INTERPRETIVE RESOURCE

COLOUR

Part two: The Science of Colour

ART GALLERY OF SOUTH AUSTRALIA
NORTH TERRACE, ADELAIDE Open daily 10am – 5pm artgallery.sa.gov.au

PART 2: THE SCIENCE OF COLOUR

Part one of this resource delves into the science of colour, exploringwhat colour is, how we see colour and how colour is made. This section will help you consider works of art by French Impressionists, as well as other works in the Gallery's collection, through the lens of colour.

During the nineteenth century France was experiencing great change and positivity which included a belief and confidence in design, industry and science. As mentioned in *Colour: Part one Impressionism*, innovations in science and technology helped to shape the Impressionist movement. The invention and increased use of photography liberated artists to explore their own stylistic approach, which included explorations with colour theory and principles of science.

The invention of synthetic pigments meant that a wide range of colours became available to artists – new fabric dyes transformed women's clothing, gardens were being populated with new species of plants imported from Central America and firework displays illuminated the night sky. Artists were seeing colour everywhere, however, had it not been for the collapsible paint tube in 1842, that allowed artists to paint *en plein air*, one could argue Impressionism may never have happened. The Impressionists redefined the parameters of painting, moving away from idealisation of subjects, chasing hues and focusing on the experience and sensation of looking.

WHAT IS COLOUR?

Colour has been central to art making throughout history due to its ability to convey meaning and provoke emotion. But what exactly *is* colour? Colour is the range of visible light. It can be seen when light strikes an object and then is reflected into the human eye. Colour can be broken down into three components; hue which is colour in its purest form; intensity which is the vividness of a colour; and tone or value which refers to the light or darkness of a colour.

IS BLACK A COLOUR?

Physicist Sir Isaac Newton (1642–1726) showed that colour itself is light and colour is not 'in' objects as previously thought. Instead, the surface of an object reflects some colours and absorbs others. Black pigments absorb all of the colours of light, thus being perceived as black. Black is therefore the absence of light. One of the first black pigments was 'carbon black' made from charcoal, followed by 'bone black' which was made from burnt animal bones. Black pigments played a major role in realist paintings before Impressionism, and although the Impressionists did not banish black altogether, they were inspired by the theory of complementary colours and were convinced that no shadow was actually black. Instead, the Impressionists painted shadows in dark shades of violet, in contrast to its complementary sunlight (yellow), resulting in bright and vivid scenes.

image detail: Auguste Renoir, France, 1841–1919, *Madame Darras*, c. 1868, oil on canvas, 48 x 40 cm; Gift of Baroness Eva Gebhard-Gourgaud, 1965, Musée d'Orsay, Paris, France, photo: © RMN-Grand Palais (Musée d'Orsay)/Hervé Lewandowski

image detail: Paul Signac, France, 1863–1935, *Saint Tropez: the port*, 1897–98, Paris, colour lithograph on paper, 43.3 x 32.7 cm (image), 52.0 x 39.9 cm (sheet), South Australian Government Grant 1980, Art Gallery of South Australia, Adelaide

SEEING & PERCEIVING COLOUR

Colour and light are inseparable. Two scientists working in the field of chemistry and physics, Sir Isaac Newton (1642–1726) and Michel Eugéne Chevreul (1786–1889) were instrumental in helping us understand the way we see and perceive colour. Newton analyzed the nature of light, and chemist Chevreul analyzed the visual effects of colour juxtapositions. Chevreul determined that when the eye sees two colours side by side, they appear vastly different in colour and strength.

Responding

Research other advancements in science and technology that occured during the nineteenth and twentieth centuries. Consider how new technologies and materials have transformed the way artists work today.

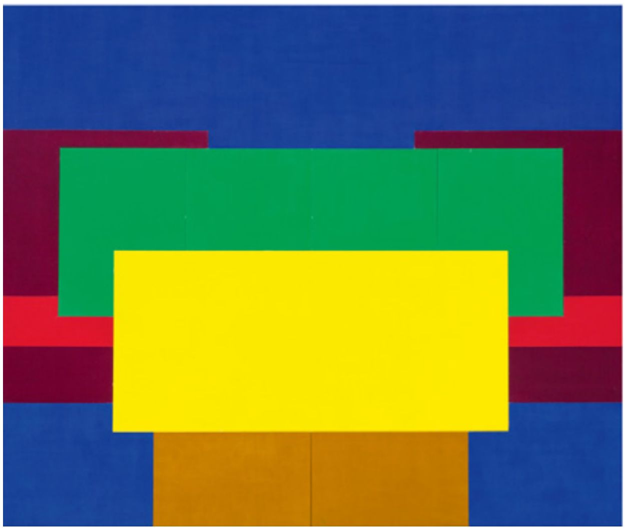
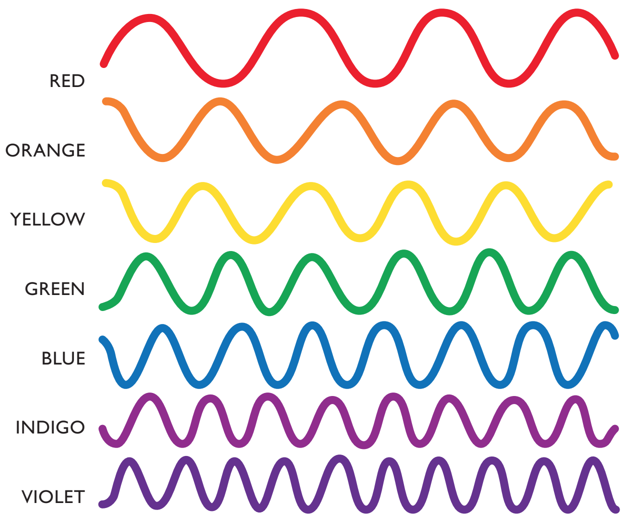


image detail: Sydney Ball, Australia 1933–2017, *Banyon Wall*, 1967–68, Collinswood, South Australia, synthetic polymer paint on canvas (combination of separate panels), 330.2 x 396.2 cm, Art Gallery of South Australia, Adelaide

WHAT IS LIGHT?

