INSECTS AS ART LOVERS: BEES FOR VAN GOGH

The visual aesthetics of animals, and the ways they perceive the world, often differ fundamentally from those of humans. A biologist's view is that these differences have, at least in part, evolutionary roots. In an attempt to provoke thinking about the subjectiveness of visual appearance, and its biological relevance, a biologist and an installation artist got together to launch a Sci-Art project in which bees were confronted with a series of paintings highly appreciated in Western society, such as Van Gogh's Sunflowers.
Text by ***Lars Chittka & Julian Walker***

"Where the bee sucks, there suck I …"

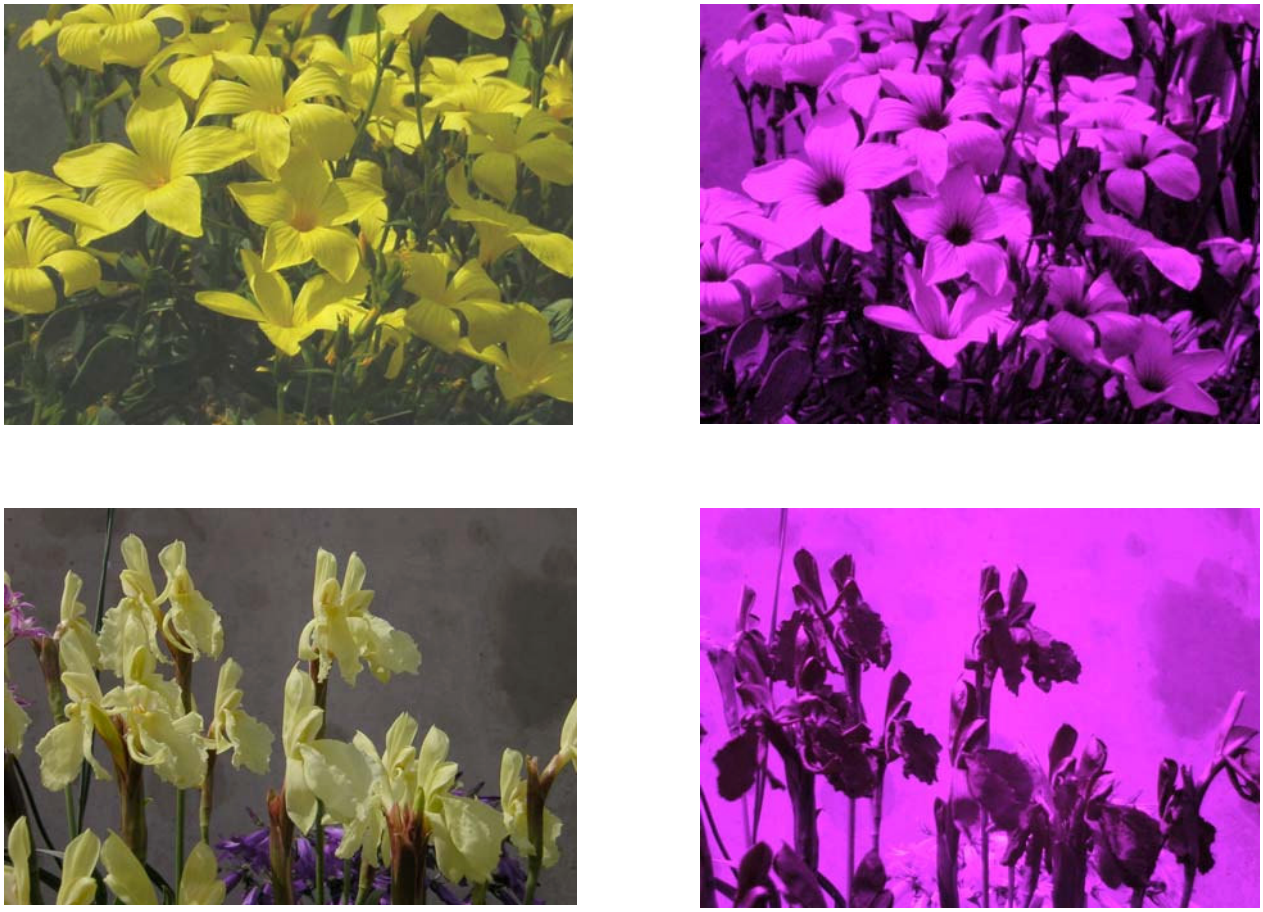
William Shakespeare 1564–1616 (From: The Tempest)

