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Goethe in the Age of Artificial Intelligence

Enlightened Solutions for a Modern Hubris

Malte Ebach

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For Giesela

Prologue

Modern Hubris: when human experience is replaced by the tools that supplement them, resulting in a disconnection between the observer and Nature.

The idea of (parts of) this book came to me during a walk along the North Downs Way in East Surrey in the summer of 2004. I had decided to give up academia since postdoctoral positions were scarce as no one wanted a palaeobiogeographer fascinated with modern biotic distributions. Not wanting to give up research entirely, I decided to fund it by working part-time at a local county library. The system worked well, that is, until a dear friend and colleague came to visit later that year. In 2005, I found myself back into the meat mincer that is modern academia, having to find a new postdoctoral position every 12–18 months, while not letting the number of publications slip. All academics know this life and some love and others find it rather tiring. I was one of the latter and bid farewell to academia for the second time in 2020.

A lot happened in those 15 years. Artificial intelligence blossomed and so too did big data. Every time I came across big data projects within my own field of research, I wondered what Goethe would have made of it all. Herein lies the genesis of the second part of this book, the Modern Hubris. I tried to get funding to investigate the Modern Hubris, but no luck. There was no interest in understanding the technology that is slowly replacing human experience and our connection with Nature. I started reading Goethe again and remembered the walk along the North Downs Way that long summer afternoon. Finally, after 18 years, the book is finished… or is it? There is much more to discover about Goethe and his scientific life, as well as the why's and how's of his method, which he applied across a multitude of fields, including geology, comparative biology, geography, colour theory and much more.

I hope, dear reader that you get something from this book other than a headache. Perhaps, you too may learn something from Goethe that may help you and others. I am grateful to Bernard Michaux, Fred Amrine, Robin Bruce, Evangelos Mantzios, Marcelo de Carvalho, Penelope Gordon, Evgeny Mavrodiev, Wendy Shaw and Melinda Tursky for reading through drafts of this book. I also thank two anonymous reviewers for their valuable feedback. I am also grateful to Simone Meakin for her help with editing.

Wentworth Falls, Australia
May 2022

Malte Ebach FRSN

Note on Language and Translation

Nature[1] and Earth will be written in capitals (with the exception "of the earth") as these are names. Earth is the name of our planet, as opposed to "soil" or "ground". I also use the term "natural world" to refer to the biota (life forms), geology and landscapes of our planet. In the case of the name "Nature", I refer to *Mother Nature*, namely, the creative force that includes the earth, and human experience, and is greater than the sum of its parts. The notion that humans are disengaged from Nature is analogous to people no longer engaging with the other inhabitants of our planet.

Translations from German to English either are made by the author or are from original sources as described. I have used translations from recent texts because older texts, particularly from the nineteenth century and early twentieth century, show a degree of bias.

The following abbreviations are used in citations by the author:

WA = Goethes Werke. Herausgegeben im Auftrag der Großherzogin Sophie von Sachsen. IV. Abteilung: Goethes Briefe, Bd. 1–50, Weimar 1887–1912.

LA = Die Schriften zur Naturwissenschaft, herausgegeben im Auftrage der Deutschen Akademie der Naturforscher (Leopoldina). Kuhn D, Matthaei R, Troll W, Wolf L (Eds), Hermann Böhlaus Nachfolger, Weimar (1947–2012).

[1] Charles Sherrington noted in his *Goethe on Science and Nature*, "Two facts we may, at outset, recall about Goethe. Poet though he was, he was yet life-long an ardent student of the sciences of Nature. And this other, that with him—not merely as usage of the German language—Nature was usually Nature with a capital N" (Sherrington, 1961, p. 5).

Rethinking Nature and How This Book Is Structured

It is difficult to rethink the way we perceive Nature. Many of us have been trained how to view Nature in a scientific way. We are told from the outset that what we do is "scientific" and is in no way artistic or a form of self-expression. We are told that any personal views or feelings we experience are personal and should be kept separate from our scientific work. To do otherwise, it seems, is to cross a dangerous barrier—the one that separates the objective scientist from the so-called frivolous artist. To a scientist, a photo of a flower is far more objective representation of Nature than a painting of the same flower.[1] The painting is a representation of the flower, one that has been processed by the human mind, and somehow tainted with opinions that may bias the evidence. In modern science, a painting of a flower would never be used in a scientific study. To an artist, a photograph of a flower is just another form of expression. The mark of the photographer is in that picture. Why did the person take the photo? Why at that angle? Why that flower? To the artist, the photograph is just as accurate in depicting the flower as is the painting. In fact, the painting has more expression in it because the observer of the flower can express more than form. The painting captures the flower emerging into the consciousness of the observer. Emergence is what we experience when we observe Nature. Emergence is not as potent in many photos we take of a landscape or natural object. We may observe the ochre sky illuminated by a dramatic setting sun. The colour emerges, it intensifies and it captures our attention

[1] That is not discount scientific illustrations, which serve an important function in areas such as comparative biology.

and our emotion. It has changed us. Yet, when we take a photograph, it always lacks that intensity, that intense emergence. There are photographers who can capture that intensity, but not by simply taking a snapshot. There are filters and settings to consider. The photographer may take days and hundreds of photos as well as further image manipulation before they achieve that perfect shot. We start to notice something happening. Art engages the observer because it acknowledges human observation. Science tends to dismiss human observation as subjective, even though the scientific photos we take are influenced by the human observer.

The hard border between art and science is a fiction. Art has used technology as a supplementary tool to enhance and express human experience. Science has done the reverse: it has replaced human observation with technology and tools that once supplemented it. I call this replacement the *Modern Hubris* and I believe that it has a negative effect on the way science is practised. Suddenly, we rely on Artificial Intelligence, or AI, to assist us with day-to-day science, which at one point a scientist would have performed manually. To draw an analogy, imagine the people who used to retouch photographs, adjusting colours and blemishes. That job was done using scalpels, chemicals, hand lenses, cameras and a dark room. Retouchers completed this task without measuring quantities of chemicals or keeping time on how long negatives soaked in alcohol. They just *knew*. That job is now performed equally well by a computer program. The retoucher was replaced by a set of algorithms. Not only that, we now have to train people to design and use those algorithms and build the hardware to run them. The experience and observation of the retoucher no longer exist, thanks to the Modern Hubris.[2] Slowly, those who still use experience and observation to do science are also being replaced by AI. Human experience and observation have no place within the Modern Hubris.

Unfortunately, the Modern Hubris has been normalised in science and in the wider public. How then, dear reader, do I expose the Modern Hubris when our lines of communication are jammed? Scientists call "human observation" and "perception" subjective or biased, whereas I label them "trained scientific observation" that is objective and balanced. Before I can present a possible way out of the Modern Hubris, I need to show how damaging it really is and provide several examples through

[2] If the word "Luddite" has entered your head, please bear with me. The Luddites were not opposed to technology. They simply did not want their skills to be replaced by machines. Many skills have since been lost.

history. Furthermore, there are concepts that I need to introduce as well as a history to deconstruct throughout the book. Much of this book will be dedicated to understanding how we perceive Nature through our own mind's eye. Once we expose the Modern Hubris and how it works, we can finally start to understand a way out for scientific practice. To help me in this quest is a German polymath, Johann Wolfgang von Goethe (1749–1832). The reason I chose Goethe is because he attempted to do this in the late eighteenth and early nineteenth centuries, at a time when the term "science" was coined, and in a period where science was professionalised, that is, when natural scientists were employed to do science at universities, museums and herbaria. Reading Goethe today in the Age of AI may offer a way to deal with the Modern Hubris.

I have structured this book into seven chapters, throughout which run a golden thread of Goethe's ideas. Each chapter starts with a summary and includes anecdotes from my experiences. The book has been structured in the following way:

In Chap. 1 I introduce Goethe the scientist, or Naturschauer, and how his travels in Italy inspired his scientific writings. I also discuss how AI is a useful tool and compare it to the eighteenth-century equivalents, namely telescopes, microscopes and complicated mathematics and geometry. I show that Goethe was weary that tools, such as telescopes, were increasingly replacing human observation. I show how Goethe is an excellent example of someone warning readers of the Modern Hubris.

In Chap. 2 I summarise how Big Data is collected and how it drives AI, in both industry and science. I explore some ideas that have sprung from AI, such as the Age of Entanglement, to demonstrate how technology affects the way we see and understand the natural world. I link this type of thinking to Goethe's Faust and explain how modern technology drives the Modern Hubris by disconnecting scientists from experiencing Nature. I briefly outline concepts that will be discussed in the proceeding chapters.

In Chap. 3 I show how the term "science" was coined after Goethe's death and how that simple term further widened the divide between the arts and the natural sciences. This divide fuelled the Modern Hubris in which human aesthetic appraisal became seen as subjective in science. I show that at least in the world of art and architecture these same experiences are seen as objective. In addition, I explore how observation followed by mathematical reasoning can work together to discover natural phenomena, such as Uranus and Neptune. The reverse, using mathematical reasoning to explain natural phenomena puts the cart before the horse, as Goethe eloquently points out in his *Zur Farbenlehre*, in which he criticises Newton for doing the same thing in his *Beyträge zur Optik*. I continue to show how important observation and aesthetic appraisal are in viewing the mammalian forelimb and introduce the concept of Anschauung, which is of primary importance in understanding Goethe's scientific thought.

Chapter 4 begins with a conversation between Goethe and Schiller in 1794 and how a slight misunderstanding resulted in confusing what Goethe called an idea, namely the urphenomenon, with a fiction or theory. I attempt to diffuse this misunderstanding by providing several examples in which you can use your own Anschauung and urphenomenon, and how, with a little training, you can use them precisely and scientifically. I also show how Goethe may have stumbled onto the urphenomenon during his travels in Italy while studying the architecture of Palladio. We return to Goethe and Schiller's conversation and show how important the urphenomenon was as an idea, rather than as a theory.

In Chap. 5 I tackle direct observation, when we simply view an object without employing Anschauung, and how it can lead to erroneous interpretations of scientific observations. I use the craters on the Moon and the canals on Mars as examples of how nineteenth- and early twentieth-century astronomers were fooled by direct observation. I also show how these interpretations have affected human society, demonstrating why the results of direct observation need to be approached with caution. I give examples of modern-day astronomical observations that are hypothesised to exist due to direct observation. I also detail the limits of Anschauung, the urphenomenon and direct observation, showing where scientific thought ends and where speculation begins. I also show how philosophers in Goethe's era sought to overthrow Cartesian thinking, which had stifled the way many thought about Nature objectively.

In Chap. 6 I delve into bad metaphysics and the two ways of thinking that exist in the sciences. I show how one way of thinking is fuelled by the Modern Hubris, while the other underpins Anschauung and the urphenomenon. I give examples of bad metaphysics in current scientific practice and how it is central to the Modern Hubris.

Chapter 7 will examine how Goethe changed his way of thinking during his journey in Italy, and how it impacted his life in Weimar. The golden thread of Goethe's ideas will find the clew in this chapter. I attempt to identify when and where Goethe's thought and scientific life started to change. I also show that experiencing phenomena via Anschauung and the urphenomenon transforms us, in just the same way it transformed Goethe. What if Goethe had not experienced what he did in Italy? Would that have changed his life completely? Would he have written the bulk of his scientific work? Would he have discovered Anschauung and the urphenomenon and dedicated his life to natural science? Alas we will never know. Regardless, we may use Goethe's life as an allegory for the transformation of the scientist.

Much of this book is based on a talk I delivered in 2017 for the *Evolving Morphology* international conference in Dornach, Switzerland. The resulting paper was published in the 2018 autumn issue of *Elemente der Naturwissenschaft*.[3]

[3] Ebach MC (2018) "Mehr Licht!" Anschauung and Its Fading Role in Morphology. Elemente der Naturwissenschaft, 108: 22–37.

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CHAPTER 1

Goethe in the Age of AI

Abstract In this chapter, I introduce Goethe the scientist, or Naturschauer, and how his travels in Italy inspired his subsequent scientific writings. I will also discuss how Artificial Intelligence (AI) is a useful tool and compare it to the eighteenth-century equivalents, namely, telescopes, microscopes and complicated mathematics and geometry. I will show that Goethe was weary that tools, such as telescopes, were increasingly replacing human observation. I will show how Goethe is an excellent example of someone warning readers of the Modern Hubris.

Keywords Goethe • Observation • Nature

> Thus in artistic work, as in scientific and mathematical work, the essential element is the underlying truth which is disclosed not so much by speculative thought as by practical application; here we find the touchstone for what is born of the spirit, what an inner sense recognises as true.[1]

I am often amazed at how little people know about Goethe. The two reactions I get when I ask people about Goethe are either a complete blank or a vague account of a "German Shakespeare". It is interesting that the same is true of Artificial Intelligence, or AI, also known as machine

[1] von Goethe (1995, p. 47).

M. Ebach, *Goethe in the Age of Artificial Intelligence*,
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learning. People seem confused about what it is, often recalling dystopian robots taking over the world. In this introduction, I hope to dispel any myths about Goethe and AI and explain how an eighteenth-century polymath can inform us of twenty-first-century machine learning and its role in scientific discovery.

In March 1787, Johann Wolfgang Goethe was sightseeing at Pompeii, near Naples in Italy. Goethe was halfway through his Italian journey, one that would take him 2 years to complete, from the Brenner Pass to Sicily and back, a trip that his father Johann Caspar had taken 47 years earlier. The journey was to transform Goethe from someone keen to pursue the arts who had an interest in natural history to a fully fledged "scientist" who had an interest in the arts. It was in March 1787 that Goethe wrote,

> I should really devote the rest of my life to observation, for I would discover much that might increase human knowledge.[2]

I use the term "science" hesitantly throughout this book when referring to eighteenth- and early nineteenth-century people and ideas. Unfortunately, there is no other translation for Naturwissenschaft other than "natural science". The problem is that the term "science", in English at least, had not been coined until a year after Goethe's death in 1833. Neither did Goethe identify as a natural historian nor a natural philosopher, terms that identified "scientists" of the day. Rather, he considered himself a Naturschauer, an Observer of Nature,

> I was recently able to look into the workshops of the natural philosopher and naturalist and have found my quality as a *Naturschauer* reaffirmed.[3]

Moreover, Goethe did set himself apart from the practices of natural historians and philosophers.

[2] *Italian Journey* Naples, March 13, 1787.

[3] Goethe to Schiller 28 June 1798. "Ich konnte so recent in die Werkstätte des Naturphilosophen un Naturforschers hineinsehen un have mich in meiner Qualität als Naturschauer wieder aufs neue bestätigt gefunden" My translation.

> I am currently in the same position as the natural philosophers who want to lead from above and with the natural scientists who want to lead from below. I at least find my salvation only in Anschauung, which stands in the middle.[4]

As a Naturschauer, Goethe was primarily interested in form; indeed, he coined the term "morphology" and made several important discoveries himself, such as the location of the intermaxillary bone in humans. So why pursue the work of this Naturschauer? English Germanist Elizabeth M. Wilkinson once asked the same question.

> But why should we turn to Goethe in particular? Has he anything more to offer us than, say, Aristotle for whom form was a master concept in all branches of knowledge? I think he has. For Goethe was not only a discerner of form; he was a maker of it, and a maker of an immense variety of forms.[5]

To understand what Wilkinson means, we need to understand who Goethe was as a person and as a thinker. Goethe shot to fame as a young man through his two books: *Götz von Berlichingen* (1773) and *The Sorrows of Young Werther* (1774). It is important to note that while his books were quite well known, as was Goethe the author, he was not a professional writer/poet, as is commonly believed. In 1775, the now-famous Goethe was invited to the court of Karl August, the Duke of Saxe–Weimar–Eisenach, in what is now eastern Germany. In Weimar, Goethe held many roles within the privy council, as a companion to the young duke, and was responsible for mines, roads, universities, taxation, as well as other administrative duties. The weight of these roles led Goethe, with the permission of the duke, to flee Weimar in 1786 and pursue interests that were unfortunately neglected due to the overwhelming pressure of work. On 3 May 1827, Goethe recalled to Johann Peter Eckermann,

> … in the first ten years of my life as minister and courtier in Weimar I did next to nothing [of study], I was driven to Italy in despair.[6]

[4] "Ich stehe gegenwärtig in ebendem Fall mit den Naturphilosophen, die von oben herunter, und mit den Naturforschern, die von unten hinauf leiten wollen. Ich wenigstens finde mein Heil nur in der Anschauung, die in der Mitte steht" (Goethe to Schiller 30 June 1798, my translation).

[5] Wilkinson (1951, p. 181).

[6] Boyle (1991, p. 391).

It was in Italy that Goethe rediscovered his love for Nature, collecting and examining rocks as he travelled, as well as reigniting his interest in botany: "With respect to plants I still feel very much a novice".[7] Goethe had the naive notion of running off to Rome to become a visual artist, "pursuing the arts with all my might and main"[8] and meeting with German artists such as Johann Heinrich Wilhelm Tischbein. Towards the end of his journey, however, Goethe finally conceded that his talents lay in studying form.

> My titanic ideas were just chimeras haunting me on my way to a more serious epoch. I am now engrossed in the study of human form, which is the *non plus ultra* of all human knowing and doing. The fact that I have diligently prepared myself by studying all of nature, especially osteology, helps me to progress rapidly.[9]

The "titanic ideas" possibly refer to the *Sturm und Drang* [*Storm and Stress*] movement and the more serious epoch of his scientific studies. Goethe's time in Italy also changed him as a person. Having been freed from courtly duties and in the presence of artists and other Bohemian types, Goethe no longer tolerated the "retiring mode of life[10]", something he was going back to on his return to Weimar. Not surprisingly, for almost two years after his return to Weimar, Goethe was publicly shunned by the Weimar elite. His dedication to form was what drove him and his scientific studies; his *Metamorphosis of Plants* was published soon after in 1790, followed by *Beyträge zur Optik* [*Contributions to Optics*] in 1791, *Zur Farbenlehre* [*The Theory of Colours*] in 1810, and *Zur Morphologie* [*On Morphology*] in 1817.

In the polemic section of *Zur Farbenlehre*,[11] Goethe criticised Issac Newton's proposition[12] that the observed colour, namely, the phenomenon, itself represents a theory. The notion that a coloured spectrum comes from colourless light is forcing a particular mathematical theory onto a real phenomenon, even when other equally plausible theories may also fit.

[7] Italian Journey On the Brenner, September 8, 1786.

[8] Italian Journey September 12, 1787.

[9] Italian Journey Rome, January 10, 1788 (Goethe, 1989a, p. 383).

[10] Italian Journey Rome, December 25, 1787 (Goethe, 1989a, p. 358).

[11] First published in 1793 as *Über Newtons Hypothese der diversen Refrangibilität* [On Newton's hypothesis of diverse refrangibility] LA I 3.

[12] Newton (1704).

> An astronomer, for example, would have to behave in the same way if he decided arbitrarily to place the moon at the centre of our planetary system. He would then be forced to make the earth, the sun, and the rest of the planets orbit the lesser body, and to explain away and conceal the erroneous nature of his initial assumption by using contrived formulas and conceptual models.[13]

In other words, Newton had confused mathematical theory with evidence, a problem that hampered science in the eighteenth century as much as it does now. Goethe quite rightly called out Newton's error, something that was not appreciated until the late twentieth century.[14]

What of the science of today? Goethe could not have imagined the technology of the twenty-first century, yet he did warn of visual aids replacing human observation, namely, of tools that help us to see becoming the sole means of observation. Here, we see Goethe's ideas, particularly those in his *Zur Farbenlehre*, reengaging with Newton's legacy in Artificial Intelligence (AI), or machine learning. We now know a little more about Goethe, but what about AI?

There are many different definitions of AI. The *Oxford English Dictionary* defines AI as

> The capacity of computers or other machines to exhibit or simulate intelligent behaviour; the field of study concerned with this.[15]

The "intelligent behaviour" to which the *OED* refers is the ability of machines to learn some functions, possibly the reason why AI is often known as "machine learning" within academia and industry. The point of allowing a "machine", that is a computer that operates under various commands called algorithms, to "learn" is to expedite a function. To put it more succinctly, it is so your smartphone can recognise your face and unlock the screen while you are wearing glasses or a hat. The algorithm is constantly learning your favoured choices so that your spellchecker won't confuse "she'll" with "shell" after the first few text messages. The

[13] von Goethe (1995, p. 163).

[14] see Semper (2009).

[15] "artificial intelligence, n.". OED Online. December 2021. Oxford University Press. https://www.oed.com/view/Entry/271625?redirectedFrom=artificial+intelligence (accessed January 13, 2022).

so-called intelligence in AI isn't human intelligence, but the ability of an algorithm to process data. Kaya Ismail frames AI far more eloquently,

> An algorithm is a set of instructions—a preset, rigid, coded recipe that gets executed when it encounters a trigger. A.I. on the other hand [...] is a group of algorithms that can modify its algorithms and create new algorithms in response to learned inputs and data as opposed to relying solely on the inputs it was designed to recognize as triggers. This ability to change, adapt and grow based on new data, is described as 'intelligence'.[16]

AI is a super tool, one that makes our collective lives much easier and expedient. Yet many technologists and futurists have mixed views regarding the future of machine learning or AI,

> A.I.s will colonize and transform the entire cosmos [...] and they will make it intelligent.[17]

> If the world is taken over by unconscious robots, that would be about as disastrous and bleak a scenario as one could imagine.[18]

AI shouldn't be frightening. We have adapted to AI in how we use our phones, computers and supermarket self-checkouts. AI becomes an encumbrance because of our own attitudes to technology. AI isn't taking over the world in the way James Cameron had imagined *SkyNet*, but rather it is us allowing for more technologies to smother our own senses. Australian artist Michael Leunig perhaps described it best in his 1982 drawing *TV Sunrise* (Fig. 1.1) in which, we assume, a father is showing his son a sunrise on television, the very same event that is happening outside their window. We too are victims of convenience and would rather watch

[16] CMS Wire October 26, 2018, https://www.cmswire.com/information-management/ai-vs-algorithms-whats-the-difference/#:~:text=According%20to%20Mousavi%2C%20we%20should,to%20make%20such%20a%20decision

[17] Juergen Schmidhuber, a pioneering computer scientist based at the Dalle Molle Institute for Artificial Intelligence in Switzerland, https://www.smithsonianmag.com/innovation/artificial-intelligence-future-scenarios-180968403/

[18] David Chalmers, professor of philosophy at New York University, https://www.smithsonianmag.com/innovation/artificial-intelligence-future-scenarios-180968403/

Fig. 1.1 *TV sunrise*. Image courtesy of Michael Leunig

a lunar eclipse on television or online rather than experience it directly.[19] That is not to say that we do not want to see the lunar eclipse, rather that we have prioritised our own comfort over our experiences of Nature.

Our use of AI is more *WALL-E* than *Terminator 3: Rise of the Machines*. To understand our relationship with technology, we need to return to Goethe and his poetic and scientific writings. Goethe saw the danger in our desire to create machines to expedite knowledge. The use of machine learning or Artificial Intelligence is only a development of what Goethe feared would cloud our own judgements. Consider, for example, what AI uses. Data. Lots and lots of data. Big Data. Without it, AI has nothing to do and nothing to learn.

Big Data has become an integral part of our lives, our culture and everyday existence. It is there when we check our smartphones in the morning, at the checkout when we pay for our groceries, and even at the

[19] While writing this I witnessed the lunar eclipse, or a "Super Blood Moon" of May 26, 2021. As I braced the cold night air many had watched it online: https://www.gizmodo.com.au/2021/05/can-you-watch-the-super-blood-moon-eclipse-online/

doctor's when we go for a check-up. Without Big Data and the infrastructure that collects and dispenses data, none of the tasks would be possible. Yet, to a human Big Data is perfectly meaningless. The vast arrays of numbers, binary code and other computer code are incomprehensible. The tool that assists with everyday life, be it a smartphone, a computer or the internet, appears to us as a black box. We need this black box, that is AI, to process Big Data so we understand what it means. Already we have given up some of our autonomy. We cannot comprehend what all the ones and zeros mean, yet we place great trust in the algorithms that "look" at the data for us. Already, scientists are using Big Data and AI to image body parts (via MRI scans) and to observe black holes (via radio telescopes). What we see isn't what is really there. What we see are interpretations of the data via algorithms.

Like it or not, we are living in the Age of AI and many of us haven't a clue what it is or how it works. This book is neither a guide nor a criticism of AI. In many cases, we need this technology to save lives and understand the nature of celestial objects. The book is a guide to the modern world of large databases and complex algorithms, but it also provides perspective on what matters most, namely, our relationship to the natural world via observation. Technology is a tool that helps us to observe natural form (think of a telescope or microscope), because,

> Where there is no form, there is no meaning.[20]

Once that tool replaces observation, then we have entered a hubris, namely, a Modern Hubris,[21] one that has slowly entered science through the reliance on technology, rather than humans, to do the observing. In biological classification, for example, morphology—the study of form—has been replaced by DNA. People who specialise in living groups of organisms no longer observe form; rather, they simply take part of the DNA and use that to identify and find relationships between different species. The abandonment of form is an example of the Modern Hubris in biology. While DNA is an excellent way to find the relationships between organisms, it is not a replacement for morphology and observation. Not

[20] Wilkinson (1951, p. 197).

[21] The term "Modern Hubris" was inspired by the "Big Data Hubris", namely "…the often implicit assumption that big data are a substitute for, rather than a supplement to, traditional data collection and analysis" (Lazer et al., 2014, p. 1203).

surprisingly, morphologists, such as taxonomists, are in slow decline as there are no longer any jobs that require observation as a skill. By removing the observer, biology has moved on from Nature appreciation to accounting.

There is a joke that routinely circulates among taxonomists about a geneticist who visits a farm. The geneticist asks the farmer if he wants to wager a sheep for guessing how many individuals are in his flock. The farmer agrees, and in seconds, the geneticist correctly states the number. "How did you do that?" asked the farmer. "Why, I am a geneticist" came the reply, as he quickly claimed his prize and walked away. "I guessed so", cried the farmer, "you have just taken my sheep dog!"

What makes this joke work isn't that geneticists are unable to identify sheep, but rather it lies in the difference between a quantitative and qualitative approach to viewing Nature. For the qualitative scientist (depicted here as the geneticist), a number serves to place the flock in context with an algorithm. For a naturalist (represented by the farmer), understanding the difference between a sheep and a dog places the organisms in context with each other and the natural world.

The nature of this context has resulted in scientists changing the way they do their science, by shifting away from understanding the organism to contextualising a new scientific model. This model attempts to reproduce the complexity we believe is happening in Nature, in the form of an algorithm. In short, we can take the joke further. The geneticist could have sequenced the entire genomes of each individual sheep (and dog) in the flock. The result would be a neural network so large that it would be impossible for a single human to comprehend.[22] Either result, a single number or a neural network, will not tell you what type of organisms are in the flock or how they relate to one another.

I admit the above is a simple anecdote to explain a complex issue, but in essence, that is what communication about the natural world is about. We don't need to know a vast amount of information to understand that the big hairy thing with large teeth roaring at us is highly likely to be dangerous to our well-being. Not that the information whole genomes provide is useless. It just isn't contextual to us, the human observer, interacting

[22] Routinely, large phylogenies (trees that show a hierarchical classification of organisms) are so big, that they are no longer published in scientific journals. Many of these phylogenies are instead placed into the supplementary material. Imagine a scientific field in which the result of an analysis is too complex for a human to comprehend!

with Nature. The world makes greater sense to the human observer without the added complexity of superfluous information. In fact, by simply saying "hairy thing with lactating glands" gives us enough information to classify a highly complex organism, in this case, a mammal, without losing our connection to Nature.

This book is about us, human observers of the natural world, in a global economy that is becoming automated, in a scientific community that is slowly replacing human observation with machine learning and models. As the context shifts away from the human observer and the natural world, scientists are enabling machines to contextualise Nature's complexity via self-perpetuating algorithms. Scientists are increasingly failing to understand how the models find the results they do and are putting greater trust into technology than they do into their own eyes. The rise in machine learning and its inherent impenetrable processes has led some to declare this the Age of AI, when artificial complexity has become indistinguishable from the natural complexity it seeks to replicate. What scientists fail to understand is that we are losing control of our own science as we eliminate ourselves from the scientific process, in favour of more so-called objective machines and models. The obsession with the notion of objectivity in machine learning or Artificial Intelligence has even led to scientists and philosophers seriously discussing whether we all are in a computer simulation.

To understand how the Age of AI came to be, we need to go back 200 years to a time when naturalists were equally puzzled about Nature and its complexity. Basic statistics and more sophisticated mathematics were seen as tools, employed to help understand the complexity we see in Nature. Even then, there was a tendency to dismiss human observation as limited and subjective, better served by investigating phenomena as abstractions or models through mathematical formulae. Goethe was deeply passionate about viewing Nature and warned that such abstractions do not replace human perception, as in the case of Newton's *Opticks*. He was perhaps the first person to understand the Modern Hubris and the first to point out how human observation was losing its importance as a way to understand Nature.

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CHAPTER 2

AI and the Modern Hubris

Abstract In this chapter, I summarise how Big Data is collected and how it drives AI, in both industry and science. I explore some ideas that have sprung from AI, such as the Age of Entanglement, to demonstrate how technology affects the way we see and understand the natural world. I link this type of thinking to Goethe's Faust and explain how modern technology drives the Modern Hubris by disconnecting scientists from experiencing Nature. I briefly outline concepts that will be discussed in the proceeding chapters.