Physics is a strand of science that helps us to understand the properties of matter and energy, such as heat, sound and light. Light is all around us and is made up of **waves** with varying **wavelengths**. These different wavelengths are perceived by our brain as different colours. The part that we can see is the visible spectrum (familiar to us as the colours of the rainbow), which was discovered by Sir Isaac Newton, author of *Opticks*.

Wavelengths are perceived by our brain as different colours. Most objects that we see in everyday life reflect a range of wavelengths of light to the back of your eye at different intensities.



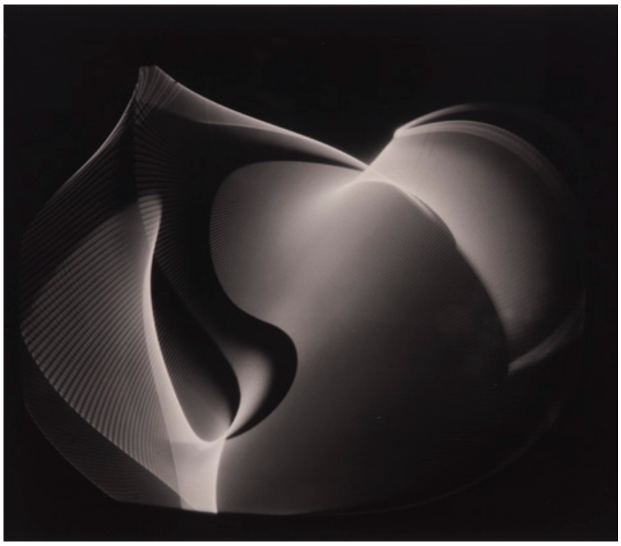


image: Stanislaus Ostoja Kotkowski, Australia, 1922 – 1994, *Light composition*, c.1966, Adelaide, gelatin silver photograph, 49.6 x 60.2 cm (sight); Gift of Andrew S.R. Booth and Edward H.S. Booth 1995, Art Gallery of South Australia, Adelaide, Estate of J.S. Ostoja Kotkowski.

Responding

Investigate the work of Stanislaus Ostoja Kotkowski and his use of light, colur and movement.

THE HUMAN EYE

The human eye plays a very important role in how we see colour. It consists of many components including, but not limited to, the cornea, pupil, iris, lens and retina. The retina contains approximately 126 million light-sensitive cells, which can be categorised into two types of cell, rods or cones.

Rods help us see in grey scale, particularly in low light conditions such as night time. Cones allow us to see colour. In humans, each cone can contain one of three types of photopsins (photoreceptors), which are pigments sensitive to either a red, blue or green wavelength of light.

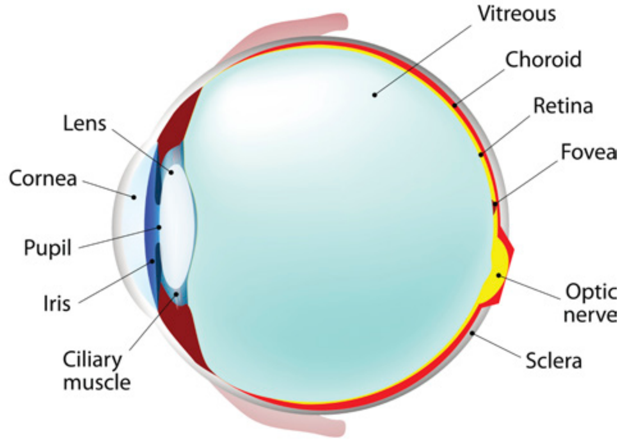


image: iStock.com/ttsz.

WAVELENGTHS

The wavelengths of light reflected towards the eye stimulate different combinations of these pigments, enabling us to see a variety of colours (not only red, blue and green). Stimulation of different combinations of the pigments enables us to perceive millions of different colours. For example, the perception of different shades of purple is due to varying combinations of red and blue cone cells being stimulated. Yellow light (which has a wavelength between that of red and green light) stimulates the red and green cones and this information is decoded by the brain to give the perception of yellow light.

image detail: Stanislaus Ostoja Kotkowski, Australia, 1922–1994, *Polachromatic image*, 1966, Adelaide, cellulose, glass, 35.5 x 35.5 x 13.7 cm; South Australian Government Grant 1973, Art Gallery of South Australia, Adelaide, © Art Gallery of South Australia, Adelaide.