A "Colour and Design" symposium of the Linnean Society in 2003 was dominated by physicists and artists. Yet, colour is neither purely physics nor a domain of the arts: it is, to a large extent, biology. The coloured world we see is not the real or the physical world – instead, the colours we perceive are filtered through the specific sense organs that we have acquired in evolutionary history. Colour vision systems differ widely between different animal species, and the reason is that different aspects of the coloured world are biologically relevant for different species. Our goal was to raise appreciation of this fact in an audience not specifically trained in the biology of vision, and to use live bees' attraction to a series of paintings as a vehicle towards this goal.

The insight that flowers (and their colours) have not been created solely to please us humans dates back to the 18th century. The history of that discovery is a healthy lesson for those who think that science in the olden days was less riddled by competition and strife. The idea that flowers are in fact sex organs, designed to attract the services of pollinators, is commonly attributed to Sprengel 1793, who entitled his book "The uncovered mystery of nature...". When Goethe heard of Sprengel's progress with that book, he forged ahead at full speed to publish his own botanical work. Goethe won the race, and published his book in 1790. His work ended up with a strongly different focus, and what Goethe offers on flower colouration (e.g. that floral colours are caused by the contaminating influence of male seed in the petals) shows he would have done better to leave the field to Sprengel. However, Sprengel himself was no little innocent: more than 30 years before him, Kölreuters noted that "... anyone who had made these observations, would have much earlier discovered them [the causes of pollination in the activities of insects], and would have ... *removed the curtain from this mystery of nature*" – which shows that Sprengel did not only borrow a key idea from Kölreuters, but that in fact the very title of Sprengel's volume stems in part from Kölreuters' original wording.

Flower colours are clearly important signals to bees, since flowers provide bees with nectar and pollen. But how do insect pollinators see colours? In 1874, Lord Rayleigh pointed out that 'The assumed attractiveness of bright colours to insects would appear to involve the supposition that the colour vision of insects is approximately the same as our own. Surely this is a good deal to take for granted'. Lord Rayleigh was right: in 1924, Kühn discovered that bees see ultraviolet light, and in subsequent decades a wealth of information has been collected on how bees process colour information. Bees (including the familiar bumblebees and honeybees) have three colour receptor types, with maximum sensitivities in the ultraviolet (UV), blue, and green. Brightness, a parameter so fundamental to our own visual experience, has a relatively minor role in bee colour discrimination. But bees use a single colour receptor, the green receptor, for detection of flowers from a longer distance.

Old world primates, including humans, have three colour receptor types (typically called blue, green and red receptors). The light sensitive pigment of human photoreceptors has some sensitivity to UV



David Pye & Lars Chittka
A series of flower species as seen in the visible light (left) and in the ultraviolet (right) which bees but not humans can perceive. ©

light, but such radiation never reaches the retina because it is absorbed by the lens. C. Monet (1840-1926), an avid painter of flowers, had the lens removed from his right eye in 1923 due to cataract, and would therefore have been able to see UV patterns of flowers.

