compelled by the similarity between this experience and viewing moving works of art elsewhere. It is well known that design principles in Zen landscapes are deliberate and have been thoroughly developed over at least the past thirteen centuries to create 'gardens for contemplation', leading us to a more formal investigation on the relationship between Zen design principles and human visual perception. After consulting with numerous expert gardeners in Japan and training and working in various gardens in and around Kyoto we hypothesize that four main classes of design principles are used to guide our visual perception in gardens of superlative design. The first is that placement and visual colour and texture of objects in gardens are manipulated specifically to destruct gestalt related to sub-parts of those objects. This simplifies the visual landscape by implicitly emphasizing each object or grouping of objects as a whole instead of sub-parts of objects. The second is that objects and plants in gardens are carefully chosen to have balanced shapes, again leading to a form of simplification of the visual scene. The third principle is that various elements are applied to enlarge the perceived spatial dimensions of the garden, creating the illusion that the landscape is relatively 'empty' in terms of the number of objects present within the spatial extent of the garden. The fourth is that shapes and textures are repeated at various scales. This may enhance the perception of naturalness, because it is known that fractals, replicating shape and texture at various spatial scales, are ideally suited to visually render natural features such as clouds, mountains and water. Specific examples of each principle are presented.

We illustrate the hypothesis via computer simulation using the 'patchwork engine' (Van Tonder & Ejima, Neural Networks, 2000, Perception, 2000), a model of image segmentation based on human visual perception to show which parts in images of gardens are expected to cause strong gestalt and hence attract visual attention. Simulations for both good and inferior landscape designs are shown, demonstrating why and how balanced visual shapes contribute toward simplification of the process of visual perception. We present proposals for further experiments using eye movement tracking to provide data on how the viewing of Zen landscapes and the design principles at work in those landscapes influence the behaviour of human visual perception.

We conclude that specific design principles are at work in Zen landscapes to simplify the visual scene and guide our visual perception, requiring less visual activity without sacrificing a rich visual environment. We propose that application of Zen design principles calms perceptual activity and could be of general interest in the design of calming visual environments without the need to resort to Spartan minimalism.

A CONTROVERSIAL HISTORY OF DEPTH REPRESENTATION: FROM GREECE TO MAGRITTE

Christopher W. Tyler

Although Panofsky (1935) suggested perspective style was a symbolic form of the worldview of the times, there has been little analysis of the advent of each perspective form. The history of space representation through perspective has been one of great conceptual effort, with full mastery taking six centuries to evolve.

Even in classical times, there was a substantial appreciation of the expression of space, including perspective construction, from Agatharchus in the 3rd century BC to early Roman painting. These early painters exhibited a mastery of shading, shadows, highlights and aerial perspective. They also generated good approximations to both one-point and two-point perspective constructions.

The earliest accurate perspective, however, is found in the zero-point construction initiated by artists such as the Lorenzetti brothers in the 1300s. This metric construction allowing accurate convergence of single planes such as floor tiling without committing to the concept of a vanishing point at infinity.

Accurate one-point perspective dominated the 1400s, being first used by Masolino da Panicale (1423). It was taken to great heights of sophistication by Masaccio, Mantegna, Ucello, Carpaccio, Leonardo and Raphael. Nonetheless, they all showed weaknesses of construction, implying that they lacked a full understanding of the intricacies of the one-point perspective.

Two-point perspective was first described by Viator in 1505, but early examples may be attributable to Brunelleschi, Masolino and Van Eyck before 1440. Other than these isolated instances, the two-point construction was unused throughout the entire Renaissance until its introduction in The Netherlands in 1650 by Houckgeest; it came into wide use in the 1700s with the Bibiena family, Canaletto, and Piranesi.

Three-point and multi-point construction diagrams for mathematical treatises were attempted unsuccessfully by Piero della Francesca and Leonardo da Vinci in the late 1400s, but none appeared in art works until a plausible example by Tiepolo (1744). In 1840, Ruskin addressed the issue of convergence of verticals, but no examples can be found from the 1800s. Surprisingly, the earliest use of vertical convergence seems to be by Georgia O'Keefe in 1925, followed by a full-fledged three-point construction in Escher's engraving of the 'Tower of Babel' in 1928. Far from springing into force during the early Renaissance, therefore, a full understanding of linear perspective was not achieved until the 20th century. Remarkably, almost all of the conceptual advances in perspective construction were associated with artists rather than geometers.

In the 20th century, interest shifted from representation to the ambiguity of the depiction of depth in painting. This development can be traced to the late work of Matisse, but it was graphically explored by de Chirico, Albers, Magritte and others. In this case, much of the artistic exploration of perceptual ambiguity was preceded by studies in perceptual psychology, by Necker and by Mach in the 1880s.

VAN EYCK TO VIRTUAL
Ruth Waller

Following a recent research trip to Belgium, France and the UK, the author, a painter, speculates about the role of illusionism and the nature of the picture space in the early Northern panel painting. How do the works of Van Eyck, Bouts and Van der Weyden reflect both the theological and the worldly context of C15th Flanders, and how is it that these pictures seem strangely resonant with aspects of virtual imagery?