Keywords Big Data • Artificial intelligence • Age of entanglement

> Spock: I am most impressed with the technology, Captain. Doctor Daystrom has created a mirror image of his mind.[1]

To understand AI is to understand what drives it, namely, Big Data. Technology and the data it uses and produces have been with us since the Age of the Enlightenment. Much of what is written about Big Data aims at justifying its use and the ways in which it can be improved. In fact, few people have explored how Big Data affects us as observers of the natural

[1] *Star Trek* Season 2, Episode 24, 1968.

M. Ebach, *Goethe in the Age of Artificial Intelligence*,
https://doi.org/10.1007/978-981-19-6741-2_2

world. To do so would be a monumental task, as Big Data has truly changed the way we see ourselves in relationship to Nature. Rather than being observers, we have demoted our own observations as subjective and flawed and have elevated technology, namely, the machines and abstract mathematical concepts, as objective and flawless. Since the Age of the Enlightenment, we have replaced our own senses with abstract and artificial mechanisms to observe the natural world. This disconnection between the observer and Nature is at best a Modern Hubris and it has influenced many aspects of modern life, for good and bad. What has changed the most is the study of natural history or science. Yet scientists are the least critical of the Modern Hubris. You may appreciate warnings of a Modern Hubris when reading or watching science fiction, such as *Star Trek*,

> "… you have brought us down to the level of the machine. Indeed, you have elevated that machine above us",[2] and; "Data is power. It's something to take from and hold over somebody else; quantified dominion. The more you have on someone, the more you have over them. The more personal it is, the more power, until you've eaten right through the skin of social relationships and into the flesh itself".[3]

Too often, the discussion about Big Data comes from the perspective of those who either use or benefit from large-scale data harvesting, computing and data creation—large corporations, governments and engineers—while remaining silent about those whom it affects. When questioning Big Data, we should not ask about its benefits or its future, but rather about how it has changed the way we look at the natural world; otherwise, we risk isolating those who benefit from those who are adversely affected by it. The Luddites of the nineteenth century were viewed as those unwilling to accept technological change by beneficiaries of Big Data. In fact, the term "Luddite" means just that—anti-technology. History, however, tells a different story, namely, workers who have lost their jobs and livelihoods because their skills were replaced by machines. In the case of the Luddite rebellion, the definition was written by the victors. The definition implies that everyone benefits from technology, and those who are adversely

[2] *Star Trek* Season 1, Episode 20, 1967.
[3] Bridle (2016).

affected are automatically portrayed as opposed to technological changes. The point of this chapter is not to demonise Big Data, but rather to explain what it is and how it affects us and those who use it to understand the natural world. How, then, do we define Big Data in the twenty-first century?

Since 2014, the term "Big Data" has made it into the mainstream media and vocabulary. In June 2013, "Big Data" was entered into the *Oxford English Dictionary* as "data of a very large size, typically to the extent that its manipulation and management present significant logistical challenges; (also) the branch of computing involving such data".[4] Critics of the OED's definition of Big Data were quick to fire back,

> Viktor Mayer-Schönberger and Kenneth Cukier, in their recent book, Big Data, argue that the criterion is not the absolute size of your data set but whether it counts as all or nearly all the data relevant to a particular question.[5]

> In Big Data@Work, Tom Davenport concludes that because of 'the problems with the definition' of big data, 'I (and other experts I have consulted) predict a relatively short life span for this unfortunate term'.[6]

Defining Big Data is difficult as it is still evolving to become something that many hope will bring a positive change and others fear will turn out to be a digital panopticon. Already Big Data has proven to be both, such as providing the infrastructure to run driverless cars as well as illegally harvesting social media data and selling it to third-party buyers, who use it to spy on consumers. Regardless of the media attention, Big Data is easy to understand if we treat it for what it is, namely, data and the means to process it, and for what it does: create new data.

Rather than defining a constantly changing topic that is reinventing itself, it is worth considering what people identify as "Big Data".

Big Data is not necessarily big. True, there are vast server farms constantly collecting data about our online shopping habits or astronomical readings collected automatically from radio telescopes, but you don't need oceans of data to make a prediction. What makes Big Data big is that we, as humans, are unable to understand it in context to the problem we are

[4] https://public.oed.com/blog/june-2013-update-a-heads-up-for-the-june-2013-oed-release/

[5] Poole (2013).

[6] Press (2013).

looking at. Take the human genome as a case in point. Along its DNA, in particular the human chromosome 21q,[7] we find the following sequence:

CATGTTTCCACTTACAGATCCTTCAAAA
AGAGTGTTTCAAAACTGCTCTATGAAAAGGAAT
GTTCAACTCTGTGAGTTAAATAAAAGCATCA
AAAAAAAGTTTCTGAGAATGCTTCTGTCT
AGTTTTTATGTGAAGATATTTCCATTT
TCTCTATAAGCCTCAAAGCTGTCCAAA
TGTCCACTTGCAGATACTACAAAAAGAGT
GTTTCAAAAGTGCTCAATGAAAAGGAAT
GTTCAGCTCTGTGAGTTAAATGCAAACA
TCACAAATAAGTTTCTGAGAATGCTTCT
GTCTAGTTTTTATGGGAAGATAATTCCGT
GTCCAGCGAAGGCTTCAAAGCTTTCAAAA
TATCCACTTGCAAATTCTACAAAAAGAGT
GTTTCAAAGCTGCTTTATCAAAAGAAAGT
TTCAACTCTGTGAGTTGAATGTGCACATC
ACAAAGAAGTTTCTGAGAATGCCTTCAGTC
TGGTTTTTATGTGAAGATATTCCCTTTTCCA
ACGAAAGCCTCGAAGCTGTCCAAATATCCACTTGTAAGTGC
TGCAAAAAGAGTGTTTCAAAACTGCTACAGCAAAAGAAAGG
TTTATCTCTGTGAGTTGAGTAGACACATCAAGAAGAAATTTC
TGAGAATGCTTCTGTCTAGTTTTTATGTGAAGATATTTCCTTT
GTCACCATAGGCCTCCAAGCCCTCCAAATGTCCACTTGCAGAT
GCTACAAAAAGAGTGTTTCAAAACTGCTGTATGAAAAGAAATG
CTCAAATCTGTGAGATAAATGCATACATCACAAAGAAGTC
TTTGAGAATGCTTCTGTCTAGTTTTTATGTTAAGATATTTC
CTATTTCACCATACGTCTCAACGCACACAAAATGTACACT
TGCAGATGCTACAAAGAGAGTGTTTCAAAACTTGTAGAT
CAAAACAAGTGTTCAACTTTGTGAGTTGAGGACACACAT
CTGAAAGAAGTTTCTGAGAATGCTTCTGTCTAGTTTTT
ATGTGAAGATATTCCCGTTTCCAGCGAAAGCCCCAA
AACTATCCAAATATCCACTTGCACATTCTACAAAAAG
AGTGTTTCAAATCTGCTCTATCAAAATAAAGGTTCAAC
TCTGTGAGTTGACTACACACATCACAAAGAAGTT
TCTAAGAATGCTTCTGTCTGGTTTTTATGGGAA

[7] >BA000005.3 *Homo sapiens* genomic DNA, chromosome 21q (NCBI https://www.ncbi.nlm.nih.gov/nuccore/BA000005.3?report=fasta)

G A T A T T T C C T T T T T C A A C A T A G G C C T T G C A G C A T C T A C A A A A A G A G T T T T T C A A A A C T C C T C T A A G AAAAGGAATGTTCAACTCCATGAGTTT

Seen as a small snippet, the sequence tells us very little. However, within the entire genome, it has greater meaning. Unfortunately, we are not able to tell what that sequence means without the aid of a computer that implements one or more algorithms that do the "looking" for us. "Big" in this sense simply means "not readable nor understandable by a human". Many such large datasets are at the mercy of algorithms, namely, a set of rules created by us to allow the machine to do the reading on our behalf. Humans do not read genomes, machines do, and we read what they tell us based on these sets of rules.

Big Data is complicated. These sets of rules, or algorithms, are seemingly impenetrable to most people who use them. In its most basic form, an algorithm is an unambiguous set of instructions to carry out a task. If we wish to boil an egg, our instructions would be: place egg in saucepan, add cold water, place saucepan on flame and heat for 5 minutes. Drain and serve. Even more simple tasks, such as adding up two numbers, requires a computer and a computer language, sometimes referred to as code. The algorithm simplifies the task from a sentence "add 2 and 3 together" into a more compact set of instructions such as "2 + 3". A computer language, such as Python, converts this into a machine-readable instruction using the "sum()" algorithm, namely,

```
numbers = [2, 3]
numbersSum = sum(numbers)
print(numbersSum)
```

The first instruction or command "numbers" lists the numbers. The "numbersSum" command adds the numbers together and the "print" command displays the answer: 5.

The more complex the task becomes, the more complicated the algorithm. While a programmer may be able to read the algorithm and understand its underlying function, many users simply trust that the computer is doing the task correctly. In other words, the users who designed the tasks are obliged to trust that the programmers have understood and written the sets of instructions correctly.

Big Data creates more data. To read the masses of data, computers need a language, and to accomplish a set of tasks, they need algorithms. This creates more data, to the point that much of it is no longer decipherable by humans. Many of the self-learning algorithms, such as speech or image recognition, require reprogramming so that algorithms "learn" new tasks based on the behaviour of people using speech recognition software. The constant reprogramming is often referred to as machine learning or Artificial Intelligence. The reprogramming results in a custom code written by the machine, leaving programmers scratching their heads as to what the code is attempting to accomplish. *Google* has achieved this through its AutoML technology, which "relieves human effort by automating the design of ML [machine learning] algorithms".[8]

The creation of new data by algorithms, along with the constant collection of data from the internet, shopping tills, metrological stations, seismometers, telescopes, CCTVs and so on, has led to a diversity of data and algorithms, much of which seems like a digital wilderness with no laws or structure. Daniel Hillis likens this to the Age of Enlightenment, when people first understood that the natural world had natural laws, many of which could help us understand and predict natural processes. The digital wilderness created by Big Data has created, in Hillis' view, a new Age of Entanglement, one in which we explore the digital world for laws so we can predict and manipulate its structure, creating and discovering artificial objects. At some point, we "build into our machines the power to learn, adapt, create and evolve. In doing so, we will give them the power to surpass us, to shape the world and themselves in ways that we never could have imagined". Hillis believes that we are part of the Age of Entanglement, one that is so complex that it is immune to human understanding and in which "we must watch the flows of information, ideas, energy and matter that connect us, and the networks of communication, trust, and distribution that enable these flows".[9]

Hillis' Age of Entanglement is possibly the most explicit description of us within the world of Big Data. Not as observers, but as blind participants dependent on machines in order to see and understand our world. While we are far more interconnected than at any time before, our social circles have become superficial networks, our lives recorded as digital photos or videos, and our ideas online as social media posts. Has the rise of Big Data been at the cost of our independence as observers and active participants of natural world? Have Big Data and the Age of Entanglement created a Modern Hubris? Has this Modern Hubris removed us as an observer of

[8] Wong et al. (2018, p. 1).
[9] Hillis (2016).

Nature by confusingly labelling technology as superior to our own senses, resulting in artificially derived images and sounds replacing natural forms?

The Modern Hubris is as real as it is metaphorical. As with the hubris faced by Goethe's fictional character Doctor Heinrich Faust, a skilled scholar and necromancer, who was willing to use his art to gain insight into the natural world,

> Calling on spirits and their might
> To show me many a secret sight,
> To relieve me of the wretched task
> Of telling things I ought to ask,
> To grant me a vision of Nature's forces
> That bind the world, of all its seeds and sources
> And innermost life — all this I shall see,
> And stop peddling in words that mean nothing to me.[10]

Hubris is the vanity in Faust's request—to attain a higher knowledge beyond what can be achieved through reading or observation alone. It is important to remember that reading and observation are activities that lead to experiences. To "grant a vision of Nature's forces" is akin to seeing the sleight-of-hand in a magician's trick—it is passive and requires no engagement of the senses—it is simply accepted. Faust's desire is to simply understand Nature without any active participation and for the answer to simply appear. His anguish is palpable.

> We snatch in vain at Nature's veil
> She is mysterious in broad daylight,
> No screws or levers can compel her to reveal
> The secrets she has hidden from our sight.[11]

The hubris of Faust lies in his thinking—Nature is there to be *revealed*, rather than to be appreciated. To "reveal" is to shine a light on what is hidden, either literally or metaphorically. To reveal say, the innards of a pumpkin, we use a knife to cut it open, count the seeds and make note of the colour. Newton believed he had revealed the inner workings of light through abstract mathematics. Appreciation, however, requires something completely different, namely, our senses. The touch of the pumpkin's skin,

[10] von Goethe (2008, p. 15).
[11] von Goethe (2008, p. 23).

its weight in our hands, the texture of the flesh, the feel of the seeds, the taste, the smell. Technology is significantly absent when we appreciate an object, and it is missing in Faust's lament of the natural world. This hubris, that Nature is there to be revealed, has existed since Goethe's day. The technologies that have developed since the Age of Enlightenment have also engulfed us and our attitudes to Nature. For a modern Western culture, Nature's secret is something to be revealed. The ability to reveal lends credence to science, as it requires hypotheses, tests and experimentation. Appreciation, on the other hand, is implied to be amateurish, something within the domain of the fine arts. If a scientist reveals sub-atomic particles or the genetic makeup of a bird, it gives science a veneer of professionalism, of Big Science that governments can fund to progress humanity. On the contrary, a naturalist appreciates a bird and may be able to identify a species by its call or the shape and colour of its eggs. A naturalist immediately conjures up an image of a twitcher hiding behind shrubs, something benign but not vital to science.

The Modern Hubris centres around the belief that technology alone is needed to make sense of the natural world. It is important to state that technology is not where the hubris lies. Rather, it is our relationship to Nature that determines the Modern Hubris—are we so entangled with technology that we have become disconnected from Nature, or are we merely impartial users of devices and data?

Let us return to the problem at hand, namely, that the Modern Hubris has disconnected us as observers of Nature by confusingly identifying technology as superior to our own senses, resulting in artificially derived images and sounds replacing natural forms. As observers, we actively engage with natural objects. We may *see* a blossom or a leaf, but we never sit down with a flower and *observe*, that is, explore its petals and stamen. In other words, do we observe Nature in the same way we observe a painting in an art gallery? Do we appreciate the natural objects we observe in the same way we appreciate our favourite works of art? When confronted by wildlife, are we inclined to reach for our devices or cameras and take a photograph? The parody of the tourist bus arriving at a lookout, its passengers disembarking, taking a photo each and clambering back on board again within minutes, or tourists travelling 1000 of kilometres to doze on foreign beaches, are comical but true examples of how we have become disconnected with Nature. Of all our holiday snaps, how many truly represent what we have actually observed?

> In a course I taught at a university, I would introduce students to the observable universe, namely the universe that we are able to observe. After presenting the students with figures, such as the size of the observable universe (roughly 93 billion light years in diameter), I ask them where the centre of the observable universe is located. It has always astounded me how the students fail to realise that the observable universe is centred on them, namely the observer. Could this be due to a disconnect between the observer and nature? Is this the Modern Hubris in action?

As observers, we also take our own senses for granted. A true connection between the observer and the thing being observed is compromised once we place something between it and us. Take reading glasses or hand lenses as a case in point. These aids are not eye replacements, but simply tools to assist in seeing. The technology, be it a scanning electron microscope or an infrared camera, doesn't do the seeing. You do. Granted, technology helps us see things we would not see with our own eyes and it has helped us make discoveries, but not using our own observations. A pair of reading glasses or an electronic microscope are technologies that aid us to see better. While our connection with the object is compromised to a degree, these technologies help us see things that we could not see with our own eyes. These technologies are an addition to human observation. Where we become completely disconnected from Nature is when we assume that human observation is subjective and therefore flawed and that it should be completely replaced with mechanical devices. Reading glasses may be the thin edge of the wedge in our disconnection from Nature, but there are many other technologies currently in use that are closer to replacing the human sensory system altogether. These technologies are mostly employed in both the physical and social sciences.

The Modern Hubris in science may be defined as the disconnection between scientists and Nature by confusing technology as an objective means and our own senses as subjective, which results in artificially derived images that replace natural forms. For example, the DNA sequence of chromosome 21q above is the level at which many evolutionary biologists view organisms. Rather than observing the skeletal structure or exoskeletons of animals, scientists now extract DNA and view it as hierarchical trees or networks. The organism has completely disappeared from the laboratory and has been replaced by machines that can read DNA sequences. Moreover, scientists are starting to hand over the job of analysing DNA to technicians called informaticians, who specialise in handling and processing vast amounts of data using algorithms to produce the trees that are presented to scientists. In many cases, the informaticians have no idea which organisms they are dealing with, and conversely, the scientists have no idea what the data means. The same may be said about other scientific fields that traditionally used observation as the main means to understand Nature, including ecology, astronomy and geology. One scientist and science communicator, Neil deGrasse Tyson, has unwittingly summarised the Modern Hubris in science within a single sentence:

> It only really becomes science after you have replaced the human sensory system with an apparatus that can make an objective measurement.[12]

Other scientists are far more explicit, labelling human observation as subjective and algorithms as objective:

> … as taxonomists adopt more objective species delimitation methods (such as [Molecular Bayesian Phylogenetics]) and move away from … subjective species diagnoses.[13]

Fujita and Leaché are referring to complex algorithms that have been adapted to find hierarchical classification schemes in biology. The practice of observing organisms and their parts (i.e. the morphology) to create a taxonomy or new names (i.e. species names) is seen as subjective. Rather, phylogeneticists use algorithms to compare the similarities between DNA sequences to create new species names or taxonomic ranks. In doing so, traditional scientific practice has been significantly altered. In fact, the taxonomist, and the taxonomic knowledge acquired over many years of experience, has been replaced by someone who uses an algorithm and does not necessarily need to have any knowledge of the organisms being compared. Taxonomists, who once were lauded for their ability to appreciate and identify organisms by their morphology, are no longer employed by scientific institutions.

> Purely morphological research in invertebrate taxonomic research is becoming rare […] as molecular techniques become more popular.[14]

[12] deGrasse Tyson (2016).
[13] Fujita and Leaché (2011, p. 494).
[14] Pilgrim et al. (2002, p. 184).

The taxonomist with many years of experience has been replaced by a technician who is able to write algorithms and handle vast amounts of data. The technicians have virtually no experience in biology, nor do they need any skills in identifying organisms.

The disconnection between scientists and Nature has gone further, with scientists organising debates on whether we are in fact all living in a computer simulation. At the Isaac Asimov Memorial Debate at the American Museum of Natural History in 2016, a panel of "high-profile scientists and philosophers gathered to debate whether we are real or virtual".[15] Neil deGrasse Tyson thought the likelihood of a simulated universe "may be very high", whereas the philosopher David Chambers noted that any evidence that we are in a simulation "could be simulated". At this point, one would ask why the question was being asked in the first place. Why would we think that we are in a simulated universe? The answer comes from simulations the scientists make themselves: if the universe is governed by mathematical laws that may be turned into algorithms and run to predict events, why wouldn't we assume that one is running already and that we are the unwitting participants?

The hubris here isn't the assumption that *we* are being simulated, but that our own consciousness, experiences and observations *can* be simulated. Believing that a consciousness can be simulated is akin to equating our senses, such as observation, to a technology, one that can be reproduced by a set of algorithms. Yet, scientists create algorithms to reproduce whatever natural processes they think are happening. The simulations they create are artificial in the same way that a universal simulation, such as depicted in the film *The Matrix*, is human-made or machine-made. To assume that we are in a simulation of Nature presumes that one is possible, and why not? Scientists create them to make predictions about natural processes, thereby creating another problem: only *some* processes are visible or measurable. What about the unobserved processes we think happened millions of years ago? These ancient processes may not have left behind evidence of a process. For example, the Andes mountain chain, which runs along the western coast of South America, is not evidence of plate tectonics. Mountains were explained in numerous ways, from uplift due to retreating glaciers, Earth expansion and even Earth contraction.

[15] https://www.amnh.org/explore/videos/isaac-asimov-memorial-debate/2016-isaac-asimov-memorial-debate-is-the-universe-a-simulation

The processes that we believed shaped the Andes were derived from inferences and not evidence. These inferences are subjective perceptions. A simulation of Earth would contrast remarkably between 1890, 1950 and 1990 considering how the views of geologists have changed. How, then, do we know whether these simulations based on our perceptions are any good? We don't. Simulations are only as good as our arguments for them, and these can change at any time. In fact, algorithms and the simulations they create are merely replications of our own opinions, meaning that our own flaws and biases are reproduced. Perhaps, the way scientists do science is a direct result of this disconnection between our observations and the natural world?

The Modern Hubris or the disconnection from Nature deeply affected US philosopher Ronald Brady (more of him later). As a student, he was interested in observing Nature and perhaps studying it in a way to explore his own observations. The enquiry took him to a professor of biology, who replied, "You are interested in this approach because you are a Nature appreciator, while I am a productive scientist".[16] Brady referred to this attitude as the "demotion of experience", namely, when we remove ourselves from appreciating Nature to the point where scientists and philosophers seriously debate whether they are part of a simulation.

The hubris may be defined further as an *indirect observation* in which we rely on instruments other than our own senses to make observations. Indirect observation results in metaphysical phenomena, namely, human-made or machine-made reconstructions of natural objects that lie beyond our own sensory perception. The hubris also includes the people and their careers, the peer group pressure of conforming to current scientific practice leading to a lack of self-awareness of observers, particularly scientists.

Taking back control of our own observations and perceptions was something that Goethe championed during the last days of the Age of Enlightenment and the bringing of the turbulent *Strum und Drang* [Storm and Stress] movement of the German Romantic period. Goethe was faced with a fledgling scientific process, one that was wedded to indirect observation and metaphysical phenomena and one that rejected human perception as flawed and demoted experience. Nature appreciation was defended by Goethe as a means to rediscover our own connection to Nature in an age that had reduced colour to a set of equations. The way in which Goethe did this was to reinforce our ability to observe and

[16] Brady (2006, p. 12).

appreciate Nature as a science of aesthetic appreciation by Anschauung and empirical observation, in which we explore the natural world independently through our own sense perceptions; acknowledging two ways of thinking, by defining how we see the world as subjective observers versus us as objective Nature appreciators; getting rid of bad metaphysics and rediscovering natural phenomena; and exploring the transformation of self, using Goethe's life as a metaphor or allegory for the development of a scientist.

I will elaborate on these points in the following chapters, which act as a guide to understanding Goethe's scientific method, the age in which he lived and how it compares to the Age of AI today.

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CHAPTER 3

Goethe and the Birth of the Modern Hubris

Abstract In this chapter, I show how the term "science" was coined after Goethe's death, and how that simple term further widened the divide between the arts and the natural sciences. This divide fuelled the Modern Hubris in which human aesthetic appraisal became seen as subjective in science. I show that at least in the world of art and architecture, these same experiences are seen as objective. In addition, I explore how observation followed by mathematical reasoning can work together to discover natural phenomena, such as Uranus and Neptune. The reverse, using mathematical reasoning to explain natural phenomena, puts the cart before the horse, as Goethe eloquently points out in his Farbenlehre, in which he criticises Newton for doing the same thing in his Optiks. I continue to show how important observation and aesthetic appraisal are in viewing the mammalian forelimb and introduce the concept of Anschauung, which is of primary importance in understanding Goethe's scientific thought.

Keywords Natural phenomena • Neptune • Uranus • Anschauung

> We often find that the more limited the data, the more artful a gifted thinker will become. As though to assert his sovereignty he chooses a few agreeable favorites from the limited number of facts and skillfully marshals the rest so they never contradict him directly. Finally he is able to confuse, entangle, or

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push aside the opposing facts and reduce the whole to something more like the court of a despot than a freely constituted republic.[1]

There is an apocryphal story[2] about a confrontation between English polymath William Whewell and the poet Samuel Taylor Coleridge at the third meeting of the *British Association for the Advancement of Scienc*e in Cambridge, in July 1833. The anecdote appeared in an anonymous book review of *On the Connexion of the Physical Sciences* by Mary Somerville, in which the reviewer notes the lack of unity in science, "the mathematician turns away from the chemist; the chemist from the naturalist; the mathematician, left to himself, divides himself into a pure mathematician and a mixed mathematician, who soon part company".[3] With all these names, there was no general term that the "members of the British Association for the Advancement of Science, at their meetings at York, Oxford and Cambridge […] could describe themselves with reference to their pursuits. *Philosophers* was felt to be too wide and lofty a term and was very properly forbidden them by Mr. Coleridge […] some ingenious gentlemen proposed that, by analogy with *artist*, they might form *scientist*".[4] That "ingenious gentleman" was revealed as Whewell by his biographer Isaac Todhunter in 1876, but it was not surprising that Whewell coined the term in 1834 as it appeared in his two volume 1840 work *Philosophy of the Inductive Sciences,* "Thus we might say, that as an Artist is a Musician, Painter, or Poet, a Scientist is a Mathematician, Physicist, or Naturalist […] ideas exist in a very different form in the mind of an Artist and the

[1] von Goethe (1995, p. 15).

[2] A parody of the *British Association for the Advancement of Science* meeting appeared in *Bentley's Miscellany* as the "Full Report of the First Meeting of the Mudfrog Association for the Advancement of Everything". Of particular note is "SECTION A.—ZOOLOGY AND BOTANY. GREAT ROOM, PIG AND TINDERBOX. PRESIDENT—PROFESSOR SNORE. VICE PRESIDENTS—PROFESSORS DOZE AND WHEEZY. The scene at this moment was particularly striking. The sun streamed through the windows of the apartments, and tinted the whole scene with its brilliant rays, bringing out in strong relief the noble visages of the professors and scientific gentlemen, who, some with bald heads, some with red heads, some with brown heads, some with grey heads, some with black heads, some with block heads, presented a *coup-d'œil* which no eye-witness will readily forget" (Dickens, 1837, pp. 403–404; also see Owens, 2019, p. 179, Wordsworth, Coleridge and "the language of the heavens").

[3] Anon (1834, p. 59).

[4] Anon (1834, p. 59).

Scientist".[5] While the term was not popular—"I think 'Scientist' must be about as pleasing a word as 'Electrocution'"[6]—and had been adopted relatively late in the mid-nineteenth century, it does signify a divide between scientist and artist, both of which would have been referred to as philosophers or natural philosophers. We only have Whewell's account of the 1833 exchange, as there is no written account by Coleridge. Historians have speculated that Coleridge was attempting to draw a line between those who practised science from those who thought about scientific theory. In his *Biographia Literaria*, Coleridge states that natural science (e.g. nature, or the material world) is distinct from our theoretical understanding of nature (e.g. our own intellect), meaning that nature requires us to make philosophical sense of phenomena. In other words, "the highest perfection of natural philosophy would consist in the perfect spiritualisation of all the laws of nature into laws of intuition and intellect".[7] Rather than splitting philosophy in twain, a *natural philosophy* would combine natural phenomena and natural laws until they merge as a total consciousness. Identifying scientists as separate from artists only reaffirms the disconnection between the observer and Nature. Philosopher Justin Smith sums up this division eloquently in his book *Irrationality*:

> Science was now the home of reason; poetry, and art, and the exercise of the imagination more generally, of unreason. Both of these spheres of human life continue to hobble along today, injured by the violence of their separation.[8]

Goethe died a year before the 1833 meeting of the *British Association for the Advancement of Science* and Coleridge followed a year later. The word *scientist*,[9] coined by Whewell and born between the years of Goethe and Coleridge's deaths, marks the uncanny point in the history of the Modern Hubris. The last defenders of a human-conscious centred science,

[5] Whewell (1840a, p. cxiii) and Whewell (1840b, p. 416).

[6] Huxley (1894 in Ross, 1962).

[7] Coleridge (1817, p. 125).

[8] Smith (2019, p. 130).

[9] It is worth noting perhaps that Mary Wollstonecraft Shelley never described her character Victor Frankenstein as a "scientist", as her book *Frankenstein* was published earlier in 1818. Frankenstein would no doubt describe himself as a Natural Philosopher.

From this day natural philosophy, and particularly chemistry, in the most comprehensive sense of the term, became nearly my sole occupation (Wollstonecraft Shelley, 1818, p. 78).

one that incorporated our senses and our appreciation of the Natural world, had ended. The disconnection between the observer and Nature, the Modern Hubris, had been accepted as how a *scientist* should see the world. The natural philosophers Coleridge and Goethe were labelled as "artists", and the work of the latter was dismissed or ridiculed. Nature had laws and mechanisms that remained hidden from view and it was up to the scientist to reveal them in abstract forms without our subjective senses getting in the way. Issac Newton, the poster boy of Enlightenment science, was perhaps the greatest advocate of such an approach.