THE HUMAN EYE AND IMPRESSIONISM

The mosaic-like surfaces of paintings by the Neo-Impressionists play on the function of the retina's cone cells. The brain attempts to make sense of the pixelated field of colour, which consists of small strokes or marks of contrasting coloured paint placed next to each other, giving the work a shimmering, luminous quality and thus dazzling the retina. This can be seen in *Prairie à Éragny*, 1886, by Camille Pissarro. Neo-Impressionist artists were interested in colour division, that is, in placing both contrasting and complementary colours (colours opposite on the colour wheel) side by side. This approach is based on Michel Eugéne Chevreul's *Laws of Simultaneous Colour.* Paul Signac's use of this technique, combined with pure colour and rhythmic lines, enabled him to also create the illusion of movement. The boundaries between the complementary colours used in *Red Buoy, 1895*, and *Saint Tropez: the port*, 1897–98, create an intense colour effect making his works of art luminous and bright.

image detail: Paul Signac, France, 1863–1935, *La bouée rouge (The red buoy)*, 1895, oil on canvas, 81.2 x 65 cm; Gift of Pierre Hébert, 1957, Musée d'Orsay, Paris, France, photo: © RMN-Grand Palais (Musée d'Orsay)/Hervé Lewandowski.

image detail: Paul Signac, France, 1863–1935, *Saint Tropez: the port*, 1897-98, Paris, colour lithograph on paper, 43.3 x 32.7 cm (image), 52.0 x 39.9 cm (sheet), South Australian Government Grant 1980, Art Gallery of South Australia, Adelaide

EARLY YEARS

Responding

Place a variety of coloured frames around reproductions of different French Impressionist works. As a class discuss and vote on which coloured frame looks best and explain why.

Making

Using bright coloured paper create your own geometric collage. Experiment with placing different colours next to each other. How do different combinations of colour change the way these colours appear? Is one colour brighter when placed next to another colour?

RAINBOWS, COLOURS, PRISMS & WAVELENGTHS

The light we see, both natural and artificial, is made up of all the colours of the rainbow. These separate colours can be viewed if the white light moves from the air into a different medium, such as water or glass, at an angle. In both of these cases, the wavelengths of light slow down and bend. The different colour wavelengths slow down to different extents which makes them bend differently, separating the colours. When this occurs in moisture in the atmosphere, we see rainbows in the sky! We can also manipulate light by passing it into a glass prism at an angle to see the same effect. A good explanation can be found on ABC Education, 'How do Prisms create rainbows? (see resource list).

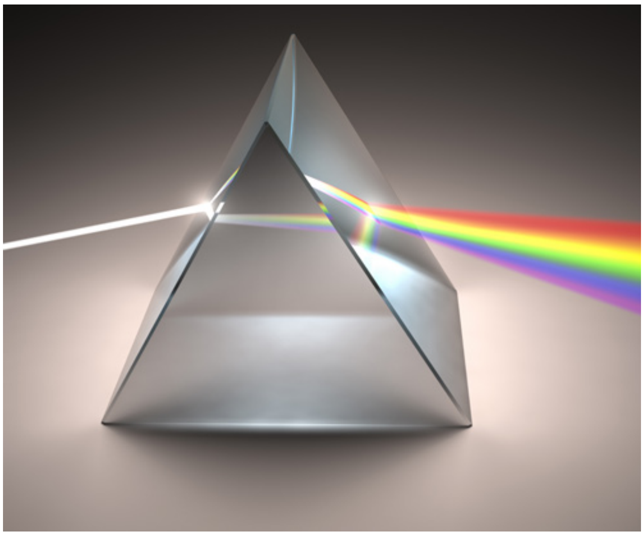


image: iStock.com/ktsimage.

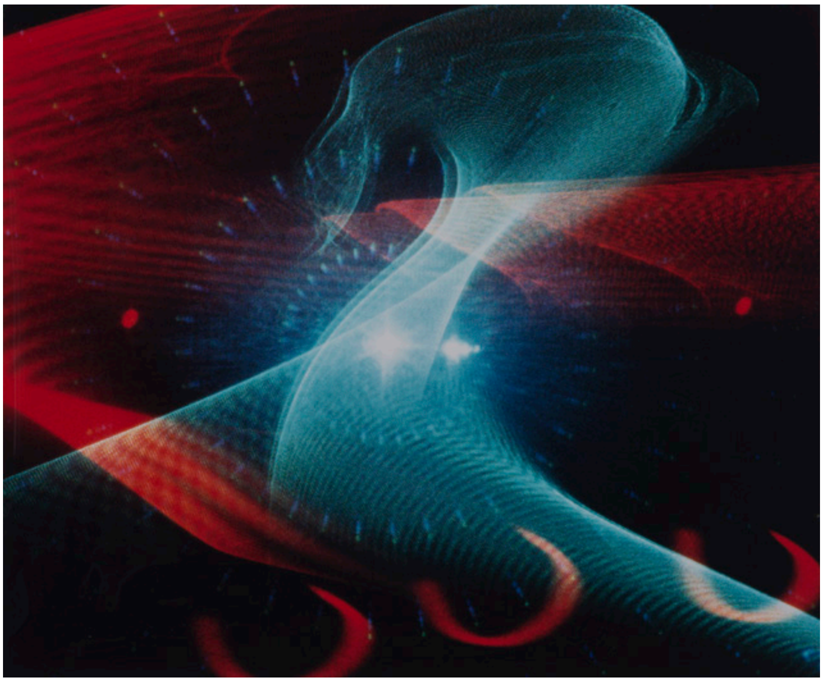
PRIMARY

RESPONDING

When do we see rainbows in nature? Draw a diagram that shows how rainbows appear in nature.

Locate works of art in the collection that capture different times of the day. As a class discuss the qualities of the works that suggest to you what time of the day it is.

Look for works of art that where artists have used Chevreul's theory of colour juxtaposition. What do you notice about the relationship between the colours that sit side by side?



MAKING

Set up the prism experiment in your classroom. Shine a light (i.e. torch) at the prism on an angle and view the effect on a screen (a white piece of paper). Investigate what happens as you move the prism. **TIP:** See The Tinkering Studio video in resource list.

If you have access to a convex lens, try positioning the lens to bring the separated colours back together. Where would you position the lens?