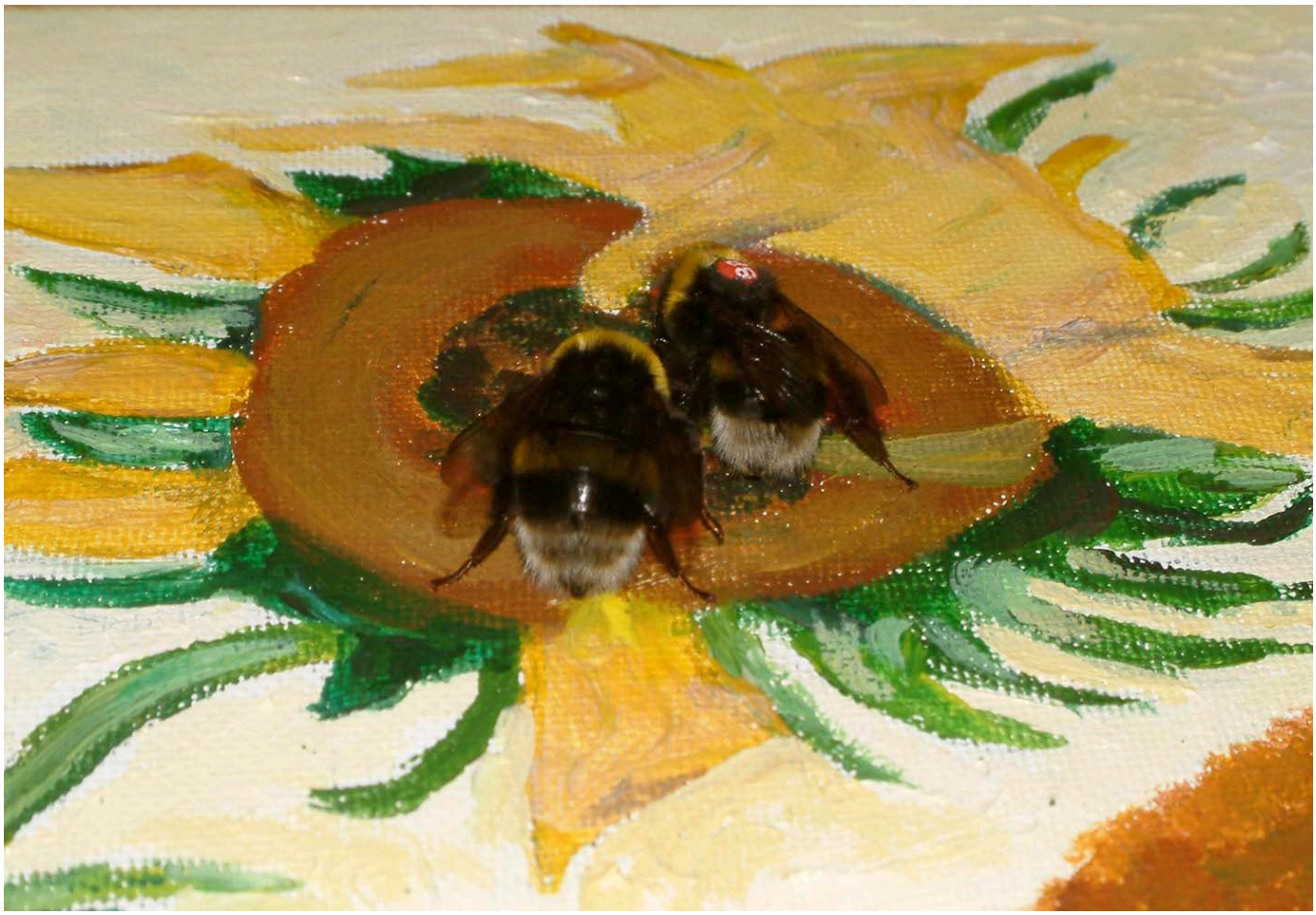
It is thought that the mammalian ancestors of primates had only blue and green receptors, and that the red receptor is an adaptation to frugivory. Flowers do not play a major role in the diet of humans and other primates; the biological significance of human attraction to flowers is discussed later. It is clear from the above, however, that there will be differences both in perception and in meaning for human and bee observers of floral colours – and that perceptual differences have evolved alongside the biological significance of the objects in question.