> This is the Method of Analysis: And the Synthesis consists in assuming the Causes discover'd, and establish'd as Principles, and by them explaining the Phænomena proceeding from them, and proving the Explanations.[10]

"Newton", says one late eighteenth-century critic, advocates "his own cause, however, for after starting off by accepting as already known what ought first be introduced, derived, explained, and demonstrated, he seeks out from the great mass of material only those phenomena which appear to add plausibility to what has already been stated".[11] The point of the argument is that one may proceed from "experiences to principles" or from "principles to experiences" and switch between them as necessary. Newton, our critic states, just moves from principles to even more principles, cherry-picking certain phenomena and by-passing observation, altogether thereby creating distortions.[12] These are extraordinary claims. Newton's legacy was enshrined by the end of the eighteenth century and few dared to openly criticise its legitimacy. Incredibly, the person who made the claim above was none other than Goethe. Why then would Goethe be critical of Newton?

The reason lay in Goethe's aesthetic appraisal, that is, his ability to recognise, identify and compare artefacts, whether they be paintings, vases or other works of art. Within the realm of aesthetic appraisal, there is no mechanical law or mathematical model (although recently they have been applied to identify fakes and authenticate genuine articles, but more on that later[13]). You only need to switch on a TV or go online to see an

[10] Newton (1730, pp. 404–405).
[11] Duck and Perry (2016, p. 3).
[12] Sepper (1988).
[13] C. R. Johnson et al., "Image processing for artist identification", in IEEE Signal Processing Magazine, vol. 25, no. 4, pp. 37–48, July 2008.

example of a modern-day aesthetic appraisal. The BBC's *Antiques Roadshow*, for example, has experts who can not only identify a carriage clock, its maker, and the year it was made, but also have it corroborated by another expert. Hallmarks and other written evidence aside, the form itself reveals what the item is, whether it be a Toby jug or a seventeenth-century wine glass, through the experience of the expert.

Goethe honed his skills as an artist during his Italian journey between 1786 and 1788. David Lowe and Simon Sharp[14] believe that it was the architecture of the sixteenth-century Venetian Andrea Palladio "that affected his way of looking at both art and Nature".[15] They go further, "Goethe wrote *Italian Journey* in part to show how he had discovered the bridge between how we look at art and how we look at Nature. He does so by a structural juxtaposition in the book of Nature and art, in particular architecture. Through this juxtaposition he points to how we can school our seeing to develop a higher form of seeing, imagination, which allows us to perceive the process of metamorphosis. This allows 'conversation' with the phenomena to being".[16] Philosopher Joan Steigerwald makes a similar suggestion, "Goethe's growing sense of himself as an artist, especially from the time of his Italian journey, led him to reflect increasingly upon the problems of aesthetic appraisal".[17] Steigerwald, however, does not attribute Goethe's aesthetic appraisal to Andrea Palladio's architecture, rather attributing it to his immersion into the Roman art world and his "vocation as an artist and a new sense of the significance of artistic sensibility".[18]

Goethe's views of Nature during his Italian journey seem to be linked to descriptions of architecture. In Padua, for example, Goethe comments on an acquired book of Pallaido's work, the solemnity of a university building, a large public square called the Prato della Valle and statutes surrounding an oval are interpreted with thoughts about plants: "We eventually think no more at all about plants we are accustomed to, like long

[14] Lowe and Sharp cite Sir Nikolaus Pevsner "Thus Goethe's ideas about plant life, and about Gestaltung (morphology) and metamorphosis in general are here applied to architecture. It was an intellectual process, just like the process by which Goethe succeeded in appreciating the [Greek] ruins of Paestrum" (Pevsner, 1968, p. 172).

[15] Lowe and Sharp (2005, p. vii).

[16] Lowe and Sharp (2005, p. 54).

[17] Steigerwald (2002, p. 303).

[18] Steigerwald (2002, p. 304).

familiar objects; and what is observation without thought?"[19] It is easy to forget that Goethe collated these memories from letters and diary entries 25 years later, allowing for any biases in hindsight. Although Goethe developed his aesthetic appraisal in Italy, he did however conduct scientific observations earlier in 1784, when he discovered the intermaxillary bone in humans (now known as the premaxilla). In his 1784–1786 (published in 1820) *Dem Menschen wie den Tieren ist wen Zwischenknochen der oberen Kinnlade zuzuschreiben*,[20] Goethe was convinced that the *os intermaxillare* (the intermaxillary bone), known to ancient scholars such as Galen of Pergamon as *Liber de ossibus*, "has been the object of recent attention because it is said to be a characteristic which separates ape from man: its presence is admitted in the former, but denied in the later".[21] Goethe cites Petrus Camper's *Collected Shorter Writings* and Johann Friedrich Blumenbach's *De varietate generis humani nativa*.[22] The notion that humans lacked pre-maxilla was not disputed as a well-established anatomist, such as Petrus Camper and Johann Friedrich Blumenbach, did not "construe its absence as an important distinguishing mark between humans and animals".[23] In fact, many eighteenth-century anatomists "considered the difference to be entirely *spiritual*, acknowledging, in fact, that the anatomies of the human and ape were nearly indistinguishable".[24] Indeed, the intermaxillary bone was not a significant distinguishing mark between us and the apes, nor was Goethe's discovery new.[25] Rather, Goethe's discovery had another aspect to it, namely, the "certain rigid opinions" that had become "established" in the way comparative anatomists thought about the intermaxillary bone. "No one realised that the indirect denial of the archetype [*typus*][26] deprived osteology of a promising approach",[27] which, philosopher Ryan Feigenbaum concludes, is Goethe's unique non-anthropocentric comparative method.

[19] *Italian Journey*, Padua September 27, 1786.

[20] LA 9 I, p. 154.

[21] von Goethe (1995, p. 111).

[22] Camper (1784, pp. 93–94) and Blumenbach (1795, p. 33).

[23] Feigenbaum (2015, p. 73).

[24] Feigenbaum (2015, p. 75).

[25] The intermaxillary bone was discovered in humans well before Goethe (see Nordenskiöld, 1936). It is Goethe's unique approach that makes his discovery significant.

[26] I will discuss the role of the *typus* in Chap. 4.

[27] von Goethe (1995, p. 124)

Goethe's comparative method is remarkably modern as it requires the comparison of all possible forms, at all developmental levels, across the entire animal and plant kingdoms. Doing so means shedding any preconceived association that a natural object, be it an animal or plant, has with a particular function (functionalism) or assumed purpose (teleology). Goethe saw comparative science faltering due to its adopting an artificial "conventional terminology" that values Nature according to how well it serves their purposes and to what end (i.e. anthropocentricism). For example, "the statement 'The fish exists for the water' seems to me to say far less than 'The fish exists in the water and by means of the water'. The latter expresses more clearly what is obscured in the former; that is the existence of a creature we call 'fish' is only possible under the conditions of an element we call 'water', so that the creature not only exists in that element, but may also evolve there".[28]

Observation is difficult enough without being burdened with explanations about what purpose or function phenomena serve (i.e. functionalism and teleology). Take the intermaxillary bone as a case in point. The term itself excludes it from being associated with humans, in the same way that "gills" are associated with fish and some amphibians. The terminology and rhetoric alone would discourage anyone from looking for the intermaxillary bone (or gills) in humans. For instance, an eighteenth-century anatomist may not register the presence of a highly modified intermaxillary bone in humans. But look at the skull of a child or an embryo and there you find the human intermaxillary bone and gill slits. Conventional, that is eighteenth-century anthropocentric terminology in anatomy, as Goethe suggests, may hinder progress due to its association with certain objects, behaviours or processes. Semantics alone may stop us from seeing Nature objectively, as the eighteenth-century discovery of the human intermaxillary bone demonstrates. Language is not the only abstract concept that had prevented natural philosophers from viewing nature. Mathematics was another abstract concept that blinded the natural philosopher.

> The student assignment was to classify plastic toys in the shape of various animals: cows, penguins, walruses and dinosaurs. Students had to find characteristics that they could use to relate the objects within a hierarchical classification, that is, a taxonomy. Every year there are students who use characteristics unobserved in the plastic toys. One student insisted that her

[28] von Goethe (1995, pp. 54–55).

> plastic toy cow was warm blooded. Others were certain that their toys had backbones and hair. To disabuse them of their folly I cut a toy in half and exclaim "See, it's made of plastic!" They admit their mistake, yet they insisted on calling their characteristics legs, fins and wings.

Goethe's condemnation of conventional terminology or anthropocentrism in comparative anatomy is minor when compared to his polemic of Newton's *Optiks*.[29] Here Goethe attacks Newton's use of language and interpretations that "presuppose the very theory they are meant to prove".[30] For example, Newton uses the term "light" to refer to anything relating to colour, because, according to Newton, light is made up of rays. In Goethe's view, Newton is putting the cart before the proverbial horse. If Newton's theory sets out to "prove" that colour is a result of refracted light, or rays, of various colours, it seems impertinent to assume that colour comes from something unobservable, nay, from nothing. The objections set out by Goethe aren't radical, namely, that Newton is confusing his own prejudices with the phenomena, and like a true botanist he or she "must remain unmoved by beauty or utility in a plant" and "must explore its formation, its relation to other plants".[31] Note the comparative aspect to Goethe's method—to explore the relation to other plants—something that is lacking in Newton's explanatory approach. Goethe wishes to observe the observable, whereas Newton attempts to abstract the unobservable, namely, the behaviour of waves of light. We see this contrast in the discoveries of Uranus and Neptune.

Friedrich Wilhelm (William) Herschel is credited with discovering Uranus when he noted a "Nebulous star or perhaps a Comet"[32] on 13 March 1781. The way in which Herschel discovered Uranus heralded a break from traditional positional astronomy through a "different kind of knowledge and a different kind of observation".[33] Historian Simon Schaffer suggests that Herschel attempted a natural history of astronomy, in which he embraced the characteristics of light, such as size, brightness and colour, emanating from the stars through a telescope rather than accurate positional alignments that were traditionally used to calculate trajectory and orbit. The characteristics of a planet, comet or star's light,

[29] Newton (1704).
[30] Ribe (1985, p. 324).
[31] von Goethe (1995, p. 11).
[32] Herschel in Schaffer (1981, p. 12).
[33] Schaffer (1981, p. 23).

could be compared to other stellar objects in order to form a classification. Not only did Herschel's method of observing the stars differentiate him from other astronomers, but so did his background. Trained as a musician and in natural philosophy, Herschel characterised himself as a natural philosopher and viewed astronomers as mathematicians who, assisted by trigonometry, had "boldly ascended into the planetary regions, and measured the diameters and orbits of the heavenly bodies".[34] As a natural philosopher, his method was comparative, as all celestial objects have colour, shape and brightness, and a classification or catalogue would place each object into a natural class, run the same way a species is diagnosed and described within a biological taxonomy. Herschel's taxonomy of "double stars" almost reads like a species diagnosis: "1. Bootis [...] Ad dextrum femur in perizomate. Double. Very unequal. L. reddish; S. blue, or rather a faint lilac. A very beautiful object".[35] Herschel's "different kind of observation" focussed on qualities rather than mathematical abstractions as well as training one's eye: "Seeing is in some respects an art, which must be learnt".[36]

The discovery of Neptune in 1846 was a major departure from Herschel's method and one more familiar to astronomers at the time. Leaving the scandal as to whom first discovered Neptune to one side, the eighth planet was predicted to exist via mathematical astronomy, namely, through calculations based on the erratic orbit of Uranus. It fell upon French mathematical astronomer Urbain Le Verrier to predict the orbit, meaning that any astronomer could find the place of Neptune in the sky by pointing their telescopes in its direction. Neptune's orbit was communicated to the French Academy of Sciences, on 31 August 1846, by Le Verrier and observed by German astronomer Johann Galle a month later, on 23 September. The contrast between the discoveries of Uranus and Neptune couldn't be starker. One through observation alone and the other through mathematical abstraction, highlighting the differences between the approaches. Herschel's method required people to observe, compare and classify a known celestial body, whereas the method of mathematical astronomy was to identify a "hidden" object through measurement and observation. These two approaches are equally empirical and have been proven to work, however, Herschel's method is akin to

[34] Herschel (1782a, p. 82).
[35] Herschel (1782b, p. 115).
[36] Hershel to Watson January 7, 1782.

aesthetic appreciation, and dependent on clear images from large telescopes, while Le Verrier's is abstract and dependent on accurate mathematics.

What we see in Herschel's approach is a natural philosophy that incorporates artistic and scientific techniques that together offer *an experience* in which the organ of observation, namely the eye, is central. Goethe understood that Herschel's new discoveries "are a perfect match to the experience that I have told you several times before" (Goethe to Schiller 3 April [6 March] 1801). The mathematical approach to astronomy of Le Verrier denied an experience to the observer as the discovery was based on mathematics and geometry that lacked any external stimuli. The dichotomy between experience and abstraction is emphasised in the short novella by Goethe and fellow playwright Friedrich Schiller, *The Collector and his Circle*. The novella explores the organ that produces the experience in a conversation between a philosopher and his guest:

> "I [the philosopher]: I can assure you that I was not speaking as a philosopher just now, for these are matters of common experience.
> Guest: Do you call that experience, which no one else can understand?
> I: Each experience has its organ.
> Guest: Do you mean a separate one?
> I: Not a separate one, but it must have one peculiarity.
> Guest: And what is that?
> I: It must be able to create"
> Guest: Create what?
> I: The experience! There is no creative experience that is not itself created.[37]

The organ of perception, Germanist Alan Cotterel explains, produces the world of experience and, at the same time, is an organ of creation. Colour, for example, may be perceived by the eye, but at the same time, may create after-images such as complementary colours. Goethe explores these experiences as experiments in his *Zur Farbenlehre*, written between 1791 and 1807 and published in 1810.

Zur Farbenlehre or *Theory of Colours* is divided into three sections: the Didactic, Polemic and Historical. The Didactic section outlines the method, the Polemic section, mentioned above, criticises Newton, while the Historical explores previous studies of colour from Pythagoras up to

[37] Goethe and Schiller (1799, in Gage, 1980, p. 57).

his own age.[38] The Didactic section, divided into six parts, explores the physiological, physical and chemical nature of colour, its general characteristics, relationship to other fields, such as philosophy and natural history as well as its application in art and elsewhere. As Goethe notes in the introduction to the section "colour is an elementary phenomenon in nature adapted to the sense of vision; a phenomenon which, like all others, exhibits itself by separation and contrast, by commixture and union, by communication and dissolution: under these general terms its nature may be best comprehended".[39] The point of the Didactic section was to class the phenomena of colours, something Goethe claims had been done twice since his own Theory, by their appliance to the viewer in the form of natural light as opposed to artificially created colour, such as pigments and paints. In this sense, it is us, *the observer*, who gets to explain how colour appears through a series of experiments outlined in each part. Armed with a prism anyone can recreate Goethe's light experiments and experience exactly what Goethe had done when writing his *Zur Farbenlehre*. Moreover, both laypeople and artisans will be able to understand the phenomenon of colour and its behaviour without understanding complex mathematical equations or geometry as "they were the first who perceived the insufficiency of the Newtonian doctrine".[40] It is Goethe's Polemical section that draws the greatest criticism, namely, in his *explanation* of light,

> Light is the simplest, most elementary, most homogenous entity that we know. It is not composite.[41]

Goethe's denial that white light contains variously refrangible coloured light was a belief he held until his death. The controversy is not helped in that Goethe and Newton understood *theory* to mean two different things. The theory for Goethe wasn't a "set of propositions" or a mathematical model, rather it was "more akin to something suggested in the root meaning of the ancient Greek *theoria*, which was the activity of the spectator, a seeing and recognising, a sense also conveyed by the German

[38] The last reported study was that of Robert Blair and his Experiments and Observations on the unequal Refrangibility of Light (Transactions of the Royal Society of Edinburgh, Vol. 3, 1794). Unfortunately, Goethe did not comment on Mary Gartside's *An essay on a new theory of colours* (1805, 1808), which complements his own *Theory* quite nicely.

[39] von Goethe in Judd (1970, p. liv).

[40] von Goethe (1970, p. lxi).

[41] Goethe in Duck and Perry (2016, p. 233).

Anschauung".[42] The non-mathematical approach that *Zur Farbenlehre* advocated was sadly rejected by physicists of the nineteenth century, who increasingly relied on mathematics. There lies the crux of *Zur Farbenlehre;* it attempted to challenge the abstract view of nature, one that is divorced from experience and wedded to mathematics. Canadian art historian Gerald E. Finley summed up Goethe's beef with Newton succinctly: "[Goethe] had opposed his mathematical approach to colour in the *Opticks* since, because of the highly abstract nature of mathematics, he believed that it was difficult to reconcile its results with the human perception of colour" (Finley, 1991, p. 40). Without that human perception, Newton's *Opticks* was just another distraction from direct observation, analogous to the mathematical astronomy that had failed to observe Uranus. Moreover, the confusion between optics, something that Goethe admits "cannot dispense with mathematics",[43] and colour theory, also meant that many scientists dismissed the phenomenology of colour as highly subjective and not worthy of scientific pursuit. While *Zur Farbenlehre* may seem to have failed in the minds of Newtonians and conventional scientists, it was, as Philosopher Dennis Sepper offers "a new beginning for colour science".[44] What Sepper means is that Goethe's Way of Science addresses the relationship between theory and phenomenon, not just in colour but in all its forms. That is, it does not intend to abolish hypothetical or abstract science, but offers an alternative, namely, evidence-based science, in which our observations and experiences of phenomena serve as both the experiment and theory. We experiment with colour using, for example, Goethe's examples and a prism, from which we form the theory, by observation and recognition, from which we come to an understanding of Nature. Goethe's Way of Science is an evidence-based science of *form* that makes no propositions beyond what we can observe. The "hidden" process such as Newton's rays of light or elementary particles and the course they take through a prism are beyond what we can observe. Naturally, there is room for such hypothesis-based science, one that is highly reliant on mathematics, but it comes *after* we have understood form.

Form is also a loaded term as it mostly pertains to a static physical morphology. Think of museum specimens stuffed with cotton or pickled in jars. Many scientists cringe when confronted by museum collections as

[42] Sepper (1988, p. 17).
[43] von Goethe in Judd (1970, p. 287).
[44] Sepper (1988, p. 179).

though they are artefacts from the past, only comparable to antique brass tubed microscopes squirrelled away in dark mahogany cupboards in dusty rooms. Far from it! Form is dynamic and alive. Think of physical movement, a dancer perhaps, or water swirling down a creek. Other types of forms are a rainbow, a colourful mural, a Henry Moore sculpture and a Beethoven symphony. These all are types of form and each has its own morphology or shape, and its own sets of unique and shared qualities. Goethe's way of science applies to all types of forms that can be observed and appreciated by an observer, who in turn creates the experience.

In the story *The Collector and his Circle,* Goethe and Schiller point out the dichotomy between experience as unique to an individual and experience as common and shared. If the organs of experience are us, our eyes and our mind, then collectively together we will be able to share the same experience. In his colour experiments, published in *Farbenlehre*, you can experience the exact same colour phenomena that Goethe experienced over 200 years ago. Goethe had even made provision for those with colour-blindness in his section on Pathological Colours: "they could not distinguish green from dark orange, nor, more especially, from a red brown".[45] The common experience is shared. Think of the emotional responses to ballet or opera, meaning that form can be the subject of experimentation by sense perception and theory. As in normal scientific experimentation, the form may be repeated and the same experience produced. Perhaps Herschel and Goethe were on the same path creating an alternative science of observation and shared experience? "Too much has hitherto been taken for granted in optics", says Herschel, a sentiment also shared by Goethe, as "every natural philosopher is ready enough to allow the necessity of making experiments, and tracing the steps of nature; why this method should not be more pursued in the art of seeing does not appear. Theories are only to be used when proper data are assigned; but the data are carefully to be re-examined, when new improvements may widely alter the result of former experiments".[46] Even in the final days of the Enlightenment, natural philosophers were concerned with the disconnection between humans and Nature. For Herschel, it was the over-reliance on mathematics to make predictions about the positions of planets, stars and nebulas in the sky at the cost of not actually seeing their qualities in the form of brightness and colour. Goethe had the same

[45] von Goethe (1970, p. 47).
[46] Herschel (1782a, b, pp. 91–92).

misgivings. Newtonians placed too much emphasis on the abstract and metaphysical at the cost of not understanding the nature of colour, how it behaves and produces new experiences. It did not help separating scientists from artists, the latter inserting the right to explore form and common experience, while the former remained blinkered, debasing experience as subjective and irrelevant. Ironically it is in the Enlightenment where the Modern Hubris begins and where attempts to establish a science of qualities and experience seemingly had failed. Or did it?

Natural history did not dispense with observation and the production of common experiences entirely. Geology and biology still required observation, experience and recognition as a basis to identify and classify minerals, rocks, soils and organisms as well as their parts. The fields of mineralogy, petrology, pedology and biological taxonomy employ aesthetic appreciation, one that requires an observer to produce an experience.

Let us, as observers, compare these natural objects, the hind-limbs of a giraffe and a cat (Fig. 3.1).

Look at these hind-limbs and compare the bones. Notice how the giraffe seems to have an extra bone in its leg? If we follow the bone down from the hip, we see the femur (*a*) then the fibula (*b*), but unlike the cat, there is another elongated bone where the ankle and foot should be. The cat has a very long foot consisting of the tarsals (*c*), metatarsals (*d*) and

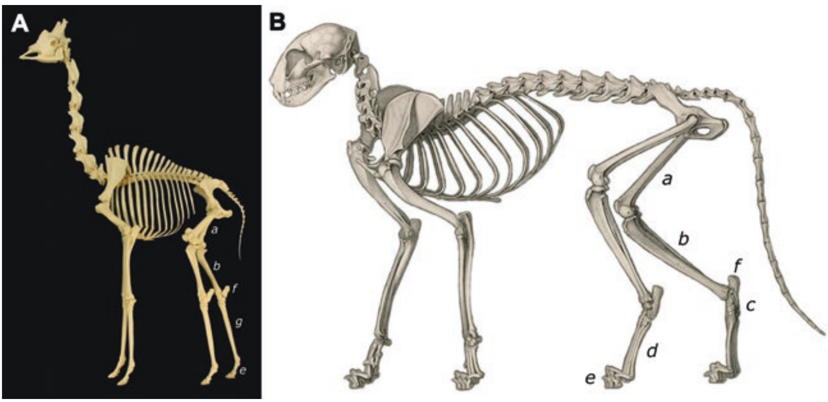

Fig. 3.1 (**A**) The hind-limbs of a giraffe; (**B**) the hind-limbs of a cat; *a*. the femur; *b*. the fibula; *c*. tarsals; *d*. metatarsals; *e*. phalanges; *f*. heel bone; *g*. cannon bone. Wikimedia Commons, License CC0 1.0. Source Wikipedia

phalanges (*e*), but both the giraffe and the cat have a long protrusion just under their fibula called a *tuber calcaneus* or the heel bone (*f*). Now compare the equivalent bones in a human foot. See how these are different manifestations of the same structure. Let's move down to the metatarsals in the human, the long bones in our feet (between our toes and heel). These seem to be longer in cats. In fact, cats walk on their tippy-toes. Now look at the same structures in the giraffe—they are incredibly long, making up much of what we think of as the leg.[47] Rather than having the four metatarsals as humans do, giraffes just have one,[48] which they use, not as a foot, but as a leg (*g*). Giraffes have taken walking on tippy-toes to the extreme. But these structures are the same, and when seen individually as single bones have enough characteristics for an anatomist to identify them as such. The anatomist does this because they are observing, recalling and recognising different manifestations of the same structure.

As observers, we have observed cats, giraffes and people previously and experienced the way they appear and move, meaning we are able to recognise them by recalling previous manifestations of these forms. After all, this may be the first time you have seen the bones of a leg or foot, and yet you are able to recognise them in their different manifestations. The eye and mind interacting with the object producing the experience, and our ability to recognise by recalling past experiences, is what Goethe termed *Anschauuang*. The limits of our observations produce a collective experience of all the different types of cats we have seen previously. That collective experience or *idea* is the *urphenomenon*. Anschauuang and the urphenomenon are not restricted to natural objects. Any object may be appreciated in this way, whether it be a mineral, an organism or a piece of art. What is central to Anschauung is an observer who produces an experience, which is, in effect, a discovery. The scientific inferences and hypotheses, such as the notion of rays or elementary particles and the mathematics that it involves, come after the discovery of the urphenomenon. Herschel discovered Uranus through observation, and by recording a wobble in the orbit of the seventh planet Le Verrier predicted the orbit of Neptune. But prediction alone isn't enough, as Neptune had to be observed before it could be said to exist. The inferences and mathematics of the Enlightenment are analogous to present-day Big Data. That disconnection between our

[47] Craig Holdrege has examined the Giraffe in great detail in his book *The Giraffe's Long Neck* (Holdrege, 2005).

[48] Fused metatarsals known as the cannon bone.

own Anschauung, the urphenomenon, and the object is a result of the Modern Hubris, in which we believe that the inferences, models and mathematics replace, rather than supplement, our own observations. Already, there have been attempts to "train" algorithms to "learn" human behaviours like seeing. One such Artificial Intelligence or AI methodology "facilitates attribution of drawings of unknown authors [...] based on quantifying the characteristics of individual strokes in drawings".[49] The AI hopes to outperform the Morellian analysis pioneered in the nineteenth century as well as more modern techniques, such as carbon dating, chemical analysis and x-rays, by allowing the algorithm to catalogue and thereby identify the brush strokes of classic artists, such as Pablo Picasso, Henry Matisse or Egon Schiele. The AI has been shown to be efficient at spotting fakes, so much so, that some have entertained the idea that "A.I. seems to understand the secrets of artistic genius better than we do ourselves" and that "while machines might not yet be able to make good art, they are getting eerily good at appreciating it".[50] We could ask ourselves if "appreciating" is the correct verb. The AI is certain doing something, but it is not appreciating art, rather it is quantifying and identifying brushstrokes. No experience is produced. By anthropomorphising AI—in fact, the term "Artificial Intelligence" is itself anthropomorphic—we replace our own observations with that of a supplemental tool. The Modern Hubris, born in the Enlightenment, is still with us today in the form of Big Data, AI and technology. Goethe's attempt to preserve a science of observation, one that is wedded to our own perception and experience, was perhaps the first attempt to thwart the Modern Hubris. Goethe's Way of Science is personal as much as it is empirical, and one way to re-establish that connection between us and Nature is to understand Anschauuang and the urphenomenon.

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[49] Elgammal et al. (2018).

[50] https://www.theguardian.com/us-news/2018/aug/06/the-new-tool-in-the-art-of-spotting-forgeries-artificial-intelligence

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CHAPTER 4

Anschauung and the Urphenomenon and the Path to Discovery

Abstract This chapter begins with a conversation between Goethe and Schiller in 1794 and how a slight misunderstanding resulted in confusing what Goethe called an idea, namely, the urphenomenon, with a fiction or theory. I attempt to diffuse this misunderstanding by providing several examples in which you can use your own Anschauung and urphenomenon, and how, with a little training, you can use them precisely and scientifically. I also show how Goethe may have stumbled onto the urphenomenon during his travels in Italy while studying the architecture of Palladio. We return to Goethe and Schiller's conversation and show how important the urphenomenon was as an idea, rather than as a theory.

Keywords Schiller • Urphenomenon • Palladio

The meeting of two legendary minds, namely that of Goethe and Schiller, is a watershed moment in aesthetic appreciation towards the end of the Enlightenment. Each represented a unique view of aesthetic appraisal that helped shape the Modern Hubris.

The two differing views of Schiller and Goethe were revealed on the night of 20 July 1794, after the Meeting of the Natural Research Society[1] in Jena. Schiller had been trying to reach out to Goethe with little success, even residing near him in Weimar between 1788 and 1789, then moving

[1] Tagung der Naturforschenden Gesellschaft, Jena (Golz et al., 1995).

M. Ebach, *Goethe in the Age of Artificial Intelligence*,
https://doi.org/10.1007/978-981-19-6741-2_4

on to Jena to take up a position at the university. A brief meeting in 1788 proved unfruitful and Schiller was keen to get Goethe to join the staff of his monthly philosophy, art and history journal *Die Horen*.[2] On the night of 20 July, Schiller and Goethe bumped into each other while leaving the meeting. Goethe describes the encounter:

> We reached his house, and the conversation drew me inside. There I gave an enthusiastic description of the metamorphosis of plants, with a few characteristic strokes of the pen I caused a symbolic plant[3] to spring up before his eyes [...]. But when I stopped he shook his head and said, "That is not an observation from experience. That is an idea". Taken aback and somewhat annoyed, I paused; with this comment he had touched on the very point that divided us. It evoked memories of the views he had expressed in *On Grace and Dignity*; my old resentment began to rise in me. I collected my wits, and replied, "Then I may rejoice that I have ideas without knowing it and can even see them with my own eyes".[4]

Rather than ending an already strained relationship, it blossomed into one of the great friendships[5] of the Romantic Period, ending with Schiller's untimely death in 1805. Let us, however, take a step back to understand what happened in what was, presumably, Schiller's study.

Goethe had been bothered by the influential essay *On Grace and Dignity* that was published in Schiller's short-lived journal *Neue Thalia* a year before, in 1793. In it, Schiller critiques Kant's moral philosophy,[6] but it is not the philosophical underpinnings that Goethe takes umbrage with, rather it is how the act of human aesthetic appreciation is described. Take, for instance, Schiller's remark that "there are two ways by which phenomena become objects for reason, and are capable of expressing ideas".[7] The first is objective, in which the idea is received from the object. The second is "supremely subjective", in which expressions are *made* independently of the phenomenon. Goethe does not specify which part of *On Grace and*

[2] Robertson (1902, p. xxiii).

