

Lovely Colours: Colour and Affect in the Early Royal Society of London
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Résumé: This article explores the affective language used to describe colour by three key members of the early Royal Society of London – Robert Boyle, John Ray, and Francis Willughby. In so doing, we will encounter a paradox. On the one hand, Boyle and his contemporaries understood that colour arose in part from the reactions of their own bodies to external things. It surely stood to reason, therefore, that quieting down the most unruly and subjective components of those reactions – and few were more unruly than some of the passions inspired by beautiful colours – was the best way to make colours scientifically useful. On the other hand, those same philosophers insisted that their subjective responses could sometimes be scientifically significant. Far from trying to eliminate the passions raised by lovely colours, Boyle and his contemporaries sometimes treated those subjective responses as useful tools for philosophical inquiry.

Keywords: Colour ; lovely ; affect ; science ; chemistry ; ornithology ; Royal Society ; Boyle ; Ray ; Willughby

The 17th century witnessed intense philosophical interest in the nature and causes of colour. But this interest emerged at a time when many of the day's leading natural philosophers were becoming increasingly convinced that colour was not real – at least not in the sense that many people had once seemed to think.

In his *Experiments and Considerations Touching Colours* of 1664, for instance, the Anglo-Irish natural philosopher Robert Boyle (1627-1691) criticized the loosely Aristotelian argument that colours actually belonged to the objects that seem to possess them, with light merely conveying those colours to our eyes. Instead, following the path laid down by philosophers including Pierre Gassendi and René Descartes, Boyle sought to show that colour by no means belonged to the objects that we perceive. Instead, it was a property produced in us by the interactions between those objects, the particles of light that strike them, and the human mechanisms of sensation and

perception – the eye, the nervous system, and the brain.¹ Making this case, Boyle argued a point that the philosopher John Locke would give its most famous articulation in his *Essay Concerning Human Understanding* (1689). There, Locke distinguished the properties apparently identifiable in material things into two kinds. First, there were primary qualities. Including size, shape, and motion, these were the geometrically definable properties that objects possess regardless of how humans (or other animals) might perceive them. But most of the properties that humans perceived – and colour was a prime example – did not in fact belong to objects at all. There were no truly blue or red objects in the world. There were only objects whose size and shape led indirectly, through the mediation of light, to the feeling or perception of blueness and redness in the human mind. For Boyle and Locke, therefore, colours were in some sense unreal.²

As Tawrin Baker has shown, such attacks on scholastic accounts of colour were misleading, overlooking the sophisticated ways in which thinkers such as Jacopo Zabarella (1533-1589) reckoned with the optical phenomena that together produce the experience of colour.³ Nevertheless, the conviction that colour was a secondary quality led Descartes, Boyle, and most famously Isaac Newton, to develop theories that sought out the real phenomena that they believed to lurk behind the experience of colour. Descartes thus speculated that the phenomena of colour

¹ Fokko Jan Dijksterhuis, « Understandings of Colors: Varieties of Theories in the Color Worlds of the Early Seventeenth Century », dans Tawrin Baker, Sven Dupré, Sachiko Kusukawa, et Karin Leonhard (ed.), *Early Modern Color Worlds*, Leiden, Brill, 2015, p. 227-247, 241-242; Henry Guerlac « Can there be Colors in the Dark? Physical Color Theory before Newton », *Journal of the History of Ideas*, n° 47, 1986, p. 3-20, 14-19.

² John Locke (ed. Peter H. Nidditch), *An Essay Concerning Human Understanding*, Oxford, Clarendon Press, 1975, p. 140-142.

³ Tawrin Baker, « Colour in Three Seventeenth-Century Scholastic Textbooks », dans Magdalena Bushart et Friedrich Steinle (ed.), *Colour Histories : Science, Art, and Technology in the 17th and 18th Centuries*, Berlin, De Gruyter, 2015, p. 161-177, 174-175. Baker has shown that philosophers such as Descartes and Boyle much exaggerated the differences between their own accounts of colour, and those of their late scholastic predecessors. In particular, he shows that thinkers such as Zabarella were keenly aware of the role of the sensorium in producing our experience of colour. As a result, it is incorrect to take at face value the Descartes's claim that scholastic natural philosophers straightforwardly regarded colour as a real property of objects.

emerged from the shape, arrangement, and motion of the particles making up light. Boyle didn't share Descartes's confidence in his own reasoning, and therefore refrained from specifying the precise mechanisms involved. But he made an essentially similar suggestion in *Touching Colours*, arguing that light emerged from the interactions between variously modified particles of light and the mechanisms of the eye.⁴ And most famously of all, Isaac Newton demonstrated that there was an exact analogy between the apparent colour of light and the refrangibility of its rays. In other words, he showed that the subjective experience of colour depended on a real property identifiable in light, and susceptible to expression in the supposedly objective language of geometry.⁵ It is not difficult to understand, therefore, why later theorists such as Johann Wolfgang von Goethe disliked Newton's inattentiveness to the affective aspects of the experience of colour. For Newton, the best way to understand colour was by attending not to the subjective feelings arising in the sensorium, but instead to the real properties from which those feelings apparently emerged.⁶

Some natural philosophers nevertheless believed that they could use their experiences of colour to learn about the real properties of physical things. Robert Boyle is a case in point. As a committed empiricist, he wanted to use highly specialized and disciplined forms of sensory experience to obtain knowledge of the natural world – and this commitment to deriving knowledge from the phenomena of experience extended to colour. Indeed, we can find a good example of this commitment in his *Touching Colours*. There, Boyle demonstrated that changes in the colour of syrup of violets, along with other blue vegetable juices, reliably revealed whether chemical

⁴ Guerlac, « Can there Be Colors in the Dark? », p. 14, 18; Baker, « Colour in Three Seventeenth-Century Scholastic Textbooks », p. 174.