Photograph your observations during the prism experiment. Using these images as references, create an impression of what you witnessed using collage or watercolour paints.

image detail: Stanislaus Ostoja Kotkowski, Australia, 1922 – 1994, *Laser light composition*, c.1982 84, Adelaide, direct positive colour photograph, 25.4 x 30.4 cm (image & sheet); Gift of Edward and Jane Booth 2003, Art Gallery of South Australia, Adelaide, Estate of J.S. Ostoja Kotkowski.

FRANK HINDER

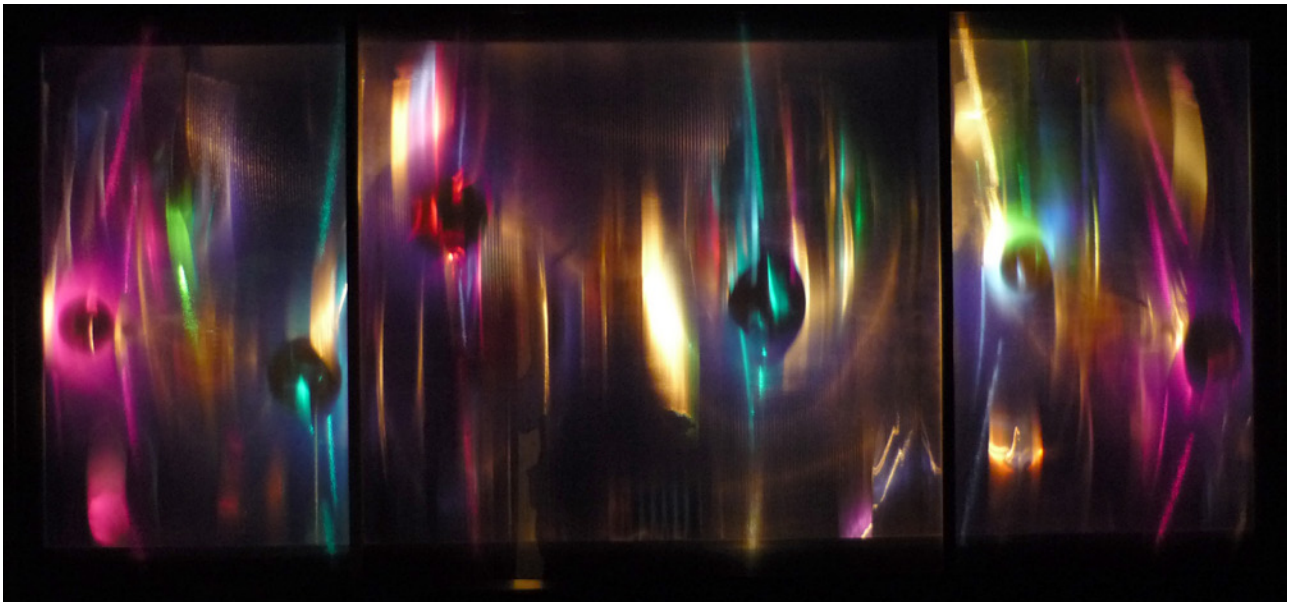


image: Frank Hinder, Australia, 1906 – 1992, *Dark Triptych*, 1969, Sydney, Luminal kinetic: wood, aluminium, electric motors, coloured lights, tinted plastics (or gels), glass, 76.2 x 195.0 x 22.0 cm; South Australian Government Grant 1974, Art Gallery of South Australia, Adelaide, © Art Gallery of South Australia, photo: Stephen Jones

Modern Australian artist Frank Hinder (1906 – 1992) had a strong interest in cubism, abstraction and futurism. Futurist artists were inspired by speed, qualities of machinery and new technology. Hinder's *Subway escalator*, 1953, in the Gallery's collection captures the speed, movement and energy of the wooden escalators in Wynyard station in Sydney. In the 1960s, Hinder began creating luminal kinetics, works of art that reflected light and moved within a boxed frame, such as *Dark Tryptic*, 1969, which creates an everchanging painting of light. He was interested in mathematical patterns, geometry and making science visible, which included the structural effect of colour and the dynamic illusion of movement.

RESPONDING & MAKING

Investigate artists who use light and movement. Compare their work to that of Hinder. Consider how technology and art has changed since Hinder's creation of his luminal kinetic works. **Tip:** Look at the work by Daniel Crooks, Lindy Lee, Yayoi Kusama, Jonathan Jones, Sandra Selig and James Turrell.

Hinder explored ideas about the real world, what we can see, and what is imagined. Think about a place you have visited that was busy. It might have been a special event like a concert or somewhere you visit regularly like a supermarket or sporting arena. What was the atmosphere like and how did it make you feel? Create a work of art that captures the essence of this place.

Hinder was fascinated by science and how everything in our daily lives is interconnected. Select a work of art and consider how the artist has relied on, or responded to, science, history, technology and mathematics. Write a response to: *Works of art provide us with pivots for a greater understanding about the world we live in*. Use your work of art to support your argument.