[3] The symbolic plant does not refer to the Urpflanze, an idea Goethe had by this time abandoned. Rather the drawing would have been "a representation of the different stages of metamorphosis" (see Boyle, 2000, p. 837–838, footnote 223).

[4] von Goethe (1995, p. 20).

[5] Goethe and Schiller's relationship is still celebrated in Germany today in the form of street signs: Every Goethe Strasse intersects a Schiller Strasse.

[6] See Baxley (2010).

[7] Schiller (1988, p. 345).

Dignity upset him, but in the context of Schiller's remark, the symbolic plant is *subjective* and independent from experience.[8]

Schiller may have been surprised by Goethe's reaction. After all, Goethe had not published anything of substance on his own ideas about aesthetic appreciation. The *Metamorphosis of Plants* did not discuss the topic, and his *Theory of Colours*, which does deal with aesthetic appreciation, was over a decade away. Even Goethe's own account of the event, *Fortunate Encounter*, written in 1794 (published in 1817), doesn't account for Schiller's ignorance of Goethe's unpublished views. Even the use of the term "old resentment" is somewhat unfair as Goethe only discovered his own aesthetic appreciation six years earlier in 1787 on his Italian journey. Needless to say, in Goethe's own telling of the story, Schiller's aesthetic appreciation still hit a nerve. What, then, were Goethe's views on the matter of aesthetic appreciation, and why react in such a manner?

In *A Study Based on Spinoza*, written between 1784 and 1785 (published posthumously in 1891), we find a reasonable response. Rather than the Cartesian dualism of objective versus subjective, Goethe embraced Spinoza's monism, namely, "a living thing cannot be measured by something external to itself; if it must be measured, it must provide its own gauge. This gauge, however, is highly spiritual, and cannot be found through the senses".[9] To use Spinoza's terms, the object can only be measured subjectively rather than, say, mechanically (i.e. objectively).

At first, the difference between Schiller and Goethe seems laughably trivial. Look again and the vastness between the two modes of thought becomes apparent. In Goethe's thinking, Schiller's "subjective" is clearly *objective* and vice versa. For instance, what many consider to be objective, namely, mechanical measurement is, for Goethe, highly subjective. "Even in the circle", Goethe explains, "the gauge of the diameter may not be applied to the periphery". That is to say, that the diameter is measured as twice the radius or, if you know the circumference, it is divided by *Pi* only if we assume it is a perfect circle. In nature, the circle will not be perfect, and therefore the mathematics used to calculate its circumference is "subjective", that is, it doesn't represent the circle in Nature, but a wholly

[8] Schiller did make several comments that may be loosely translated at taking aim at Goethe, namely, "in respect of those poetic geniuses, who become famous, sooner than they are mature…" (Schiller, 1988, p. 390). Regardless, if Goethe only had found umbrage with these comments then it would be unusual to recall it during conversation on botany.

[9] von Goethe (1995, p. 8).

abstract one. These two modes of thought present a conundrum. Our ability to observe and experience the phenomenon is objective. Once we explain abstractions, say, by creating a mathematical model, our explanation becomes subjective. See how it jars with the twenty-first-century scientific mode of thought. By adding in human experience, we as scientists immediately render it subjective, since the human mind is not infallible and would never be able to accurately recall or physically reproduce the phenomenon. By measuring it or photographing it, the phenomenon is accurately captured. Yet, for Goethe, the phenomenon is best "captured" when we, that is, our experiences, become part of the phenomenon. By removing or replacing the phenomenon and the experience with abstractions, we effectively remove ourselves. The abstractions take away information and understanding from the phenomenon. Take this Necker cube, for example (Fig. 4.1):

As a static object on a screen or on paper, it is nothing more than 12 lines that form a shape. Once you introduce your own senses and actively participate in observing the shape, you discover that you can see a box, in fact two boxes, each facing a different direction. This is not simply a trick or an illusion; the image can be actively viewed as one of two cubes (Fig. 4.2).

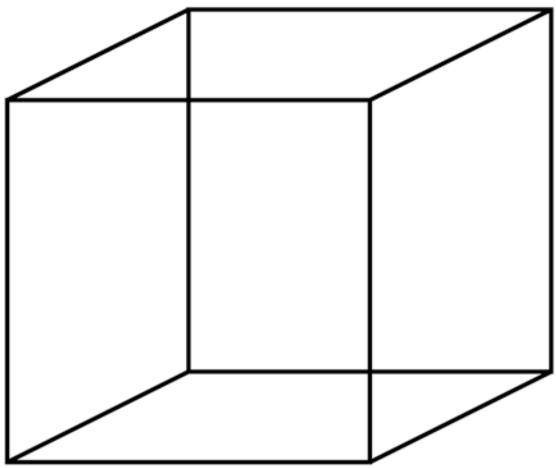

Fig. 4.1 A Necker cube. Wikimedia Commons, License CC0 1.0. Source Wikipedia

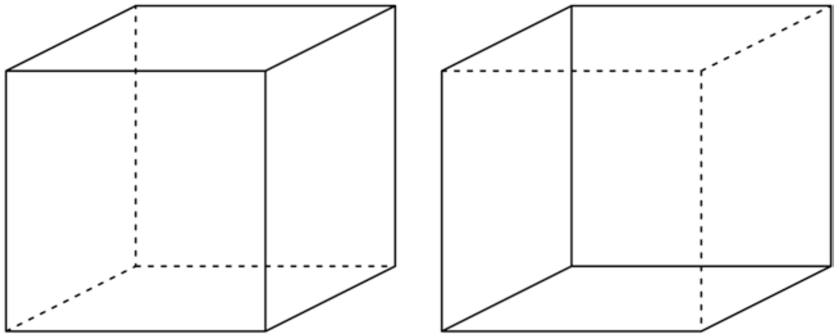

Fig. 4.2 The two different manifestations of a Necker cube. Wikimedia Commons, License CC0 1.0. Source Wikipedia

Through active observation, the phenomena reveal themselves as part of our experiences. Goethe called this Anschauung and, given that it is an in-built process, we may consider it to be the pinnacle of human discovery. Let us explore Anschauung further in the next image (Fig. 4.3).

The rabbit and duck image first appeared in the German magazine *Fliegende Blätter* under the heading "Which animals are most similar to another? Rabbit and duck"[10] If you look at the eye, you can see a rabbit looking to the right. Look again and you can see a duck looking to the left. As a static image, it is neither, until you look at it (Anschauung) and suddenly the phenomenon reveals itself. Anschauung can also help us identify phenomena. Consider the next image (Fig. 4.4).

Here, we see an animal, in fact, a mammal, even though we cannot see some of the diagnostic characteristics, such as lactating glands and the vertebral column. We can see through Anschauung that the animal has hair and, as we recollect from previous observations of dogs, cats and so on, we "see" in our mind's eye a *mammal*. But what kind of mammal is it? I can rattle off information that is impartial and not part of the phenomenon you are seeing. I can give you its scientific name, *Galemys pyrenaicus*, or a snippet of its mitochondrial DNA,

TCTTGTAGAA TGGATCTGAG GTGGCTTCTC AGTAGACAAA GCAACACTCA CCCGATTCTT.[11]

[10] The original reads "Welche theire gleichen einander am meisten?" Anon (1892).
[11] CYTB gene for cytochrome b. Positions 61–120, GenBank: LT799646.1.

Fig. 4.3 The duck and rabbit image. The text translates as "Which animals are most similar to another? Rabbit and duck". From *Fliegende Blätter* (1892, Vol. 2465, p. 147). Wikimedia Commons

Fig. 4.4 A Russian desman (*Desmana moschata*). Copyright Didier Descouens, Wikimedia Commons, License cc-by-sa-4.0. https://commons.wikimedia.org/wiki/File:Desmana_moschata_MHNT.INS.10.jpg

Fig. 4.5 A European mole (*Talpa europaea*). Copyright Didier Descouens, Wikimedia Commons, License cc-by-sa-4.0. https://commons.wikimedia.org/wiki/File:Talpa_europaea_MHNT.jpg

I can even tell you where it is found—in the Pyrenees, northern Spain and Portugal—but none of this gives us any understanding of this mammal. We crave an "ah ha!" moment when the mammal fits into our understanding of previous experiences that we "see" in our mind's eye. Yet, there are some things that are familiar. It has beady little eyes and a long and hairy nose; in fact, it looks something we have seen before—a mole (Fig. 4.5).

Another Anschauung reveals a relationship between these two phenomena, yet no abstract information has assisted us with identifying the mole-like creature, as a desman. Yet we made a discovery—an "ah ha!" or "Eureka!" moment, namely that desmans are a *manifestation* of a mole-like organism. If we were to look at other mole-like organisms, called talpids, we would find similar forms and, if we were to look harder, we would see that the leg bones are partially fused. But how do we make sense of the leg bones in the talpid? What is a leg bone—the tibia and the fibula—and how would we recognise it in a mole?

The ability to "see" manifestations of forms in other objects is key to Anschauung. We may see a mole in a desman or, in the case of the mammalian forelimb, we may recognise manifestations of the same bone in different mammals. Note how I use the term “same”. The metatarsal, for example, is an imagined bone, of which there are many manifestations. We never directly observe the *idea* of a metatarsal, rather we see individual examples throughout the Mammalia. We will return to this concept later. It is important to note that we have restrictions on what we can observe and experience and retain in our mind’s eye. The cube example above is limited to three manifestations of the same form: the cube pointing left, the cube pointing right and the parallelogram. These are the limitations of what we can see. Beyond that, we are imagining new abstract forms that we have not observed. The object limited by Anschauung is termed the *urphenomenon*, neither of which is in any way static. During Anschauung, we interact with the object and the urphenomenon presents itself in our mind’s eye. It changes as we discover more objects, such as a bat’s wing or a dolphin’s fin. A biological taxonomist, for example, uses Anschauung to develop the urphenomenon. Taxonomy uses Anschauung as it combines what the taxonomist has experienced, namely, the urphenomenon. Let us practise Anschauung with a recently described trilobite from Tasmania in Australia, *Gravicalymene bakeri* (Fig. 4.6).

At first glance, I can tell simply by its shape that it is a trilobite and specifically that it is a phacopid, in the taxonomic Order Phacopida. I know this as I have observed many phacopids as a student. Phacopids have a large cephalon, or head, and a generic thorax with rounded pleurae (the segments) and a wide, stout pygidium (tail). Classic phacopid. What sort of phacopid is it? More importantly, is this a new species? I notice that in the lower-middle part of the cephalon (the glabella) there are two pairs of large and round protuberances called lobes (see Fig. 4.7). I also notice that the glabella, without its free cheeks, is hat-shaped (not a technical term or a natural characteristic but will do for a quick identification). Immediately I recognise this as a calymenid (I have observed 100 of them). Just examining the sheer number of specimens a student needs to observe, it may take four years before they can identify a trilobite down to the taxonomic rank of family, genus or species. That is four years of Anschauung and carefully developing the urphenomenon in their mind’s eye. For a professional taxonomist, more Anschauung is required. After all, we wish to know if this is a new species (or not).

A taxonomic key, a classification system designed to identify organisms, would help someone unfamiliar with this group find the correct name to describe this organism. Through Anschauung, the process is far more

Fig. 4.6 A dorsal photograph of the Ordovician trilobite *Gravicalymene bakeri*. Photograph by Patrick Smith

intuitive, that is, based on experiences and recall. Before we venture further, it is important to distinguish between the organism and the name of the organism. The organisms we call calymenids all share different manifestations of the same form. For the purposes of communication, we could leave it there, and state that we have a type of calymenid or phacopid or even trilobite. Each of these has a unique set of manifestations (characters) that it shares with nothing else. Applying a name to a particular manifestation of a form is largely trivial. The application of a name is about communication as in "could you please pass me the calymenid". The name does not embody the form and its various manifestations. The name could change as indeed many scientific names have in the past. Rather the name is a way to communicate a particular urphenomenon and its interrelationships with other urphenomenon.

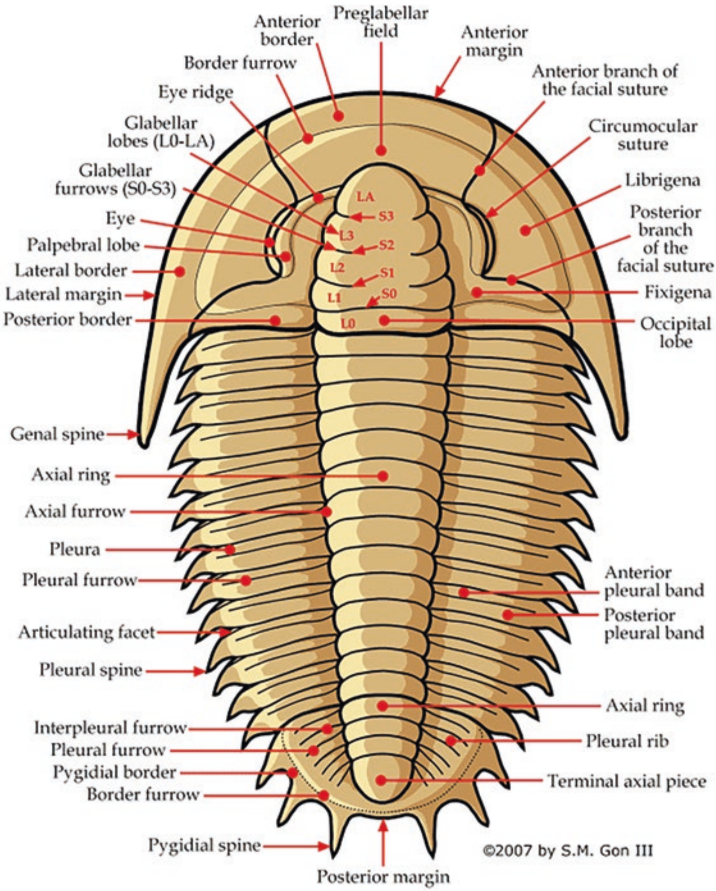

Fig. 4.7 Trilobite dorsal anatomy. Copyright Sam Gon III. Used with permission

When we observe trilobites, we see their characteristics, which via Anschauung are recalled in the mind's eye as an urphenomenon. The calymenid we see before us may be one of many forms. As a phacopid, the cephalon provides the most diagnostic characteristics, one of which is bullet-shaped glabella with deep glabellar furrows and distinct lobes (L0, L1 and L2) and suture furrows (S0, S1 and S2). Since we are attempting to identify the calymenid to a name at the genus level, we will need a key or diagnostic list of properties. A taxonomic key or diagnosis refers to a type specimen, namely, a token individual specimen that is linked to a taxonomic name. Our Tasmanian specimen looks like it might be *Gravicaylmene* or *Flexicalymene,* which are two very similar calymenid forms. But what do we know about *Gravicaylmene* or *Flexicalymene*? We know that both genera were diagnosed and described by Jack Shirley in 1936 as

> *Flexicalymene*: "glabella outline sub-parabolic to bell-shaped; preglabellar field stretched forwards or recurved …".[12]

> *Gravicaylmene:* "glabella outline bell-shaped; preglabellar field recurved with roll-like edge …".[13]

Looking at our Tasmanian specimen, we find that the preglabellar field has a "bell-shaped" glabella outline, confirming that it is likely to be *Gravicaylmene*. Identification such as this is not straightforward; much data are missing and there are only a few specimens available to examine. What do we know about our Tasmanian trilobite? We know its form is clearly a manifestation of a calymenid, which is a manifestation of a phacopid. The more specimens we look at and the more characteristics (and their manifestations) we see, we start to form the phacopid and calymenid urphenomena. Yet, we cannot draw or picture a phacopid or calymenid urphenomenon. No single static picture can capture the entirety of manifestations of each characteristic. Rather the urphenomenon is a dynamic ever-changing image in our mind's eye, namely, what Goethe drew in Schiller's study and what Schiller called an "idea". The experiences involved to simply say "it's a calymenid" takes years of intensive training to attain. Even the genus designation is somewhat in doubt as Shirley's diagnoses are somewhat vague. Some may argue, and indeed some have argued, that *Gravicalymene* and *Flexicalymene* are both synonymous, meaning they are two names that designate the same thing, indicating that more collection, observation and diagnostic characters are needed. Anschauung may be in-built, but it needs discipline, practice and training.

[12] Shirley (1936, p. 395).
[13] Shirley (1936, p. 395).

Anschauung and the urphenomenon are discoveries that Goethe made through his own aesthetic appreciation; after all, aesthetic appreciation *is* Anschauung that can be refined through practice and training.

> A car drove up to a lonely outcrop, along an empty road somewhere in northern Tasmania. I got out of the car and headed straight for the limestone outcrop, keen to relieve myself. As I stood there I noticed the limestone had a thin layer of mudstone within. Limestones often have mudstone lenses formed when mud, possibly from the nearby coast had flooded the reef. I first noticed a form in the mudstone, then it jumped out at me. One, three, no … 10 trilobites! The fossils were embedded in a mudstone layer only a few millimetres thick. Suddenly they were everywhere. I recognised certain forms: calymenids, asphasids, lichids, styginids! I wondered how many people had seen this outcrop and the trapped forms within it? How many had seen these forms and not recognised them as trilobites? How many? My practice and training had really paid off.

Goethe's first foray into observing animal morphology was in 1784–1786, when he tried to settle on whether humans had the *os intermaxillare* or the intermaxillary bone. On 27 March 1784, Goethe wrote to Herder that he and anatomist Justus Christian Loder had discovered the *os intermaxillare* by comparing animal and human skulls "and saw there it is". Goethe dipped his toe into morphology before his departure to Italy in August 1786, but the difference between his views before and after the journey is a testament to his insight into Anschauung. His 1784 discovery of the intermaxillary bone with Loder does not allude to the aesthetic appreciation he extols in later encounters. Take this account, written in 1794,

> For years already I had laboured in vain along the traditional path, and had wondered if another path—a better one—might not open up for me. I readily admitted that human anatomy required infinite precision in describing each part of the individual bone and grasping the manifold variations in every aspect of the bone. The surgeon must know how to find the inner wound with eyes of the mind, sometimes without the help of the sense of his touch; thus he finds it necessary to apply the most exacting knowledge of the detail to gain a kind of penetrating omniscience.[14]

[14] von Goethe (1995, p. 127).

Goethe abandoned this approach as ill-suited to comparative biology, after a "long and fruitless labour", in favour of "constructive relationship" one which moves away from number and quantity, which "dissolve from and banish the spirit of a living perception". Douglas Miller refers us to Faust,

> When scholars study a thing, they strive,
> To kill it first, if it's alive;
> They have the parts and they've lost the whole,
> For the link that's missing is the living soul.[15]

That living perception is Anschauung, one that moves away from the quantitative to the qualitative. How then did Goethe pick up on Anschauung in the first place? Here is a clue:

> Every path leading to a new discovery has its own influence on opinion and theory. We can hardly resist the thought that what led us to a phenomenon is also the origin, the cause of the phenomenon. We then persist in this belief instead of thinking the opposite approach and putting our first opinion to the test in order to gain the whole.

Goethe's observation, written in 1823, is remarkably modern and resonates well with twenty-first-century biology. The discovered phenomenon is obscured by opinion, namely, models and hypothetical processes, something that Goethe thought would hinder or even paralyse science. In the same piece, Goethe makes an interesting analogy,

> What would we say of an architect who entered a palace by the side door and then tried to relate everything in his description and drawings to the minor aspect he encountered first? Yet in the science this happens every day. We must acknowledge this as a historical fact, but it is hard to admit that we ourselves are still caught in these shadows.[16]

The architecture was possibly Goethe's first insight into Anschauung, particularly during his Italian journey. While in Venice, Goethe lost his way "in the remotest quarters of the city […]. Finally one does disentangle oneself, but it is an incredible maze, and my method, which is to acquaint

[15] Faust I, lines 1936–1939.
[16] von Goethe (1995, p. 42).

myself with it directly through my senses, is the best".[17] The Italian journey was to reconnect Goethe with the world and his senses. "At present I am only concerned with sense impressions, which no book, no picture, can give. The fact is that I am taking an interest in the world again, am trying my powers of observation, and testing the extent of my knowledge and scientific training".[18] Two things excited his senses, architecture and botany, the latter being encapsulated in his copy of Linnaeus *Species Plantarum*, essentially an identification guide to plants. The early accounts of his Italian journey were a mix of discussing the work of the Italian Renaissance architect Andrea Palladio and botany. While in Vicenza, Palladio's hometown, Goethe visited the botanist Antonio Turra, who had "concentrated passionately on botany" but had left it to pursue medicine. The meeting wasn't a great success. Turra refused to show his collection and the conversation "soon faltered and stopped".[19] On the same evening, Goethe met Ottavio Bertotti Scamozzi, architect and editor of Palladio's work, who was far more engaging and offered some guidance. The stark difference between Turra and Scamozzi reflected Goethe's own feelings towards form. While feeling competent in the ways of architecture, Goethe would lament that "my botanical philosophy remains stuck at this point, and I do not know how to proceed". He knew that taxonomy was not done arbitrarily and that some method was involved, but what that method was puzzled him. "Here in this newly encountered diversity [of plant forms] that idea of mine keeps gaining strength, namely that perhaps all plant forms can be derived from one plant".[20] At this point, it is necessary to pick apart what Goethe wrote in his diary and what he published as his *Italian Journey* 30 years later in 1816. Goethe didn't detail his botanical ideas in his diary, rather he wrote,

> "Once again I've had my botanical ideas splendidly confirmed. It will certainly command I'm advancing further. Only it's odd and sometimes it makes me afraid, that such an immense amount is as if pressing in on me that I can't fend off, so that my existence is growing like a snowball, and some-

[17] Italian Journey, Venice September 30, 1786.
[18] Italian Journey, Trento September 11, 1786.
[19] Italian Journey, Vicenza September 21, 1786.
[20] Italian Journey, Padua September 27, 1786.

times it feels like my head can't grasp it or stand it, and yet it's all developing from within, and I can't live if that doesn't happen".[21]

The idea "that perhaps all plant forms can be derived from one plant" was added later in the 1816 edition. Whether Goethe thought this at the time is academic, although one may speculate that his 1817 *Zur Morphologie,* which he put together at the same time, may have influenced his edited 1816 *Italian Journey.* What is important is that Goethe had been pondering his botanical ideas at the same time he studied Palladio's four volumes *I quattro libri dell'architettura*, which he had picked up in Padua on the same day in 1786. Palladio's *dell'architettura* presented Goethe with rules of construction. In case of columns, for example, Palladio describes the five orders of the ancients, "the Dorick must always bear the Ionick, the Ionick the Corinthian, and the Corinthian the Composite. The Tuscan is so rude and material, that it is seldom used above ground, unless it be for a Rustick Edifice of one Order only".[22] Much of Palladio's sets of rules derives from *De architectura* written by the Roman Vitruvius, a copy of which Goethe picked up in Venice, "I am glancing through it, and am left with many a valuable impression".[23] Did those impressions, left by Palladio and Vitruvius, really influence Goethe's botany? Lowe and Sharp seem convinced that Palladio may have influenced Goethe's ideas on metamorphosis. A starker connection can be made if we compare Goethe's scientific writings with that of Palladio. It is worth comparing Palladio's order of columns ("measures if the Tuscan Order as taught by Vitruvius[24]") to Goethe's 1789 Outline for a *General introduction to comparative anatomy, commencing with osteology*:

[21] Goethe Tagebuch 27 September 1786; in Reed (1999, p. 58), see also von Engelhardt (2003, p. 169–170).
[22] Palladio (1742, p. 11).
[23] Italian Journey Venice October 12, 1786.
[24] Palladio (1742, p. 15).

VI. The osteological type organised in its parts	*Measures of the Tuscan order, as taught by Vitruvius*
(A) The head	(A) Abacus
(a) *Ossa intermaxillaria*	(B) Ovolo, or Echinus
(b) *Ossa Maxillae superioris*	(C) Collarino, or Frise of the Capitel
(c) *Ossa palatina*	(D) Astragal
(d) *Ossa zygomatica*	(E) The Body of the Column above
(e) *Ossa lacrymalia*	(F) The Body of the Column below
(f) *Ossa nasi*	(G) Listella, or Cincture, or Annulet
(g) *Ossa frontis*	(H) Torus, or Tore
(h) *Os sphenoideum anterius*	(I) Orlo, or Plinth
(i) *Os ethmoideum*	(J) Pedestal, or Stylobatum
(j) *Conchae*	
etc.	

Here, we see the urphenomenon revealing itself. "The head", for example, is conceptual in that it refers to all mammalian heads, *in the same way* that the "Abacus" refers to all abacuses in the Tuscan order. To be able to compare different mammals, we need a type—an individual, or a description of an ideal individual, which has all the parts of the head, for instance. Throughout his *General introduction to comparative anatomy,* Goethe uses the same approach for organisms as Palladio and Vitruvius did for architecture. Each mammal has an *Ossa intermaxillaria* or intermaxillary bone, but their manifestations vary, for example, between mammals, such as a human and a horse. So do the manifestations of a plinth (or orlo), for example, between the Tuscan and Ionic orders. Taxonomists use types to compare an individual specimen to a description of a species or genus. "If we compare our general [type] to the different parts of the most developed animals (which we call mammals), we will find that a limit is set to nature's structural range, but the number of parts and their modifications allow for the form to be changed *ad infinitum*".[25] It is not clear if Palladio gave Goethe the idea for types as Linnaeus' *Systema*, the main taxonomic text of his day, would have only contained a long list of species, genera and so on. It is hard to tell where Goethe would have received any taxonomic training, given he was trained in law. Perhaps Palladio gave Goethe the training to compare architecture as well as organisms.

Another interesting fact is Palladio's comparison of the Corinthian order to that of a plant, "following in that the Example of the Plants,

[25] von Goethe (1995, p. 120).

which are thicker at the bottom than at the extremities of their branches".[26] Naturally, art imitates nature, particularly in Corinthian columns, which has a leaf-like structure on the capital. Seeing Palladio's description of the order would have reinforced Goethe's view that nature, in this case, Anschauung, may imitate art. In other words, we appreciate and classify art in the same way we appreciate nature. For example, we recognise an elephant based on how its parts are ordered and how they manifest themselves in the organism. It would come as no surprise if a new and unknown elephant species were discovered that we would recognise it as being part of the elephant "order" in the same way we would recognise and be able to distinguish a Doric or Corinthian column. Anschauung and its use in architecture kept Goethe quite active in Venice as he sought to find buildings designed according to Palladio's architecture. But had Palladio helped Goethe with his botanical problem, where he did "not know how to proceed" and which "his head can't grasp"?

> … it was only in Padua I found the book [Palladios' *dell'architettura*], now I'm studying it and the scales are falling from my eyes, the mists are dissolving too and I understand the objects I see. Simply as a book it's a great work […] The revolution that I foresaw and that is now going on within me is the same as has happened to every artist who for a long time was diligently true to nature and now behold the remains of the great ancient spirit, his soul swelled within him and he felt a kind of inward transfiguration of himself, a feeling of freer life, higher existence, lightness and grace.[27]

Goethe was getting his eye in, that is, his mind's eye or Anschauung. Perhaps the works of Palladio and Vitruvius had shown that nature too had an order, one that is experienced as the urphenomenon, which is represented physically or descriptively by an order or a type.

Palladio had steered Goethe on the right path, towards the type, but as with anyone learning a new art, mistakes will be made. Most notably was the notion of the *Urpflanze*, possibly Goethe's most cited idea, which caught the imagination of readers and scientists alike.

Goethe first recalls the Urpflanze in his *Italian Journey* in 1787,

[26] Palladio (1742, p. 22).
[27] Tagebuch, Goethe Venice September 30 1786, translation in Goethe (1999, p. 64).

> I was taken again by my old fanciful idea: might I not discover the primordial plant [Urpflanze] amid this multitude?[28]

> Please tell Herder that I shall soon have figured out the [Urpflanze]. Only I fear that no one will be willing to recognise the rest of the plant kingdom in it.[29]

Goethe may have added this text later, as there is no letter or diary entry from the time to confirm if he did. The only surviving mention of Urpflanze from Goethe's Italian journey is in a letter to Charlotte von Stein:

> The [Urpflanze] is turning out be the most marvellous creation in the world, and nature itself will envy me because of it. With this model and key to it an infinite number of plants can be invented, which must be logical, that is, if they do not exist, they *could* exist, and are not mere artistic or poetic shadows and semblances, but have an inner truth and necessity. The same law will be applicable to every other living thing.[30]

At first glance, Goethe seems to be describing a type, but "inventing" plants that "could exist" is beyond what he would later call the urphenomenon. Unlike a type, which details what is known about a species or genus, the Urpflanze seems to be a way to generate new forms based on a model. Perhaps Goethe was confusing how one would *use* the plant type: a diagnostic description may be revised with every new discovery, but it cannot make new discoveries. By 1787, Goethe was still working out how the type would be implemented. Palladio's work guided architects to make new columns based on an order, but unlike organisms, new columns were not discovered in Nature, they were created. Goethe had clearly rectified this mistake, as he refers to types (*typus*) in his later morphological work.