⁵ Rosalind Powell, *Perception and Analogy: Poetry, Science, and Religion in the Eighteenth Century*, Manchester, Manchester University Press, 2021, p. 124-125.

⁶ Frederick Burwick, *The Damnation of Newton: Goethe's Color Theory and Romantic Perception*, Berlin, De Gruyter, 1986, p. 9-53.

solutions were acid or alkali. The acids would always turn such blue liquids red, while the alkalis would always turn them green.⁷ Of course, Boyle was well aware that the phenomena of colour were potentially unreliable. Therefore, as Tawrin Baker has shown, Boyle used the expertise of craftsmen – such as metalworkers – when devising experimental methods for distinguishing between changes that yielded real insights into the internal constitution of substances, and those that were of no significance.⁸ In so doing, he sought to discipline the sensory perceptions that, understood as products of his own body, threatened his project for an empirical science of nature with their potentially irreducible subjectivity. Like other natural philosophers associated with the early Royal Society of London, he hoped that the application of method to experience would make it possible to bring individual experiences into some kind of alignment, furnishing reliable data for an empirical science of nature.⁹

For a long time, therefore, the consensus among historians was that philosophers such as Boyle reckoned with the subjectivities of experience – including the subjectivity of secondary qualities – by seeking out dispassionate strategies for observing and describing natural things. In recent years, however, it has become increasingly clear that, for some natural philosophers, the cultivation of sensory pleasure and other affective states was important to this disciplinary process.¹⁰ Elsewhere, for instance, I have shown that many of the natural philosophers associated with the early Royal Society of London regarded the capacity to experience moderate forms of pleasure as

⁷ William Eamon, « New light on Robert Boyle and the Discovery of Colour Indicators », *Ambix*, n° 27, 1980, p. 204-209.

⁸ Tawrin Baker, « Color and Contingency in Robert Boyle's Works », dans Tawrin Baker, Sven Dupré, Sachiko Kusukawa, et Karin Leonhard (ed.), *Early Modern Color Worlds*, Leiden, Brill, 2015, p. 248-273.

⁹ Rose-Mary Sargent, *The diffident naturalist: Robert Boyle and the Philosophy of Experiment*, Chicago, University of Chicago Press, 1995, p. 35, 51, 65 ; Simon Schaffer et Steven Shapin, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton, Princeton University Press, 1985, p. 55-76.

¹⁰ Jessica Riskin, *Science in the Age of Sensibility: the Sentimental Empiricists of the French Enlightenment* (Chicago: University of Chicago Press, 2002), p. 69-103.

important to the task of discovering how nature worked.¹¹ There is no need, therefore, to repeat the now familiar observation, made among others by Tawrin Baker, William Eamon, and Domenico Bertolomi Meli that some philosophers of the 17th century regarded colour as a potentially useful guide to the reality of physical phenomena, notwithstanding its association with sensory pleasure.¹² Instead, the purpose of this article is to explore the strikingly affective language that those natural philosophers used when describing the colours they saw. In so doing, we will encounter a paradox in their attitude to colour. On the one hand, as we have seen, Boyle and his contemporaries understood that colour arose in part from the reactions of their own bodies to external things. It surely stood to reason, therefore, that quieting down the most unruly and subjective components of those reactions – and few were more unruly than some of the passions inspired by beautiful colours – was the best way to make colours scientifically useful. On the other hand, those same philosophers insisted that their subjective responses could sometimes be scientifically significant. Far from trying to eliminate the passions raised by lovely colours, Boyle and his contemporaries sometimes treated those subjective responses as useful tools for philosophical inquiry.

Lovely Colours

In early 1686, the Royal Society's journal *Philosophical Transactions* included a chart depicting colours and their combinations, as well as giving their names, and indications about the composition of their pigments. Devised by the naturalist and illustrator Richard Waller (c. 1660-

¹¹ Alexander Wragge-Morley, *Aesthetic Science: Representing Nature in the Royal Society of London, 1650-1720*, Chicago, University of Chicago Press, 2020, p. 135-160.

¹² Domenico Bertolomi Meli, « The Color of Blood: Between Sensory Experience and Epistemic Significance », dans Lorraine Daston et Elizabeth Lunbeck (ed.), *Histories of Scientific Observation*, Chicago, University of Chicago Press, 2011, p. 117-134, 130 ; Baker, « Color and Contingency » ; Eamon, « New Light on Robert Boyle and the Discovery of Colour Indicators ».

1715), each copy of this striking printed included samples of the colours in question, giving readers the relatively rare opportunity to see actual samples of the pigments to which the chart's verbal depictions referred.¹³ As Sachiko Kusakawa has pointed out, the aim here was to facilitate the use of colours in natural philosophy by bringing people's experiences into alignment. Thus instead of wondering whether a reader had correctly grasped the colour of the plant they were describing, a naturalist could simply pick the name given to that colour on the table. Likewise, readers had no need to worry about whether they had correctly pictured the colour that the naturalist had described. Instead, they could use the table to look the description up, confident that the table would lead them to a real specimen of the colour in question (Fig. 1).¹⁴

Fig. 1, 'Tabula Colorum Physiologica', from « A Catalogue of Simple and Mixt Colours, with a Specimen of each Colour Prefixt to its Proper Name », *Philosophical Transactions of the Royal Society*, n° 16, 1686, p. 24-32.

¹³ Richard Waller, « A Catalogue of Simple and Mixt Colours, with a Specimen of each Colour Prefixt to its Proper Name », *Philosophical Transactions of the Royal Society*, n° 16, 1686, p. 24-32.

¹⁴ Sachiko Kusakawa, « Picturing Knowledge in the Early Royal Society: the Examples of Richard Waller and Henry Hunt », *Notes and Records of the Royal Society*, n° 65, 2011, p. 273-294, 284.