The authors of the current article, a biologist and an installation artist, were drawn to each other's work by the fact that bees and people obviously are both drawn to flowers, and that one of the most obvious ways that humans express this in western culture is by creating and appreciating paintings of flowers. By presenting such paintings to bees, we hope to address people with an interest in colour (but not necessarily a training in the biology of colour vision). We hope to stimulate thinking about the fundamental philosophical issue of whether perception reflects reality, about the nature of the image as object, and about the biological meaning of colour for different receivers.

What are bees favourite paintings?

We chose reproductions of two paintings that contained flowers, and two that didn't. These were: Vincent Van Gogh "Sunflowers" ((c) The National Gallery, London), Paul Gauguin "A Vase of Flowers" ((c) The National Gallery, London), Patrick Caulfield's "Pottery" (Tate Gallery, London; (c) Patrick Caulfied 2004. All rights reserved, DACS) and Fernand Leger's "Still Life with Beer Mug" (Tate Gallery, London; (c) ADAGP, Paris and DACS, London 2004). Bumblebee nest boxes were connected to a flight arena. These bees had never seen natural flowers prior to or during the experiments. We placed the paintings onto the floor of the flight arena and bees' responses to objects in the paintings were filmed using a digital video camera.

Van Gogh's *Sunflowers* proved to be the most popular: of 146 approach flights by bees to the painting, 99 were to flowers. Bees mostly approached the high



Two bumblebee workers attempting to imbibe nectar from one of *Vincent Van Gogh* 's(1853-1890) Sunflowers (1888). The original is in the National Gallery, London. The copy was painted by J. Walker (acrylic on canvas-board 45.5 x 35.5cm). ©

contrast margins of flowers, or the contrast between periphery and centre. Interestingly, 17 approaches were to the blue-on-yellow *Vincent* signature. 15 landings were recorded in total, of which 13 were on flowers. Caulfield's *Pottery* came second in terms of approach flights (138) but only 4 landings were observed. Gauguin's *A Vase of Flowers* attracted only 81 approaches, of which 25 were to blue flowers. Two landings occurred on the blue flowers in the upper right, 9 were distributed over other flowers of the painting. On Leger's *Still Life with Beer Mug*, a light blue square was frequented most strongly (24 out of 117 total approaches). In summary, the fraction of approach flights that terminated in landing was substantially higher in the paintings with flowers (11%) than it was in the paintings without flowers (4%). Thus, there is evidence that the flower paintings have captured the essence of floral features from the viewpoint of a bee, and that these features are recognised by bees that have never been exposed to flowers before.

What do bees aesthetic preferences tell us?

In more standard, controlled laboratory measurements of visual pattern attractiveness for flower-naive bees, we had previously found that bees will prefer blue and especially violet over other colours, which is what was also found in this study. The evolutionary explanation is that flowers with these colours offer high nectar rewards in nature. Hence, "favourite colours" (in bees) have biological significance; we assume that selection has favoured individuals which prefer colours associated with nutritional desirability.