After his Italian journey, Goethe only refers to the Urpflanze three times again, once in a letter to Christian Gottfried Daniel Neesvon Esenbeck in August 1816, and twice in *Zur Morphologie*, the introduction

[28] Italian Journey Palermo April 17, 1787.

[29] Italian Journey Naples March 25 1787.

[30] Italian Journey, Rome 8–9 June 1787. The letter was written to Charlotte von Stein from Rome, however in the *Italian Journey* it is listed as a Letter to Herder written in Naples May 17, 1787. The letter was written between 8 and 9 June 1787 (see LA II 9A, p. 365–366). The same passage is repeated in the third part of the *Italian Journey* under the title "Report" (Italian Journey, Naples May 17, 1787, p. 299).

(along with *urtier*) and a short autobiography of his botanical training. At no time is the Urpflanze discussed, explained or defined in his scientific writings.[31] The 1816 letter to Esenbeck does reveal an interesting titbit:

> In the diary of my Italian trip, which is now being printed, you will notice, not without a smile, the strange ways in which I have followed the vegetative transformation. At that time I was looking for the [Urpflanze], unconscious that I was looking for the idea and the concept by which we could develop it.[32]

After 1817, Goethe never mentioned the *Urpflanze* (or *urtier*) again, yet it appears in several works by nineteenth-century naturalists as Goethe's greatest achievement: an archetype for all plants. The archetype as a blueprint (*bauplan*) for all plants runs contrary to what Goethe had written in his scientific studies (as listed above). Moreover (and to my knowledge), Goethe never discussed the term. The archetype was a static materialistic concept that did not exist in nature. It was no different to the blueprint of a car or building, one that can be imagined and even drawn. The archetype is the opposite of the urphenomenon. How could botanists, who admired Goethe, such as Franz Unger, Anton Kerner von Marilaun and Wilhelm Troll, get it so wrong? Agnes Arber sums it up quite nicely,

> On his [Goethe's] view, the "Urpflanze" could neither be described adequately in words, nor represented pictorially—an essential limitation which some of his followers unfortunately ignored.[33]

Cherry-picking, Goethe may have given historical authenticity to many of the ideas postulated after his death, such as the archetype and the various pictorial representations of the *Urpflanze*.

Much of what has been attributed to Goethe has been misrepresented by scientists, as well as historians and philosophers of science. In reading

[31] See Boyle (1991, p. 501), particularly note: "… it will take Goethe another three years to formulate his botanical principles, and by then the concept of the primal plant [urpflanze] will be practically forgotten".

[32] "In den Tagebüchern meiner Italiänischen Reise, an welchen jetzt gedruckt wird, werden Sie, nicht ohne Lächeln, bemerken, auf welchen seltsamen Wegen ich der vegetativen Umwandlung nachgegangen bin; ich suchte damals die Urpflanze, bewußtlos, daß ich die Idee, den Begriff suchte wonach wir sie uns ausbilden könnten" (WA 27, pp. 143–144, my translation).

[33] Arber (1946, p. 81).

Goethe, we see someone discovering an inherent intuitive process (Anschauung) that captures an idea in our mind's eye (the urphenomenon). The ability to express this as a form of aesthetic appreciation, something that humans have been doing for millennia, may have stumped natural historians. As a gifted poet and playwright, describing Anschauung and the urphenomenon as a scientific as well as an artistic endeavour was a challenging process. Goethe only told us how aesthetic appreciation worked using his own senses. He made us aware of our own inherent ability to observe and appreciate Nature without recourse to scientific models or speculative opinions. The teleological constraint imposed by Kant, in which Nature needed to be explained in some way, only held us back as active observers of Nature. Goethe challenged Kant and the reliance on mathematical models to seek truth, when the truth lies open before us unimpeded as Nature. To read Goethe is to go on a journey of self-discovery, to join him as he develops his skills as a morphologist and how he expresses his experiences as scientific monologues, as poetry, or as *novella*.

Goethe presents us with a science of morphology, more discovered than created, and one that involves the active participation of the mind and a gentle empiricism. Morphology for Goethe was not there to explain, in the same way, mathematics or physics is there to explain how the movement of particles creates different colours of light. Morphology was not about cause and effect, instead "Goethe substituted a process that can be described only by the untranslatable German word, 'Darstellung'",[34]

> Since its [Morphology] intention is to portray [Darstellung] rather than explain, it draws as little as possible on the other sciences ancillary to [physiology], although it ignores neither the relationships of force and place in physics nor the relationship of element and compound in chemistry. Through its limitations it becomes, in fact, a specialised set of principles.[35]

Darstellung may be translated as "representation" or "portrayal", but in Goethe's use of the term, it is best described as "embodiment". Goethe was cautious of explanation, keeping Kant's teleology at arm's length and adopting Anschauung and the urphenomenon as the true aims of science of aesthetic appreciation. In the same way, we may appraise an artwork or

[34] Arber (1946, p. 85).
[35] von Goethe (1995, p. 57).

the craftsmanship in a desk or building, we can do the same with organisms. When we identify an artist through their brushstrokes or use of colour, or remark on the beauty of a landscape painting or sculpture, we do not explain. In order to explain, we need to ask the artist (if still alive) why they painted or sculpted. Their answers may or may not be subjective or pure fiction. We may explain how the marble was quarried, or how the bronze was tempered, but that does not "explain" the phenomenon. Even if we did know who created the artwork, how the paints and brushes were manufactured, or how the paint was applied, it still does not give a reason or justification for the phenomenon. Enter Darstellung. If we see a portrait as an embodiment of a person or a landscape painting as the embodiment of a place, then the explanation, that is the reason or justification, resides in the picture. A good example of this is the Archibald Prize for portraiture in Australian art. Every year, a winner is selected from hundreds of entries, the shortlisted finalists being exhibited in the Art Gallery of New South Wales in Sydney. Here people can see portraits of famous (and infamous) Australians in abstract, expressionist or modernist styles, yet the pictures embody a well-known Australian, in the same way we see calymenids embodied in our Tasmanian trilobite. Anschauung needs no justification or explanation. Those few specimens of *Gravicalymene* embody a whole assemblage of trilobites. No mathematics and no models are needed; they are simply subjective abstractions from the truth. Goethe continues, "[T]he less applicable mechanical principles become, the more an organism grows in perfection".[36] "Perfection" is not a term that one expects to show up in any scientific study, particularly not in association with "mechanical principles".

Let us return to Schiller's study in the summer of 1794 and Goethe's indignant riposte, "Then I may rejoice that I have ideas without knowing it, and can even see them with my own eyes". Schiller clearly represents the established scientific view that experiences and ideas are merely subjective because they are indistinguishable from make-believe. Anschauung and the urphenomenon lie beyond the cold surgical steel of mechanical measurement. You can't prod, dissect or photograph the urphenomenon, so how can it be real? Surely we'd be better off with just the phenomenon? Remember the photos of the Tasmanian trilobite? That one plate was all we had published of the phenomenon in the scientific journal in which the species was diagnosed and described. The rest, the urphenomenon, still

[36] von Goethe (1995, p. 58).

resides in our heads. The experience of urphenomena is exciting, and taxonomists discuss these with colleagues in the confines of their community. Yet the urphenomenon remains hidden within the taxonomist, who has no way of expressing themselves creatively in print. Goethe conveyed this very feeling,

> I can no longer conceal the pleasure which has come upon me more than once in recent days. I have a wonderful feeling of being in harmony with serious productive researchers here and elsewhere. Although they admit the need to postulate and acknowledge something beyond knowing, they do not draw a line the researcher is forbidden to cross […] The following bit of light verse should be read and understood in this spirit.[37]

Goethe penned the following prose, "Spontaneous Outburst":

> 'Into the course of Nature'—
> O Philistine—
> 'No earthly mind can enter.'
> The maxim is fine;
> But have the grace
> To spare the dissenter,
> Me and my kind.
> We think: in every place
> We're at the centre.
> 'Happy the mortal creature
> To whom she shows no more
> Than the outer rind',
> For sixty years I've heard your sort announce.
> It makes me swear, though quietly;
> To myself a thousand times I say:
> All things she grants, gladly and lavishly;
> Nature has neither core
> Nor outer rind.
> Being all things at once.
> It's yourself you should scrutinise to see
> Whether you're venture or periphery.[38]

[37] von Goethe (1995 pp. 37–38).
[38] von Goethe (1995, pp. 37–38).

The Enlightenment, via Kant, may have stifled the teleology of divine design and purpose, but it just replaced it with another, one that spawned the Modern Hubris and the eventual replacement of human observation and Anschauung with technology or direct observation (see Chap. 3). Goethe saw this Modern Hubris at work in his own time. His attempts to counter it through discussing the science of morphology (including his *Theory of Colours*), by practising morphology, putting it into words and prose, and showing that art and science both use Anschauung and urphenomena, was something that naturalists had failed to do previously. After Goethe's death, Whewell's designation of *artist* and *scientist* finally cemented the separation between art (dynamic and creative), from science (static and unimaginative), two great disciplines that desperately need each other to make sense of the natural world.

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CHAPTER 5

How to Remedy Direct Observation

Abstract In this chapter, I tackle direct observation, something we do when we simply view an object without employing Anschauung, and how it can lead to erroneous interpretations of scientific observations. I use the craters on the Moon and the canals on Mars as examples of how nineteenth- and early twentieth-century astronomers were fooled by direct observation. I also show how these interpretations have affected human society, demonstrating why the results of direct observation need to be approached with caution. I give examples of modern-day astronomical observations that are hypothesised to exist due to direct observation. I also detail the limits of Anschauung, the urphenomenon and direct observation, showing where scientific thought ends and where speculation begins. I also show how philosophers of Goethe's era sought to overthrow Cartesian thinking, which had stifled the way many thought about Nature objectively.

Keywords Mars • Venus • Martian canals

A large part of the Modern Hubris is direct observation, the ability to see but not observe. Surely seeing and observing result in the same experience? What we mistake as a subtle difference between "seeing" and "observing" may be clarified in Ronald Brady's example of the "double-take".

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> The simplest military camouflage is paint—buildings to be camouflaged are painted with patterns similar to the surrounding countryside. When such structures are surrounded by heavy foliage the strategy can often fool the uninitiated eye. On the other hand, no amount of paint can entirely hide the geometric shape of the human structures with the rigid verticals and horizontals and right angles. Thus, the simplest way to "see through" such camouflage is to look for just these things. After all, the point of painting foliage-like shapes on the buildings was to allow the observer to find his or her own expectation met—we expect to see foliage and think that we have when our gaze crosses the camouflage area. But when we look for verticals and horizontals, something we were not looking for in foliage, the buildings, jump out. Of course, were we to look again for foliage the previous view can sometimes be reestablished, and the buildings vanish once more. The whole experience is quite similar to the "double-take," in which the first "take" produces a phenomenon that is later canceled by a new take, resulting in a second phenomenon.[1]

In effect, the double-take results in two phenomena, as the following image demonstrates (Fig. 5.1).

At first glance, the image is just visual noise, a selection of dots that make little to no sense. But at a second glance, the phenomenon emerges from the noise to make an unmistakable image. Here we have the result of a second take, the emergence of the whole image, both the visual noise and the object concealed within. Once you have seen the object, you really cannot be "unseen". Here we see the so-called subtle difference between simply looking and observing. If we return to the rabbit–duck figure from the *Fliegende Blätter*, we understand that there is more to see than simply looking at an object.

> At first glance we may think nothing of it, but on a second and closer inspection we see something emerge. Something did emerge during my walk with T— in Jægersborg Dyrehaven, literally "Deer Park" north of Copenhagen. T— and I walked for ages and came onto a copse. I complained that Dyrehaven had no deer. The large grass meadow was devoid of deer, and all that stood between us and the next meadow was a copse with large pieces of dead wood that somehow sat oddly on the ground. A piece of dead wood moved. In an instant 20 deer at 10 paces appeared. They had been resting in the long grass looking at us looking at them, an unobserved herd of Red Deer (Cervus elaphus) each weighing up to 200kg. These were not small

[1] Brady (2001).

Fig. 5.1 Image of a cow, also known as the "Renshaw cow", named after American psychologist Samuel Renshaw (1892–1981). Copyright Optometric Extension Program Foundation, Timonium, Maryland. Used with permission

> animals. The dead wood were the antlers of the deer. There was a lot of "dead wood". The sudden appearance, or the "second-take", of the phenomenon had shaken me. How had I not seen what was sitting right in front of me?

Direct observation is that first glance at a phenomenon, not exactly recognising it as a phenomenon, but rather seeing it completely out of context to our own past experiences. Goethe referred to this glancing of the phenomenon's surface as confusing. Rather, the observer should be immersed and "the fundamental elements of the phenomena impressed on the mind, if we really wish to contemplate and imitate what moves in living waves before our own eyes as a beautiful, unified whole". Next, Goethe says something that pertains to this understanding of the phenomenon: "'We see only what we know'. For as a short-sighted man sees an object from which he withdraws more clearly than one he approaches, since he is aided by his intellectual vision, so perfect observation really depends on knowledge".[2] So it is our *knowledge* of the phenomenon that is our "intellectual vision" or Anschauung that helps us to observe it perfectly. Observing the red deer in Dyrehaven would only have been possible if I had previously seen deer, or at least a mammal. Seeing only what we know does not inhibit learning. As Brady noted, "Goethe was evidently aware that the intelligibility of phenomena was a product of our own activity of understanding even if we were unconscious of that activity".[3]

Understanding phenomena, the whole and its parts means we can understand new phenomena, such as the discovery of a new trilobite form or a new mammal. The image above is one example. We all know what a cow is, even if we haven't seen one, we can still equate it with something we have already seen and understood, such as a cow. Even if we were to see something so remarkable that it has no resemblance to anything ever observed, there is still the ability for the observer to liken it to something already known. Think of all the seventeenth-, eighteenth- and nineteenth-century names for new discoveries made by explorers, such as Willem de Vlamingh who coined *Rottnesteiland* (literally Rat's Nest Island) after the kangaroo relative called the quokka (*Setonix brachyurus*). A large part of the Australian fauna was named after unrelated animals, such as, the Tasmanian tiger (*Thylacinus cynocephalus*) a marsupial, or the spiny anteater (*Tachyglossus aculeatus*) a monotreme. To a modern taxonomist, these oversights are extraordinary, but to an eighteenth- or nineteenth-century explorer, it is a way to describe the phenomenon in a way that helps communicate the idea. These oversights are the results of direct observations that are devoid of Anschauung. Early explorers may be excused for not having the relevant morphological experience, however, when it comes to twentieth-century astronomy, the results may be a little more alarming.

On Mars Hill in Flagstaff, Arizona, lies the Lowell Observatory, a campus of several telescopes, including the Pluto Discovery Telescope, which was made famous by Clyde Tombaugh in 1930. The Lowell Observatory was famous well before Tombaugh's discovery of Pluto. In fact, it was where Percival Lowell first saw the canals on Mars, features that were

[2] Goethe in Gage (1980, p. 7).
[3] Brady (2001).

made famous by Giovanni Schiaparelli[4] in 1877. In 1896, Lowell saw similar features on Venus that appeared to radiate like spokes, something his own assistant, Andrew Ellicott Douglass, confirmed in 1898. The discoveries generated excitement and touched the imaginations of the public. Lowell deliberately translated Schiaparelli's *canali* (in Italian) to *canals*, rather than the more appropriate transcription "channels", possibly to emphasise the idea of an alien civilisation. The idea of Martian canals wouldn't be that far removed from what was happening on Earth, the construction of the Panama Canal, the largest superstructure of its age. Lowell had never considered the canals to be naturally occurring erosional structures. The idea that Mars had artificial canals, and therefore Martians, captured the public imagination and inspired works of science fiction that enthralled generations of readers.

> The community of which the green Martians with whom my lot was cast formed a part was composed of some thirty thousand souls. They roamed an enormous tract of arid and semi-arid land between forty and eighty degrees south latitude, and bounded on the east and west by two large fertile tracts. Their headquarters lay in the southwest corner of this district, near the crossing of two of the so-called Martian canals.[5]

> They sat still and felt the canal water rush cool, swift, and glassy. The only sound was the motor hum, the glide of water, the sun expanding the air.
>
> 'When do we see the Martians?' cried Michael.[6]

> All the rest of the planets cut into enormous red polygons by the many green lines crisscrossing the planet—the famous canals, incised into the landscape in the first days of terraforming.[7]

The novelisation of Mars came from the musings of Lowell and earlier by Camille Flammarion. In his *La Planète Mars* (The Planet Mars), published in 1892, Flammarion also hinted at intelligent Martian civilisation,

[4] Readers may find the name familiar. In 2016 a Mars lander called Schiaparelli EDM, part of the ExoMars programme (a joint mission by the European Space Agency and the Russian Roscomos), crash landed on the Martian surface.

[5] Burroughs ([1917] 2003, p. 43).

[6] Bradbury (1977, p. 213). Science fiction writer Ray Bradbury grew up on Lowell Street in Tucson, Arizona. You can't make this stuff up.

[7] Robinson (2013, p. 555).

spurred by both Schiaparelli's observations of canals on Mars. Flammarion notes:

> Mars seems habitable as well and even better than the Earth, and may very well be currently inhabited by a human race much superior to ours, being, in all probability older and more advanced.[8]

The jump from channel-like structures seen on a planet far, far away to alien civilisations may seem a leap too far for a twenty-first-century reader. By 1892 our own world was being discovered. No one had explored continental Antarctica; we had no idea about the vast underwater mountain ranges powered by plate tectonics, and reaching the Moon was still a pipe dream. The notion of life on Mars was equally plausible to life in the Amazon or the Antarctic. Could not only life, but intelligence has evolved on Mars? Could it have constructed canals that irrigated the barren lands when the ice caps melted in the Martian summers? These were plausible explanations for Lowell and Flammarion. In his last lecture on the topic, Lowell reported dark vegetation along the canals that changed hue in summer and autumn and that the plains of Mars had no mountains.[9] To scientists of the early twentieth century, such as astronomer Edward Holden, Martian-built "canals" were simply an impossibility.

> In the first place, according to the best knowledge attainable, the temperature of Mars is always far below the freezing point. Water can never melt on Mars. In the second place there is, in fact, little or no water on Mars.[10]

One wonders, what did Schiaparelli, Flammarion and Lowell see? Their canals were clearly marked on their maps of Mars (e.g. Fig. 5.2), but what did they see through their telescopes? The reason this becomes pertinent is that other astronomers, also armed with powerful telescopes, did not see canals. One such astronomer and artist was Nathaniel Everett Green, who in 1878 also published a Mercator map of Mars that lacked any sign of Martian canals (Fig. 5.3).

[8] "Au point de vue de l'atmosphère, des saisons, des climats, des conditions météorologiques, Mars paraît habitable aussi bien et même mieux que la Terre, et peut fort bien être actuellement habité par une race humaine très supérieure à la nôtre, étant, selon toute probabilité, plus ancienne et plus avancée" Flammarion (1892, p. 589).

[9] Los Angles Daily Times, 17 October 1916, p. 4.

[10] Holden (1901, p. 442).

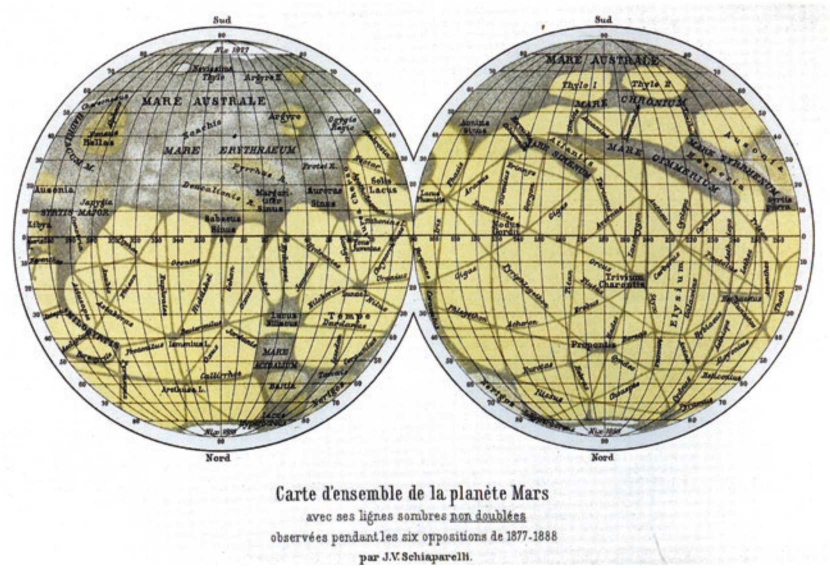

Fig. 5.2 Overview map of the planet Mars with its unlined dark lines observed during the six oppositions of 1877–1888 by J.V. Schiaparelli. Wikimedia Commons

Green's map was somewhat shady and indistinct when compared to the crisp lines and detail in the maps of Schiaparelli, Flammarion and Lowell. Green also used colours that represented what he saw (reddish hues), rather than the yellow-green hue used by Schiaparelli to represent oceans and canals. Lowell's photographs taken through the telescope resemble the paintings of Green.[11] The photographs showed none of the details that Lowell claimed to have seen with the naked eye. Long after Lowell's death, no one had managed to photograph the Martian canals.

> Many attempts have been made to photograph those difficult markings, the canals of Mars. Although interesting pictures have been obtained, no photograph has shown the fine details described by visual observers.[12]

[11] Lane states that "By 1910, the astronomical communities of Europe and North America had largely abandoned their thirty-year flirtation with the idea of an inhabited Mars and returned to a naturalistic mapping style that closely resembled the pre-1877–1878 maps" (Lane, 2006, p. 208), mostly notably that of Green.

[12] Pettit (1947, p. 5).

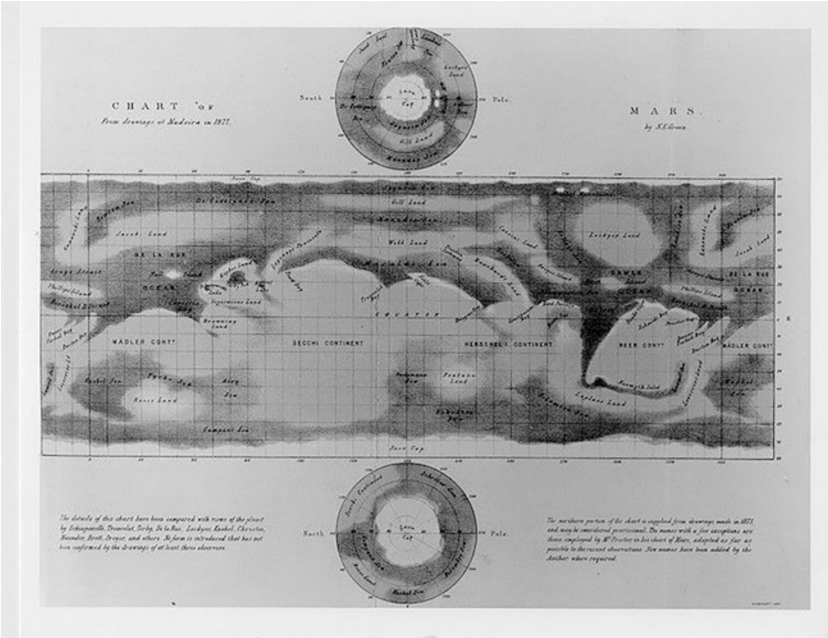

Fig. 5.3 Green's 1877 Mars map without the reddish hue. Wikimedia Commons

It was the observer, through direct observation, who saw the canals. Not the camera. Edison Pettit, who was unable to photograph the canals, nevertheless observed them in 1939. The thread-like lines that protrude from the dark "seas" were no different from the pictures drawn by Lowell, a phenomenon that had been labelled as the "Flagstaff markings". To any rational mind, these people were observing the same, or similar, phenomena, to which a camera was effectively blind. What were those phenomena? An explanation of how these structures may have manifested lies in Lowell's next discovery: the spokes on Venus.

The Martian canals were short and connected to "seas" and "oceans", but the spokes covered an entire planet. Moreover, they were in the same positions at different times of the year, leading astronomers, such as Edward Emerson Barnard, to question the Flagstaff markings. The problem was that Lowell's own staff also saw the same markings.

> They are rather lines than spots; as will be seen from the accompanying drawings (Fig. 5.4) by me and my assistants Mr. Draw and Mr. Leonard. A large number of them, but by no means all, radiate like spokes from a certain centre. In spite of this curious system there is about them nothing of the artificiality observable in the lines of Mars. They have the look of being purely natural.[13]

The anomaly of the Flagstaff markings did not stop there. Two years later Lowell published a paper in which he claims to have seen markings on Mercury.

> In their characteristics the markings on the planet's surface are both unique and suggestive. The markings are: (1) unlike those on any other planet, coming nearest in appearance to those on Venus, but not resembling them to any extent; (2) long and narrow, of the nature of lines, not patches; (3) among the darkest of planetary markings; (4) although linear, not of uniform width; (5) given to appearing as a succession of dark dots, like beads on a chain; (6) darkest at points where they cross, giving rise to spots at the intersections; and (7) singularly symmetrically placed.
>
> To prevent misconception, I may add that neither the lines nor the spots show any of that startling regularity observable in the 'canals' and oases of Mars. Unlike the markings on Mars, they do not suggest artificiality.[14]

Lowell's assistant Douglass, who had defended the spokes on Venus in 1898,[15] was in no doubt that these markings were an optical illusion. Thanks to astronomers William Sheehan and Thomas Dobbins, we have a complete picture of what happened.

> Douglass quietly began to observe 'artificial planets'—featureless little globes placed almost a mile from the telescope—and to his alarm soon realized that he could 'see' many of the markings that appeared in Lowell's drawings of Venus.[16]

[13] Lowell (1896, p. 22).
[14] Lowell (1898, p. 442).
[15] Douglass (1898).
[16] Sheehan and Dobbins (2003, p. 57).

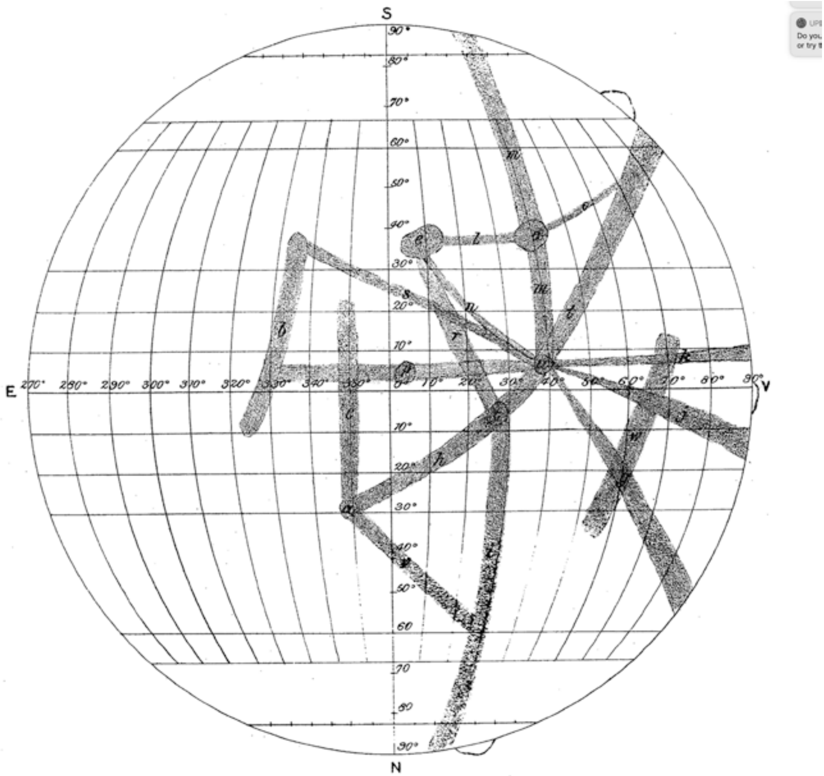

Fig. 5.4 The Venus “spokes”. “Chart of Venus” (Lowell, 1897, plate 6)

Douglass’s experiments led Lowell to retract his claim in 1902. The markings, however, remained a mystery until Sheehan and Dobbins had published a popular account of Lowell’s findings in *Sky and Telescope*.

> Several ophthalmologists quickly pointed out that by stopping down his telescope so severely, Lowell had effectively converted it into an ophthalmoscope.[17]

Lowell and Douglass saw the vascular network of veins and arteries in their own eyes. The observations were, in effect, real; they were just not

[17] Sheehan and Dobbins (2003, p. 59–60).

related to Venus. We may even extend this to the markings on Mars, which appear to resemble those on Venus. A certain Captain Noble, at the 1896 Meeting of the Royal Astronomical Society, commented on the similarity.

> [The spokes on Venus] looks to me suspiciously like Mars. I do not know whether Mr. Lowell has been looking at Mars until he has got Mars on the brain, and by some transference has ascribed the markings to Venus.[18]

Not until the colour images taken by the Viking landers and orbiters in 1976 did Mars finally resemble the images produced by Green (Fig. 5.5), along with large features that neither observer of Mars had previously seen. A red to ochre planet with mountains, including the largest mountain in our Solar System, Olympus Mons and long-deep valleys.