Waller's colour table therefore served a purpose similar to the bishop and natural philosopher John Wilkins's (1614-1672) famous attempt at developing a universal language. Wilkins had hoped that his language would make a truly philosophical form of communication possible, eliminating the ambiguities of language by ensuring that each character referred to a known entity, and nothing else besides.¹⁵ In like manner, Waller hoped that his table would help natural philosophers to develop a « Standard of Colours », making it possible to communicate philosophically about colours by eliminating the ambiguity in their names.¹⁶

There is little evidence, however, that any of the Royal Society's key members actually disciplined their descriptions of colour in this manner. It is true, of course, that the Society maintained a corporate commitment to the reform of language, with authors such as Thomas Sprat and Robert Hooke claiming to use a plain style that would enable their verbal descriptions to serve as neutral, transparent stand-ins for the objects of scientific inquiry. But it is also well known that the same authors made extensive use of strategies derived from poetry and rhetoric in their scientific descriptions, seeking to help their readers form clear, vivid, and oftentimes emotionally powerful mental images of natural phenomena.¹⁷ And when we turn to their descriptions of colour, a similar picture emerges. Time and again, natural philosophers emphasized the emotions that they had felt, apparently hoping to share with their readers the affective components of the experience of colour.

¹⁵ Rhodri Lewis, *Language, Mind and Nature: Artificial Languages in England from Bacon to Locke*, Cambridge, Cambridge University Press, 2007, p. 146-187. Courtney Weiss Smith has shown, however, that Wilkins built a rhyme scheme into his universal language. In so doing, he sought to exploit the affective power of rhyme, well known to and theorized by early modern theorists of poetics. See Courtney Weiss Smith, « Rhyme and Reason in John Wilkins's Philosophical Language Scheme », *Modern Philology*, n° 115 (2017), p. 183-212.

¹⁶ Waller, « A Catalogue of Simple and Mixt Colours », p. 25.

¹⁷ Wragge-Morley, *Aesthetic Science*, p. 127-134, 147-152.

This tendency is very clear, for example, in Boyle's *Experiments and Considerations Touching Colours*. As we have already seen, this book occupies a fairly important place in the scientific history of colour, both for Boyle's account of colour indicators for acids and alkalis, and for his argument that that colours were secondary qualities arising from the operations of imperceptibly small particles of matter on the sensorium. Let's begin by considering how Boyle reckoned with the colours in just one of the experiments with which he vindicated this hypothesis. Here, he described the colour changes that take place when he sequentially added spirit of salt (hydrochloric acid) and potash (potassium) to a solution of litmus (a dye extracted from lichen):

I had now (as formerly) the pleasure to see, and to show others, how these few tinted drops variously dispersing themselves through the Limpid Water, exhibited divers Colours, or varieties of Purple and Crimson. And when the Corpuscles of the Pigment seem'd to have equally diffus'd themselves through the whole Liquor, I then by putting two or three drops of Spirit of Salt, first made an odd change in the Colour of the Liquor, as well as a visible commotion among its small parts, and in a short time chang'd it wholly into a very Glorious Yellow, like that of a Topaz. After which if I let fall a few drops of the strong and heavy Solution of Pot-ashes, whose weight would quickly carry it to the sharp bottome of the Glass, there would soon appear four very pleasant and distinct Colours; Namely, a Bright, but Dilute Colour at the pick'd bottome of the Glass; a Purple, a little higher; a deep and glorious Crimson, (which Crimson to terminate the operation of the Salt upward) in the confines betwixt the Purple and the Yellow; and an Excellent Yellow, the same that before enobled the whole Liquor, reaching from thence to the top of the Glass.

This experiment was one of many seeming to indicate that colour was not an intrinsic property of matter, but instead a phenomenon that arose from the interactions between light and particles of matter joined together in different shapes and densities. The litmus solution had changed from purple-crimson to yellow through the addition of something without colour – nitric acid. For Boyle, it therefore stood to reason that what was going on was not really the mixture of something coloured with something transparent. Had that been the case, the mixture would simply have grown paler. Rather, a deeper transformation in the shapes and textures of the particles making up the solution seemed to be the cause, effecting a startling transformation from purple-crimson to a vivid yellow.¹⁸

Making this case, Boyle mobilized descriptions saturated with feeling. He began by registering the pleasure to be had from witnessing the spread of those crimson and purple colours through water after only a few drops of litmus had been added. Next, he enumerated the colours arising from the subsequent chemical reactions using language that communicated his own affective responses. He spoke of a « very glorious Yellow, » a series of « very pleasant and distinct » colours emerging after adding the potash, including a « deep and glorious Crimson » and « an Excellent Yellow. » Throughout the book, Boyle used similarly affective language to describe the colours that he encountered. Consider this description of light passing through a piece of wood from a fir or pine tree:

¹⁸ Robert Boyle, *Experiments and Considerations Touching Colours*, London, 1664, p. 334-335. On Boyle's use of colourless solutions to illustrate the mechanical production of colours, see William R. Newman, *Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution*, Chicago, University of Chicago Press, 2006, p. 182-183; Wragge-Morley, *Aesthetic Science*, p. 65-66.