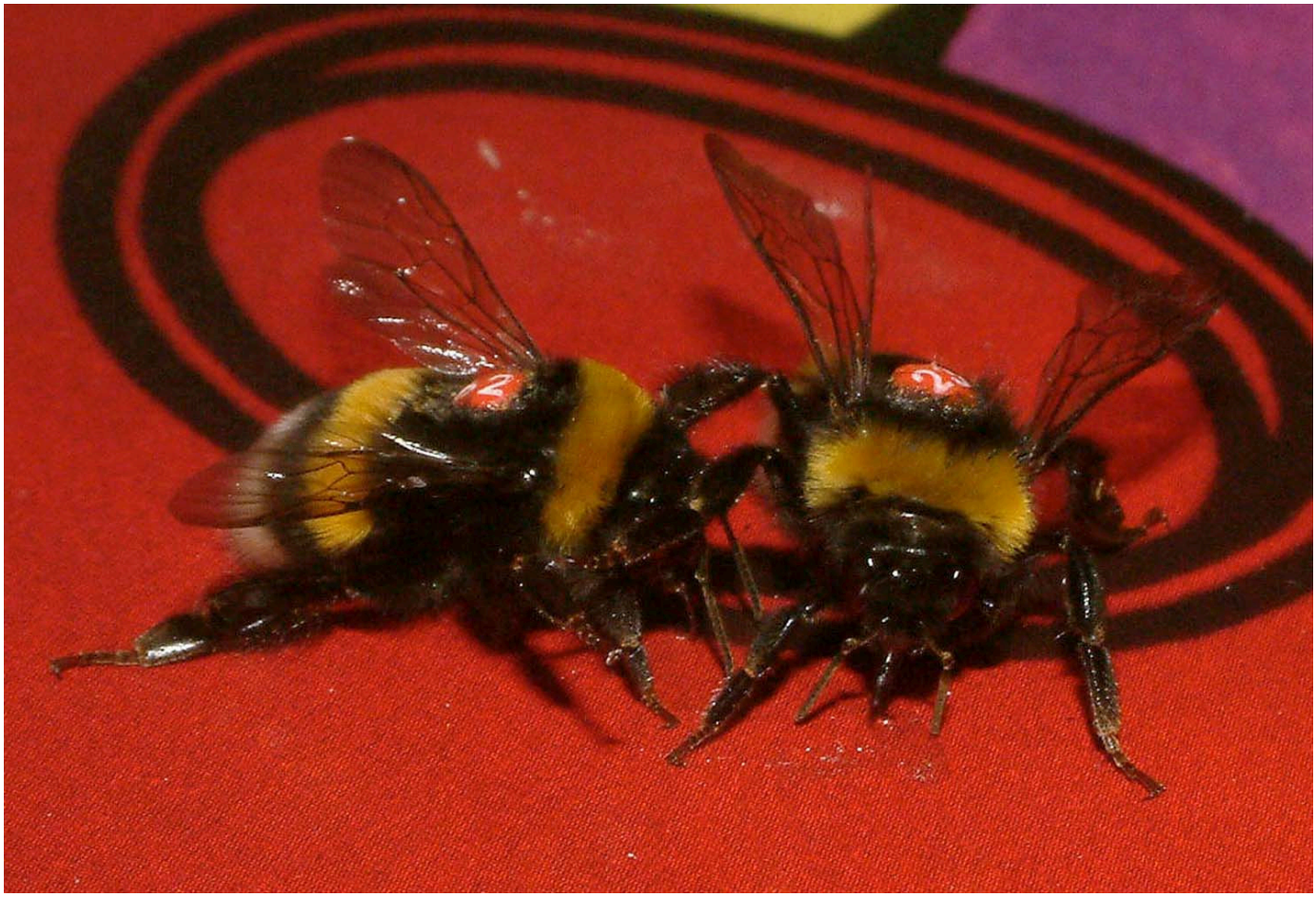
How do human observers react to presentations of bees visiting flowers in paintings? When our study was first published online in 2005, press reaction was more interpretative than we had expected, the research being described as "important" (Discovery Channel), "cutting edge" (Art Monthly), and even meriting a cartoon in the Sydney Morning Herald. The study was covered on BBC and ABC television news, Science, New Scientist, The Times, and multiple radio stations). We were excited by the readiness with which reviewers proposed that the bees' response to the picture proved its value, as if the biological "rightness" of the image confirmed its aesthetic value. Such willingness to delegate aesthetic judgement to bees raised the possibility that our responses could be linked to a wider biological visual reaction based on survival and the assessment of resources. Some viewers commented on the absurdity and surrealism of seeing live bees in an out-of-place context (paintings), yet in another sense the bees do seem to belong (since the paintings contain flowers). In some cases there was an assumption that the fact that the bees were