The use of instruments such as telescopes and microscopes to view the natural phenomena had troubled Goethe, at least in his fictional writings. Goethe was an avid user of microscopes and understood the need for such instrumentation, nonetheless, he acknowledged that the dangers of direct observation were there.

Astronomers Lowell or Douglass would not have been out of place in Goethe's *Bildung* novel, *Wilhelm Meister's Journeyman Years*. The heroes, Wilhelm Meister and his son Felix, encountered an astronomer, who was

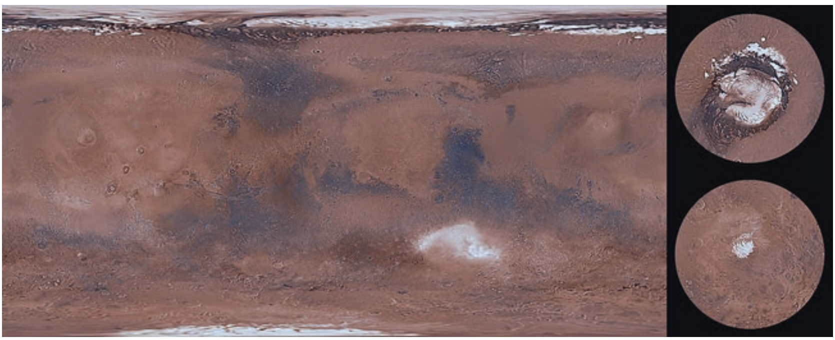

Fig. 5.5 Colourised Mars digital image model (MDIM) 2.1. Wikimedia Commons

[18] Anon. (1896, p. 420).

also a physician and companion to the elderly and frail Markarie.[19] After formal introductions, the astronomer took Meister to his observatory, up in a high-round tower, to observe the night sky. Meister "caught sight of Jupiter, the planet of good fortune, shining as magnificently as ever. He took this as a favourable omen and continued to gaze joyfully for some time". The astronomer summoned Meister to look at Jupiter "through a telescope, significantly enlarged and accompanied by its moons, as a wonder of the heavens". Meister was not satisfied.

> I do not know whether I should thank you for bringing this star so very much nearer to me. When I saw it before, it stood in its proper relationship to all the other countless bodies of the heavens and to myself. But now it stands disproportionately in my imagination, and I do not know whether I should want to bring the remaining hosts closer in the same fashion […] I understand very well that for you stargazers it must be the greatest joy gradually to draw the immense universe as close as I have just seen and still see this planet. But allow me to say: I have discovered in life, altogether on average, that these aids with which we enhance our senses have favourable moral effect. Someone who sees through spectacles considers himself cleverer than he is, because his external senses have been thrown out of balance with his inner judgement; it requires a higher degree of cultivation, of which only superior people are capable, to balance to some degree their inner sense, the truth, with this false image drawn closer from outside […] We can as little ban these glasses from the world as we can machinery. But to the observer of morals, it is important to find out and to know how various things we deplore in humanity have crept in. Thus for example, I am convinced that the custom of wearing spectacles is largely responsible for the arrogance of our young people.[20]

Later, in the same novel as similar statement is made:

> Microscopes and telescopes actually confuse man's clear senses.[21]

We know that both Meister and Goethe had the same sentiments regarding optical devices such as telescopes:

[19] There is much written about the character Markarie and her embodiment of Kantian philosophy (see Saman, 2020; Ishihara, 1998).

[20] von Goethe (1989b, p. 178–179).

[21] von Goethe (1989b, p. 301).

> People are so made that they like to see through a telescope, and when it is correctly placed to their eyes, they praise and praise it …[22]

What Meister or, Goethe, meant is wonderfully summed up by Frederick Amrine:

> Goethe warned against interposing instruments between the perceiver and the phenomena, claiming that it is instead the scientist who is—or can become through practice—the most precise scientific instrument.[23]

The "interposing instrument" only gives us images of the phenomenon, further distortions of direct observation.

We need to return to the issue of direct observation and question what we are seeing. In the case of Lowell, what he saw was not Mars or Venus, but rather an image that was produced by the telescope. The same is also true with microscopes: they produce images of phenomena and not the urphenomena. In other words, direct observation prevents Anschauung, indicating that it is a lesser form of observation. Before I explain why direct observation has its own problems, let's return to the point both Meister and Goethe made when viewing an object.

If we look up into the night sky, we may see the Moon. To the naked eye, the Moon is a bright celestial object of certain qualities, such as colour, shape, size and smaller details such as dark markings. You see the Moon in context to its surroundings, namely, the horizon, the stars and the planets. What you see is the Moon's relationship to the rest of the universe. The mind's eye and the object undergo the intuitive perception that Goethe called Anschauung. If we view the Moon on other days and nights at different times of the year, we start to form a mental image, or urphenomenon, of the Moon in all its phases, differing colours, shapes and sizes. The Moon emerges as something that is greater than the sum of its constituent parts—there are all the times that you have seen it undergoing a waxing, waning or eclipse. You may even see curvature. If we were now to view the Moon through a telescope, as Meister did, we would notice something different. The Moon is an image. Not a static image such as a photo, but an image that is produced by the telescope. We may notice that the colour may change because of the refractive nature of the

[22] Goethe to Jenny von Voigts, 21 November 1781.
[23] Amrine (1990, p. 194).

telescope. We may notice hues of blue at the edge of the viewing field. Also, the darker markings are now gone and replaced by more intricate markings of various colours; dark browns, lighter browns and so on. The Moon seems to have colour, albeit a very limited range, but the surface looks smooth and flat with sharp ridges.

People have orbited the Moon in spacecraft. If we were to orbit it, we would not see the hues of brown or the sharp ridges. The surface is dull and grey. The sharp crests are gone. Everything seems to undulate. The texture of the surface is smooth but not flat.

People have walked on the Moon. If we were to do that we would see that the undulations are in fact vast mountains, hills or deep ravines covered in dust and rocks. Nothing appears to be smooth.

The lucky few who have walked on the Moon have related these experiences. Yet, for most of us, these experiences are simply unavailable, and the telescope becomes an important way to observe the Moon, albeit indirectly. A photograph taken through a powerful telescope is limited to what it can reveal, namely a two-dimensional image, as Fig. 5.6 demonstrates, but nothing emerges from such an image. Observing directly interferes with Anschauung, but it does not prevent it entirely, as Goethe suggests:

> The *metaphysics of phenomena* proceed from the greatest and minutest things made present to the human mind only by artificial [technical] means; what is particular to our senses lies in the middle and on this I depend for which reason I bless from my heart the gifted people who bring these regions within my reach.[24]

Both the telescope and microscope reveal more detail, but only up to a point. After observing the Moon for many nights during a waxing, we may clearly make out what appear to be holes in the Moon's surface. These holes or craters may be revealed as the shadow moves across the Moon. These experiences through direct observation allow some Anschauung, as we can intuit the craters as actual holes. Here we come to the edges of the urphenomenon, what Goethe called the metaphysics of phenomena, which Hartmut Böhme eloquently describes in the following passage:

> What 'emerges' through the new instruments becomes 'presence' to the 'person', just as a tree becomes on sight the presence of the onlooker. But a

[24] von Goethe (1998, p. 155; emphasis added).

Fig. 5.6 The Moon on 6 February 1903 at 4.30 am. Photograph by P. Puiseux, Paris, in Moreux (1913, opposite p. 38)

difference remains: no 'metaphysics of phenomena' 'emerge' from the perceived tree, but they do from the telescope and microscope.[25]

The urphenomenon encapsulates all our experiences derived from Anschauung and direct observation. Those experiences derived from Anschauung become present to the person, whereas direct observations are metaphysics of phenomena.

Where, then, does Lowell fit into this example? He undertook direct observation, so did he see the metaphysics of phenomena? The short answer is "no". Lowell did something rather common. Rather than look at the phenomenon and experience the presence of the object or a metaphysics of the phenomenon, as Goethe would have done, Lowell put the cart before the horse. We need to remember that Lowell saw canals on

[25] Böhme (2005, p. 357).

Mars. If he had said that he saw his own optical nerve, then that would be metaphysics of phenomenon via direct observation. Instead, Lowell made an assumption: he speculated that any lines he saw via direct observation through the telescope must be canals. In other words, he allowed his opinions to be confirmed through corroboration via direct observation. The result is bad metaphysics, that is, fiction or make-believe, assumptions with no basis in reality.[26] Bad metaphysics has no place in the urphenomenon and should not be confused with the metaphysics of phenomena (Fig. 5.7).

Lowell's Flagstaff markings are an extreme example of direct observation and metaphysics. In one sense, the markings were direct observations of optical nerves, but in another, it was plain metaphysics.[27] Lowell was

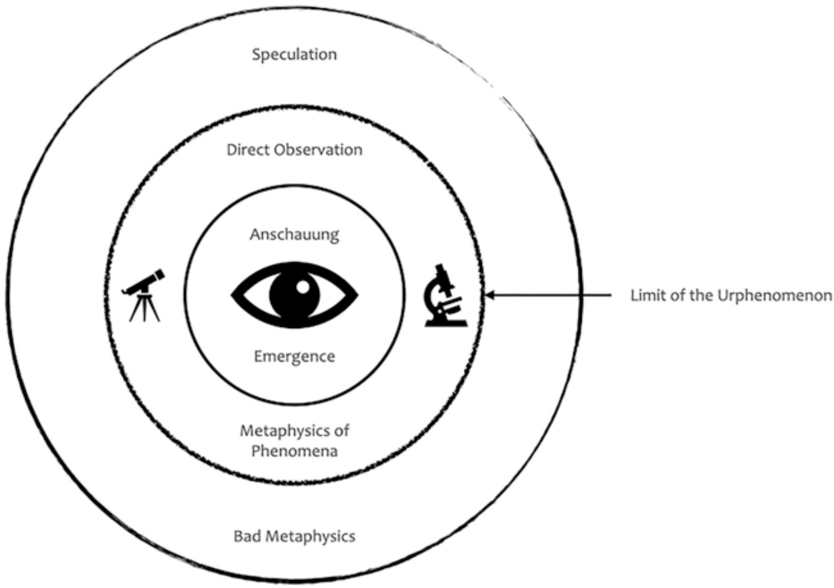

Fig. 5.7 Anschauung results in the phenomenon emerging; direct observation results in metaphysics of phenomena; speculation results in bad metaphysics. The urphenomenon is limited to what we can actually experience with our senses. Speculation lies beyond the urphenomenon

[26] I will discuss metaphysics and its impact on observation (direct or otherwise) in Chap. 5.

[27] For the purposes of this discussion we may even call metaphysics of phenomena "Good Metaphysics", and pure metaphysics "Bad metaphysics".

called out by colleagues who were not convinced, simply because these markings were not seen through other telescopes. Yet, there are several good examples of the move from the metaphysics of phenomena to metaphysics via direct observation. The observations of the Moon's surface by astronomers Camille Flammarion and Théophile Moreux, for example, are a perfect example of how the metaphysics of phenomena can lead to "bad metaphysics".

Flammarion and Moreux both worked in the late nineteenth and early twentieth centuries. I have mentioned Flammarion previously, who like his contemporaries Schiaparelli and Lowell believed the canals on Mars to be artificial. Unlike his contemporaries, Flammarion depicted elaborate reconstructions of the surfaces of the planets based on his observations.[28] In his 1884 *Terres du Ciel*, Flammarion imagined Mars with lush vegetation, canals and large lakes (Fig. 5.8), and the Moon having wide mountains with rounded peaks. Flammarion had also depicted how a solar eclipse would appear on the Moon, and this depiction has been praised as being a major landmark in Space Art.[29] The astronomer and artist Moreux also drew landscapes of the lunar surface, however, his mountains were tall and craggy, as shown in his 1913 *A Day in the Moon*. Given that both Flammarion and Moreux had access to telescopes with a similar magnification, why did they get two very different interpretations of the lunar landscape (Fig. 5.9)? The answer lies in how these metaphysical phenomena are interpreted. The shape and size of the mountains were determined by the shadows cast across the surface of the Moon. Shadows cast by a low-lying sun may give the impression of tall and craggy mountains, but when the sun was higher, it would give the impression of a rounded and smoother surface. Given the lack of presence of being there, both Flammarion and Moreux relied upon some form of interpretation based on what they thought the surface might look like. Direct observation plus our own opinion (or model) of what we think we understand the Moon's surface may look like, generates the metaphysics of the phenomenon. While metaphysics of phenomena is still better than sheer speculation, it still represents a shift towards models or "what we understand might be happening". I use Cathy O'Neil's definition of a model, namely, "models are opinions embedded in mathematics".[30] These opinions might be

[28] The interpretations were drawn by Paul Fouché.

[29] A summary of early Space Art can be found in Miller (2014).

[30] O'Neil (2016, p. 21).

Fig. 5.8 Sunrise over the canals of Mars. Drawing by Paul Fouché in Flammarion (1884, p. 65)

incredibly well-thought-out logical arguments based on evidence, either from our own Anschauung or from direct observation. Opinions may also be borne out of bias or belief. In any case, they are opinions. Good models can predict, for instance, where in the sky we might find Uranus. Bad models may mislead and misinform us about the natural world. An over-reliance on models over our own experiences and observation is where the Modern Hubris begins. The differences between using models to predict the existence of celestial objects via direct observation, and the over-reliance on models to make sense of the universe are quite subtle. This difference was not lost on Goethe.

Fig. 5.9 (**a**) From a drawing by the Abbé Moreux. The Earth seen from the Moon. (The landscape shows part of the range of the Lunar Alps) (Moreux, 1913, frontispiece). Moreux's interpretation has very high craggy peaks and deep narrow valleys. (**b**) "Lunar Landscapes. The Mountains of Eternal Light". Fouché's interpretation of the lunar landscape depicts wider mountains with fewer craggy peaks (Flammarion, 1884, p. 481)

> [Georg Christoph] Lichtenberg [1743–1799] has also planted an amusing notion in the vast empty space between Mars and Jupiter. After Kant had carefully proved that these two planets had consumed and incorporated whatever matter could be found in that space, the former asked in his usual witty way: why should there not be invisible planets as well? And was he not perfectly right? Are not the newly discovered planets invisible to the entire world, except for the few astronomers, whose words and calculations we must accept?[31]

[31] von Goethe (1989b, p. 428). "In den großen leeren Weltraum zwischen Mars und Jupiter legte er auch einen heitern Einfall. Als Kant sorgfältig bewiesen hatte, daß die beiden genannten Planeten alles aufgezehrt und sich zugeeignet hätten, was nur in diesen Räumen zu finden gewesen von Materie, sagte jener scherzhaft, nach seiner Art: Warum sollte es nicht auch unsichtbare Welten geben?—Und hat er nicht vollkommen wahr gesprochen? Sind die neu entdeckten Planeten nicht der ganzen Welt unsichtbar, außer den wenigen Astronomen, denen wir auf Wort und Rechnung glauben müssen?" My translation.

Goethe is referring to an unseen planet between Mars and Jupiter, an idea originally proposed by Johannes Kepler in 1595, but one he later recanted. The idea of a new planet between Mars and Jupiter was revived over 100 years later by various authors; however, it was the Hungarian Franz Xaver Zach (1754–1832), who in 1800 predicted its orbit using the Titius-Bode Law. Herschel had used the Titius-Bode Law to calculate the orbit of Uranus, and now Zach had used it to equal effect. The "few astronomers" Goethe refers to may include Zach, who was incorporated Zach into *Wilhelm Meister's Journey Years* as the bumbling astronomer.[32] Lowell, Moreux and Flammarion may well all fall into the category of metaphysics of phenomena, but where does it leave astronomers such as Le Verrier and Zach?

Using mathematics, or any tool, to make predictions falls under metaphysics, for the simple reason that it doesn't use observation. Yet, we can use the observed orbits of other celestial bodies to predict the position of a new object, as in the case of the search for Planet X.

Here we return to Percival Lowell, who believed there to be a ninth planet after Neptune. Lowell was so convinced that Planet X existed that he left a million-dollar reward for its discovery. Ironically, it was Lowell's own observatory that found a ninth celestial object in 1930, 14 years after his death. As it turns out, Pluto, as the new planet was to be known, wasn't the elusive Planet X. It was simply too small to significantly affect the orbit of Neptune. The final blow, however, came in 1989 when Voyager 2 photographed and measured Neptune, only to reveal that the last of the gas giants were lighter than previously thought. After some recalculation, scientists concluded that the orbits made sense after all. Lowell once again backed a loser. There was no Planet X. In 2016, 27 years later, the search for Planet X, re-branded as Planet Nine, resumed. Writing in the *Astronomical Journal*, two US astronomers had shown

> … that distant orbits within the scattered disk population of the Kuiper Belt exhibit an unexpected clustering in their respective arguments of perihelion.[33]

The authors' aim was to "establish whether gravitational perturbations arising from a yet-unidentified planetary-mass body that occupies an extended, but nevertheless bound, orbit can adequately explain the

[32] Cunningham (2017).
[33] Batygin and Brown (2016, p. 22).

observational data". The observational data are the predicted orbits of Kuiper Belt Objects (KBOs) and not the unidentified planet. Here we depart from the metaphysical Titius-Bode Law and enter a new arena, namely, the metaphysics of phenomenon. Given that KBOs can be observed and their orbits modelled, we may interpret these phenomena as clustering, that is, interacting with another mass. The problem is we don't know what that mass is—whether it is a large gas giant or a grapefruit-sized black hole. There is, however, a twist. The original observations of KBOs clustering may themselves be biased because the modelling only selects some KBOs, thereby leaving room for plenty of bias. Planet Nine, just like its previous incarnation, is based on the metaphysics of phenomena, not unlike the interpretations of shadows on the Moon's surface. Much of the theory behind Planets X and Nine is based on expert opinions that eventually become models. After all, models are mathematical representations of opinions, no matter how well-informed, we believe those opinions to be. If we take a step back from metaphysics and enter the world of the urphenomenon, we notice that much of these mathematical musings do stimulate the imagination. Whether there is a Planet Nine or not doesn't really affect our knowledge of, and interaction with, the universe. The theory of dark matter, however, does pose such a conundrum.

Dark matter was proposed to deal with the lack of mass in the observable universe. According to astrophysicists, there simply isn't enough mass (observable matter), such as stars, planets and black holes to keep whole galaxies together. With all the mass we do see, via either optical or radio telescopes, galaxies should simply pull apart. How then do you explain spiral galaxies? Enter dark matter. A material that by its very nature is unobservable (hence "dark"). Dark matter does not interact with observable, that is, baryonic, matter. The only way scientists hope to observe it in some way is at the quantum level. Making discoveries through observing small particles has been done before. Gravity is the single constant in the universe as it affects all baryonic and dark matter. Even photons, matter with no mass, are affected by gravity, as famously proposed by Albert Einstein in his Theory of General Relativity. If we were to see what objects are behind a star, such as our own sun, we would observe the sun during a solar eclipse and map the stars in the area the sun is set to pass. If Einstein was right, then the stars, which normally would be obscured by the eclipsing sun, should show up above or below it, as the light is bent around the sun. The phenomenon, called gravitational lensing, was observed by English astronomer Arthur Eddington in 1919, which in turn shot

Einstein to fame, even though his Theory of General Relativity was proposed earlier, in 1907. All it needed was an observation. The same is true for dark matter, as it too needs empirical evidence to seal it as a viable scientific phenomenon. The way scientists are planning to do this is to create large tanks filled with an inert liquid, such as xenon. Many physicists believe that dark matter is a type of Weakly Interacting Massive Particle or WIMP, which lets off a spark when it collides with a xenon atom. The LUX project has so far not observed the spark of colliding WIMPs and xenon atoms. Neither have similar projects succeeded to date. Regardless, the theory that dark matter exists is a compelling one, and no doubt soon, or at least in the coming decade, scientists may find the evidence they need. How, then, does dark matter affect us, the observer? To an extent, it explains how the universe functions. More important is that dark matter accounts for 85% of the matter in the universe and together with dark energy, a related concept, makes up 95% of all energy and matter, leaving 5% that includes us and all we can observe. How would a person see themselves in a universe if they can only interact with less than 5%, remembering that some of it is energy? Here we return to the Modern Hubris and its role in how the observer is literally being severed from the observed world. In the case of "are we living in a computer simulation", we are completely severed, as everything we see is an illusion. Living in a universe in which we can observe a few per cent is no better. Why do we place such great importance on the hidden rather than on the observable?

The way the observable universe behaves does not match what the mathematics tells us. In other words, the real and tangible do not reflect on what the unobservable states. In this sense, a planet's unusual orbit, for example, lacks observable explanations. The discovery of an observable object leads us to the metaphysics of the phenomenon, as we use direct observation to view planets. Dark matter, until it is discovered via observation, is still in the realm of metaphysics, regardless of how much sense it makes in the abstract medium of mathematics. One thing is true. Mathematics may lead us from the metaphysical towards discovering something real, such as a new phenomenon. Models, however, do the exact opposite. By models, I mean an attempt to recreate a phenomenon in an abstract medium, whether it is an algorithm or a mathematical premise. In this sense, we move away from Anschauung and the urphenomenon towards speculation, that is, "bad" metaphysics. The discovery of observable objects, via mathematics or any other abstract medium, such as the icy gas giants like Neptune, or sparks of colliding WIMPs and xenon atoms, is an example of "good" metaphysics. Although direct observation is on the periphery of the urphenomenon, it aims to go back to the phenomenon. Bad metaphysics, on the other hand, continues beyond the urphenomenon into total speculation.

Direct observation of the Moon and other celestial bodies has led to the metaphysics of phenomena and, in turn, good and bad metaphysics. To remedy direct observation is to embrace good metaphysics and abandon bad metaphysics. Yet, little is being done to understand the limitations of direct observation, let alone remedy them. One explanation may be that observation *per se* is seen to be biased in some way, as was noted in Plato.

In his *Republic,* Plato reports on a dialogue[34] between his older brother, Glaucon, and the philosopher Socrates, in which they discuss knowledge (*epistēmē*) and opinion (*doxa*). Socrates considered knowledge to be part of mathematical reasoning (*dianoia*) and intelligence (*noēsis*), both part of the intelligible realm (*to noēton*). Opinions, on the other hand, were belief (*pistis*) and illusion (*eikasia*), which were manifest in physical forms and images within the visible realm (*to horātion*). The division between the intelligible and the visible is at odds with the urphenomenon, as the visible is seen to be too subjective and illusory to contain any kind of truth or knowledge, whereas abstract mathematical concepts, such as geometry, are not polluted by actual observation. Again, there is an attempt to remove the observer from what is to be observed. Plato isn't subscribing to the Modern Hubris; rather, he imagines the observable world to be shadows of the truth. Yet, his argument is compelling as it does promote the notion that observation is corrupt and that the natural world is better represented by an abstract medium, such as mathematics.

Plato, and his student Aristotle, did influence a large part of the Western philosophical canon, one in which human observation is somewhat problematic. Descartes brought this to a high point in his mantra "I think, therefore I am", an idea that was challenged by Johann Gottlieb Fichte (1762–1814), a post-Kantian philosopher who was influenced by his contemporary, Goethe. Kant's philosophy had revolutionised eighteenth-century thinking, yet it still held onto old rationalist notions of human limitations, namely our cognition. In his *Science of Knowledge,* Fichte returns to the fundamentals of logic, one that Descartes also had investigated, namely, the principle of identity or A = A. The argument is quite

[34] The dialogue is in the *Analogy of the Divided Line*, part seven, book six.

true, but what of the "="? Fichte goes on to say that the equals sign is *experiential* rather than a factual statement. That is to say, A is not a quantity or number that is identical to A, but rather A is related to A and stands "in transparent relation to itself".[35] In other words, the equals sign represents an activity, something, Amrine explains, that makes sense when you return to Aristotle. In order to explain the relationship between two things, you need a third thing. To explain the relationships between these three things, you need a fourth and so on, leading to an infinite regress. Amrine continues, "… the relationship between things can never be explained in terms of things; only a process can explain structure". In this sense "A = A implies I = I; what's implied is that there's a unity in the subject".[36] In biology we call this unity homology (synapomorphy), yet few biologists understand that homology is an activity (Anschauung) that results in an urphenomenon.[37] While homology and Anschauung cover the empirical side of this argument, Fichte was attempting to establish a philosophy of the self-conscious. If A= A implies I = I (or *Ego* = *Ego*), then we have a problem with Descartes' self-knowing, portrayed in his dictum "I think, therefore I am". Which *self* is doing the cognition and which *self* do they hope to find? The self as subject searches for the self as object and finds, well both: self-subject and self-object. Descartes model falls down in two ways: if you go out searching for yourself and find something different, you haven't found yourself; or if you look for yourself and find yourself, you have already found yourself before you even started searching.[38] Fichte termed this the "unavoidable circle"[39] and his reply to Descartes' "I think therefore I am" was simply "I am therefore I am … you do not think necessarily when you are, but you are necessarily when you think".[40] The dualism between object and subject also fails as the self as subject is the self as object (I = I). Fichte's genius is recognising that we are dealing with acts rather than with abstract logic. We are inside the problem, or the structure, and we have moved beyond words and symbols: we have moved behind logic. Fichte termed this *Tatshandlung*,[41] simply "deed-act" or

[35] See Amrine (2013).
[36] Amrine (2013, p. 24).
[37] See Ebach (2005).
[38] Amrine (2013, p. 24).
[39] Fichte (1889).
[40] Fichte (1889, p. 73).
[41] *Tathandlung* combines the German terms *Tat* and *Handlung*, which are synonyms of each other.

"deed and act in one", which Amrine describes as a "pure activity of positing" rather than a statement of logic. Fichte had solved the problem of dualism within an "organic unity", the ego as subject–object, one in which our own experience and actions are essential, rather than abstract logical categories.

Fichte's *Science of Knowledge* reveals that there are essentially two ways of looking at nature: a dualistic, or in the case of Spinoza and Fichte, a monistic way. Accepting these two ways of thinking and seeing means that there is a greater appreciation of Nature, as Goethe's approach actively engages the observer and the object. Traditional approaches to science also contribute to our knowledge, but they involve the observer less and do not require someone to actively engage with the observed object. To understand Goethe's way of science, we need to deconstruct the traditional approach, one that encourages bad metaphysics. Fichte, Goethe, and many others have attempted to do this in their own way, unsuccessfully within the realm of science. In the twentieth century, there were further attempts to view natural phenomena experientially and to deconstruct bad metaphysics. In the next chapter, I explore the ideas of three of these twentieth-century thinkers, Agnes Arber, Ronald Brady and Henri Bortorft, and how they attempted to explain these two ways of thinking.

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CHAPTER 6

Getting Rid of Bad Metaphysics

Abstract In this chapter, I delve into bad metaphysics and the two ways of thinking that exist in the sciences. I show how one way of thinking is fuelled by the Modern Hubris, while the other underpins Anschauung and the urphenomenon. I give examples of bad metaphysics in current scientific practice and how it is central to the Modern Hubris.

Keywords Scientific practice • Modern hubris • Metaphysics

> To 'see things with your own eyes' as they say, is not always to see the truth. One must see with eyes of the mind.[1]

Scientists tend to dislike neologisms. Two terms, good metaphysics and bad metaphysics, were introduced to show two ways in which general abstractions (i.e. metaphysics) can be justified as being good, or bad, for the purposes of discovering new phenomena. Yet, the term "metaphysics" has many different definitions, made by different people who see things in different ways. How, then, do we differentiate between two opposite ways of thinking using the same terms?

[1] Christie (1991, p. 157).

M. Ebach, *Goethe in the Age of Artificial Intelligence*,
https://doi.org/10.1007/978-981-19-6741-2_6

Ronald Brady attempted, successfully, to decipher the two meanings of *metaphysical*:[2]

> (1) an echo of a possible original meaning of relations that make the world intelligible, and (2) the modern sense of speculations beyond the reach of physical evidence.

Brady was concerned with the distinction between these definitions. In order to make the world intelligible via experience requires cognition, again harking back to Fichte's "I am because I am". The second definition requires no experience, simply because we could make things up. Yet, both definitions are considered to mean the same thing because observation of phenomena (as appearances) implies an observer and some form of cognition. The observer is only observing how things seem, rather than how things are. Think of a magic trick where a coin *seems* to appear or disappear. The reality is that what we observe is a sleight of hand; a trick. The best path forward for science at least is to be:

> … very much dependent upon the attempt to remove the differences between observers by deleting all observer contribution from the objects observed. Thus, research into the preconditions of experience in general, and a theory of cognition, are recognized as legitimate tasks in psychology, where they tell us about the observer, yet are labeled as speculative 'metaphysics' when the intention is to learn about the world. After all, the conditions that attach to the observer may be general for all observations but are not necessarily informative about the objects to be observed.[3]

[2] The noun *metaphysic* refers to the philosophy of Metaphysics. This is possibly why Brady and Arber attempted to define *metaphysical*.

[3] Brady (2001).

Brady wasn't the first to see the problem with this definition. In 1964, Agnes Arber proposed a similar definition:[4]

> … 'the visual and conceptual interpretation of the perceived' as opposed to 'the conceptual prediction of the unperceived'.[5]

Arber's definitions are synonymous with Brady's. Curiously, Arber's definitions concerned the "goal of pure morphology". Yet both sets of definitions refer to two different ways of thinking, which Arber termed *physico-chemical thought*, which deals with the phenomenon, and *morphological thought*,[6] which "attempts to penetrate towards the thing-in-itself".[7] Perhaps morphological thought suits Arber's first definition, "… the visual and conceptual interpretation of the perceived". Regardless, both Arber and Brady had discovered that these two definitions stem from two different ways of thinking.