I have also found that a piece of Deal, far thicker than one would easily imagine, being purposely interpos'd betwixt my Eye plac'd in a Room, and the clear Day-light, was not only somewhat Transparent, but (perhaps by reason of its Gummous nature) appear'd quite through of a lovely Red

This description culminates with a piece of phrasing that, on the face of it, does little to help us identify the colour. Instead, the qualifier « lovely » coming before the final « Red » tells us that Boyle found that colour beautiful or attractive.¹⁹ And consider his description of the blue liquid that emerges when you leave thinly sliced pieces of *lignum nephriticum* – a wood used to treat kidney stones – overnight to infuse in water: « if you hold this Vial from the Light, so that your Eye be plac'd betwixt the Window and the Vial, the Liquor will appear of a deep and lovely Coeruleous Colour. » Boyle took care once again to signal that he had found the colour attractive – it was not just blue, but a deep blue that impressed him with its loveliness.²⁰

This was a pattern that Boyle would repeat on at least thirty-five occasions in *Touching Colours*, repeatedly qualifying the colours that he had seen as lovely. Moreover, he did the same thing in many other philosophical works, including (but not limited to) *The Origine of Formes and Qualities*, *An Essay About the Origine and Virtues of Gems*, *Memoirs for the Natural History of Human Blood*, and *A Disquisition about the Final Causes of Natural Things*. And Boyle was by no means the only one of his contemporaries to use the word lovely in this manner. If we search the « Early Print Lab » run by Northwestern University and Washington University in St. Louis for such uses of the word – for phrases including « lovely colour », or « lovely green », « lovely

¹⁹ Boyle, *Touching Colours*, p. 71.

²⁰ Boyle, *Touching Colours*, p. 201.

purple », or « lovely scarlet » – we find a concentration of results in two of the most influential scientific works by Boyle’s contemporaries – Robert Hooke’s *Micrographia, or Some Physiological Observations on Minute Bodies*, and the *Ornithology* composed by John Ray and Francis Willughby. Thus the word crops up at least 22 times in Hooke’s *Micrographia*, and most often in relation to colours. In his observations on the louse, for instance, Hooke explains that the blood eaten by lice rapidly changes colour as it passes through their digestive systems, turning from a blackish colour when sucked out of the body to « a very lovely ruby colour » by the time it reaches the louse’s stomach. Meanwhile, the term appears at least 63 times in the *Ornithology* of Willughby and Ray, perhaps in part because the colours of plumage were so important to the identification of the different species and genders of birds. In their account of the common swallow, to take just one example for now, the authors describe the « lovely shining, but dark purplish blue colour » in the feathers of its head, neck, and back.²¹

Of course, this brief survey leaves out the many other affective forms of speech these philosophers used in their efforts to communicate the experience of colours. In *Touching Colours*, for instance, Boyle used terms such as « vivid », « delightful », and « glorious », while in his *Micrographia* Hooke also expatiated on the vividness of the colours that he had countered.²² In their *Ornithology*, meanwhile, Ray and Willughby often remarked on the beauty of colours, explicitly identifying that beauty as part of the observational experience through formulations such as « very elegant and beautiful to behold ».²³ What all these expressions have in common with « lovely », however, is

²¹ These searches and all others in this article were performed with the “Corpus Search” tool of the Early Print Lab, <https://eplab.artsci.wustl.edu/corpus-frontend-1.2/eebotcp/search/> ; Robert Hooke, *Micrographia, or some Physiological Descriptions of Minute Bodies*, London, 1665, p. 213 ; John Ray and Francis Willughby, *The Ornithology of Francis Willughby*, London, 1678, p. 212.

²² Boyle, *Touching Colours*, p. 24, 253, 334 ; Hooke, *Micrographia*, p. 48.

²³ Ray and Willughby, *Ornithology*, p. 287.

that they emphasize not the tone of the colour in question, but instead its effects on the beholder. In a technical sense, as we have seen, Boyle and his contemporaries knew that all the appearances of colour were secondary qualities – perceptual phenomena arising in the mind through the operation of bodies on the senses. But there was nevertheless an expectation, made clear through projects such as Waller’s colour chart, that an approximate consensus about those secondary qualities could be accomplished. But here we see natural philosophers identifying colours through expressions of an even more subjective, and thus less transmissible, kind. In the following sections of this article, therefore, we will try to understand precisely what these philosophers meant when they described colours as lovely, and attempt to establish what kinds of knowledge they sought to share by resorting to such language.

The Meanings of Loveliness

Almost a century after Boyle and his contemporaries made such full use of the word, the lexicographer Samuel Johnson (1709-1784) defined lovely as « Amiable; exciting love ». Although written in the 1750s, this definition captures the way the term was used in Boyle’s day – and indeed all but one of Johnson’s illustrative quotations come from 17th-century texts.²⁴ For readers and writers, of the 17th century, the adjective lovely expressed the idea of being attracted to a pleasing object or person. We can use the « Early Print Lab, » moreover, to reveal that the term appeared most frequently in two kinds of writing – devotional literature encouraging readers to desire both God and a virtuous life, and stories or poems treating of love. Take, for example, the 1657 sermon *CHRISTS LOVELINES, OR, A Discourse setting forth the Rare Beauties of the Lord Jesus, which may both amaze the eye, and draw the heart of a sinner to him* by the Puritan

²⁴ Samuel Johnson, *A Dictionary of the English Language*, London, 1755.

minister Thomas Watson. There, Watson drew very explicitly on the image of physical love to depict Jesus as something worthy of our attraction, exclaiming that « If Christ be thus full of sparkling beauties, then fall in love with this lovely object. »²⁵ We get a similar sense, meanwhile, from Charles Cotterell's translation of Gauthier de Costes, seigneur de la Calprenède's *Cassandra*, a work in which the term appears on at least 105 occasions. At one moment, for instance, an oracle speaks of « The lovely object which made thee a Lover. » Once again, the emphasis here is on the transformation that the object may provoke in the onlooker. It is the loveliness of the object that transforms Orontes – the subject of this oracular utterance – into a lover.²⁶

Both of these genres were important to Robert Boyle. During his youth, as Lawrence M. Principe has shown, Boyle had become infatuated by the heroic romances then written by leading French writers, including Pierre Corneille and the aforementioned La Calprenède. Over time, he became wary of their potentially corrupting force, but he nevertheless continued to admire their vivid and entertaining style. Indeed, during 1647 Boyle copied out thirty pages of quotations from those romances, creating a store of stylistic examples to emulate in his own writing. Strikingly, one of the romances that he quoted from most of all was – as Principe points out – La Calprenède's *Cassandra*.²⁷ But Boyle's own aims as an author, especially during the 1640s and early 1650s, were closer to those of Thomas Watson. He wanted to use the stylistic tools of romance to fashion a newly potent genre of moral and religious exhortation. Believing that the wealthy, young readers he hoped to attract would pay little attention to « dry Precepts, or Languid Discourses », he sought

²⁵ Thomas Watson, *The Saints Delight. To which is annexed a Treatise of Meditation*, London, 1657, p. 387.