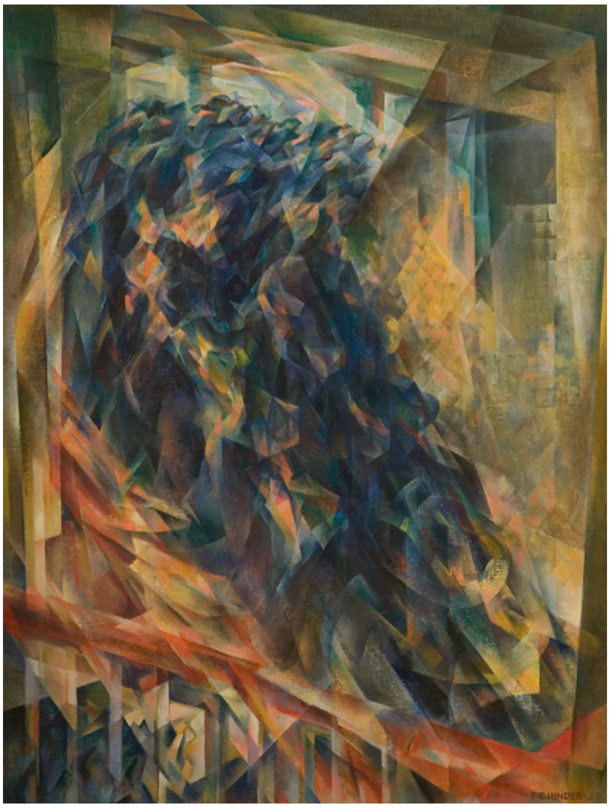


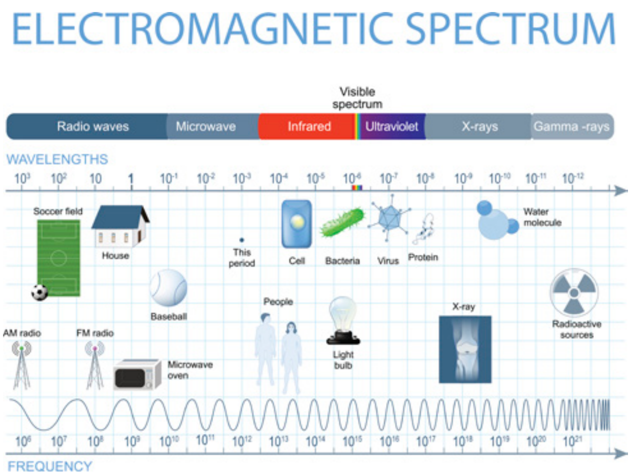
image: Frank Hinder, Australia, 1906 – 1992, *Subway escalator*, 1953, Sydney, tempera, oil on canvas laid on composition board, 92.8 x 72.5 cm; Elder Bequest Fund 1972, Art Gallery of South Australia, Adelaide, © Art Gallery of South Australia

SEEING COLOUR: HUMAN VS OTHER SPECIES

Humans can only see a very narrow band of colours – red, orange, yellow, green, blue and purple. There are colours that run through the Ultraviolet (UV) and Infrared spectrum, above and below the colours humans can see. The section that humans can see (from 400nm to 700nm) is highlighted on the Electromagnetic Spectrum diagram. UV radiation is outside of this spectrum, but you can get UV decorations such as stars for bedroom ceilings or special effects makeup and body paint, that only shows up under UV light. These items contain chemicals that absorb UV light, and re-emit the energy as visible light. Most humans cannot see the UV light emitted by the light, but can see the re-emitted visible wavelengths. Some animals can see in the other spectrums. For example, spiders and a lot of insects, including giant centipedes, can see in the Ultraviolet range.

In any species random variations in genetic makeup occur during reproduction, which result in different characteristics. Within the human species there is genetic diversity, which results in some people having different characteristics, like eye colour. Some people have genetic differences that effect the cones in their eyes, and hence some people see very little colour and some people can see beyond the visible spectrum into the UV and infrared wavelengths.

In many psychological experiments, it has been shown that people perceive colours differently. A person's mood has an impact on how shades of colours are perceived. The brain tries to interpret what it is seeing, using previous experiences.



Light entering the eye is the first stage of seeing. The brain must process the information and make a decision as to what information it wishes to prioritise. This results in people perceiving colours and images differently. The brain interprets colours using contrast, hence colours look different to us depending on the surrounding colours. **TIP:** Look at *Banyon Wall* by Sydney Ball and *Seris 33, orange and magenta added to green and violet in two colour twist* by Bridget Riley.

image: Electromagnetic spectrum image including the narrow band (in colour) that humans can see. iStock.com/ttsz.

Bridget Riley, Britain, born 1931, *Seris 33, orange and magenta added to green and violet in two colour twist*, 1979, London?, gouache, pencil on paper, 64.0 x 91.5 cm; Gift of Diana Ramsay AO and the late James Ramsay AO 1999, Art Gallery of South Australia, Adelaide.

RESPONDING

Sometimes our brains are 'tricked' into seeing different colours, these are optical illusions caused by the mixed messages that our brain receives. What colours do you see in Bridget Riley's work? Using the scientific principles of how we see colour, explain how Riley has created an optical illusion.

Introduced species of plants and flowers were one of the many inspirations for the French Impressionists. Investigate one of these species and discuss the pros and cons for introducing foreign plants and flowers.

Imagine if people could see into UV and infrared wavelengths and suggest any evolutionary advantages. Although some people can see slightly into seeing other spectrums, most humans haven't adapted to this (yet!). Why do you think this is? Suggest how in the future we may evolve and adapt to seeing in other spectrums.

Why do some animals or insects have the ability to see in different spectrums? **TIP:** Consider what they eat, and what colours those things are. Perhaps look at scorpions as a starting point.

MAKING

After investigating other moments in art history where artists have explored colour, make your own work of art that responds to the science of colour. You might like to consider optical illusions or investigate contemporary 4D practices.