INTOXICATED VISION: HALLUCINOGENS, THE VISUAL SYSTEM AND PSYCHEDELIC ART

Dr Jeff Ward

Substances such as LSD, psylocibin and mescaline reliably produce visual hallucinations in human beings when taken in sufficient amounts. These substances occur naturally in some plants and fungi, and have been used widely in many cultures to induce spiritual experiences and enhance creativity. Often the hallucinations experienced are reproduced in the visual art of these people, for example in the decorative patterns that adorn houses, ritual objects and utensils. As well as being seen in the traditional art of people who use hallucinogens for ritual purposes, the influence of these hallucinogenic substances can be seen in Western culture in the work of individual artists and in the popular visual culture that developed out of the 60's psychedelic movement. In this paper, the defining features of these hallucinatory images are characterised and related to what is known about the actions of hallucinogens on the visual system. Psychedelic images characteristically involve repeated swirling and grid patterns of colour. These images often occur as a result of synesthesia; that is, they often occur in response to stimulation in another sensory modality, especially in response to patterned stimulation such as is found with music. The effects of hallucinogenic drugs, such as LSD, may be explained mainly in terms of their actions on the serotonin system in the central nervous system (CNS), and the involvement of this system with areas of the CNS associated with vision and sensory integration. If this explanation is correct, then the nature of these images should be similar in both the art of people who have used these drugs for religious purposes for many centuries, and in the visual culture that has arisen since the 1960s as part of the more recent use of these drugs in non-traditional contexts. This will be explored via a comparative examination of traditional art, Western psychedelic art and similar patterns induced in non-drugged subjects through other means.

AN OBLIQUE EFFECT IN AESTHETICS REVISTED

Rosemary Bagot, Lexine Stapinski, Nicola Watts and Branka Spehar

In his interesting and ambitious attempt to provide a biologically based theory of aesthetics, Zeki (1999) proposed that we prefer those shapes and arrangements of shapes which are most effectively processed by our visual system. Consistent with such a claim, Latto, Brain & Kelly (2000) report an "oblique effect" in aest6hetics. They examined the effect of orientation of Mondrian's paintings on their aesthetic appeal and found that there was a stronger preference for pictures presented so that their component lines were horizontal-vertical than for pictures shown with their component lines in an oblique orientation. To control for the effect of frame orientation, Latto *et al.* (2000) used four Mondrian paintings with conventional horizontal-vertical frames and four paintings with oblique frames. Paintings where the component lines were parallel to the surrounding frame were preferred, although the observed preference for horizontal-vertical component lines was independent of this. Latto *et al.*(2000) suggested that the reported oblique effect is related to the oblique effect in orientation perception and the privileged status that vertical and horizontal lines seem to enjoy in visual processing. Here we assess the generality of this conclusion by testing for the aesthetic appeal of eight abstract paintings by a variety of artists, presented at both horizontal-vertical and oblique orientations. In order to more adequately control for the effects of confounding variables, stimuli were selected such that half originally contained horizontal-vertical component lines and half contained oblique lines. In addition, pictures were presented within a circular aperture to control for framing effects. Under these conditions we found no evidence for the aesthetic effect.

MOTION IN ART – ART IN MOTION

Johannes M. Zanker

In a three-dimensional and animated world the human visual system is exposed to light changes in *three spatial and one temporal dimensions*. Because visual motion, characterised by correlated changes in the spatial and temporal dimension, conveys sensory information of outstanding biological significance, *motion perception* is one of the most thoroughly investigated topics of neuroscience. The presentation will explore how the perceptual quality of motion has been captured by visual artists, and will raise the question what brain scientists can learn from the practical knowledge expressed by artists in their work.

Early attempts to depict the world, from cave drawings through Egyptian frescos to medieval paintings, are characterised by the absence of clear depth effects. Sculpture was the only chance to transcend the limits of such a flat and frozen world of art, and creating fountains offered the only and rather limited opportunity to introduce a temporal component to the three-dimensional creation. From this point of view, the early history of painting may be regarded as *the quest for third dimension*. Depth was eventually mastered in the Renaissance as element of pictorial representation, creating a tradition of great illusionist painting in which the borders between sculpture and picture faded away – the visual system of the human observer was offered a kind of information that resembles that of the three-dimensional world so closely that discrimination became difficult or impossible. Motion, however, was still not more than captured as gesture or symbolic posture, as snapshot, as indirect textural cue, or as motion streak, and for a few more centuries didn't reach the same perceptual immediacy which had been achieved for depth.

Did the *quest for the temporal dimension* reach its goal with the invention of cinematography and the development of kinetic art? Alexander Calder's programmatic notion of a 'four-dimensional painting' may suggest so, and this view may be supported by the all-embracing perceptual experience of being emerged in certain installations, and perhaps even more convincingly by the vivid and realistic motion sensations of apparent motion stimuli, which we routinely encounter in cinema, on TV and on our computer screen. But one cannot deny the fact that the temporal dimension is physically present in such works of art rather than being captured by pictorial means. Alternatively, we may want to turn to some peculiar pictures of op art, like those of Bridget Riley, which create strong and compelling motion sensations from very simple, and clearly static, graphical images. Such visual illusions challenge our scientific understanding of the visual system, and an attempt is presented to interpret this phenomenon in the context of involuntary eye movements.

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