²⁶ Gauthier de Costes, seigneur de la Calprenède (tr. Charles Cotterell), *Cassandra the fam'd Romance*, London, 1652, p. 23.

²⁷ Lawrence M. Principe, « Virtuous Romance and Romantic Virtuoso: The Shaping of Robert Boyle's Literary Style », *Journal of the History of Ideas*, n° 56, 1995, p. 381.

instead to convert them to virtue by captivating them with vivid and pleasurable turns of phrase. Boyle was, in other words, committed to transforming his readers, and saw his stylistic choices as the means of accomplishing this purpose. He wanted to turn his readers into better people by enabling them to experience pleasure at the thought of pursuing a virtuous life.²⁸

For Boyle, therefore, the term lovely belonged to a stock of phrases referring to the attractive force that a beautiful or pleasing object might exert over those who encountered it. This is the sense we get, for instance, from Boyle's unintentionally amusing meditation on the lessons to be learned from peeling an apple, included in his *Occasional Reflections* of 1665. There, he made the link between lovely colours and physical desire explicit:

Pomona seems to have affected, in the fresh and lively Vermilion that adorns this smooth Rind [...] to have aim'd at manifesting, That she can give her Vegetable productions, as Lovely, and Orient, though not as lasting, Colours as those that make Jewels pretious Stones; and if, upon the hearing the Praises this Scarlet deserves[,] her Blushes ennoble her own Cheeks with so Vivid a Colour perhaps such a Livery of her Modesty might justifie her Pride.

Transforming the apple into a precious stone and then into the blush then so widely regarded as the symptom of feminine modesty, Boyle made plain the link between lovely colours and physical desire. Of course, his final purpose was to make his readers wary of those desires – a point that he made painfully clear by subsequently likening his apple to the one that had tempted Adam and

²⁸ Principe, « Virtuous Romance and Romantic Virtuoso », p. 389.

Eve, bringing about humanity's first experience with sin. In addition, he pointed out that the colours of an apple might be deceptive. After all, those colours appeared only on the skin – and the skin was the part that nourishes us the least. The only way to judge whether the fruit was truly nourishing was by reckoning with its interior.²⁹

On the face of things, therefore, the word « lovely » in its seventeenth-century meaning would seem to make an unpromising piece of unscientific vocabulary. Taken together, its associations read like a laundry-list of the qualities that the philosophers of Boyle's generation claimed to avoid in their scientific writing. Far from bespeaking a dispassionate observational posture, the term lovely suggested the arousal of a passion – the desire that draws us towards things we find attractive. This passion sought the fulfilment of physical desire, and thus brought with it the suspicion of conduct at odds with the Royal Society's claim to be promoting the sober and virtuous pursuit of useful knowledge. At the same time, as we have seen, the allure of beautiful colours also carried with it the possibility of deceit. Time and again, moralists, rhetoricians, and even some art theorists warned that beauty on the surface might distract us both from interior ugliness, or alternatively from other objects that were less attractive, but perhaps ultimately more useful. You might therefore say that the loveliness of colours was something like an extreme version of the secondary qualities that Boyle and his contemporaries already understood colours to be. Loveliness was not simply a state produced in an observer through their encounter with an object. It was a highly subjective, passionate state – one associated not with the calm formation of a consensus, but rather with an individual's overwhelming desire to obtain physical satisfaction. We must

²⁹ Robert Boyle, *Occasional Reflections upon Several Subjects*, London, 1665, p. 181-182.

therefore try to understand how and why natural philosophers could put the language of loveliness to the task of scientific representation.

Loveliness and Scientific Meaning

The first and most widespread purpose for which Boyle and his contemporaries deployed the vocabulary of lovely colours was to distinguish one entity from another. This work, however, took two very different forms. In *Touching Colours*, along with other works in which he obtained chromatic changes by chemical means, Boyle used the phenomena of colour to indicate the likelihood that transformations had taken place among the imperceptible particles of matter that he believed ultimately to have caused them. Here, in other words, Boyle's chief interest was in the possibility that colour changes might indicate changes in the composition either of material things, or alternatively in the media through which light interacted with them, and ultimately led to the production, in the human sensorium, of the colours that we experience. In their *Ornithology*, Ray and Willughby also acknowledged the possibility that the colours of birds could change over time. But for the most part their aim was to focus on colours that seemed more or less fixed, aiming to include them in lists of fixed morphological features that would enable naturalists to distinguish one species of bird from another.³⁰ But these authors had one thing in common. They believed that highlighting the feelings of pleasure and desire inspired by some colours would make it easier for readers to distinguish between one natural kind and another.

³⁰ Tim Birkhead, *The Wonderful Mr Willughby: The First True Ornithologist*, London, Bloomsbury, 2018, p. 185-190.