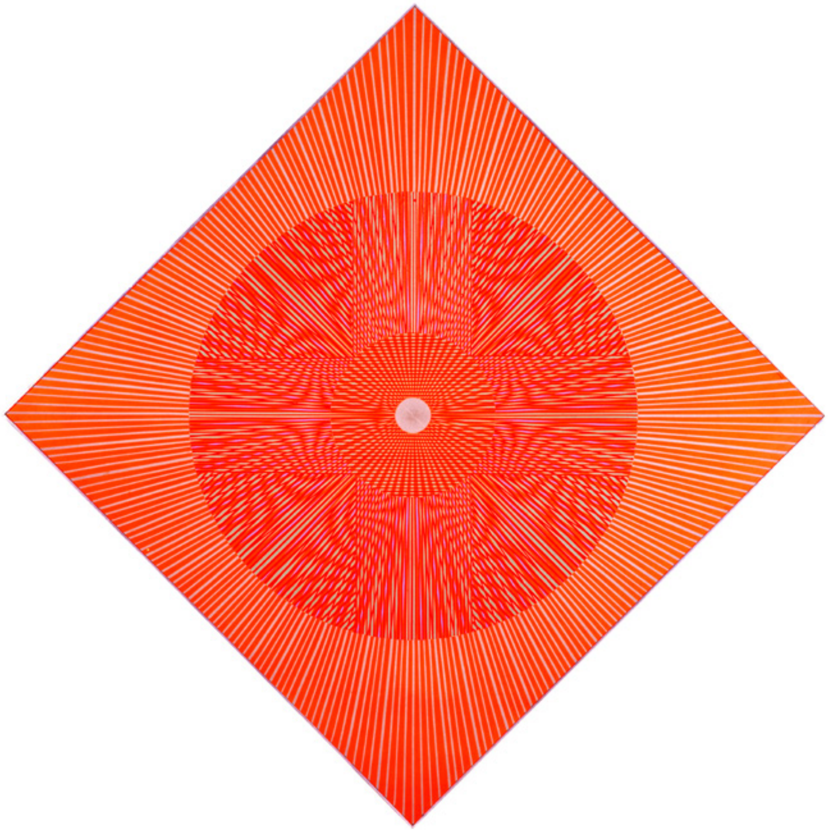


image: Stanislaus Ostoja Kotkowski, Australia, 1922 – 1994, *Vibra*, 1967, Adelaide, collage on board, 173.5 x 173.5 cm; A.R. Ragless Bequest Fund 1967, Art Gallery of South Australia, Adelaide, © Art Gallery of South Australia, Adelaide.

image detail: Henri Fantin Latour, France, 1836 – 1904, *Zinnias*, c.1897 99, Paris, oil on canvas, 62.0 x 49.5 cm; Elder Bequest Fund 1899, Art Gallery of South Australia, Adelaide.

CHEMISTRY OF COLOUR: PIGMENTS

Chemistry is the study of the composition, structure, properties and behavior of a substance, such as pigments (a powdered substance) found in paint. Thanks to the discovery of new chemicals in the nineteenth century, such as coal tar used to make mauve, the French Impressionists could experiment extensively with colour contrasts by using synthetic paints. Pre-mixed synthetic colours, such as magenta and arsenic-based emerald green, replaced prior methods of mixing primary colours. As painting landscapes outdoors or *en plein air* was favoured by the Impressionists, emerald green was a much-loved hue due to its vivid appearance.

WHAT IS PAINT?

A natural pigment is a powder which has been used by grounding materials such as clay and minerals. These pigments are usually mixed with a binder and/or a medium, such as animal fat or plant extract, which then makes the paint wet and holds the pigment together. A synthetic pigment is made artificially and may be either chemically identical to the original pigment, or a new chemical all together.

Modern paint is a mixture of pigment, binding medium and solvent. The binder is a liquid polymer that hardens to form a continuous layer when paint dries, while the solvent dissolves the binding medium to make the paint more fluid.

Historically artists used paint created with only a pigment and a medium (such as oil). However, since the invention of solvents, modern paints are easier to work with as they don't dry as quickly so you can work them more easily, and they last longer.

Binding mediums (or binders) come in different types. For modern oil paints a binder may consist of a drying oil, most commonly linseed oil. In water-based paint a popular binder is poly vinyl acetate (PVA). The binding process gives the paint the texture we are all familiar with.

However, to make paint easier to work with on a surface and extend its volume, some artists use a solvent or medium to thin the paint. The solvent for water-based paint is water, used in acrylic paints or watercolours. In oil-based paints the thinners are an oil based solvent such as Flow Medium, odourless solvent, Oxide Patina or Turpentine.

image detail: Auguste Renoir, France, 1841-1919, *Claude Monet*, 1875, oil on canvas, 84 x 60.5 cm; Bequest of Mr and Mrs Raymond Koechlin, 1931, Musée d'Orsay, Paris, France, photo: © RMN-Grand Palais (Musée d'Orsay)/Jean-Gilles Berizzi

DID YOU KNOW?

Emerald green was highly toxic and was used as a pesticide to kill rats in the sewers of Paris, as well as pigment for paint!

image: iStock.com/Andreas Kermann

NATURAL

For thousands of years Aboriginal people have been blending science with art by creating paint and developing techniques, combining these to tell their stories. Historically, the most common colours to be found on rock and bark paintings consisted of red, white, yellow and black. These colours are found to naturally occur in the Australian environment. For example, Kaolinite is a soft white clay and can be found in most parts of Australia, while areas between Uluru and the South Australian border are unique for their metallic red pigment. These pigments are then mixed with natural binders such as egg yolk, kangaroo blood, bush honey or tree resin. The survival of ancient rock and bark paintings are dependent on the conditions in which they exist today and can be affected by climate, location and exposure to the impacts of the tourism industry.

SYNTHETIC

Today, oil paint is made by mixing a synthetic pigment with oil and consequently this can take a long time to dry. Artists such as Ben Quilty use large quantities of oil paint mixed with gel medium to make the paint thick and lusciously textural.

image: Ben Quilty, Australia, born 1973, *Evening shadows, Rorschach after Johnstone*, 2011, Robertson, New South Wales, oil on linen, eight panels, 115.0 x 175.0 cm (each panel), 230.0 x 702.0 cm (overall); Gift of Ben Quilty through the Art Gallery of South Australia Contemporary Collectors to celebrate the 10th anniversary of Contemporary Collectors 2013. Donated through the Australian Government's Cultural Gifts Program, Art Gallery of South Australia, Adelaide, © Ben Quilty.