> Notice that the two meanings of metaphysics derive from two directions in thought—actually two ways of thinking—which result in two very different notions how the world is known.[8]

[4] It is important to stress that "pure morphology" is something Arber considered to be part of a *Natural Philosophy*:

There is much to be said for the suggestion that, whereas *Metaphysics* studies 'being' as such, and *Natural Science* (of the physico-chemical type) treats of the corporeal world, Natural Philosophy may be so defined as to link the two; it would then connote that mental activity which ceaselessly weaves connexions between the planes of intangible 'essence' and tangible 'existence' (Arber, 1964, p. 25, original emphasis).

Arber mentions metaphysics at the end of her classic *The Mind and the Eye,* whereas Brady tackles these two definitions in the first paragraph in his article *Getting rid of metaphysics.* In my view both authors reach the same conclusion, but approach the problem of two ways of seeing in a very different manner: Arber, cautiously as she addresses a scientific audience critical of Goethe; and Brady boldly as he addresses a Goethean audience.

[5] Arber (1964, p. 125).

[6] Arber uses the term morphological thought in her translation of Goethe's *The Metamorphosis of Plants* (1790), and Tobler's *Ode to Nature* (1782),

… finally, by a transition natural to his mental growth, he reached a stage in which his morphological thought reached out to the reconciliation of the antithesis between the senses and the intellect, an antithesis with which traditional science does not attempt to cope. (Arber, 1946, p. 86)

Unfortunately, over 200 years later, traditional science still has not attempted to cope.

[7] Arber (1950, p. 208).

[8] Brady (2001).

What, then, are these "two ways of thinking"? I briefly discussed one of these, Anschauung, in Chap. 4. The other, which I will call the *received view*, is a dualistic interpretation of Nature where truth is hidden from us and is only accessible via abstract means. Our own observations are simply too naive or subjective to see the underlying mechanisms of Nature. The received view is understood as the Cartesian mind, which heralds back to the ancient Greek philosophers and was challenged by German and English idealism, as I have discussed in Chap. 5. To contrast these two ways of thinking, we need to move beyond the terms "subjective" and "objective" and associated connotations; negative in the case of "subjective", and positive, in the case of "objective". What if I were to tell you that while bird-watching several weeks ago, I saw a double-barred finch (*Taeniopygia bichenovii*)? You would only have my word for it. I am not an ornithologist nor a bird specialist, so can you be sure that I saw a double-barred finch? You can't. You would have to trust me as an individual, namely, that I don't lie about the types of birds I claim to have seen, and you would have to trust what science knows about double-barred finches—do they occur in the area where I claim to have seen them? Are they a common bird? Are they easy to identify? In any case, my observation would be labelled as "subjective" simply because I had seen the bird, but I am unable to produce it to show you. If, for example, I was an expert on Australian estrildid finches who had caught the same individual bird, either in a cage or on a camera, then the *very same observation* would be considered "objective", simply because we have the evidence to show that it was indeed a double-barred finch. What makes something subjective or objective is the presence or absence of human emotion, opinion or mind. In other words, something is subjective simply because human observation and a human mind had gotten in the way of the truth. Something that is subjective is almost unreal—a product of a mind through which facts are sullied—whereas objective facts are real. This received view is endemic in current scientific thinking.

Remembering the shape of a bird or its call or foraging behaviour is how birdwatchers identify birds while observing them. Birdwatchers have some training in identifying birds, not to the standard of an ornithologist, but they know the birds they observe. Once an unknown bird comes into view, the excitement grows: "Have I seen this bird before?" The behaviour, call and shape of the bird are at first unfamiliar. What follows is a frenzy recording in a notebook, detailing the characteristics, or in the case of the less serious birdwatcher, a hurried look through a field guide.

> I once had followed a little brown bird with an unusual call and plumage for nearly an hour through dense bush within a national park on the outskirts of Sydney. The bird call was familiar, so was the plumage. The bird would have been a normal size for an Australian finch, in fact it displayed very finch-like behaviour, darting in and out of bushes, never foraging up high. Finally I caught a glimpse of its beak—it was a juvenile. Then everything fell into place. The experience and knowledge I had gained through years of observing birds revealed it to be a juvenile house sparrow (Passer domesticus)—a common and introduced species. I had heard the call before: in a park in the middle of the city. The disappointment was palpable.

If someone well trained in observing bird form, behaviour and colour were to identify a bird for you, we would have to consider it a subjective observation, because the observer had merely given an opinion, that is, an interpretation.[9] If another observer, equally trained in observing birds, were to give an alternate interpretation, then the situation would almost certainly appear subjective. How, then, do we make this situation objective? The received view would be to throw as much expertise at it so that eventually, the situation resolved itself. Enter two highly qualified and experienced ornithologists. Each disagrees with the other about the identity of the bird. Perhaps it is a new type of bird unknown to science? Perhaps it is a hybrid? The two experts can't work it out. Now someone suggests they use an app (AI) to identify the bird. The app they use asks specific questions about the bird and leads them through an algorithmic process. The app identifies the bird, but the two experts disagree. Here we discover that the algorithm, which identifies birds, uses a technique that another expert uses: the algorithm does nothing more than emulate the technique of a third expert. Now we have *three* interpretations, all from bird experts. Another suggestion is to take the DNA of the bird and check that against a bird DNA database. The database reveals it to a certain type of bird. Here we encounter another problem: who identified the bird from which the database DNA was extracted? Now we have *four* expert

[9] The philosophically minded may wonder whether I'm reinventing Norwood Russell Hanson's theory-laden observation, an idea also attributed to Thomas Kuhn and Paul Feyerabend. The short answer is "not in this case". Theory-laden observation refers to ideas, such as adaptationism or functionalism, as influencing what scientists see as a group rather than as individuals, as in the example above. Too often I'm confronted with biology students reacting an image to a dark Pepper Moth (*Biston betularia*) set against the bark of a tree as "natural selection", rather than as "oh look! A pepper moth". I believe that is an example of theory-laden observation.

interpretations of what the bird may be. DNA may be great in identifying similar or exact matches, but has the problem of contamination, other human errors and, most of all, misidentification. A taxonomist suggests that the two experts consult the specimen types, namely, a specimen that displays the diagnostic characters that link it to a scientific name. Whichever bird it is will have the same characteristics as the type. In other words, another bird will help us understand the identity of this bird. Eventually, both experts agree on the identity of the bird, through observing two or more specimens. In the end, it was observing form, that is, morphology, and not AI or DNA that resolved the situation. Moreover, in the case of using AI and DNA, we believe we are being objective, when in fact most "facts" or data have been processed in some way by a person. If objective means no interpretation or opinion or mind, then nothing we do can be considered objective. Nothing we consider to be objective can help us; science would have to be done in total isolation, uncontaminated by human ideas or thoughts.

So clearly, the monikers "objective" and "subjective" do not help when describing the scientific practice. Much in science is "interpreted", but it does not mean that makes the phenomena we observe untrue or unreal. The platonic notion of hidden truth in nature, one we are incapable of directly observing, has affected our language and attitudes of how we view Nature. What if we did something radical, and in the spirit of Fichte, reject the Cartesian dualism of truth versus mind, and switch our way of thinking from one that treats everything observed as tainted to one that treats what we see as real? Let's return to the cube (Fig. 6.1), which we used to demonstrate how form manifests itself in Nature.

When we view the Necker cube, we see one of two manifestations: a cube facing the bottom left and a cube facing the top right. Are these manifestations created in our minds? Yes, they are. Do they exist in Nature? Yes, they do. The emergence of one of the two manifestations is directly due to our interaction with the object from which the phenomenon emerges. The received view of these two manifestations is that they are illusions. Again, the language is not helping us understand what is happening, as the term "illusion" refers to a flawed perception or a false idea. Yes, these manifestations are the result of thinking, but without the object, namely, the cube, they would not exist. In this sense, our thinking and the objects of thought (the manifestations) are intertwined. Our thinking is not independent from the objects of thought as both are needed to create the phenomenon. Yet, the received view insists that thinking be

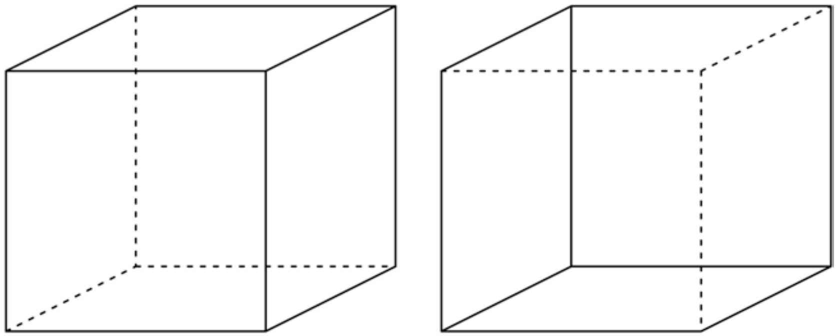

Fig. 6.1 Necker cube with all two manifestations shown. Creative Commons CC0 1.0 Universal Public Domain Dedication licence. Source Wikipedia

independent from the objects of thought, so as not to sully it with human imagination, emotion or opinion. In his article, *Getting rid of Metaphysics*, Brady concludes:

> … such thinking [contrary to the received view] would not be 'scientific.' The 'metaphysical' basis of science, in the modern sense of a principle adopted without evidence, shows in the conspicuous absence of a form of thought which could investigate such evidence. Scientific thinking is limited to a form of thought that cannot question its own premises.

What Brady means is that current scientific thinking, or the received view, does not recognise the intuitive participation of the mind in understanding Nature. How then, can we investigate these manifestations and the objects from which they emerge? How do we investigate homology if we do not accept homologues as manifestations of an urphenomenon, which are somehow related? How can we do taxonomy without the intuitive participation of the taxonomist? The Modern Hubris resurfaces once again.

As I have shown above, bad metaphysics plays a key part in the Modern Hubris by severing the observer from the observed world. Bad metaphysics stops Anschauung by treating models as the main purpose of investigation, rather than observation and the data collected from observation. Bad metaphysics prevents the urphenomenon by dismissing objects of thought and insisting on independent thinking. If the Modern Hubris is the problem, then bad metaphysics is the cause.

The impact of bad metaphysics can be seen in various aspects of science, particularly in how it has shaped scientific premises. One area, evolutionary biology, has embraced technology and models to the extent that it defines how scientists decide what they do. One of the practices of morphological classification is to propose the relationships between taxa, that is, species, genera and so on, within a hierarchical classification. The process of finding these relationships requires the practitioner to observe many specimens and compare their parts, such as their wings or thoracic segments. As we observe these organisms and compare their parts, we use Anschauung and slowly we piece together the urphenomenon; we start to see, in our mind's eye, a generalised part, and its many manifestations, in the same way, we see a mammalian forelimb. Within that mammalian forelimb, we see a bat's wing, a horse's leg, a human arm and so on. Yet, when we note this all down, we need to construct the information into a grid called a matrix, so it is machine readable. This whole process has been termed "coding". Following this, a set of algorithms combines the data to form a graph that depicts a hierarchy. Unfortunately for the theoretical development of evolutionary biology, the graph is indistinct from a hypothesised evolutionary tree in appearance (Fig. 6.2).

What is in fact a hierarchical classification based on morphological characters is often (too often) mistaken for an actual evolutionary tree. The nodes, which are necessary for the graph to show a hierarchy, are misrepresented as ancestors, or ancestral characteristics. The branches which emphasise a hierarchy are mistaken for lineages. The independence of our thinking and the objects of thought lead us down a very dangerous path. There is simply no evidence in the data for any ancestors or ancestral characteristics: they are merely suppositions based on a mistaken belief that hierarchy, any hierarchy, is equivalent to an evolutionary lineage that contains ancestors or ancestral characteristics or both. How can there be? The practitioner has never knowingly seen one. The practitioner would know this if they were accepting the dependence on thinking and the objects of thought. Yet, the premise of these models means that these suppositions are accepted because the practitioner believes that there is some form of hidden truth in the data that they cannot see merely through observation. Philosophers of science have been remiss in not asking evolutionary biologists what they are doing when they compare and find new characteristics in the parts of organisms. If they do ask or read their papers, they uncritically accept what is said, giving rise to more suppositions, such as the species concept. Medawar warned of such follies:

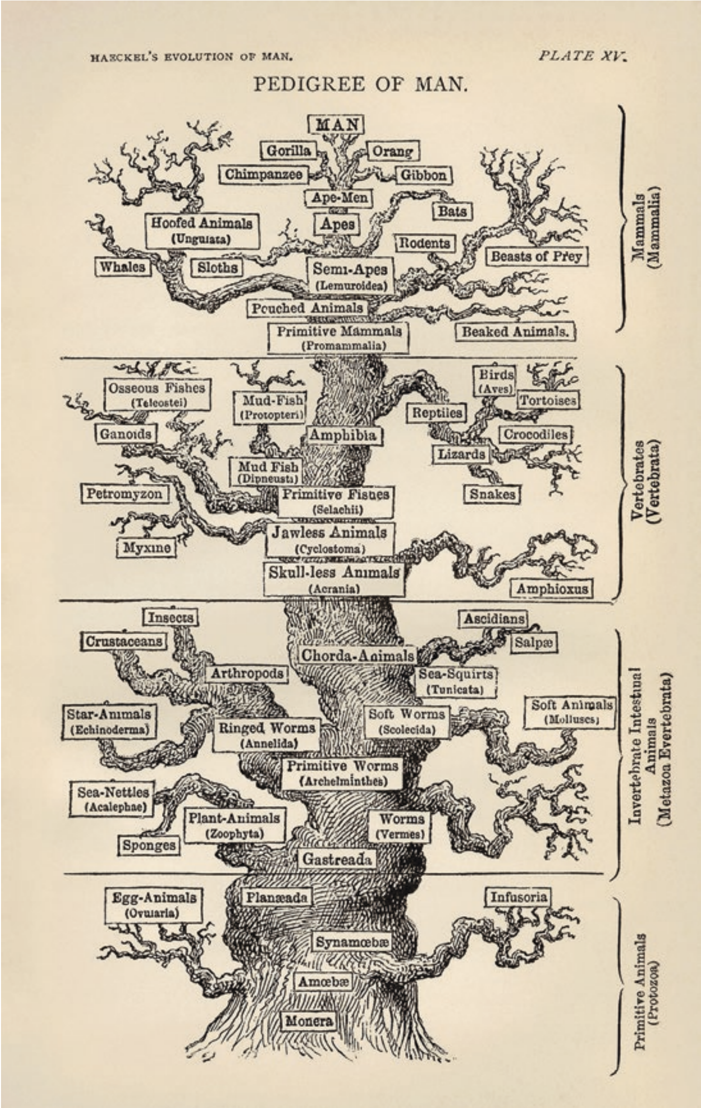

Fig. 6.2 (**a**) An evolutionary or genealogical tree. The tree is read as one group giving rise to another, such as semi-apes giving rise to apes, then to ape-men and so on. The tree can be written out as a linear progression: semi-apes —-> apes ——> ape-men. This linear progression is merely speculation and not based on any evidence; (**b**) a hierarchical classification shown as a graph, known as a cladogram. The letters indicate different taxa (e.g. species, genera etc.). The same cladogram may be written out as a Venn diagram or in parentheses: (A,(B,(C,(D)))). No linear progression is assumed. The evidence simply states the relationship between taxa, namely, D is more closely related to B than it is to A

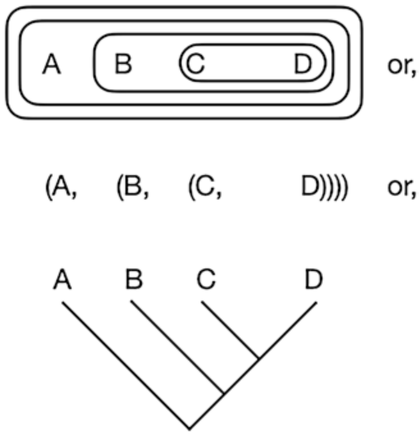

Fig. 6.2 (continued)

> What scientists do has never been the subject of a scientific, that is, ethological inquiry [. . .]. It is no use looking to scientific 'papers', for they not merely conceal but actively misrepresent the reasoning that goes into the work they describe [. . .].[10]

The characters that evolutionary biologists talk about are not actual real tangible objects found in Nature. Rather, they are objects of thought—urphenomenon—something derived through Anschauung. Either our practitioners do not know this, or they deliberately conceal or even "actively misrepresent the reasoning that goes into the work they describe". Stating that a graph, which shows hierarchical relationships, contains information or inferences about ancestors or ancestral characteristics is an example of bad metaphysics, for the simple reason that these are not the result of observation. They are purely illusory and are used to make speculative claims that appeal to readers rather than to elucidate something about Nature. The same problem also occurs in palaeontology, in which there are also claims about illusory ancestors.

[10] Medawar (1968, p. 15).

Ancestors are virtually impossible to identify. This does not mean they do not exist. Ancestors do exist, but we can't identify them in the same way we can identify a species of bird. Ancestors are hidden organisms. The problem with evolutionary biology, and this includes palaeontology, is the underlying premise that species evolve into other species. Given that no one has wittingly observed, or measured, species evolution, the next best thing is to identify the fossil ancestor of a living species, or a transitional fossil between two species. The premise follows along these lines: if you find the oldest of one type of organism, say a bird, then you have the ancestor of all known descendants of birds. The one question students rarely ask me, when presented with this premise, is "how do you know?" Well, how do you? There is no link between a fossil bird specimen and a living bird. True, they might share characteristics, but all birds do, that's why they are birds and not say, salamanders. All birds, whether they are fossilised or alive, are more closely related to each other than they are to any other known organisms. We would assume that the ancestor of one species is the most closely related species, more related than any other species. Yet, that may or may not be true. We don't know how evolution took place, remember, we haven't observed the process. The ancestor may have had one, two or more descendants at the same time. We do not know, nor can we know. Knowledge of ancestors lies beyond the urphenomenon and within the realm of metaphysics. All we know is that a species has or had an ancestor living in some point in time. Anything else is mere speculation, as is seen in these online news headlines:

> Scientists find 'oldest human ancestor'.[11]
>
> Dinosaur ancestors 'may have been tiny'.[12]
>
> A set of ancient footprints may have belonged to an unknown Human ancestor.[13]

The journalists who faithfully report these news stories are either assuming that these are ancestors or they are retelling what a scientist has told

[11] BBC News Online January 30, 2017, by Pallab Ghosh https://www.bbc.com/news/science-environment-38800987

[12] BBC New Online July 7, 2020 https://www.bbc.com/news/science-environment-53319635

[13] Smithsonian Magazine Online December 3, 2021, by Rasha Aridi https://www.smithsonianmag.com/smart-news/a-set-of-ancient-footprints-may-have-belonged-to-an-unknown-human-ancestor-180979157/

them. Yet, when we look at the papers from where these stories originate, we find that only one—the second story—used the term "common ancestor". One reporter reported an identified "common ancestor" in the first story and another referred to "human ancestors" in the third. The use of "ancestors" in these stories are merely speculations that help to drive the narrative for a popular, as well as a scientific, audience. In contrast, claiming knowledge of an ancestor, identified within a graph or as an individual organism, for example, is bad metaphysics.

I have shown that bad metaphysics is a core component of the Modern Hubris. How, then, do we remedy bad metaphysics? We return to Brady and Arber, and the two ways of seeing, namely, acknowledging that thinking is not independent of objects of thought, or as I have shown above, Anschauung—thinking and observing—is not independent of the urphenomenon—the objects of thought. Accepting this, we switch from seeing the universe from the outside in, to seeing it from the inside out. The consequence of this is that phenomena become greater than just the sum of their parts.[14] Observe your pet dog or cat and think of all the manifestations within that one individual, for instance, the mammalian forearm in all its manifestations. The more members of the cat family you observe, the more manifestations you are able to see in your mind's eye—a puma, a tiger, a lion. Suddenly, you are able to see cats in all their various manifestations. Arber, a plant taxonomist, saw the world in this way:

> The One *is* the Manifold, and the Manifold *is* the One.[15]

So too did Goethe, while travelling through Italy in 1786.

> […] perhaps all plant forms can be derived from one plant.[16]

It was Goethe, after all, who first attempted to remedy bad metaphysics in his *Theory of Colours* or *Zur Farbenlehre*, in 1810. In it, he explored the ideas of Anschauung and the urphenomenon as methods that deviate from the received mathematical view that was so prevalent in physics at the time, namely, that observations were secondary to mathematical theory and hypothesis.

[14] The concept of Wholeness is covered in great detail by Henri Bortoft (1996, 2012).
[15] Arber (1957, p. 118).
[16] Goethe IJ p. 54.

In any scientific method, the scientist proposes a hypothesis and then sets out to test it through experimentation. Woodger puts this quite eloquently:

> There are several ways of making scientific discoveries. One way is by making observations in field or laboratory; another is by using your powers of invention; and a third way is by uncovering clashes of doctrines, in other words, by revealing contradictions in existing beliefs.[17]

The first of these is relevant to scientific fields such as taxonomy and comparative biology. No explicit hypothesis exists other than "what on Earth is this?" If we were to go into the field and collect beetles to see what new forms there are, our only other hypothesis is "Are there new forms out there that we have not discovered yet?" This is certainly the underlying hypothesis when I go into a quarry or to an outcrop in the hope of finding something new. But hoping to find something new isn't really a scientific hypothesis. It is just the basic tenet behind the discovery, which drives scientific endeavour. Without wanting to find something new, we will never make any discoveries. When we are faced with something new, we observe it. Anschauung kicks in and we compare our object with others and slowly add new characteristics and variations of form to the growing knowledge-base that is the urphenomenon. At some point, the scientist finishes, and the discovery is carefully published as a scientific article. There was no hypothesis or experiment, simply because both are superfluous. Yet, this type of science, known as historical science,[18] is not the science that the public thinks of when they think of scientists. Experimental science is what is instantly conjured up in people's minds when they think of "scientists": men and women in lab coats and goggles, pipetting colourless liquid vials that are then carefully inserted into centrifuges. The geologist studying an outcrop of granite, or a palaeontologist examining a fossil under a microscope are often seen as natural historians rather than scientists. Yet, these historical scientists differ considerably from chemists, medical scientists and physicists. Historical scientists are interested in examining and describing form, that is, morphology. From form, you may make interpretations, such as where the object lies in a hierarchical classification. A geologist, for instance, may be able to

[17] Woodger (1961, p. 67).
[18] See Wilkins and Ebach (2014).

determine the relative age of the rock based on the fossils it contains. The phenomenon, the object, is of primary significance. The inferences made about these objects, such as the processes that created them, that is, the explanations, are secondary. No taxonomist, for example, invents an organism or a process in their minds and then goes out to find them. The move from explanation, such as a hypothetical process, to a real natural object, is placing the proverbial cart in front of the horse. The explanation (*explanans*) cannot come before the phenomenon that is to be explained (*explanandum*). Yet, scientists do this often when they do not deal with form.

The misinterpretation of Goethe's method is that it is considered a method, rather than scientific praxis. Anschauung is an activity. Thinking about a hypothetical process is not. The problem with Goethe's *Farbenlehre* is that colour is considered by physicists to be a process, namely, the moment of particles or waves. Goethe viewed colour as an object, as it has form and is morphological. In that sense, Goethe's *Farbenlehre* is a historical science in which colour is examined as an object we experience, rather than as processes, which we do not. There are no explicit hypotheses other than "how can we experience colour?" Newton's approach was the complete opposite. He proposed a mathematical model, the hypothesis, that white light is made up of coloured light, and then sought to see if he was correct via experimentation. While there is nothing wrong with Newton's approach, it is not really a historical scientific study of an object, using our perceptions and understanding the resulting experience. Newton didn't care about human perception, but rather about proving a set of mathematical hypotheses that explain the behaviour of "rays of lights" using real experiments. It is when the hypothesis gains a life of its own that it becomes a problem. Goethe had warned:

> A false hypothesis is better than none at all, for the mere fact that if it is false does no harm. But when such a hypothesis establishes itself, when it finds general acceptance and becomes something like a creed open to neither doubt nor test, it is an evil under which centuries to come will suffer.[19]

Shoehorning an explanation, such as a mathematical hypothesis, into a real-world phenomenon is another symptom of the Modern Hubris. The fact that something completely abstract—an explanation—has far greater

[19] von Goethe (1995, p. 49).

impetus in science than the actual phenomenon is worrying. Why is knowing where our human ancestors come from more important than understanding observed form? Why do stories about the "oldest human ancestor" or the ancestors of dinosaurs garner greater attention than the actual fossils themselves? Does bad metaphysics say more about the scientist as an individual? After all, scientists want jobs and recognition as much as anyone else. Creating sensationalist stories that can never be proven is one way to gain recognition; you don't see stories about scientists discovering small and evolutionary insignificant fossils, even if the scholarly impact of the research is significant. Another reason for bad metaphysics is that scientists believe in what they say, even if the evidence is completely missing or a favourite hypothesis is arbitrarily chosen over another. In any case, bad metaphysics cannot be justified in science, and it is best that we get rid of it before it overwhelms the sciences and replaces evidence with belief. To be rid of bad metaphysics is to embrace our own intuitive perception or Anschauung and train a generation of scientists in how to hone their observational skills to develop the urphenomenon. While we all can practise Anschauung from which the urphenomenon emerges, it needs practice and discipline. It takes a fledging palaeontologist more than three years to learn a group of fossils, the same is true for any comparative biologist. Yet, this training is sadly lacking. So too is the experience of the individual. Many science students I have taught have no personal interest in science or observing the natural world. Science has become a vocation rather than an interest or hobby. Science students come to universities, colleges and schools to learn about the natural world in the hope of gaining employment, some because they genuinely care about the state of Nature and hope to one day save it. The development of science not only depends on new discoveries, and perhaps advances in technology, such as the invention of better microscopes, but it also depends on the development of an individual. Someone who is already skilled in say, bird-watching, will be a much better student of taxonomy because they have already honed their observational skills. Observation is an activity, so in the same way, an unfit student will generally fail in learning a new strenuous sport, and so too will someone who has poor observational skills. Rather than promote observation through experience, we now have handheld devices, such as mobile phones, to take photos of birds, insects and trees that an app—read AI—will use to predict what type of organism is featured in the digital image.

We will never be able to embrace Anschauung and the urphenomenon when we choose to be inert. AI may help us identify a plant or animal, but it takes way far more than it gives. AI removes our observational independence, our ability to observe. I don't mean our ability to see, rather our ability to observe, and actively participate in noticing and understanding Nature. Goethe, through the character of Wilhelm Meister, complained that placing a visual aid between the observer and the object alters it in some way, taking it and the observer out of context. Placing a VR set between you and the world has taken Goethe's warning to nightmarish extremes.

The point is to embrace the Anschauung and urphenomenon that are already present in scientific practice, such as taxonomy, and treat it as the primary task of natural science. The applied scientific approaches, such as abstract analysis and interpretation, should be treated as secondary. Modelling, based on speculations or misrepresentations, should be eliminated entirely. Once we depend on such models as ways to "know" the natural world, then we lose our ability to discover the natural phenomenon. Remember, it is from observation, such as the wobble in Uranus' orbit that led Le Verrier to calculate the orbit of Neptune, which was later confirmed by Galle, who observed it from the observatory in Berlin. There is a place for abstract mathematics, hypotheses and theories in natural science, an important one, but it does not replace observation and the phenomenon. It rather acts as a tool or scaffolding to help the observer conduct experiments, or in the absence of experiments, know and understand phenomenon via Anschauung. We start with observing the phenomenon and end with the urphenomenon. Once modern scientists had removed Anschauung and the urphenomenon, and replaced it with the tools that assisted observation, the Modern Hubris was born. That scaffolding has become far more complex as newer and more complex theories and hypotheses have ensued. Now speculative models have been created using large data sets blindly amassed by machines, leading to bad metaphysics.

Only through Anschauung are we able to discover Nature. The way to practise natural science free of bad metaphysics is to adopt or to continue practising Anschauung. It is pointless starting natural science anew as we will just end up reinventing taxonomy and natural classification via an arduous process in which we repeat the same mistakes. Natural science needs to be reformed, not remade.

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CHAPTER 7

Goethe's Italian Journey and the Transformation of Self

Abstract This chapter will examine how Goethe changed his way of thinking during his journey in Italy, and how it impacted his life in Weimar. The golden thread of Goethe's ideas will find the clew in this chapter. I attempt to identify when and where Goethe's thoughts and scientific life started to change. I also show that experiencing phenomena via Anschauung and the urphenomenon transforms us in just the same way it transformed Goethe. What if Goethe had not experienced what he did in Italy? Would that have changed his life completely? Would he have written the bulk of his scientific work? Would he have discovered Anschauung and the urphenomenon and dedicated his life to natural science? Alas, we will never know. Regardless, we may use Goethe's life as an allegory for the transformation of the scientist.