Let's consider how Boyle used his accounts of chemical experiments to vindicate the suggestion that changes in the colour of substances arose from changes in the size, motion, and arrangement of the imperceptible particles out of which they were formed. One way in which Boyle made this point, as we have seen, was by seeking to show that colourless liquids could be made to produce changes in colour. His reasoning was that using colourless liquids would make it clear that the cause of the change had nothing to do with colour, or at least not with colour understood as an inherent property of material things. Instead, Boyle hoped to show that some other property must be the one to cause the transformation. In one experiment, for instance, he discussed what would happen if you mixed together the two colourless solutions of « common Sublimate » (perhaps mercuric chloride) and « Oyl of Tartar » (potassium bitartrate). The results would be as rapid as they were astonishing: « these two Limpid Liquors will in the twinkling of an Eye turn into an Opacous mixture of a deep Orange Colour ». ³¹ Later on, he discussed another experiment in which he poured clear water onto the white-coloured precipitate of « Quick-Silver » (mercury) and « Oyl of Vitriol » (sulphuric acid). Once again, the results were rapid, and visually striking:

[...] though this Precipitate were a Snow White Body, yet upon pouring on it a large quantity of fair Water, we did almost in a moment perceive it to pass from a Milky Colour to one of the loveliest Light Yellows that ever we had beheld. ³²

In these two experiments, Boyle used the controlled conditions of experimentation to show that the physical changes brought about by mixing two substances – changes that he had himself

³¹ Boyle, *Touching Colours*, p. 304.

³² Boyle, *Touching Colours*, p. 324.

effected – were the most likely cause of the emergence of the new colours. In each case, moreover, Boyle insisted on both the rapidity with which the colour emerged, as well as its vividness or beauty. Thus the yellow resulting from the second of these two experiments emerged with surprising rapidity, and struck onlookers forcefully with its beauty.

I have shown elsewhere that Boyle often designed experiments with such rapid and visually striking phenomena in mind. As he explained in another work, *The Origine of Formes and Qualities*, Boyle knew that it was much easier to judge whether or to what extent a transformation had taken place if that transformation had been both palpable and memorable. In addition, he knew that it would be easier to make judgments about the causes of those transformations if the link between the action undertaken by the experimenter – such as mixing two fluids together – and the resulting phenomena were made clear by their rapid and vivid appearance.³³ Taking such remarks into account, we can see that Boyle's constant evocation of lovely colours was central to his persuasive strategy. The controlled circumstances of the experiment and the rapidity of the result made it possible to establish a clear link between the action performed and the production of the colour. Since the beautiful yellow had emerged almost as soon as the mercury precipitate and the sulphuric acid were combined, it stood to reason that it was the act of combining those two liquids that had produced the colour. Meanwhile, the sudden appearance of so beautiful a colour made it clear that some kind of change had truly taken place. There could be no doubt that the experiment had resulted in the production of a new colour when it had provoked such potent affective responses in those who observed it. For Boyle, therefore, describing the feelings arising from the

³³ Alexander Wragge-Morley, « Robert Boyle (1627-1691) and the Aesthetics of Chemical Experimentation », dans Milena Ivanova et Alice Murphy (ed.), *The Aesthetics of Scientific Experiments*, New York, Routledge, 2023, p. 59-79.

experience of colours served to produce an intersubjective consensus. Those powerful feelings of beauty and pleasure served not only to gratify readers and onlookers, but also to help them agree about both the nature and likely causes of the changes that had taken place.

For Ray and Willughby, meanwhile, the purpose of describing colours was classificatory. In their *Ornithology*, published in two different versions under Ray's supervision after Willughby's untimely death in 1672, the aim was to identify and distinguish bird species through a combination of verbal descriptions and engraved images. Published in 1676, the first version of the book was in Latin, and almost invariably deploys the Latin word « pulcher » – « beautiful » – to qualify colours as attractive. Sometimes, that usage came from the descriptions of earlier naturalists, which the two naturalists often included without making any changes. Consider, for instance, the book's description of the scarlet macaw, lifted directly from Aldrovandi's *Ornithologiae, hoc est de avibus historiae libri XII* (1599). There, the bird's plumage is described as being « pulcherrimo colore puniceo decorantur » – « adorned with a very beautiful crimson colour ».³⁴ In many other cases, however, Ray and Willughby used the same sort of language in the descriptions they had written themselves on the basis of their own observations. For instance, they described the head of the black woodpecker as being black, with the exception of its crown, which was « miniaceo pulcherrimo tingitur » – « tinged with a very beautiful vermilion ». When Ray translated the book into English to produce the *Ornithology* of 1678, he generally replaced the word « pulcher » with « lovely ». In this version of the book, he thus described the woodpecker's crown as being « of a lovely red or Vermilion colour ».³⁵

³⁴ John Ray et Francis Willughby, *Ornithologiae Libri Tres*, London, 1676, p. 73. Cf. Ulisse Aldrovandi, *Ornithologiae, hoc est de Avibus Historiae Libri xii*, Bologna, 1599, p. 665.

³⁵ Ray et Willughby, *Ornithologiae Libri Tres*, p. 92. Cf. Ray et Willughby, *Ornithology*, p. 135.

Ray and Willughby may have insisted so much on the beauty of the colours that they encountered because they wanted to convince that contemplating birds would bring pleasure as well as wisdom.³⁶ But there are clear indications that they also saw describing the beauty of colours as part of the work of classification. The two naturalists both regarded the classification of species as an exercise in enumerating the features that made one species of bird distinct from another. The aim was to produce a list of characteristics detailed enough to prevent the reader from getting superficially similar species mixed up with another, but not one so long that it would prove tiresome or troublesome to use. Despite paying generous homage to Willughby in the work's preface, Ray was not afraid to intervene when he thought that his colleague had included details that would not aid in distinguishing species. Following a highly detailed description of the tail feathers of the greater spotted woodpecker, for instance, Ray added an annotation explaining that it was « not needful so scrupulously to describe every particular spot in each feather: for that nature takes a latitude, sporting her self, as they call it, in these lesser things [...] »³⁷ Given that Ray made it clear when he felt that the descriptions were encumbered by unnecessary detail, it seems likely that he regarded those descriptions upon which he passed no comment – including those expatiating on lovely colours – as well suited for their classificatory purpose.