A bumblebee inspecting the signature of Van Gogh's Sunflowers ©

attracted to the centres of the flowers in Van Gogh's painting indicated that the artist had "unwittingly" captured some essence of the flower, which rendered the painted flower attractive to bees. Elsewhere, scepticism that the bees were attracted merely by the choice and distribution of colours was mixed with some concern at the possibility of applying biological determinism to visual art. Some artists, however, also felt that bees were mistaken, or were indeed "invading" the painting, whereas biologists felt that the intimate signal-receiver relationship between flower and bees had been strangely thwarted. Inherent in all these interpretations is the implication that flowers in paintings are not really meant for bees. They are created by humans for human observers. This raises an interesting question: why is it obvious that flowers rendered by painters should be different from those which have evolved to attract bees?

Indeed, for thousands of years, humans have reshaped flowers to their liking, either through horticulture or through pictorial representation. Flowers play a major role in most cultures, and the flower trade is a global multibillion dollar enterprise. For example, the Netherlands alone exported cut flowers for more than 2 billion dollars in 1992. Could there be an evolutionary explanation for human attraction to flowers, and the fact that humans obviously prefer different floral features than those which selection has acted on to address bees?

In our evolutionary history, paying close attention to flowers might have conferred strong selective advantages. Even if flowers may play only a minor role as food for primates, they can be indicators of resource availability: they might correlate with the presence of water, and indicate future availability of fruits, nuts and honey, and they can be used to identify plants for medicinal purposes. Is human aesthetic appreciation of flowers in part based on a primordial interpretation of a landscape with flowers as one that could support human foraging? If flowers carry different information for humans than for bees, then human horticultural selection and pictorial representation is expected to emphasize the traits that indicate relevant resources for humans. One floral feature that has been clearly exaggerated by humans is flower size, and the number of floral petals and sepals. It remains to be determined whether these floral traits are indicative of future fruit set or water availability.



Two images of bumblebees (bearing individual number tags) that have landed on of Patrick Caulfield's (1936-2005) Pottery 1969; oil on canvas 213.4 x 152.4 cm. Original at Tate Gallery, London ©

What about flower colour? It is clear that human colour selection on flowers would have excluded the ultraviolet, but even within the human visual range, qualitative inspection of any flower store indicates that flower colours have been strongly altered to match human preference. Blue flowers seem underrepresented, whereas red and orange colours are common, despite being rare in natural flowers in European temperate habitats. Curiously, however, these are the typical colours of primate-eaten fruits. Could human flower colour preference be a result of our primordial lifestyle as frugivorous mammals, a lifestyle which has shaped the way we see colours? Clearly, a SciArt project such as this one cannot provide scientific answers to these questions. For that, we will have to employ conventional scientific practise. But we hope that our collaboration will stimulate thinking about the evolutionary roots of the connotations and perception of natural objects, and their representation in the arts.

Sci-art projects pose a recurrent and often uncomfortable question – what's in it for science? Projects using the methodology, tools, imagery, or language of science have produced art of undoubted aesthetic value; but the limited benefit for science, on its own terms, other than merely in terms of illustration or publicity leaves science as the senior partner in the equation, aloof and unchanged. On this occasion the scientifically unconventional approach allowed the possibility of raising awareness for between-species differences in visual perception, and provoking thinking about the implications of biology in human aesthetics and the relationship between object, representation and its (biological) connotations.

All of this begs the question what is the nature of the artwork? Despite the physicality of the bees' responses, the answer for us is that it is conceptual: the range of questions arising from the presentation of the data. These are of value to both art and science, and arise from the rather discomforting inference that at some level art may depend on biological evolution, hardwired into our minds, and therefore beyond our will.

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