EXPLORING PIGMENTS – MAVIS NGALLAMETTA
THE MOUTH OF KENDALL RIVER

Mavis Ngallametta is an Aurukun elder living in the region of Western Cape York, Northern Queensland. Practicing first as an accomplished weaver, she turned to painting in 2008 and rapidly established a local and national reputation for her works that depict the complex maze of river systems, wetlands and coastlines of her Country. She has developed her own innovative style, using traditional clays, ochres and charcoal to create images based on community life and Country.

image: Mavis Ngallametta, Kugu-Uwanh people, Queensland, born 1944, *The mouth of Kendall River,* 2015, Aurukun, Queensland, natural ochres, synthetic polymer paint and charcoal on linen, 267.0 x 200.0 cm; Acquisition through TARNANTHI: Festival of Contemporary Aboriginal & Torres Strait Islander Art supported by BHP 2015, Art Gallery of South Australia, Adelaide.

THE MOUTH OF KENDALL RIVER

The Mouth of Kendall River depicts the pristine region around the mouth of the Kendall River south of Aurukun, of which the artist is the traditional owner. It has been created using materials sourced from this very site. Ngallametta captures the region's distinctive cliff formations, and the geological points of intersection between the deep red hues of the bauxite-rich soil (sandy rock with a high aluminium content) and the bands of contrasting white clay. The artist combines multiple perspectives, weaving together macro and micro views of the coastal wetlands developed from her intimate knowledge of the area. Among the dense scattering of rivers, swamps and flora, the artist has included herself in the painting as a record of her visit to Kendall River in 2013.

THE MOUTH OF KENDALL RIVER BY MAVIS NGALLAMETTA

PRIMARY

RESPONDING

Look closely at *The Mouth of Kendall River.* Identify the areas which have been painted with synthetic paint and the areas painted with natural ochres. What qualities do each of these materials have?

Some historical rock paintings created by Aboriginal people thousands of years ago have faded and are possibly not as vivid as they once were. Suggest reasons why they are fragile and what can be done to preserve these historical records from further deterioration.

SECONDARY

EARTH SCIENCES: YEAR 8

Investigate the Kendall River south of Aurukun. Identify the rock types (sedimentary, metamorphic or igneous) located in this area. What forces or energy are required in the formation of these types of rocks or minerals? What characteristics of this rock formation has Ngallametta captured in her painting *The Mouth of the Kendall River.*

Using *The Mouth of the Kendall River* and photographs of the Kendall River region, identify the rock cycle (the stages in the formation of, igneous, sedimentary and metamorphic rocks). Include indications of the timescales involved in these changes in the rock formations.

RESPONDING

What are the advantages and disadvantages of using synthetic versus natural materials?

Investigate the history of pigments. What surprising or unusual stories can you discover? Write a narrative poem about the life of your favourite colour.

What are some things a Gallery may need to consider when conserving a work of art made from natural fibres or pigments?

Conduct a class investigation into other natural materials used by Aboriginal artists throughout Australia. Use a map of Australia to plot where different materials are located. What are the environmental conditions that enable these natural minerals, ochres and fibres to flourish in these regions? Research another artist who uses natural fibres. How are these materials sourced and utilised? **TIP:** Look at the work by Yvonne Koolmatrie in the Gallery's collection

CHEMICAL SCIENCES: YEAR 10

Some chemicals can change colour if their surrounding environment alters. One example of this would be cobalt chloride, turning pink from blue when introduced to water. Experiment with a range of (safe!) chemicals to create a colour abstract work of art. Research what chemicals change colour when introduced to water, a change of pH, different temperatures and so on.

Research thermochromatic materials that change colours with different temperatures – used in mood rings, colour-changing mugs and hyper-colour t-shirts (If you were born after 1995 you may need to research what a hyper-colour t-shirt is!!). If they change colour when exposed to water or a change in pH this is normally because they have actually chemically changed to a new substance. In fact a change in colour is usually one of the indications that a chemical reaction has occurred.

MAKING

Take a series of macro photographs of the natural environment that illustrate bands of contrasting colours or textures, such as geological formations, bark, trees or leaves. Using these images as reference, create a textural painting that captures the essence of your discovery using a mixture of natural and synthetic materials

Collect a variety of natural materials that you could crush or grind to make a pigment to create your own selection of paints. Try grinding some of the materials listed below as a starting point.

- **White chalk** painted onto a dark surface
- **Frozen berries** (also known as *Stil de Grain* which isa plant based pigment made from berries)
- **Bark** chipped away from logs. This process was often used in the nineteenth century to create sepia drawing effects
- **Walnut shells** with water to create walnut ink. Soak the shells for two months, the longer they soak, the darker the ink becomes.
- **Willow charcoal** mixed with egg to create vine black.

Continue your experiment with different binders and watch paint dry! Document your observations.

Binders:

- **Watercolor:** Pigments are dispersed in water or a water-soluble chemical.
- **Oil:** Pigments are dispersed in an oil-based (organic) chemical such as linseed oil.

image detail: Mavis Ngallametta, Kugu Uwanh people, Queensland, born 1944, *The beach at Iklet*, 2010, Arukun, Queensland, synthetic polymer paint and ochre on linen, 203.0 x 134.0 cm; South Australian Government Grant 2010, Art Gallery of South Australia, Adelaide.