Moreover, the two naturalists sometimes used the word lovely in a very precise manner, using it to help readers distinguish one shade of the same colour from another. Take for example the *Ornithology*'s description of a bird that they called the virginian nightingale, but which is today

³⁶ Ray et Willughby, *Ornithology*, sig. [A3v], « To the assistance and ease of those who addict themselves to this most pleasant, and no less useful part of Philosophy [...] »

³⁷ Ray et Willughby, *Ornithology*, p. 137

known as the northern cardinal. The two naturalists describe its colour like this: « The colour of the whole is a lovely Scarlet, in the Head and Tail more dilute. »³⁸ Here, the contrast with the dilute colour of the head and tail seems to imply that a « lovely » scarlet would be one that was bright in its shade. This impression is confirmed if we turn to Ray and Willughby's depiction of the colour of the kingfisher's back and tail, a colour that they describe as « a most lovely bright, but pale blue, which by its splendour is said to hurt their Eyes that look long and intently upon it. »³⁹ Here, we get the impression that the two naturalists expected their readers to picture a vivid or bright hue when they described the blue as « lovely » and « bright » – and that as a result they had to qualify that colour as « pale » to ensure that their readers would get the right idea. We might therefore surmise that Ray and Willughby had a similar distinction in mind when they came to describe the colours identifiable in the plumage of the greenfinch:

The borders of the outmost quill-feathers of the Wings are yellow, of the middlemost green, of the inmost grey. [...] The feathers along the base or (if you please) ridge of the Wing are of a lovely yellow. The coverts also of the undersides of the Wings are yellow. The Tail is two inches and a quarter long, made up of twelve feathers; of which the two middlemost are all over black, those next have their outer edges yellow:⁴⁰

³⁸ Ray et Willughby, *Ornithology*, p. 245.

³⁹ Ray et Willughby, *Ornithology*, p. 146.

⁴⁰ Ray et Willughby, *Ornithology*, p. 246.

Here, there seem to be two slightly different yellows in play. If the two naturalists were consistent in their use of the term, then we might reasonably suppose that the « lovely » yellow on the ridges of the wings was brighter than the yellows found elsewhere in the greenfinch's plumage.

Implicitly, Ray and Willughby expected that readers would share their image of what a « lovely » colour looked like, and be able to use that image to distinguish between different hues. We can say the same for Boyle when it came to his reports on chemical experiments – his descriptions come with the expectation that readers will grasp the difference between a lovely colour, and one that didn't have the same affective charge. It is difficult, however, to establish whether readers actually did grasp this sense of the term. One problem is that the use of the word « lovely » in relation to colours was not especially common. If we search the « Early Print Lab» for the phrase « lovely green », for example, 16 out of the 46 hits, amounting to 35% of the total, come from works by Robert Boyle. The phrase also occurs in William Salmon's *Polygraphice* (1673), a book about drawing and painting, but only because it quotes from Boyle's *Touching Colours*. Roughly the same thing happens if we search for the term « lovely blue ». Nine out of the 25 hits come from works by Robert Boyle, amounting to 36% of the total, with a further six, making 24% of the total, coming from Ray and Willughby's *Ornithology*. Once again, there is a single instance in Salmon's *Polygraphice*, but again the original source is Boyle. Searches for similar phrases, such as « lovely red» and « lovely colour » produce similar outcomes, with the result that we are forced to regard the phrasing as unusual, despite its heavy use by Boyle and his contemporaries. It is not necessarily clear that readers would have grasped precisely what Boyle, Hooke, Ray, and Willughby meant.⁴¹

⁴¹ William Salmon, *Polygraphice, or, the Arts of Drawing, Engraving, Etching, Limning, Painting, Washing, Varnishing, Gilding, Colouring, Dying, Beautifying, and Perfuming in four Books*, London, 1672, p. 161. Cf. Boyle, *Touching Colours*, p. 200-201.

Fortunately, however, we can evaluate the response of one reader by turning to a unique hand-coloured copy of Ray and Willughby's *Ornithology*, today held at the McGill University Library in Montreal, Canada. Robert Montgomerie and Tim Birkhead have shown that this special copy was prepared for the diarist and fellow of the Royal Society Samuel Pepys, with the colours added by a skilled artist.⁴² Unlike many of those who hand-coloured printed books, this artist took a great deal of care over the accuracy of the resulting images, only deviating from Ray and Willughby's descriptions when her or his own experience of relatively common birds may have suggested a slightly different coloration. In most cases, the artist took great care to follow the descriptions – something that we can gather from errors in the resulting images that can only have arisen from mistakes that the two naturalists made. Montgomerie and Birkhead note, for example, that the colouring of the toucan bears little resemblance to any known bird species, but that it is remarkably faithful to the book's flawed description. With care, therefore, we can use this hand-coloured book to find out how the artist responded to Ray and Willughby's descriptions of lovely colours.

In some instances, the artist did not follow the fine distinctions upon which the two naturalists insisted. When it came to the northern cardinal, for instance, he or she failed to distinguish the « more dilute red » of the head and tail from the « lovely scarlet » all over the rest of the body.⁴³ Elsewhere, however, the artist appears to have made a real effort to follow the descriptions. Consider, for instance, the greater spotted woodpecker (Fig. 2):

⁴² Robert Montgomerie et T.R. Birkhead, « Samuel Pepys's Hand-Coloured Copy of John Ray's 'The Ornithology of Francis Willughby' (1678) », *Journal of Ornithology*, n° 150 (2009), p. 883-891.