Keywords Goethe • Weimar • Italian journey

I, too in Arcardia.[1]

Anschauung changes you and the way you perceive Nature. The emergence of a phenomenon from a landscape has a profound affect—suddenly, the object appears and what was an empty landscape is now a

[1] von Goethe (1989, p. 11).

M. Ebach, *Goethe in the Age of Artificial Intelligence*,
https://doi.org/10.1007/978-981-19-6741-2_7

menagerie. Accepting this experience as objective and scientific is incredibly important. Comparative biologists experience this emergence of characters from organisms. It is vital to practise Anschauung and form the urphenomenon in the mind's eye. Without these, they are unable to do comparative biology. The same is true for other quantitative fields such as biology, geology and geography. Yet, the importance of Anschauung and the urphenomenon is never written out or openly discussed. Comparative biology articles that have been peer-reviewed in published in respected academic journals lack a methods section. Anschauung is deeply personal and writing how one practises it would engender vulnerability, as you are revealing private thoughts. Others might not accept Anschauung as something that they do when they observe a phenomenon. In any case, Anschauung doesn't look or feel like the technologically driven quantitative science that has been enshrined in academia for centuries. When then will Anschauung and the urphenomenon be revealed to the world? Possibly never. Once these disciplines die out, Anschauung and the urphenomenon may never be redeemed as a valid scientific practice. During Goethe's lifetime, Anschauung and the urphenomenon was used in the same way as it is today—it is the way scientists (and artists) observe and appreciate Nature. Goethe understood that Anschauung and the urphenomenon are central to the scientific method, something that he may not have at first realised. Goethe's journey through Italy did raise an awareness of the importance of observation[2] in architecture, art and Nature. By the end of his Italian journey, particularly his time in Sicily and on his second sojourn to Rome, he had knowingly completed his transformation. His flight to Italy had paid off. Goethe, the servant of the Weimar Court, *Strum and Drang* author and ideologue, was on his way to becoming Goethe the Naturschauer, the observer of Nature.

> At present I am only concerned with sense impressions, which no book, no picture, can give [September 1786].[3]
>
> But you know how I live by observing [Anschaun]; a thousand lights have dawned on me [August 1787].[4]

[2] Goethe started using the term Anschauung in his *Zur Farbenlehre* in 1810.

[3] Trent, September 11, 1786, morning (von Goethe, 1989, p. 24).

[4] "Aber Du weißt, wie ich im Anschaun lebe; es sind mir tausend Lichter aufgegangen" (Goethe to Merck August 5, 1778, my translation).

> I did not know how far the road I had started on would lead me, I could not see to what extent my earlier endeavours would succeed, and to what extent the results of my yearning and wandering would recompense me for the effort expended [September 1787].[5]

That transformation wasn't as simple as the above series of quotes suggest. Anschauung may be innate, but it requires a degree of discipline and practice. That discipline was lacking in Goethe, who himself admitted:

> … that perhaps all plant forms can be derived from one plant. Only in this way would it be possible to determine genera and species, which, it seems to me, has therefore been done very arbitrarily. My botanical philosophy remains stuck on this point, and I do not yet see how to proceed. The depth and breadth of the problem seem equally great to me.[6]

The notion of deriving all plant forms from one plant goes beyond Anschauung and the urphenomenon and into idle speculation. The idea is to observe and experience rather than to imagine new forms. Goethe still stubbornly pursued this idea into 1787:

> I was taken again by my old idea: might I not discover the primordial plant amid this multitude?[7]

> The primordial plant [urpflanze] is turning out to be the most marvellous creation in the world, and nature itself will envy me because of it. With this model and the key to it an infinite number of plants can be invented, which must be logical, that is, if they do exist, they *could* exist, and are not mere artistic or poetic shadows and semblances, but have an inner truth and necessity.[8]

It is surprising that Goethe included this passage in his *Italian Journey*, given the lack of disciplined thinking. An older Goethe would shudder at such a "primordial plant". But the urpflanze started to fizzle out as an idea

[5] von Goethe (1989, p. 324).

[6] Padua, September 27 1786 (von Goethe, 1989, p. 54).

[7] Palermo, Tuesday, April 17, 1787 (von Goethe, 1989, p. 214).

[8] Naples, May 17, 1787 (von Goethe, 1989, p. 256, original emphasis). The same paragraph is listed as "To Charlotte von Stein, from Rome, June 8, 1787" in von Goethe (1999, pp. 131–132).

and a model, being finally relegated to a formula, before being "completely displaced" by the idea metamorphosis.[9]

> I undertook a precise drawing of [the plant developing], and in this way arrived at ever deeper insights into the basic concept of metamorphosis.[10]

The importance of discipline and transformation was not lost on Goethe.

> The Northern traveler believes he is coming to Rome to supplement his own existence, to fill in the gaps; but then gradually he perceives, to his great discomfort, that he must completely change his way of thinking and being again from the beginning.[11]

When did Goethe's personal transformation set in? Clearly, it was his desire to leave the administrative burden he felt in Weimar and take a flight to Rome, where he could reawaken his senses and his creative mind. The transformation that Goethe underwent in Italy is key to understanding why he dedicated so much time to scientific endeavours in the following years in Weimar. Goethe's transformation can be used as an allegory for the transformation of the scientist[12] from the static and reductive to the dynamic and holistic. That transformation is difficult and requires time and discipline. If we follow that transformation throughout Goethe's life, starting with his journey to Italy, we may compare it to the transformation of the scientist, starting at the beginning of their career as a postdoctoral researcher. The scientist will undergo a remarkable change, which may be as heartbreaking and arduous, as well as exciting and fulfilling as Goethe's life scientific. Once we have traced this transformation, then we may have discovered a path to remedy the Modern Hubris.

Goethe left Weimar for Italy for various reasons. Twice he had seen Italy from the mountains in Switzerland, and twice he had turned his back at St Gotthard Pass, in 1775 and again in 1779. The decision to go to Weimar, rather than on a grand tour of Italy as his father had wanted, was a vexed issue for Goethe.[13] The decision to go to Italy was his alone, and the first two times did not seem right. By 1785 Goethe had lost interest in

[9] See Boyle (1991, pp. 500–501, 594).
[10] von Goethe (1989, p. 301).
[11] von Goethe (1989, p. 345).
[12] See Amrine (1990).
[13] See Boyle (1991, p. 310).

his administrative responsibilities, and his desire to study Nature was limited by his workload. In the same year Goethe's health had waned. He recuperated at the spa town of Carlsbad and hatched a secret plan. Posing under the pseudonym Johann Philipp Möller, a merchant from Leipzig, Goethe would travel incognito to and through Italy. Only his private secretary, Philipp Seidel, knew of his plans. On 2 September 1786, Goethe asked the duke for an "indefinite leave of absence".[14] Goethe left the following morning with many of his early plays (e.g. *Egmont*, *Torquato Tasso*) and novels (e.g. *Urfaust*) written up as notes or conceived as ideas. Several of these works, such as *Egmont*, were completed in Italy, but these represented the pre-Italian *Strum und Drang* Goethe. However, the works that followed were shaped by his travels in Italy, such as the *Metamorphosis of plants*, *Zur Farbenlehre* and *Faust*. What events changed Goethe? Surely travel in itself wouldn't change a person's entire outlook, particularly someone as driven as Goethe?

The Goethe that entered Italy was there to immerse himself in the art world in Rome. As someone who was obsessed with ancient mythology and literature, Goethe was unable to visit his beloved Arcadia, located in the Peloponnese in Greece. Greece was difficult for Europeans to reach as it was under the yoke of the Ottoman Empire and potentially hazardous for travelling Christians.[15] Italy, particularly Sicily, which featured in Homer's *Odyssey*,[16] was as close as Goethe would get to the lands of antiquity, hence his opening line to *Italian Journey*, "I too, in Arcadia". Sicily and Goethe's second sojourn in Rome were the defining moments in his journey.

Prior to arriving in Sicily, Goethe had to endure a four-day sea voyage. By the second day Goethe had developed seasickness and "refrained from eating or drinking anything but white bread and red wine".[17] Throughout

[14] The original reads: "und bitte Sie nur einen unbestimmten Urlaub". Goethe was quite introspective in his letter: "… selbst jets weiß ich noch night was aus mir werden soll" ["… even I don't know what will become of me"], and "… wenn ich wünsche meine Existenz ganz zu machen, ich dabei nur hoffe sie mit Ihnen und in dem Ihrigen, besser als bisher, zu genießen" ["… if I wish make my life whole, I only hope to enjoy it with you and yours better than before"] (my translation).

[15] Goethe was invited to accompany the Prince of Waldeck to "Greece and Dalmatia [the coastal region of modern day Croatia and the Bay of Kotor in Montenegro]"; however, the offer fell through as the Prince returned to Rome in May 1787.

[16] Not in name, but as the volcanic Cyclopean Isles, on which Polyphemus son of Poseidon, the cyclops, was blinded by Odysseus.

[17] von Goethe (1989, p. 184).

his journey, Goethe rarely travelled alone. German artist Christoph Heinrich Kniep (1755–1825) agreed to accompany Goethe and to sketch landscapes during their travel through Sicily. Goethe's hope to travel incognito was a great success when in mainland Italy. The German artists in Rome immediately knew who he was, and word spread in Rome and Naples that the author of *Werther* was in town. Goethe, however, had more luck in provincial Sicily. While at the Viceroy's palace in Palermo, he revealed his real identity to an astonished Conte di Statella.

> Showing the most visible signs of astonishment, he started back and cried: "Then a great change must have taken place!"—"Oh yes!" I replied, "between Weimar and Palermo I have undergone many a change".[18]

Was this an admission that something had changed? We only have Goethe's word for it. *Italian Journey* was published from a series of letters and diary entries in two volumes between 1816 and 1817. How much had Goethe remembered after 28 years? May Goethe have wittingly or unwittingly embellished these events? We simply don't know. Regardless, the literary Goethe works just as well for the purposes of elaborating on the allegorical transformation of the self.

One incident that intrigues me is the Cagliostro affair.[19] Goethe had followed the case and heard that Alessandro Cagliostro was in fact the Sicilian, and Palermo born, Giuseppe Balsamo. Having heard that the family of Cagliostro/Balsamo still resided in Palermo, Goethe organised a meeting with his mother and sister and various other family members. Goethe had news.

> I told her that her son had been released in France and was now in England, where he had been well received.[20]

[18] von Goethe (1989, p. 196, and Part II, footnote 57).

[19] Also known as the Affair of the Diamond necklace. The affair concerns the forging of Marie Antoinette's necklace, which had possibly led to the unpopularity of the Bourbon dynasty in France. Fraudster, conman and psychic healer Alessandro Cagliostro (1743–1795) was linked to the affair and jailed in the bastille. Finding no evidence against him, he was released after nine months. Goethe recounts the follies of Count Cagliostro in the comic opera *The Great Cophta* [*Der Groß-Coptha*] performed in Weimar in 1791.

[20] von Goethe (1989, p. 209).

While this brightened the mood, Goethe described the poverty of the mother's household.

> It was large and high that in our country it would have been considered a salon; but it also seemed to be the family's entire living space. A single window lighted the great walls […]. Two large, uncurtained beds stood against one wall, a little brown cabinet, in the form of a desk, against the other.[21]

Was this Goethe's first experience of poverty? Cagliostro/Balsamo had swindled his family (Goethe used the term "borrowed") the equivalent to two months wages on his departure from Palermo. The family had not heard from him since, and his sister asked,

> … after my return, I would not undertake to remind him in a kindly way of his debt, and to arrange some support for her, indeed, whether I would not take along, or possibly deliver, a letter. I offered to do so.[22]

Goethe, posing as Mr Wilton, an Englishman,[23] did not reveal his true identity. He was just interested in helping a poverty-stricken family. He sent the owed amount to the family upon his return to Weimar in 1788.[24] Would this constitute a transformation of self? Would Goethe, as a Weimar administrator, even care for some destitute family in a provincial part of Italy, let alone bother to send them money? Experiences change you, perhaps they had also changed Goethe in that large and high room lit by a single window.

Another transformation was Goethe's views on unrequited and platonic love. In Palermo, he was reminded of "the isle of the blissful Phaesacians.[25] I immediately rushed to buy a copy of Homer [and] read that canto to my great edification".[26] What caught Goethe was the story of Nausicaa, the daughter of King Alcinous and Queen Arete. She falls in love with Odysseus, who had washed up on the shore of Phaeacia. Nausicaa's unrequited love for Odysseus may have reminded Goethe of his platonic love for Charlotte von Stein, his confidant and personal correspondent

[21] von Goethe (1989, p. 208).
[22] von Goethe (1989, p. 209).
[23] von Goethe (1989, p. 207). "Mr Wilton" (Boyle, 1991, p. 469).
[24] von Goethe (1989, Part II footnote 75).
[25] Natives of the fictional island of Scheria, noted in Homer's *Odyssey*.
[26] von Goethe (1989, p. 195, also Part II footnote 56).

throughout his time in Weimar. He continued to ponder "the plan of Nausicaa and try to make a drama out of this subject matter".[27] Goethe "soon decided on the plot".

> The main idea was to present Nausicaa as a lovely maiden with many suitors, who, feeling no affection for any of them, has refused them all. However, when a remarkable stranger stirs her heart, she emerges from her condition and, by prematurely declaring her affection, compromises herself, which makes the situation wholly tragic […] Ulysses [Odysseus!], who is half-guilty, half-innocent of having caused all of this, must at last announce his departure, and the poor girl has no choice but to seek death in the fifth act.[28]

The above entry in the *Italian Journey* was headed "From Memory". Whether Goethe thought this at the time or not is hearsay. Yet, it is interesting that Goethe would regress, so to speak, into his *Strum and Drang* phase. The plot of Nausicaa is more reminiscent of *Werther* than the later works, which have a far more pragmatic and sensual quality to them (e.g. Wilhelm Meister, *Elective Affinities*). Nausicaa, however, failed to become anything. Unlike the urpflanze, it didn't transform into something else. Rather, it simply died. Fragments of Goethe's *Nausicaa: a tragedy* were published in 1827. Could this regression to *Werther* be Goethe's own narrative of his transformation? Immediately following the plot of Nausicaa, Goethe continues:

> There was nothing in this composition that I could not have painted from life out of my own experiences. On a journey myself, in danger myself of arousing affections that, even without tragic endings, could still become quite painful, perilous, and injurious; in a position myself, so far from home, to entertain the company with vividly coloured descriptions of remote objects, travel adventures, daily incidents, to be considered a demi-god by the young, a braggart by more sedate persons, to receive many an undeserved favour, face many an unexpected obstacle; all of that made me attached to this plan, to this project, that on account of it I dreamt away my sojourn in Palermo, indeed the greater part of my further Sicilian journey.[29]

[27] von Goethe (1989, p. 213).
[28] von Goethe (1989, pp. 238–239).
[29] von Goethe (1989, p. 239).

Let's not forget that this is a recollection of 28 years past, rather than a written record of the day. It still makes for interesting reading. At this point, Goethe was at the geographical mid-point of his journey, not necessarily midway through his transformation. In the last stop of their Sicilian tour, Kniep and Goethe arrived in the port town of Messina, which had been destroyed in an earthquake, on 5 February 1783. Towards the north of Messina stood "a town hastily erected out of boards".[30] The Governor of Messina was a mad tyrant, to whom it was advised Goethe and Kniep pay their respects. There, they were witness to a dressing down of a "respectable man […] connected with the Maltese Order" by the Governor, whom Goethe liked to Polyphemus, the cyclops. Goethe too ran foul of the governor by ignoring an invitation to dine.

> … the governor was having the whole town searched for me; he had invited me to dine, and I had failed to appear […] I feel how incredibly frivolous I had been to dismiss the Cyclop's innovation from my mind, glad to have escaped the first time. The servant would not let me delay, saying that the consul risked having that furious despot stand him and the whole town on their heads […] When I arrived in the lion's den, the comical footman led me into a large dining room, where some forty persons were sitting in complete silence at an oval table. The place at the governor's right was unoccupied, and that is where the footman conducted me.[31]

Goethe lacked the diplomatic immunity travelling incognito and was consoled by a chaplain who had witnessed the foreigner's dressing down and was familiar with the governor's mood swings. The chaplain wished to know Goethe better,

> … therefore I should be so kind as to identify myself more exactly, and tonight there would be a very good opportunity for that. I politely evaded this request by asking him to excuse a peculiar notion of mine, namely that on my travels I wished to be seen merely as a human being […] he tried in every way to draw me out of my incognito, but did not succeed, partly because, having escaped one danger, I could not pointlessly expose myself to another.[32]

[30] von Goethe (1989, p. 241).
[31] von Goethe (1989, p. 244).
[32] von Goethe (1989, pp. 247–248).

Travelling as a common man or as a human being, Goethe had seen beyond the protection of the Weimar court. No one would treat him with such suspicion or discourtesy in Weimar or anywhere in the German-speaking world. In Messina, he was a foreigner, a face in the crowd, not famous, not powerful, just a "human being". When would Goethe have felt that liberated? Not as the grandson of Johann Wolfgang Textor, not as the servant and personal friend of Grand Duke Karl August and certainly not as the author of *Werther*. Was *this* the first time Goethe felt truly incognito and one of the crowd? If so, it would have had a tremendous effect on Goethe's life experience. The experiences in Sicily had humbled Goethe. An encounter in Naples with "an Englishman [who] wanted to talk to me, because he had something to tell me about my *Werther*", was a request that "six months ago I would have returned a negative reply".[33]

Goethe gives us some insight into how the experiences in Sicily and Naples shaped his later relation with Schiller and his scientific work, most importantly his perception of the growth of plants.

> More and more I came to appreciate this way of looking at the plant kingdom, and while traveling the highway and byway [of Sicily and Naples] I had constant opportunity to exercise it. But these pleasant labors were destined to grow enormously in value when they led to one of the deepest relationships fortune brought me in my later years. It is to these pleasurable experiences that I owe my closer connection with Schiller, for they cleared away the misunderstandings which had long held me apart from him.[34]

Before Goethe's return to Weimar, he met Faustina Antonini, a widow and mother in her early 20s (Goethe was in his late 30s). His encounter with Faustina is recorded in the *Roman Elegies*:

> For not always kissing, often hold sensible converse;
> When she succumbs to sleep, pondering, long I lie still.
> Often too in her arms I've lain composing a poem,
> Gently with fingering hand count the hexameter's beat.
> Out on her back; she breathes, so lovely and calm in her sleeping,
> That the glow from her lips deeply transfuses my heart.[35]

[33] von Goethe (1989, p 257, original emphasis).
[34] von Goethe (1995, p. 18).
[35] von Goethe (1994, p. 107).

Goethe provides evidence of this sexual encounter in a letter to the duke dated 16 February 1788:

> … you, as *Doctor longe experientissimus*, are perfectly correct, that such moderate motion refreshes the spirits and puts the body into a delightful equilibrium.[36]

Nicholas Boyle suggests that this may be one of Goethe's first sexual encounters, if so, then it too would have had an effect—a holiday romance, one that is enshrined in verse within the *Roman Elegies,* originally published in German as *Erotica Romana*. The next sexual encounter was also with a younger woman, this time back in Weimar on 12 July 1888. The encounter was also recorded in verse.

> Lips that are so sweet, they make no motion,
> Either to speak or haply to be kissing;
> Melted are your arms, these magic bracelets,
> Which at other times you put around me;
> And your hand is stilled, of sweetest fondlings,
> Ever the provoker and companion.[37]

Christiane Vulpius (1765–1816) was the same age as Faustina, and to all intents and purposes, from the same walk of life—Faustina the daughter of an innkeeper, and Christiane the daughter of the clerk.[38]

The "new" Goethe had arrived, full of experiences gained on his Italian journey, a devotion to natural history and a sexual appetite, and had become a nuisance for the Weimar court. In 1789, Christiane fell pregnant and August, Goethe's first and only child to live to adulthood, was born. Goethe also reacquainted himself with Schiller in 1794, four years after the publication of the *Metamorphosis of Plants*, a study on plant growth and development inspired by the botanising he did in Italy.[39] At the time, both Goethe and Schiller were the two most prominent playwrights and poets in the German-speaking world, yet they met after the Meeting of the

[36] Goethe cited in Boyle (1991, p. 506, original emphasis).

[37] von Goethe (1994, p. 125).

[38] Boyle (1991, p. 537).

[39] The meeting was recorded by Goethe in *Fortunate Encounter* (see Chapter 4; von Goethe, 1995, pp. 18–21).

Natural Research Society[40] in Jena and discussed the metamorphosis of plants in Schiller's lodgings. The fortunate encounter forged the celebrated intellectual relationship between Goethe and Schiller. In the period between 1790 and 1821, Goethe had published the bulk of his published scientific work, including *Metamorphosis of Plants in* 1790, *Beiträge zur Optik in* 1792, *Zur Farbenlehre* in 1810 and *Zur Morphologie in* 1817. Keeping in mind that we are using Goethe's life as an allegory, what if Goethe hadn't fled to Italy on that cold morning in 1786? What if he headed back to Weimar and resumed his duties? Would Goethe have been transformed[41]?

Our experiences of a phenomenon affect us as we see it emerge before us through Anschauung, and in our mind's eye as the urphenomenon. We may ask what drives a botanist to dedicate their lives to studying plants. The short answer is how those plants affect the observer. For someone madly interested in plants, that dedication may be gardening, and for others, it may end up as 11 years of training and a lifetime committed to studying plant form. Phenomenon affect different people in different ways. On his journey through Italy, Goethe was deeply affected by the plants we saw, he claimed to have imagined the primal plant, and then later interpreted it as a metamorphosis. Experiencing those plants did affect Goethe and played a part in his transformation as a person. The effect was deeply personal and drove him to write the M*etamorphosis of Plants* and rekindle an acquaintance with Schiller. We will never know what would have happened had Goethe not travelled to Italy, yet it wouldn't be hard to imagine that transformation not happening if Goethe had stayed in Weimar. What would have triggered Goethe's transformation? Experiencing the flora and fauna of Central Europe would not have stirred up the image of a primal plant. Only seeing Palladio in paintings and drawings would not have cast the idea of archetypes. The platonic romance with Frau von Stein would not have given him the courage to sexually liaise with Christiane. Certainly, Goethe's scientific work would have continued, but not as a science of observation, as he had decided to dedicate his life to in Italy. There would be no *Metamorphosis of Plants*, no conversation with Schiller about observation and experience, no archetypes or *Zur*

[40] Tagung der Naturforschenden Gesellschaft, Jena (Golz et al., 1995).

[41] I apologise to historians for my Whiggish history. This is not an attempt at a biography, rather a way to present Goethe's scientific ideas, and how to practise them, through the means of an allegory.

Morphologie, no Anschauung or urphenomenon, no *Beiträge zur Optik,* and no *Farbenlehre*. The allegory of a person's life transformed, which had led to a flourishing of scientific thought, that is, Anschauung and the urphenomenon, is central to understanding how we can remedy the Modern Hubris in scientific practice. If we consider that Anschauung and the urphenomenon are a conversation with Nature, then we understand that Nature can affect us, as much as we can affect it. The more we appreciate and therefore understand Nature, learn about it and understand what it is, the more likely we are to nurture and conserve Nature. How can we have a conversation with Nature when scientists and science students are not exposed to it? Goethe noted the lack of exposure that students have to natural objects in a letter to Johannes Daniel Falk in 1809:

> Most of what is being done is just a repetition of what this or that famous predecessor said. There is hardly any talk of independent knowledge. The young people are herded into rooms and lecture halls and, for want of real objects, they are fobbed off with quotations and words. The pupils may acquire the insight [Anschauung] which the teacher himself often lacks! It doesn't really take a lot to see that this is a totally wrong way to go about it. If the professor owns a learned apparatus, it doesn't get any better, only worse.[42]

Goethe's use of the term "independent knowledge" is interesting as it refers to the personal transformation that a student, trained in Anschauung and the urphenomenon, would go through during their studies. If we disallow Anschauung and the urphenomenon, we prevent the observer from experiencing the emergence of the phenomenon, and therefore stop any transformation of the self. Rather than transforming the observer, we have simply given them information. The received knowledge is therefore dependent on a series of assumptions and rules. Furthermore, without independent knowledge, the instruments and apparatuses that help us to observe slowly replace what we lack in direct experience. An entomologist,

[42] "Das meiste, was was getrieben wird, ist doch nur Wiederholung von dem, was dieser oder jener berühmte Vorgänger gesagt hat. Von einem selbständigen Wissen ist kaum die Rede. Man treibt die jungen Leute herrenweise in Stuben und Hörsäle zusammen und speist sie in Ermangelung wirklicher Gegenstände mit Zitaten und Worten ab. Die Anschauung, die oft dem Lehrer selbst fehlt, mögen sich die Schüler hinterdrein verschaffen! Es gehört eben nicht veil dazu, um einzusehen, daß dies ein völlig verfehlen Weg ist. Besitzt nun der Professor vollends gar einen gelehrten Apparat, so wird es darduch nicht besser, sondern nur doch schlimmer" LA IA p. 730.

for example, may now only see a photograph of an insect, or compile a database. While these are necessary and vital tools, they only assist with observation and knowledge. Tools do not replace Anschauung and urphenomenon; tools do not rob us of our experiences; tools do not replace independent knowledge. How, then, do we embrace independent knowledge and show students the way forward and stop the Modern Hubris? The question is not easy to answer as everyone is different and in different situations. What the observer needs to realise is that experiences gained from Anschauung and the urphenomenon are a result of a conversation with Nature. Conversely, a natural scientist who breaks that connection may be dictating to Nature.

Dictating to Nature means we are no longer conversing, but rather forcing an opinion or argument or assumption. In other words, bad metaphysics. Dictation to Nature can only lead to the Modern Hubris. Recognising that connection with Nature and developing Anschauung and the urphenomenon are critical for us to grow as scientists, make discoveries and help natural science move forward. Goethe's life is perfect to an allegory of a scientist's life, and perhaps Goethe may be our guide to becoming better scientists.

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Epilogue

One person's life may serve as an allegory for the generic life of a natural scientist. Goethe grew up in the Age of Enlightenment, adopted its ways and challenged the orthodoxy through the *Sturm und Drang* movement in his youth, in the same way a teenager adopted punk in the 1970s and alternative sub-cultures in the 1980s, 1990s and 2000s. Idealism only gets you so far. The experience moves beyond idealism. Love and the Platonic ideal may move you to distraction, and in the case of Goethe's fictional Werther, it cost him his life. The idealism of this sort had its limits, both in love and in science. The transformation of Goethe as a person and, more importantly, as a scientist occurred when he started to practise observing Nature and other phenomena. His own ideals of science were turned upside down once he started to practise Anschauung. The imaginary urpflanze, an idealistic creation, slowly became plant metamorphosis, as evidenced by observation. Platonic love, another one-way ideal, metamorphosed into passionate and shared love-making. Science becomes real when you practise it. The same is true for passionate love. Metaphysics is static. It is thinking aloud about made-up processes and objects that may or may not exist in the real world. Practising observation by way of Anschauung is real and it involves you. Anschauung is your own dialogue with Nature. You engage with real objects that affect you in much the same way you affect the object. To treat Nature as an idealistic concept is to dictate to it, to impose laws and characteristics that may or may not

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really exist. To interact with Nature through Anschauung is akin to having a conversation or a dialogue. Without that interaction, we become disconnected from Nature and from the objects we study. Conversing with Nature had changed Goethe from someone who finds truth in metaphysics to someone who finds experience in viewing Nature, hence Goethe's insistent that he was a *Naturschauer*. I believe this transformation happened in Goethe's Italian journey between 1786 and 1788. The transformation, or metamorphosis, from thinking about abstract concepts, such as the urpflanze, to experiencing the actual phenomenon, such as plant metamorphosis, was gradual. Goethe had to change *as a person* in order for the transformation to happen. Without that change, Goethe would not have become the person who wrote *Zur Farbenlehre* and Faust. Scientists are trapped in a culture in within which metaphysical concepts dismiss our own Anschauung and urphenomenon. This culture has led to technologies that once used to supplement our experience, which now replaces human observation entirely. Where do we find human experience in natural science today? Scientists need to accept their own Anschauung and urphenomenon as a valid and empirical scientific pursuit before they can tackle the Modern Hubris. Goethe's life and work are your guides to change, a way to find yourself, to practise Anschauung, to develop the urphenomenon and, most of all, to fight the Modern Hubris.

Recommended Reading

Translations of Goethe's scientific works

Metamorphosis of Plants [*Versuch die Metamorphose der Pflanzen zu erklären*]
von Goethe, J. W. (1995). *Goethe: The collected works* (Vol. 12). Princeton University Press. Scientific Studies.
The same translation can be found in:
Goethe, J. W. (2009). *The metamorphosis of plants.* MIT Press.

Theory of Colours [*Zur Farbenlehre*]
The polemic section:
Goethe, J. W., Duck, M. J., & Perry, M. (2016). *Goethe's exposure of Newton's theory: A polemic on Newton's theory of light and colour.* Imperial College Press.
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Goethe, J. W., & Judd, D. B. (2002) *Theory of colours* [reproduced from Goethe's theory of colours, translated by CL Eastlake]. MIT Press.
Unfortunately the historical section has never been translated into English.
On Morphology [*Zur Morphologie*]
von Goethe, J. W. (1995). *Goethe: The collected works* (Vol. 12). Princeton University Press. Scientific Studies.

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