- **Acrylic:** Paint in which the binder is made from a plastic polymer emulsion.
- **Tempera:** Traditional paint that uses egg as a binder.

What things did you notice that were similar and different? Speculate as to why they are similar and different.

Consider how you might separate the pigments from a range of paints (modern and natural). How would you plan this experiment – what equipment would you need? How would you set it up? How would you stay safe?

RESOURCES

BOOKS

Finlay, F, Colour: Travels through the Paintbox, Hodder and Soughton, London, 2002

Finlay, F, Colour: A Natural History of the Palette, Random House, New York, 2002

Itten, J, The Art of Color, Van Nostrand Reinhold Company, New York, 1973

Gage, J, Colour in Art, Thames & Hudson, London 2006

Paul, S, Chromaphilia The Story of Colour in Art, Phaidon, London, 2017

Schwartz, H, Colour for the Artist, Watson-Guptill Publications, New York, 1869

St Clair, K, The Secret Lives of Colour, Hodder and Stoughton General Division, London, 2016

CATALOGUES

Colours of Impressionism: Masterpieces from the Musée d'Orsay, Paul Perrin, Marine Kisiel, Colours of Impressionism, Australian Edition, Art Gallery of South Australia, 2018

CHILDREN & EDUCATION

May, S, Colour, National Gallery of Victoria, Melbourne

Nicholson, E (editor), 'Period Pigments', Art and Science: A curriculum for K-12 from the J Paul Getty Museum, Getty Publications, Los Angeles, p 102 – 109

Strosberg, E, 'Painting and cognition' Art and Science, Abbeville Press Publishers, New York, 1999, p. 134 - 168

ARTICLES

Finlay. R, 'Weaving the Rainbow: Visions of Colour in World History', Journal of World History, Vol. 18, No. 4 (Dec 2007) p. 383 - 431

Barnett, A, Miller, S, Pearce, E, 'Colour and art: A brief history of pigments', Optics and Laser Technology, 2006, p 445 - 453

WEBSITES

ABC News – Why some chickens lay brown eggs some lay blue, the chemistry of eggshell colour explained
http://ab.co/2Fu0eNF

ABC Art – Prussian blue: From the Great Wave to Starry Night, how a pigment changed the world
http://ab.co/2DJCteJ

Art Guide Australia – Nike Savvas talks about the science and phenomenology of colour
http://bit.ly/2GSfely

Artsy – A Brief History of Color in Art
http://bit.ly/1WdegV6

Artsy – What art history tells us about Ultra Violet, Pantone's Color of the year
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Coming out of the dark – why black is such a positive colour
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Conversation: inside the colourful world of animal vision
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Conversations from the past: Pigments and palettes from the past science of Indigenous art
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RESOURCES

Cosmos: The Science of everything, The incredible – and bizarre – spectrum of animal colour vision
http://bit.ly/2FtEEsp

Crayola – Colour Experiments
http://bit.ly/2Gh2UNU

Exploratorium – Science snacks – pigments
http://bit.ly/2IlVqHG

Frieze - Experiments in the Field: Why are Artists and Scientists Collaborating?
http://bit.ly/2osH27w

The J Paul Getty Museum – About Impressionism
http://bit.ly/2FwFOPN

Google Arts and Culture: Musée d'Orsay, Paris
https://www.google.com/culturalinstitute/beta/partner/musee-dorsay-paris

Google Arts and Culture: The Magpie
https://www.google.com/culturalinstitute/beta/asset/the-magpie/rQGnadHwK8lSmg

How to build a lightbox
http://bit.ly/2pnBs7N

Inside the world of a modern alchemist
http://bit.ly/2HrILQQ

Light Play – The Tinkering Studio
http://bit.ly/2pkf6E7
Khan Academy – A beginners guide to Impressionism
http://bit.ly/1zdl3gP

A Master of Design Explores the Murky, Mutabke Science of Color
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National Gallery of Victoria – Hokusai
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National Gallery of Victoria – Australian Impressionism
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National History Museum: How do other animals see the world
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The Phenomena of Light
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Prussian Blue – The Art and Science of Color

http://bit.ly/2Dobrcl

Reggio Children Ray of Light Atelier
http://bit.ly/2opOxKc
Science Learning Hub: Colours of Light

http://bit.ly/2ofBCOA

Smithsonian Libraries – Colour in a New Light
http://s.si.edu/2Dm1BYt

Smithsonian – Never Underestimate the power of a Paint Tube
http://bit.ly/2tDTuad

The Story of Art: Impressionism
http://bit.ly/2p3uGDR

VIDEOS

ABC Education – How do prisms create rainbows
http://ab.co/2puGNdj

Colour White Light, Reflection and Absorption
http://bit.ly/2p6i3Hx

Edmund Scientific: Understanding Absorption of Light - Why do we see different colors?
http://bit.ly/2HsccUp

Institute of physics: Light Fantastic – the science of colour
http://bit.ly/2DltQ9Y

Refraction of Light Experiment:
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TED-Ed: History's deadliest colors – J. V. Maranto
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TED-Ed: how we see colour
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TED-Ed: What is colour?
http://bit.ly/2wxTEzM

Vasaricolors
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Why is blue so rare in nature?
http://bit.ly/2rqXcmx

Why don't country flag use the colour purple?
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What is colour?
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Government of South Australia
Department for Education and Child Development

This resource has been developed in collaboration with Hilary Jones from Australia's Science Channel, Susan Keylock, Chemistry teacher at Trinity College Senior, Aaron Whenan Head of Science at Trinity College, Kylie Neagle Education Officer (Art Gallery of South Australia) and the Learning team at the Art Gallery of South Australia.