⁴³ John Ray et Francis Willughby, *The Ornithology of Francis Willughby*, London, 1678, McGill University Library, f. QL673 W7413, Blacker Wood Collection, p. 245. Cf. Tab. XLVIII.



Fig. 2, John Ray and Francis Willughby, *The Ornithology of Francis Willughby*, London, 1678, McGill University Library, f. QL673 W7413, Blacker Wood Collection, tab. XXI.

Here, we can identify a difference between the artist's rendition of the (inaccurately described) red of the iris, and the more vividly depicted « lovely red » of the bird's « lower belly ».⁴⁴ In other cases, moreover, the contrast is clearer. Consider the European Roller (Fig. 3):

⁴⁴ Ray et Willughby, *Ornithology*, p. 137.



Fig. 3, John Ray and Francis Willughby, *The Ornithology of Francis Willughby*, London, 1678, McGill University Library, f. QL673 W7413, Blacker Wood Collection, tab. XX.

In this image, the artist clearly distinguishes the « lovely blue or ultramarine colour » identifiable at the top of the wing from the « pale blue » of the breast and belly.⁴⁵ We have the impression, in other words, that the artist understood that the term « lovely » to imply a rich or vivid coloration. This suggestion is confirmed, if we consult one more example from among the many that the text affords. This is the greenfinch, a bird that, as we saw above, presents two different yellows (Fig. 4).

⁴⁵ Ray et Willughby, *Ornithology*, p. 131.



Fig. 4, John Ray and Francis Willughby, *The Ornithology of Francis Willughby*, London, 1678, McGill University Library, f. QL673 W7413, Blacker Wood Collection, tab. XLIIII.

In this image, there is a clear difference between the muted yellow of the « outmost quill-feathers of the Wings » (at the rounded top of the wing in this image) and the much more vivid « lovely yellow » along the base of the wing, close to the legs and the flanks.⁴⁶ From this and several other examples that we might select, we get the impression that the colourist paid close attention to Ray and Willughby's choice of words, attempting to give « lovely » colours a greater vividness than those that were not qualified as such.

Of course, there are many questions that we cannot answer about the process by which the artist transformed Ray and Willughby's descriptions into visual images. We do not know, for instance,

⁴⁶ Ray et Willughby, *Ornithology*, p. 246.

whether Ray supervised the process, or to what extent the artist may have relied on her or his own knowledge in some instances.⁴⁷ Nevertheless, there are enough examples to suggest that the artist understood what the two naturalists meant when they described colours as lovely. He or she knew that a lovely colour would be brighter or more vivid than one not qualified as such, and attempted to reproduce that experience through the colours applied to the page. It was perhaps therefore plausible for other readers to find Ray and Willughby's evocations of lovely colours useful for the purpose of classification. In at least one instance, a reader succeeded in imagining and reproducing the lovely colours that the two naturalists described. Although we cannot conclude much from one case, we are at least left with the possibility that – despite the expression not being used widely in relation to colours – readers could use the term lovely to make scientifically meaningful distinctions between different colours, as well as different shades of the same colour.

Conclusion

In the 17th century, as we have seen, anglophone readers and writers associated the word 'lovely' with the feelings of attraction that can arise when people encounter beautiful or pleasing objects. In the case studies we have examined, natural philosophers made that attractive power serve two distinct purposes. In *Touching Colours*, and in other works dealing with chemistry, Boyle identified colours as lovely to help his readers recognize that one compound had truly been changed into another. It would be hard to disagree that a transformation had taken place when its effects on the senses – and even the passions – were so palpably felt. In turn, this vivid sensory

⁴⁷ Montgomerie et Birkhead, « Samuel Pepys's Hand-Coloured Copy of John Ray's 'The Ornithology of Francis Willughby' », p. 883-891.

experience would encourage readers to accept Boyle's hypothesis that our experiences of colour depend ultimately on changes taking place in the shapes, disposition, and motions of imperceptibly small particles of matter. For Ray and Willughby, meanwhile, the affective power of lovely colours was also important. They used the term lovely to describe the powerful experience of encountering particularly bright or vivid colours. You might have noticed earlier that they depicted the encounter with « the lovely bright, but pale blue » of the kingfisher's back and tail as being so powerful that it might even cause physical pain. Nevertheless, they used the term to assist the reader with fine work of classification, facilitating the discrimination between different shades of individual colours.

It is striking that these natural philosophers all chose to highlight the affective components of the experience of colour. Rather than attempting anything like Waller's effort to establish a philosophical standard for the names of colours, they instead used evocations of desire and pleasure to describe the colours that they had seen. Moreover, Boyle, Ray, and Willughby all seem to have assumed that their readers would be able to use such descriptions to picture the colours in question, and in turn to grasp the underlying physical realities that those colours betokened. The point of this article, therefore, is not simply to repeat the now widely understood point that early modern natural philosophers worked with a standard of objectivity that seems to differ from the ones characteristic of the modern era. It is by now well known that early modern scientists regarded (what we call) objectivity as the result of forms of observational skill and judgment – including aesthetic judgment – that may seem rather subjective by modern standards.⁴⁸ Boyle and his contemporaries did something that far exceeds this vision of objectivity based on the exercise of

⁴⁸ Lorraine Daston et Peter Galison, *Objectivity*, New York, Zone Books, 2010, p. 55-105.

acute judgment. They explicitly mobilized an aspect of experience that may seem highly subjective – in this case, the desire arising from sensory pleasure – as a means of scientific communication. They did so, moreover, in the expectation of belonging to an intersubjective community. When they wrote about lovely colours, they expected their readers to know what those colours felt like. And in one case, at least, it seems that a reader agreed.